# IMPACTS OF AGEING ON PUBLIC FINANCES AND LABOUR MARKETS IN EU REGIONS

**Smolenice, Slovakia,**
28th – 30th October 2013
**Marek Radvanský – Ivan Lichner (eds)**

eúsav Ekonomický ústav SAV
Institute of Economic Research SAS

OECD
BETTER POLICIES FOR BETTER LIVES

# IMPACTS OF AGEING ON PUBLIC FINANCES AND LABOUR MARKETS IN EU REGIONS

## *THEORETICAL MODELS AND EMPIRICAL ANALYSES*

**MAREK RADVANSKÝ AND IVAN LICHNER (EDS)**

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# Foreword

Dear colleagues,

It is almost full three years since our last international conference under the cooperation with the OECD took place in Smolenice. We are very excited and proud, that also in the present conference the OECD is our co-organising partner. This time we have decided to provide more time and space for additional discussions about one of the most crucial forthcoming governmental problems of next decades across all the European countries related to process of ageing. Lot of countries in Europe observed a decreasing total dependency ratio with the most favourable conditions to economic growth in last two decades. This trend has changed since the strongest post-war baby-boomer cohorts started to enter the retirement age. The old dependency ratio is growing steeply and the adopted policies are currently oriented to solve the current crucial short-term problems related to effects of the financial crisis. However, to tackle the problem of the ageing long-term measures will be needed to improve the sustainability of the social system.

There are two main mid-term issues related to the problem of anageing population. One, recently more visible in the fiscal field, is related to the effects of ageing on raising the public expenditures, pensions, health care and other social services covered by the social system. There are several measures currently being taken in this respect by the governments – introducing the two pillar pension systems, decreasing the pension replacement rate, increasing the age of retirement, etc... Finding an optimal policy mix to a sufficient and sustainable development is one of the main governmental challenges of these days.

Second, less visible but in mid-term even more crucial, is the effect of ageing at the national and European labour markets. Ageing of the labour force, uneven distribution of the education levels within the age groups, skill obsolescence, diminishing low skilled labour force, healthy ageing and increasing participation of the older on the labour market are some of the main issues that need to be assesed with relation to the sustainable development. Some countries are currently suffering (or will suffer within the current decade) the decrease of the total labour force and the total population.

Nowadays, an increasing number of countries are aware about this issue and are looking for a tailor made approach. The international scientific conference organized by the Institute of Economic Research, SAS and the OECD in Smolenice, Slovakia, on 28th - 30th October 2013: Impact of Ageing on Public Finances and Labour Markets in EU Regions, offers the academic grounds for the discussion of aforementioned issues from various perspectives and helps to find appropriate measures dealing with forthcoming challenges. Scholars and experts from various academic and research institutions from 7 European and 2 American countries will draw the attention on the future impact of ageing population on the labour markets, the international trade and the public finances.

We have put a lot of effort to prepare this international conference organized by the Institute of Economic Research... We want to thank Mr. Douglas Sutherland from the OECD and his colleagues for the assistance provided during the preparation phase. And our appreciation goes mainly to you, dear colleagues, because you are involved in the related research and you have made the contents of this conference richer by sending your papers. We hope that you also enjoy the venue, a romantic castle, which had been handed to the Slovak Academy of Sciences in 1953 and became a representative place for meetings of scientists from all over the world.

We would like to thank our friends and colleagues, who accepted our invitation and present their latest research findings and knowledge. We also would like to extend our appreciation to our colleagues Vladimir Kvetan from European Centre for the Development of Vocational Training – CEDEFOP in Thessaloniki, Greece; Ben Kriechel from the Economix Research and Consulting, Germany; Bernard Casey from the University of Warwick, England and Gerald Groshek from the University of Redlands, California for accepting our invitation. We also would like to thank our Slovak colleagues from the conference programme committee and the reviewers for nice cooperation.

Finally, we would like to express our deep acknowledgement and gratitude to the financial support of the Joint program of the Slovak Ministry of Foreign Affairs and the OECD and the Slovak Research and Development Agency - APVV for making this conference a reality.

We thank again all the participants of the conference and we hope to see you again at similar events.

Bratislava, October 2nd, 2013

Conference organisation committee

Marek Radvanský and Ivan Lichner,

*Paris, October 18th 2013*

*Dear colleagues,*

*It is a great honour to be invited to the international conference "Impacts of Ageing on Public Finances and Labour Market in EU Regions", which will be held on October 28th–30th at the Congress Centre of Slovak Academy of Sciences in Smolenice. I very much look forward to participating at this event, which is both important and timely following the Great Recession and now confronting increasingly the challenges posed by demographic change.*

*Across the OECD, the economic crisis that began in 2008 caused deficits to surge, and fiscal imbalances were swollen further by stimulus measures and bank rescue operations., leading to a ballooning public indebtedness. In many countries, arresting the rise in debt and returning debt stocks to sustainable levels will require large and durable improvements in budget balances. With the economic recovery weak and hesitant, growing out of the fiscal problems is unlikely to be a durable solution on its own, putting the onus on pursuing fiscal consolidation through spending cuts and revenue-raising measures. Pursuing sustained fiscal consolidation is not only needed to address the large fiscal deficits many countries have been running and meet the challenges posed by mounting pressures from ageing-related spending and providing health and long term care, but also to bring debt levels down to prudent levels.*

*The conference programme promises an excellent discussion of many aspects of the impacts of ageing on public finances and the labour market. I hope that we will be able to learn from these different perspectives to understand the interactions between ageing, public finances and labour markets better and form an overall appreciation of the challenges and opportunities for policy*

*Let me conclude by wishing you a successful conference.*

*Yours sincerely*

*Douglas Sutherland*

*OECD Economics Department*

# About IER SAS

The Institute of Economic Research is one of the institutes established right after the creation of the Slovak Academy of Sciences in 1953. During its existence for the last five decades, the Institute has been transformed several times in order to adjust its research activities to the challenges of the days. These adjustments in the research activities had an impact on the name of the Institute itself: The Institute existed under the following names: Institute of Economic Theory (January 1, 1991 to June 30, 1993) and Institute of Slovak and World Economy (January 1, 1998 to December 31, 2005).

In recent periods, the Institute has conducted economic research with the orientation on national economy and a focus on finding answers about the state, functioning, and directions of the Slovak economy. The research also includes utilization and development of the country's potential, finding ways and resources that minimize risks and threats of Slovakia's development during the completion of transformation process in the context of globalization and integration. The Institute's research integrates theory with empirical tools.

The Institute's current research activities address the following areas:

- Globalization, integration and adaptation processes in the world economy in general and in European economies in particular.
- Processes and policies affecting the social-economic development of Slovakia and its regions.
- Macroeconomic policies in relation to stability and macroeconomic growth in the national and regional context.
- Processes and policies that foster knowledge-based economy.
- Relationship between economic policy of the state and the development of the business sector.
- Economic processes with applications of mathematical economics and econometrics.

The main results of the Institute's research are shared with the professional bodies as well as the broader public through different forms of its editorial activities and offers relevant results to the government bodies.

The Institute also trains doctorate students in the field of specialization Economic Theory. The Institute is a member of the European Network of Economic Policy Research Institutes (ENEPRI).

**Research Groups and Their Heads**

- ***World Economy*** - prof. Ing. Peter Staněk, CSc.
- ***Macroeconomics and Knowledge Economy*** - Ing. Ivana Šikulová, PhD.
- ***Socio-Economic Development and Labour Market*** - Ing. Karol Morvay, PhD.
- ***Economic Modeling and Analyses*** - Ing. Marek Radvanský, PhD.
- ***Empirical Research*** - doc. Dr. Menbere Workie Tiruneh, PhD.

# About Smolenice

A Village Smolenice is situated under the south-east hill of Small Carpathians. It has approximately 3200 inhabitants and belong to the Trnava district.

***Photo: Štefan Kačena (www.slovakia.travel)***

This area was inhabited since the Stone Age. Around the 6th century BC the Celts built an oppidum above the village. Later there was a settlement from the Great Moravia period on the same place. Vast numbers of valuable findings such as stone axes, threshing-floors, pieces of ceramics, mill stones etc. date from this era.

The village was first mentioned in 1256 under name villa Solmus, though the settlement started to grow in the late Middle Ages. In the 14th century, the gothic Smolenice castle was built above the village, as a part of chain of the castle protecting passes in the Small Carpathians. In the beginning of the 16th century Smolenice became a little city surrounded by city walls with guarding towers bastions. The city had its coat of arms. Weekly markets and cattle fair took place in Smolenice since the 18th century.

The Smolenice castle was royal at first, but it kept changing its hands for several centuries, until the Pálffy family took it in the 18th century, when the castle was in decay. During the Napoleon Wars, it burned down, and only outer fortifications remained. In the beginning of the 20th century the owner of the Smolenice domain – Earl Jozef Pálffy has built this renewed chateau on the ruins of the former guard castle. He has also founded a wood processing factory near the village, which were replaced in 1968 with the chemical factory Chemolak.

Total reconstruction of the castle was finished after the Second World War. In 1945, the Castle became the property of the State; it was taken over by the Slovak National Council who decided to have their summer-house there. The castle was finished and furbished and handed over to the Slovak Academy of Sciences on 26 June 1953 to become a representative place for meetings of scientists from worldwide.

***Sights***

- The Smolenice Castle, now reconstructed as a château.
- Ruins of Celtic oppidum on the Molpír hill.
- The Driny limestone cave, the only public accessible cave in western Slovakia.
- Little Carpathians with many castle ruins, with the protected Hlboče valley, and the highest point of the Little Carpathians - Záruby (768 m)
- Grave of Štefan Banič, inventor of the military parachute during the 1st World War
- Museum Molpír with local historical and nature expositions.

# Conference programme

## *Monday, 28th October 2013*

| | | |
|---|---|---|
| 14:00 | 15:00 | ***REGISTRATION*** |
| 15:00 | 15:30 | ***INVITATION AND FOREWORD***<br><br>***Marek Radvanský, Ivan Lichner,*** *ORGANISING COMMITTEE*<br><br>***Branislav Ondruš,*** *STATE SECRETARY*<br>***MINISTRY OF LABOUR, SOCIAL AFFAIRS AND FAMILY OF THE SLOVAK REPUBLIC*** |
| 15:30 | 17:30 | ***PLENARY SESSION*** *CHAIRMAN: TOMÁŠ DOMONKOS*<br>*RAPPORTEUR: IVAN LICHNER* |
| | | FISCAL CONSOLIDATION AND THE IMPLICATIONS OF SOCIAL SPENDING FOR LONG-TERM FISCAL SUSTAINABILITY<br>***Douglas Sutherland, Rossana Merola***<br>***OECD, ECONOMICS DEPARTMENT, FRANCE*** |
| | | *SKILLS SUPPLY AND DEMAND IN EUROPE: MEDIUM-TERM FORECAST UP TO 2020*<br>***Vladimir Kvetan***<br>***CEDEFOP - EUROPEAN CENTRE FOR THE DEVELOPMENT OF VOCATIONAL TRAINING, GREECE*** |
| | | *REPLACEMENT DEMAND AND PERSONNEL PLANING ON THE SECTORAL LEVEL: CHALLENGES OF AN AGEING WORKFORCE*<br>***Ben Kriechel***<br>***ECONOMIX RESEARCH & CONSULTING, GERMANY*** |
| | | *EFFECTS OF DEMOGRAPHIC CHANGES ON HOSPITAL WORKFORCE IN EU COUNTRIES*<br>***Marek Radvanský, Gabriela Dováľová***<br>***INSTITUTE FOR ECONOMIC RESEARCH, SAS, SLOVAKIA*** |
| 17:30 | 18:00 | ***OPENNING TOAST*** |
| 19:00 | | ***WELCOME RECEPTION*** |

## *Tuesday, 29th October 2013*

| | | |
|---|---|---|
| 8:00 | 9:00 | ***BREAKFAST*** |
| 9:00 | 10:30 | ***SESSION A*** *CHAIRMAN: ROBERT MENKYNA*<br>*RAPPORTEUR: PETER HORVÁT* |
| | | *DEMAND SIDE COST-SHARING AND PRESCRIPTION DRUGS UTILIZATION: EVIDENCE FROM A QUASI-NEUTRAL EXPERIMENT*<br>***Eva Hromádková, Michal Zděnek***<br>***CERGE-EI, CZECH REPUBLIC*** |
| | | *THE EFFECT OF CHILD SUPPORT POLICY ON FERTILITY, MARITAL TURNOVER DECISIONS IN THE CZECH REPUBLIC*<br>***Robert Menkyna, Fusako Tsuchimoto Menkyna, Byeongju Jeong***<br>***CERGE-EI, CZECH REPUBLIC AND OECD, FRANCE*** |
| | | *LIFETIME EARNINGS AND LIFE EXPECTANCY*<br>***Radoslav Peter, Martin Šuster***<br>***NATIONAL BANK OF SLOVAKIA, SLOVAKIA*** |

| | | |
|---|---|---|
| 9:00 | 10:30 | ***SESSION B*** CHAIRMAN: *BRITTA STÖVER*<br>*RAPPORTEUR: FILIP OSTRIHOŇ* |
| | | *THE POWER OF ELDERLY CUSTOMERS – HOW DEMOGRAPHIC CHANGE AFFECTS THE ECONOMY THROUGH PRIVATE HOUSEHOLD DEMAND IN GEMRANY*<br>***Britta Stöver***<br>***INSTITUTE OF ECONOMIC STRUCTURES RESEARCH, GERMANY*** |
| | | *AGEING OF LABOUR FORCE IN THE AGRICULTURAL SECTOR IN THE CZECH REPUBLIC*<br>***Marta Gryčová***<br>***CZECH UNIVERSITY OF LIFE SCIENCES IN PRAGUE, CZECH REPUBLIC*** |
| | | *UNEMPLOYMENT AND PUBLIC FINANCES DEVELOPMENT IN THE SLOVAK REPUBLIC AND ITS COMPARISON WITH THE CZECH REPUBLIC*<br>***Vlasta Feješová***<br>***UNIVERSITY OF ECONOMICS, PRAGUE, CZECH REPUBLIC*** |
| 10:30 | 11:00 | ***COFFEE BREAK*** |
| 11:00 | 12:30 | ***SESSION C*** CHAIRMAN: *IVAN LICHNER*<br>*RAPPORTEUR: KRISTÍNA PETRÍKOVÁ* |
| | | *HOW TO REDUCE PENSION SYSTEM DEFICITS OF PAYG PILLAR OF SLOVAK PENSION SYSTEM?*<br>***Ivan Lichner***<br>***INSTITUTE FOR ECONOMIC RESEARCH, SAS, SLOVAKIA*** |
| | | *THE OPTIMAL DECISION STRATEGY IN THE SECOND PILLAR OF THE SLOVAK PENSION SYSTEM*<br>***Zuzana Múčka***<br>***COUNCIL FOR BUDGET RESPONSIBILITY, SLOVAKIA AND FACULTY OF MATHEMATICS, PHYSICS AND INFORMATICS, COMENIUS UNIVERSITY, BRATISLAVA, SLOVAKIA*** |
| | | *HOUSEHOLD SAVINGS FORECAST AND ITS IMPLEMENTATION TO MODELLING OF SLOVAK ECONOMY*<br>***Kristína Petríková***<br>***INSTITUTE FOR ECONOMIC RESEARCH, SAS, SLOVAKIA*** |
| 11:00 | 12:30 | ***SESSION D*** *CHAIRMAN: MIROSLAV ŠTEFÁNIK*<br>*RAPPORTEUR: MIROSLAVA JÁNOŠOVÁ* |
| | | *OCCUPATIONAL MOBILITY IN THE AGEING SOCIETY. CHANGING OCCUPATION IN THE CZECH AND SLOVAK LABOUR MARKETS IN 2003-2012*<br>***Hana Říhová, Tereza Vavřinová***<br>***NATIONAL OBSERVATORY OF EMPLOYMENT AND TRAINING, NATIONAL TRAINING FUND, CZECH REPUBLIC*** |
| | | *ANALYZING THE INCOME DISTRIBUTION OF THE HOUSEHOLDS' IN SLOVAKIA (EMPIRICAL EVIDENCE)*<br>***Tomáš Domonkos, Miroslava Janošová,Filip Ostrihoň***<br>***INSTITUTE FOR ECONOMIC RESEARCH, SAS, SLOVAKIA*** |
| | | *PROJECTING ECONOMIC ACTIVITY WITH RESPECT TO EXPECTED SHIFTS IN RETIREMENT AGE (CASE OF SLOVAKIA)*<br>***Miroslav Štefánik, Peter Horvát***<br>***INSTITUTE FOR ECONOMIC RESEARCH, SAS, SLOVAKIA*** |
| 12:30 | 14:00 | ***LUNCH*** |
| 14:00 | 16:00 | ***SESSION E*** *CHAIRMAN: ANKE MÖNNING*<br>*RAPPORTEUR: IVAN LICHNER* |
| | | *MORE FEMALE AND OLDER WORKERS ARE NOT ENOUGH: THE ROLE OF HOURS WORKED TO COMPENSATE FOR A DECLINING LABOR SUPPLY IN GERMANY*<br>***Susanne Wanger, Brigitte Weber, Johann Fuchs***<br>***INSTITUTE FOR EMPLOYMENT RESEARCH, GERMANY*** |
| | | *IMPACT OF AGEING ON CONSUMPTION AND LABOR DEMAND (EMPIRICAL EVIDENCE FROM THE SLOVAK REPUBLIC)*<br>***Tomáš Domonkos, Ivan Lichner***<br>***INSTITUTE FOR ECONOMIC RESEARCH, SAS, SLOVAKIA*** |

| | | | |
|---|---|---|---|
| | | *Labour Market Mismatch and Skill Requirements How Strong is the Trade Influence?*<br>***Anke Mönning, Gerd Zika, Tobias Maier***<br>***Institute of Economic Structures Research, Germany and Federal Institute for Vocational Education and Training*** | |
| | | *Dynamic model for the analysis of productive environments in a pseudo crisis phase: The case of demographic ageing*<br>***Ricardo Tomás Ferreyra, Alberto José Figueras***<br>***Facultad de Ciencias Económicas, Universidad Nacional de Córdoba, Argentina*** | |
| 16:00 | 16:30 | ***Coffee break*** | |
| 16:30 | 18:00 | ***Discussion Forum*** | Chairman: *Vladimír Kvetan*<br>*Rapporteur:Peter Horvát* |
| 18:30 | | ***Gala dinner*** | |

## *Wednesday, 30th October 2013*

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| 8:00 | 9:00 | **Breakfast** | |
| 9:00 | 10:15 | ***Plenary Session B*** | *Chairman: Bernard casey*<br>*Rapporteur: Kristína petríková* |
| | | *From pension funds to piggy banks: perverse consequences of the Stability and Growth Pact since the crisis*<br>***Bernard Casey***<br>***Institute for Employment Research - University of Warwick, UK*** | |
| | | *Age and the Structure of International Trade in the EU Regions*<br>***Gerald Groshek***<br>***School of Business, University of Redlands, California, USA*** | |
| 10:15 | 10:45 | ***Coffee break*** | |
| 10:45 | 12:00 | ***Closing Session*** | *Chairman: Viliam Páleník*<br>*Rapporteur: Filip Ostrihoň* |
| | | *The impact of demographic change on industry and the role of regional, national and European industrial policy in tackling imbalanced age pyramids*<br>***Viliam Páleník***<br>***European Economic and Social Committee, Belgium and Institute for Economic Research, SAS, Slovakia*** | |
| | | *Future Changes in Age and Household Patterns: Some Implications for Public Finances*<br>***Prof. Svend E. Hougaard Jensen, Rasmus Højbjerg Jacobsen***<br>***Department of Economics, Copenhagen Business School, denmark*** | |
| | | ***Closing Words – End of Conference*** | |
| 12:30 | | ***Lunch*** | |

**Chair:** The role of the Chair is to coordinate and ensure the smooth running of the session.
**Reporteur:** The role of the Rapporteur is to take notes to the discussion.

# Fiscal consolidation and the implications of social spending for long-term fiscal sustainability

*Rossana MEROLA and Douglas SUTHERLAND* [1]

***Abstract:*** During the economic and financial crisis, fiscal positions across the OECD countries deteriorated sharply. Additional challenges to the sustainability of fiscal balances are posed by ageing population and trends in social spending. Given the scale of the problem, the analysis of fiscal consolidation needs to take into account projected trends in social spending. This paper sheds light on the scale of fiscal consolidation that will be needed to ensure long-term sustainability and on the potential benefits of institutional reforms in mitigating budget pressures of social spending.

Based on alternative scenarios, results suggest that in several OECD countries, the fiscal challenges are exacerbated in the long-term by spending pressures related to health and pensions. Therefore, reforms to entitlement programmes need to be an important part of any longer-term sustainability strategy. In particular, reforms of pension and health systems can mitigate budget pressures resulting from ageing populations and hence contribute to fiscal consolidation. Institutional reforms may hence support long-term fiscal sustainability and, at the same time, reduce adverse short-term effects of fiscal consolidation on growth.

***Keywords****:* Fiscal consolidation; long-term public finance sustainability; public social expenditure; long-term projections; ageing populations

***JEL classification codes:*** E62; H50; H68; J11

## 1. Introduction

Demographic developments over the future decades, due to low fertility rates, continuous increases in life expectancy and the retirement of baby-boom generation, will induce a substantial "greying" of the population in OECD countries. Moreover, trends in social spending pose additional challenges to sustainability of fiscal balances. Health, long-term care and pensions will drive up public spending in almost all OECD countries over the horizon 2010-2050. With population ageing and projections of increasing pension and health spending, fiscal consolidation becomes more urgent in order to mitigate the economic and budgetary consequences of age-related spending.

These developments, combined with a post-crisis growth slowdown, would put increasing pressure on fiscal sustainability. During the economic and financial crisis, fiscal positions across the OECD countries have deteriorated sharply. In most countries, budget deficits soared as a result of the economic slump and the policy response to the crisis, namely the stimulus packages and support for troubled financial institutions. Current fiscal positions became unsustainable in most countries with underlying balances often very weak and debt rising rapidly.

The fiscal implications of ageing population have been widely discussed (e.g. Dang et al., 2001; Andersen, 2008; Fehr et al., 2008; Auerbach, 2012). One angle that is unappreciated in the literature is the interaction between increasing spending on health and pensions, the post-crisis

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growth slowdown and ongoing fiscal rebalancing efforts. This paper contributes to the existing literature by analyzing the interaction of these factors.

The aim of this paper is twofold. First, it assesses the scale of fiscal consolidation across the OECD countries needed to ensure long-term sustainability by 2050. The analysis emphasizes the implications of ageing populations and other spending pressures on public budgets. Second, it assesses to what extent institutional reforms can mitigate these budget pressures and hence contribute to fiscal consolidation. The paper focuses on the role of institutions in reducing the debt burden by reforming health and pension system.

Simulation results are summarized in the so-called fiscal gap indicators, as initially proposed by Blanchard (1993) and Auerbach (1994), to provide a simple metric for how much consolidation is needed under a series of different scenarios.[2] For this purpose, long-term simulations are run based on a simple country-specific model set-up built on the medium-term baseline projections presented in the Economic Outlook (OECD, 2011a). Several scenarios have been modelled, so to recognize the upward risks to the baseline projection posed by the uncertainty surrounding long-term projections. In order to isolate the effect of pension and health spending pressures, in the baseline scenario these expenditure items are assumed to remain a constant share of GDP. In a second set of scenarios, pension spending and health spending are phased in one by one, according to the projections provided by the European Commission, the OECD and the U.S. CBO. Finally, the last two scenarios simulate the potential benefits of institutional setting promoting reforms in the pension system or featuring higher efficiency in health spending.

This paper relates to the European Commission's Sustainability Report, but it complements the analysis in three dimensions. First, it provides a common framework for both European and non-European countries. Second, a more complete set of scenarios examines institutional arrangements that might support fiscal consolidation. Third, the model framework presents some extensions that help describing more realistically some economic features. In particular, the model is based on an explicit modelling framework for interest rates, which play an important role for the debt dynamics. The model in this paper assumes that there is a link between debt level and interest rates, which operates through the risk premium: the decrease in government debt burden diminishes the risk premium associated with public debt issuance, contributes to reduce real interest rates on the existing debt and finally feeds-back in lower debt. This mechanism provides further support to fiscal consolidation, which is lacking in the European Commission's analysis.

The paper states four main results. First, large differences in fiscal consolidation needs arise across OECD countries largely due to differences in underlying deficits at the starting point and to some extent the level of initial debt. Second, the various scenarios suggest that in several OECD countries, the fiscal challenges are exacerbated in the long term by spending pressures related to pension, health care and long-term care. Third, against this backdrop, institutional reforms of the pension system can contribute to fiscal consolidation. For example, increasing the retirement age can boost labour utilisation, while at the same time mitigating the budget pressures resulting from ageing populations. Fourth, moving to best practice in public sector institutions, by improving the provision of health services, can enhance efficiency and reduce spending pressures.

The paper is organised as follows. Section 2 describes the model and the baseline assumptions underlying the long-run projections and then presents the methodology for computing the fiscal gaps. Section 3 presents simulations assessing the implications for fiscal sustainability of pension and health spending. Section 4 presents simulations gauging the effects of institutional reforms. Section 5 summarises the main conclusions.

[2] For a discussion on alternative measures proposed in the empirical literature to gauge sustainability in the face of ageing, see Langenus (2006).

# *2. Model description*

## 2.1. Basic structure and data

The empirical literature has proposed two main approaches to assess fiscal sustainability, as described in Langenus (2006). A first approach assess fiscal sustainability by testing the cointegration between government revenues and expenditure (e.g. Claeys, 2007; Afonso and Rault, 2010), or by testing for a positive relationship between the primary surplus and the initial public debt ratio (e.g. Bohn, 2005 and Marinheiro, 2005). A second approach incorporates the future values of the determinant of debt and develops measures of the fiscal adjustment needed to restore sustainability. Within this approach, models have developed in three directions: generational accounting, DSGE models with overlapping generations and macroeconometric models. On the one hand, the first two methodologies have received large attention as they allow to link sustainability with intergenerational fairness considerations. On the other hand, macroeconometric models remain largely used especially in institutions – in spite of the critic of not being robust to changes in policy regime – due their ability to transform complex simulation results into synthetic indicators which can be easily interpreted. Moreover, macroeconometric models easily allow phasing in developments in population structure, due to migration and changes in fertility and longevity.

The analysis in this paper is based on a macroeconometric model.[3] A simple country-specific model set-up is built based on the medium-term baseline projections presented in the *Economic Outlook* (OECD, 2011*a*), which go up to 2025.[4] The advantage of using the medium-term baseline is that it provides a path for output to return to potential and a normalisation of interest rates in the long-run.

The basic structure of the model consists of four blocks: (i) the supply-side block; (ii) the government social spending block; (iii) the government fiscal balance block and (iv) the interest rates block.

Concerning the supply-side block, historically, cross country gaps in productivity have accounted for the bulk of cross-country differences in GDP per capita (e.g. Easterly and Levine, 2001; Duval and de la Maisonneuve, 2010). However, in the long-run, all countries converge at the worldwide rate of productivity, with some catch-up allowed for initially low-productivity countries. The Economic Outlook's medium-term baseline has labour productivity growth slowly converging from 2015 to 2025, ending up ranging from 1.4 in Denmark to 2.4 in the Slovak Republic. Between 2025 and 2035 labour productivity converges to 1.75% for all countries. Although in the long-run all countries converge at the worldwide rate of productivity, cross-country GDP gaps remain, mainly reflecting differences in labour force growth, which encompasses differences in human capital and population. Hence, we assume that GDP evolves according to:

$$GDP_t = GDP_{t-1}\left(1 + \frac{PROD_t}{100} LFG_t INFL_t\right) \quad (1)$$

where $\mathrm{PROD_t}$ is the labour productivity growth and $\mathrm{INFL_t}$ is the inflation rate, which in the long-run converges to the monetary authorities' target, typically 2% annually. Labour force growth ($\mathrm{LFG_t}$) encompasses developments in human capital, namely labour force participation rates and employment rates. Accordingly, labour force growth can be decomposed into developments in the underlying demographics (e.g. working age population), labour force participation and employment:

$$LFG_t = 1 + dlog\frac{LFPR_t}{100} ER_t WP_t \quad (2)$$

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3. The analysis is not based on any intergenerational equity criterion, and therefore differs also from the generational approach adopted in other works (e.g. Langenus, 2006; Balassone et al., 2009).

4. Due to lack of data, Chile, Estonia, Mexico, Israel, Slovenia and Turkey are not included in this analysis. Data for pension spending are not available for Iceland.

where $\mathrm{LFPR_t}$ is labour force participation rate and $\mathrm{ER_t}$ is the employment rate. Labour force participation rates and employment rates are taken from the Economic Outlook's medium-term baseline till 2025. From 2025 onwards, participation rates and employment rates are assumed to remain constant. Finally, the third component of labour force growth is the working age population ($\mathrm{WP_t}$), which evolves consistently with population cohort developments.[5] The data on population developments are taken from the United Nations population cohort- based projections (2008 revisions), assuming that migration continues at past rates. As retirement age is set at 65 years old, the working age population is defined as population between 25 and 64 years old.

Concerning government spending, the model set-up explicitly considers additional pressures on budgets arising from ageing-related spending. Spending paths for pensions, health and long-term care are derived from OECD, EU and national sources and are reported in Table 1. Long-term projections suggest that, in the absence of policy action, the average change in health spending by 2050 is 2.2% of GDP. These projected trends in public health are likely to be a source of concern for most OECD governments. Pension spending is expected to go on growing in 24 out of 26 OECD countries where data are available. On average, albeit with considerable variation across individual countries, pension expenditure is projected to grow by 2.8% of GDP over the horizon 2010-2050. While health spending increases do not vary much across the OECD countries, forecasts on pension spending are much more heterogeneous: the estimated increase in pension spending ranges between negative values in Poland and Sweden and values above 12% of GDP in Luxembourg and Greece (before recent reforms), followed by Spain, Korea and Ireland.

The data for the pension spending projections for the EU countries are taken from the European Commission's Sustainability Report 2009; the data for other countries are mainly taken from Pensions at a Glance (OECD, 2011b), while the figures for the United States come from CBO (2010). These data provide spending paths for the baseline projections and can be altered to assess effects of reforms since the estimates were done. In the model set-up, the path of pension spending (Pens) over the horizon 2012-2050 is phased in so that the profile of spending follows the profile of changes in pension spending and in the old-age dependency ratio:

$$Pens_t = Pens_{t-1}\left(\frac{GDP_t}{GDP_{t-1}}\right) + \left(\frac{OADR_t - OADR_{2012}}{OADR_t - OADR_{2050}}\right)\ (1 + \Delta Pens)GDP_t \qquad (3)$$

where OADR is the old age dependency ratio and $\Delta\mathrm{Pens}$ is the change in pension spending over the horizon 2012-2050 according to the European Commission and OECD projections. Equation (3) states that pension spending is driven by two factors. The first factor is the path of current GDP and projected increases in pension spending. The second factor is the evolution of demographics over the horizon 2012-2050. Old age dependency ratios reported in Table 1 prove that over the horizon 2012-2050 many OECD countries will experience a substantial "greying" of the working age population.

For health and long-term care spending, given that only a portion of the projected increase is ageing related, the change in spending is phased in linearly (as a per cent of GDP) over the projection horizon to meet projections for spending as a share of GDP in both 2025 and 2050.

Various assumptions about pension, health and long-term care spending can be used to examine the sensitivity of fiscal positions to such spending pressures. In order to isolate the effect of these spending pressures, in the baseline scenario spending on pensions, health and long-term care are assumed to remain a constant share of GDP. In addition, alternative scenarios show the effect of rising pensions and health spending.

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5. The cohort approach consists in calculating cohort-specific entry and exit rates into or out of the labour force by tracking the participation rates of a given cohort over the time. For more details, see Burniaux et al., 2004.

We assume that from 2025 onwards, both revenues and spending on education and other generic items will grow in line with GDP[6], with the automatic stabilisers operating while the economy moves back to potential. Total spending is the sum of spending on pensions, health, education and other generic non age-related items.

Net government debt ($\mathrm{Debt}_t^{\mathrm{net}}$) evolves according to:

$$\frac{Debt_t^{net}}{GDP_t} = \frac{Debt_{t-1}^{net}}{GDP_{t-1}} + \left(\frac{Exp_t}{GDP_t} - \frac{Rev_t}{GDP_t}\right) + (1 + R_t)\frac{Debt_{t-1}^{net}}{GDP_{t-1}} \quad (4)$$

where $\frac{\mathrm{Exp_t}}{\mathrm{GDP_t}}$ and $\frac{\mathrm{Rev_t}}{\mathrm{GDP_t}}$ are respectively total expenditure and total revenues as ratio of GDP, and their difference determines the primary deficit-to-GDP ratio $\frac{\mathrm{Exp_t}}{\mathrm{GDP_t}} - \frac{\mathrm{Rev_t}}{\mathrm{GDP_t}}$. The last term on the right-hand side represents interest payments on the outstanding debt. Equation (4) implies that the primary deficit finances new debt net of interest payments on the outstanding debt.

Gross debt ($\mathrm{Debt_t}$) is determined by adding financial assets to the net debt:

$$\frac{\mathrm{Debt_t}}{GDP_t} = \frac{\mathrm{Debt_t^{net}}}{GDP_t} + \mathrm{FA_t} \quad (5)$$

where $\mathrm{FA_t}$ are financial assets.

An important feature of this model is that the interest rate is endogenous. The implicit interest rate paid on the previous period's debt displays a certain degree of inertia and for the rest adjusts gradually to a weighted average of the short-term interest rate and the long-term interest rate (Johansson et al., 2013):

$$R_t = 0.9R_{t-1} + 0.1(0.75R_t^L + 0.25R_t^S) \quad (6)$$

where $\mathrm{R_t^S}$ is the short-term interest rate and $\mathrm{R_t^L}$ is the long-term interest rate.[7]

We assume that rising debt levels increases government debt exposure to higher interest rates. Therefore, in this set-up the long-term rate includes a premium over the risk-free interest rate of 4 basis points for each percentage point of debt in excess of 75% of GDP[8] (Laubach, 2003 and Égert, 2010):

$$R_t^L = R_t^{RF} + 0.04\left(\frac{Debt_t}{GDP_t} - 0.75\right) \quad (7)$$

where $\mathrm{R_t^{RF}}$ is the risk-free interest rate. The short-term interest rate and the risk-free interest rate are taken from the Economic Outlook's medium-term baseline till 2025. Equation (7) implies that debt overhang increases the perception of default risk, because it calls into question whether debt will be fully re-paid in the future. High levels of debt can finally lead to speculative attack on

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6. Assuming that social spending are evolving proportionally to GDP implies that expenditure to produce a given level of services evolve proportionally to the general income level in the economy. This assumption may be interpreted as a public service constraint, namely that the provision of service should respect unchanged standards. For a further discussion, see Andersen (2008).
The assumption that revenues evolves proportionally to GDP implies that most of government revenues are financed by taxes on labour and capital income, and on consumption, which increase with national income.

7. The choice of these ad-hoc weights for the short-term and long-term interest rates reflects rolling over debt and thus its maturity structure. This represents a convenient assumption that seems to capture implicit interest rate movements for most countries at most time (see also Johansson et al., 2013). The speed of this adjustment depends on the share of outstanding debt that is refinanced annually, which is assumed to gradually evolve to a common share of 10% across countries. The interest rate inertia parameter set equal to 0.9 is quite standard in the literature.

8. Japan is assumed to remain unusual, with the very high share of domestic financing keeping the risk premium at only 1 basis point for each percentage point of debt in excess of 75% of GDP.

sovereign debt markets. Some literature (Corsetti and Dedola, 2011; Favero and Missale, 2011; Greenlaw, Hamilton, Hooper and Minskin, 2013) has pointed out that an increase in the perception of default risk induces investors to demand a higher yield, which in turn makes the default more likely.

While there is a link between interest rates and high debt levels, the model does not include a link between high debt levels and GDP growth. Fiscal policy has consequences for output growth. Policy adjustments to restore sustainability can take a variety of forms, which affect decisions on labour and capital supply. In addition, given the choice of a particular policy instrument, different timing options are available. However, to keep the model set-up tractable, we do not distinguish between policy instruments nor assess their potential feedback on output. In this light, the simulations give an indication of the scale of the problem, but not the potential short-run trade-offs in undertaking fiscal consolidation.

## 2.2. Methodology: long-run projections and fiscal gaps

Consider a model of n equations in which $f = [f_{1,\dots,}f_n]'$ is a vector function of n endogenous variables $y_{t=}\ [y_{1,t,}\ \dots, y_{n,t}]$. The model does not involve variables with leads and can be described as:

$$f(y_{t-1,}y_{t,}x_t\ ) = \begin{bmatrix} f_1\ (y_{t-1,}y_{t,}x_t\ ) \\ \vdots \\ f_n\ (y_{t-1,}y_{t,}x_t\ ) \end{bmatrix} = 0$$

where $y_t$ is a vector of all the endogenous variables, $y_{t-1}$ indicates the vector of lags of endogenous variables and $x_t$ is a vector of all exogenous variables. Therefore, the equations from all periods across which the model is solved must be treated as a dynamic, or time-dependent, simultaneous system.

The model is solved by running a deterministic simulation.[9] Despite the attention gained by stochastic model literature, deterministic simulations are often used to describe the reaction to a policy change or to a shock until the system returns to the old or to a new equilibrium. For this reason, deterministic simulations are well suited to study the transition path to a new equilibrium that meets a given debt target. The model is solved iteratively applying the Gauss-Seidel method which implies that only values of the endogenous variables from before the solution sample are used when forming the forecast.

When solving the model, initial and final values have to be set. Simulations start from 2012 and run until 2050[10], implying that the tightening is from 2013 onwards. As some governments are already undertaking fiscal consolidation measures, the starting point already embodies expected fiscal tightening.[11] Starting points are reported in Table 2. The final values are set so that the debt-to-GDP ratio will meet a given target (i.e. 50% of GDP) by 2050.

The long-run projections are used to determine so-called fiscal gaps (Blanchard, 1993 and Auerbach, 1994). The fiscal gap shows the improvement in the underlying primary balance that is

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9. The robustness of results is checked by running also a set of stochastic simulations. Stochastic simulations offer an alternative way to the scenario approach of dealing with uncertainty surrounding the long-term projections. Results are omitted for the sake of space. For details, we refer the reader to Merola and Sutherland (2012).

10. Simulations are run using E-views version 7.2.

11. In some cases this tightening is substantial. Between the trough (measured by the underlying primary balance) following the onset of the crisis in 2007 and the projected value for 2012, five countries are expected to tighten by more than 5% of GDP (Spain, Greece, Ireland and Portugal), with Greece having a projected underlying primary surplus of 3.5% of GDP in 2012 as compared to a deficit of 8.9% of GDP in 2009.

required to ensure that debt meets a target at a certain point in time.[12] The fiscal gaps reported in this paper ensure that gross debt is 50% of GDP in 2050. This is intended to be illustrative and not normative.

**Table 1. Ageing, pension and health care spending assumptions**

| | Old age dependency ratio | | Change in pension spending (% GDP) | Change in health and long-term spending (% of GDP) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Health | | | | | |
| | | | | Cost containment scenario | | Cost pressure scenario | | Long-Term Care (cost pressure) | |
| | 2012 | 2050 | 2010-2050 | 2005-2025 | 2026-2050 | 2005-2025 | 2026-2050 | 2005-2025 | 2026-2050 |
| Australia | 0.2 | 0.4 | 1.6 | 1.5 | 0.8 | 1.8 | 2.4 | 0.5 | 1.5 |
| Austria | 0.3 | 0.6 | 1.3 | 1.2 | 0.8 | 1.5 | 2.3 | 0.6 | 1.4 |
| Belgium | 0.3 | 0.5 | 4.4 | 1.0 | 0.5 | 1.3 | 2.0 | 0.6 | 1.3 |
| Canada | 0.2 | 0.5 | 5.8 | 1.6 | 0.6 | 1.9 | 2.2 | 0.6 | 1.5 |
| Czech Republic | 0.2 | 0.5 | 3.1 | 1.3 | 1.0 | 1.7 | 2.4 | 0.7 | 1.0 |
| Denmark | 0.3 | 0.4 | 0.2 | 1.1 | 0.6 | 1.5 | 2.0 | 0.4 | 1.1 |
| Finland | 0.3 | 0.5 | 2.6 | 1.5 | 0.3 | 1.8 | 1.8 | 0.8 | 1.6 |
| France | 0.3 | 0.5 | 0.7 | 1.1 | 0.6 | 1.5 | 2.0 | 0.4 | 1.3 |
| Germany | 0.3 | 0.6 | 2.1 | 1.2 | 0.6 | 1.5 | 2.1 | 0.8 | 1.1 |
| Greece | 0.3 | 0.6 | 0.0 (12.5 before recent reforms) | 1.3 | 0.7 | 1.6 | 2.3 | 1.3 | 1.4 |
| Hungary | 0.3 | 0.5 | 1.9 | 1.2 | 0.6 | 1.5 | 2.1 | 0.8 | 1.3 |
| Ireland | 0.2 | 0.5 | 5.0 | 1.3 | 0.9 | 1.6 | 2.4 | 1.5 | 2.3 |
| Italy | 0.4 | 0.7 | 0.7 | 1.2 | 0.7 | 1.6 | 2.2 | 1.3 | 1.6 |
| Japan | 0.4 | 0.9 | 0.6 | 1.6 | 0.9 | 1.9 | 2.4 | 1.1 | 1.1 |
| Korea | 0.2 | 0.7 | 8.0 | 1.8 | 1.2 | 2.1 | 2.8 | 1.1 | 2.7 |
| Luxembourg | 0.2 | 0.4 | 13.5 | 1.0 | 0.9 | 1.4 | 2.3 | 1.3 | 1.8 |
| Netherlands | 0.3 | 0.5 | 3.8 | 1.4 | 0.6 | 1.7 | 2.1 | 0.7 | 1.3 |
| New Zealand | 0.2 | 0.4 | 8.0 | 1.5 | 0.8 | 1.8 | 2.4 | 0.6 | 1.4 |
| Poland | 0.2 | 0.6 | -1.6 | 1.5 | 0.8 | 1.8 | 2.3 | 1.1 | 2.1 |
| Portugal | 0.3 | 0.6 | 1.4 | 1.3 | 1.1 | 1.6 | 2.6 | 0.6 | 1.4 |
| Slovak Republic | 0.2 | 0.5 | 2.8 | 1.5 | 1.3 | 1.9 | 2.7 | 0.7 | 1.6 |
| Spain | 0.3 | 0.7 | 3.1 (6.6 before recent reforms) | 1.3 | 1.0 | 1.6 | 2.5 | 1.1 | 1.3 |
| Sweden | 0.3 | 0.5 | -0.6 | 1.1 | 0.3 | 1.4 | 1.8 | 0.3 | 0.8 |
| Switzerland | 0.3 | 0.5 | 2.8 | 1.3 | 0.3 | 1.6 | 1.9 | 0.4 | 1.0 |
| United Kingdom | 0.3 | 0.4 | 1.4 | 1.1 | 0.6 | 1.4 | 2.2 | 0.6 | 1.3 |
| United States | 0.2 | 0.4 | 1.4 | 1.2 | 0.4 | 1.5 | 1.9 | 0.4 | 1.3 |
| Average | | | 2.8 | 1.3 | 0.7 | 1.6 | 2.2 | 0.8 | 1.4 |

**Source:** United Nations 2008 revision, OECD (2011), CBO (2010), European Commission (2009b) and OECD estimates of 2010 pension reforms for Greece and Spain.

***Note:*** For Australia, Canada, Japan, Korea, New Zealand and the United States, the horizon is 2000-50.

12. The fiscal gap is related to a number of recent sustainability exercises, primarily the European Commission's Sustainability Report (2009a). The European Commission calculates two sustainability indicators based upon the projected ageing costs and the requirement of a 60% of GDP debt ratio by 2050.

**Table 2. Starting points for fiscal policy, average growth and interest rates**

| | Starting point, 2012 | | Average over simulation | |
|---|---|---|---|---|
| | Gross debt, %GDP | Underlying primary balance % GDP | Effective interest rate | Nominal GDP growth |
| Australia | 31 | 0.6 | 6.9 | 4.8 |
| Austria | 82 | 0.1 | 4.4 | 3.5 |
| Belgium | 100 | 0.9 | 4.7 | 3.8 |
| Canada | 88 | -1.8 | 4.9 | 4.2 |
| Czech Republic | 51 | 0.3 | 4.4 | 4.2 |
| Denmark | 60 | 0.8 | 5.0 | 3.5 |
| Finland | 66 | 0.8 | 4.2 | 3.9 |
| France | 100 | -0.6 | 4.1 | 3.6 |
| Germany | 87 | 0.6 | 4.3 | 3.0 |
| Greece | 159 | 3.5 | 5.5 | 3.4 |
| Hungary | 81 | 1.1 | 5.8 | 3.2 |
| Ireland | 126 | -0.4 | 4.7 | 4.3 |
| Italy | 128 | 3.3 | 4.6 | 3.1 |
| Japan | 219 | -4.2 | 3.0 | 2.2 |
| Korea | 33 | 0.5 | 4.9 | 3.2 |
| Luxembourg | 24 | 2.0 | 4.5 | 4.9 |
| Netherlands | 75 | 0.0 | 4.3 | 3.5 |
| New Zealand | 52 | -4.0 | 4.9 | 3.2 |
| Poland | 66 | -1.5 | 5.3 | 3.2 |
| Portugal | 116 | 3.5 | 4.6 | 3.1 |
| Slovak Republic | 51 | -1.7 | 5.1 | 2.8 |
| Spain | 75 | 0.5 | 4.2 | 3.5 |
| Sweden | 41 | 2.6 | 4.7 | 4.0 |
| Switzerland | 37 | 1.2 | 2.9 | 2.9 |
| United Kingdom | 93 | -3.0 | 4.6 | 4.1 |
| United States | 107 | -5.8 | 4.6 | 4.3 |

# *3. Results*

## 3.1. The baseline scenario

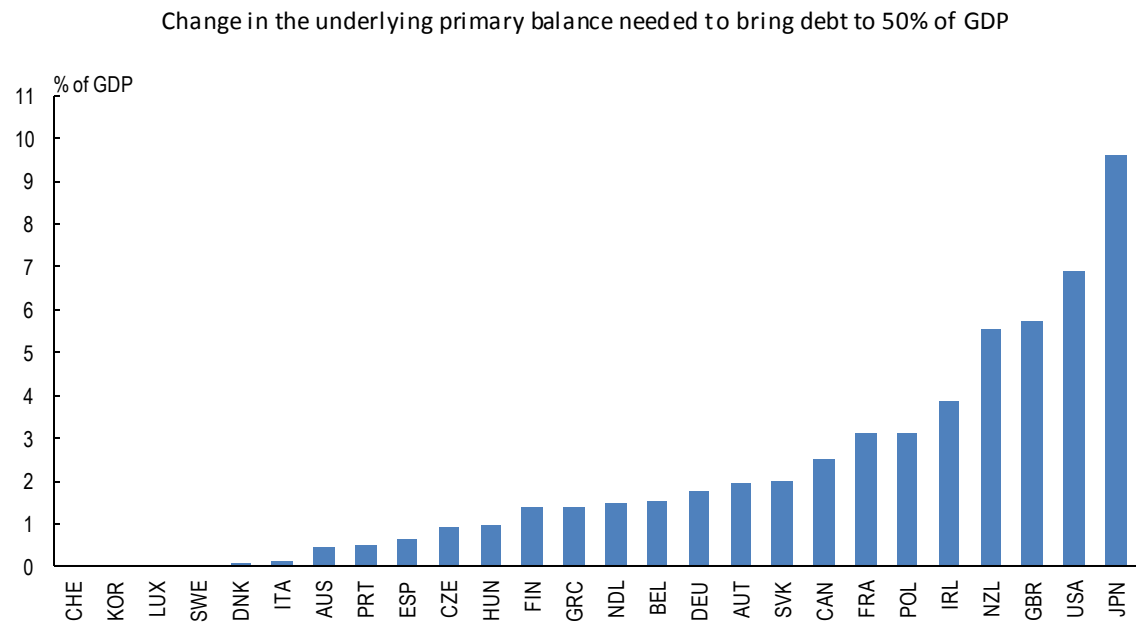
In the baseline scenario, pension and health spending grow in line with GDP over the horizon 2012-2050 and the retirement age is set at 65 years. Up to 2025, the projections for output and interest rates are based on the OECD's medium-term baseline projections. Public revenues and primary expenditure are assumed to grow in line with GDP.

The fiscal gap calculations show the size of fiscal consolidation requirements necessary to achieve the 50% of GDP debt target by 2050. The baseline simulations show the tightening of the primary balance in 2012 needed to reach this target. Considerable differences across countries emerge (Figure 1). Countries differ mainly because of large differences in underlying deficits at the starting point and to some extent the level of initial debt. A number of countries (e.g. Switzerland, Korea, Luxembourg and Sweden) do not face any tightening requirements to meet the target. In Italy, even though the initial debt level is very high, debt is already on a declining path at the start of the projection.

A relatively small tightening (below 3% of GDP) is still required for the rest of the OECD countries, where a sound budget position has already been achieved in the short term. Countries already undertaking large fiscal consolidations (e.g. Spain, Greece and Portugal) generally face moderate fiscal gaps. Most of the EU countries (e.g. Spain, the Slovak Republic, Poland and France) have targeted a reduction in the overall fiscal deficit to 3% of GDP over the next two to four years. Therefore, the prompt consolidation causes lower interest payments and requires less additional consolidation. In some of these countries, ambitious cuts in public expenditure (e.g. the Slovak Republic), higher taxes (e.g. Spain) or robust growth (e.g. Poland) have supported fiscal consolidation.

Countries where underlying fiscal deficits are expected to remain substantially high in 2012 face much larger fiscal gaps. For example, the fiscal gaps for New Zealand, the United Kingdom the United States, and Japan exceed 5% of GDP.

**Figure 1. Baseline fiscal gaps**




***Note*:** The change is with respect to the underlying primary balance projected for 2012.

## 3.2. The effect of pension spending pressures

Despite the reforms introduced during the past couple of decades, many OECD countries continue to face looming fiscal pressures related to the ongoing ageing of their populations. On average in the OECD, public pension spending is projected to increase from 8.4% of GDP in 2010 to 11.4% in 2050 (OECD, 2011b), with substantially larger increases in several countries (Table 1). The implications of such increases in spending in the absence of reform can be assessed by allowing pension spending to change over the horizon 2012-2050, according to the projections provided by the OECD and the European Commission. To isolate the effects of increasing trends in pension spending, health spending is kept constant. The simulations do not take into account taxes on private occupational pension schemes, which in some cases could significantly boosts revenues. The path of projected public pension spending is phased in so that the spending profile follows the profile of the old-age dependency ratio. Including pension spending alters the fiscal gaps for many countries radically relative to the baseline scenario (Figure 2).

When ageing-related spending is included, debt and debt servicing costs rise in all countries, except in Poland and Sweden. In these two countries, as public pensions drop households need to ensure that their retirement income is supplemented by private saving. In this light, the effects of Poland's recent reforms to the second pillar will need to be monitored to assess the impact on both sustainability of the reformed system and how household saving behaviour reacts.[13] In some countries, the increase in pension spending over the next 40 years does not represent a major challenge. For instance, in Denmark, the projected increase in pension spending is of negligible size and the population is "greying" at a slow pace. In other countries, where pension spending is expected to increase moderately, the fiscal gap is adversely affected, but the dynamics of pension

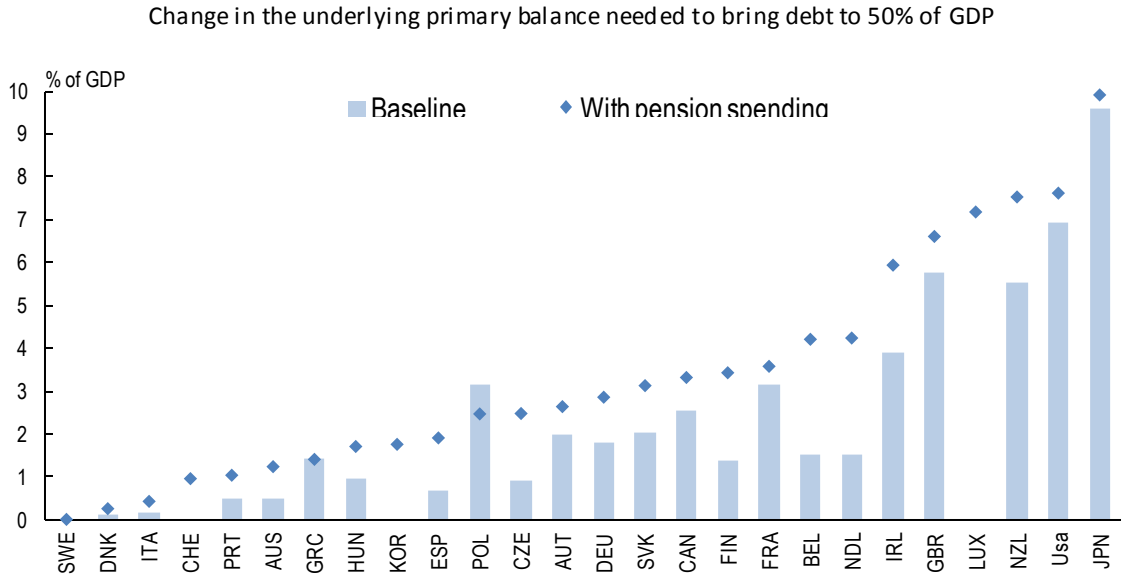
[13.] In Poland efforts have also been made to reduce the generosity of public-sector pensions, which for some groups have been particularly generous.

spending does not put significant additional pressure on public finances (e.g. in Germany, France, the United Kingdom, the United States and Japan).

The rise in consolidation requirements is far more pronounced in those countries where the increase in pension spending as a share of GDP is large (e.g. in ascending order Hungary, Switzerland, Finland, the Netherlands, Belgium, Korea and Luxembourg). In Finland, while ageing increasingly weighs on the public finances, considerable financial assets have been built up for supporting future pension spending. In the Czech and Slovak Republic and Canada, the change in pension spending is quite large. However, pressures on public finances from increasing pension spending are partially muted, because the population in these countries is comparatively young compared with the other OECD countries.

The fiscal gaps of the countries facing the largest pension spending pressures, such as Belgium, the Netherlands and Luxembourg are large and underline the need for prompt institutional reforms. In Greece and Spain, reforms of their pension system in 2010 addressed the pressure emanating from this source.

**Figure 2. Fiscal gaps with pension spending**




***Note*:** The change is from the underlying primary balance projected for 2012.

## 3.3. The effects of health spending pressures

In the last decades, government health care expenditures have been growing much more rapidly than GDP in OECD countries. Therefore an additional source of pressures on public spending comes from rising health care costs. In the case of health care spending, higher levels of spending are not necessarily undesirable, but financing higher spending can create difficulties (Hall and Jones, 2007). Rapidly rising health care prices and developments of new costly treatments put upward-pressures on health-care budgets. Spending on health care is already one of the largest public spending items, accounting for more than 15% of general government spending on average in the OECD in 2007. Pressures from spending on long-term care are expected to grow in the future across most OECD countries. Most OECD countries currently allocate between about 1 and 1.5% of GDP to long-term care, but they could at least double by 2050. [14] Changes in spending are phased in gradually so that spending-to-GDP ratios equal estimates of health and long-term care in 2025 and 2050

[14.] Oliveira-Martins and de la Maisonneuve (2006); Duval and de la Maisonneuve (2010); European Commission (2009b).

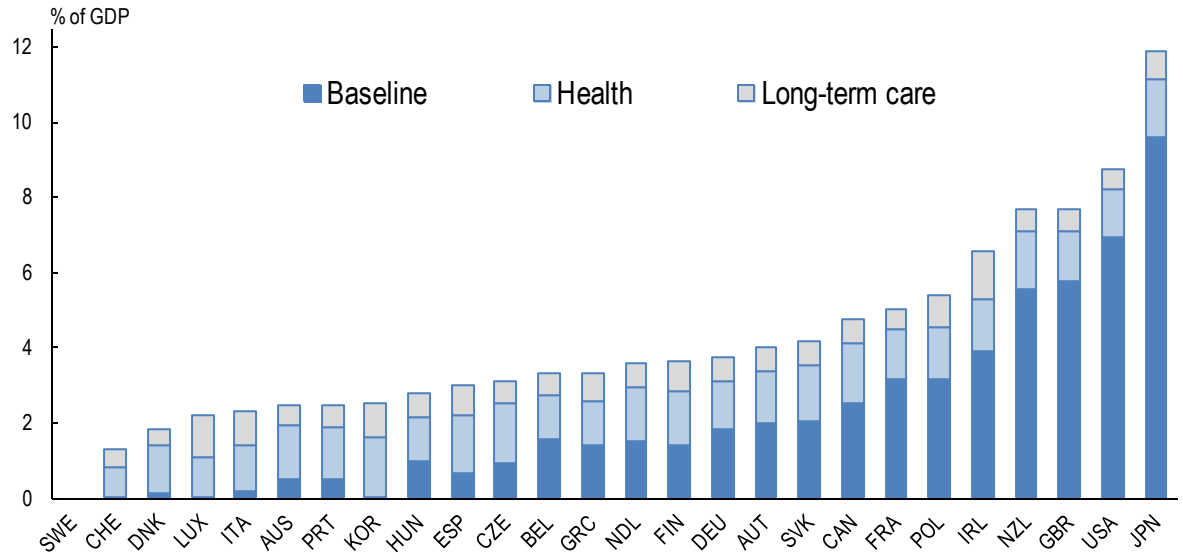
(Oliveira-Martins and de la Maisonneuve, 2006). Spending does not depend on the ageing profile over the projection horizon.[15]

This scenario is based on the assumption that only health spending is assumed to change over the horizon, while pension spending is kept constant. In this scenario, we assume that, on top of demographic effects, spending grows by 1% per annum faster than income, which would be broadly consistent with observed trends over the past two decades (see also Hagist and Kotlikoff, 2009). Additional pressures arise from long-term care spending.

The projected increase in health and long-term care spending by 2050 is on average between 3½ per cent of GDP to around 6% of GDP, depending on the assumptions about the pace of spending growth. As the projected increases are relatively similar the impact on the fiscal gaps does not vary much, but exceeds 1.5% of GDP in Switzerland, the Czech Republic, Canada, New Zealand and Japan when greater cost pressures affect health spending (Figure 3). When the projected increase in health spending is phased in, fiscal consolidation becomes somewhat more difficult in all countries except Sweden. In a few countries, the projected increases in long-term care are substantial and add significantly to the fiscal gap, particularly for Italy, Luxembourg, Finland and Ireland, where such spending adds around an additional percentage point of GDP to the fiscal gap.

**Figure 3. Fiscal gaps with health and long-term care spending**

Change in the underlying primary balance needed to bring gross financial liabilities to 50% of GDP




***Note*:** The change is from the underlying primary balance projected for 2012.

## 4. *The role of institutions in facilitating fiscal consolidation*

Against the background of impaired fiscal positions and the moderate pace of recovery, it is particularly important to implement institutional reforms that facilitate fiscal consolidation without having strong negative effects on near-term activity. In this section, we first consider the effect of reforms to pension systems (e.g. gradually rising the retirement age). Then, we consider the implications of reforms to increase efficiency in the provision of health services.

15. Future trends in spending can be affected by a number of factors (including income growth, technical progress and relative health prices), of which ageing represents a relatively small share. Moreover, a large number of papers (Seshamani and Gray, 2004; Breyer and Felder, 2006; Werblow et al., 2007) assume that what matters for health spending is not age per se, but rather the proximity to death. Therefore population ageing, if associated with additional years of healthy life, would not necessary put pressures on health spending.

## 4.1. The effects of delaying the retirement age

Population ageing has led to a substantial "greying" of the working age population in OECD countries. As a consequence, aggregate participation and employment rates are expected to decline and old-age dependency ratios to rise (Burniaux et al., 2004). Therefore, pension reform is required to put the public finances on a sustainable footing.[16] Raising the retirement age is on the reform agenda in many countries. Past work by the OECD has warned about the adverse effects of early retirement and measures that encourage labour market withdrawal on labour market performance (Blöndal and Scarpetta, 1998; Casey et al., 2003). Such schemes tend to reduce labour force participation of older workers. During the recent crisis, governments have not given in to the temptation to open pathways to early retirement. For instance, while several OECD countries have raised the level and/or duration of unemployment benefits, no specific measures have been taken for older workers (OECD, 2010). Indeed, some countries facing the fastest growth in pension spending have begun to reform their pension systems.[17] There are a number of approaches to managing pension spending, including tightening the access for a public pension through raising the retirement age and reducing access to early retirement and other pathways to early retirement such as through disability pensions.

Postponing the retirement age is desirable for various reasons. First, raising the retirement age would curb the rise in ageing-related spending, while at the same time increase private consumption and generating higher tax revenues. These gains can be used by governments to cut taxes and pay off debt (Barrell et al., 2009). Second, postponing retirement could be particularly effective in achieving medium-term consolidation, without negative effects on short-term demand. Third, raising the retirement age would increase labour force participation and employment of older workers and hence stimulate output.[18] In the fiscal gap simulations that explore the consequences of raising the retirement age, the effective retirement age is gradually increased so that by 2050 individuals are working five years longer (Figure 4).[19] The old age dependency ratio is now defined as the ratio of population above 70 years old over working age population. The impact of delaying retirement can be considerable. In those countries where fiscal gaps are large as a consequence of pension spending (e.g. Belgium, Luxembourg and the Netherlands), the reduction in the fiscal gap can be several percentage points.

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16. In the case of Luxembourg the increasing number of cross-border workers who will reach retirement age creates a particular problem. The short-term financing of the pension system is currently supported by a low old-age dependency ratio, as well as by contributions paid by relatively young cross-border workers. In the future, both factors will reverse and pension costs are anticipated to increase substantially.

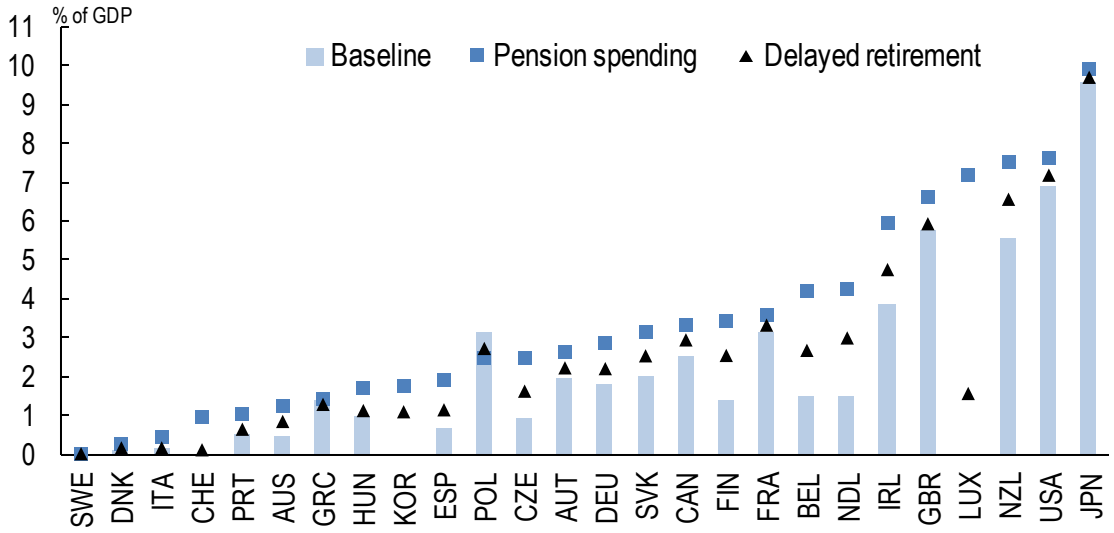
17. For example, Greece has started implementing a pension reform. In May 2010, the Greek government approved a bill aimed at reforming the country's ailing social security system. The statutory retirement age for women will be raised by five years to 65 immediately to match the current retirement age for men. The government will introduce financial penalties and disincentives for early retirement. These measures are aimed to increase employment and GDP and hence tax revenues and to lower social benefits. Following the reform, the estimates suggest there will be no further increase in pension spending as a percent of GDP, instead of projections that suggested a fiscal gap of almost 12% of GDP before the reform.

18. Duval (2003) examines the impact of early retirement incentives embedded in pension systems and other social transfer programs on the labour force participation of older workers.

19. While the labour force expands with the gradual increase, to maintain simplicity unemployment rates and participation rates are assumed to remain unchanged. Only pension spending is assumed to change over the horizon, while health spending is kept constant.

**Figure 4. The effects of delaying the retirement by five years on fiscal gaps**

Change in the underlying primary balance needed to bring gross financial liabilities to 50% of GDP in 2050



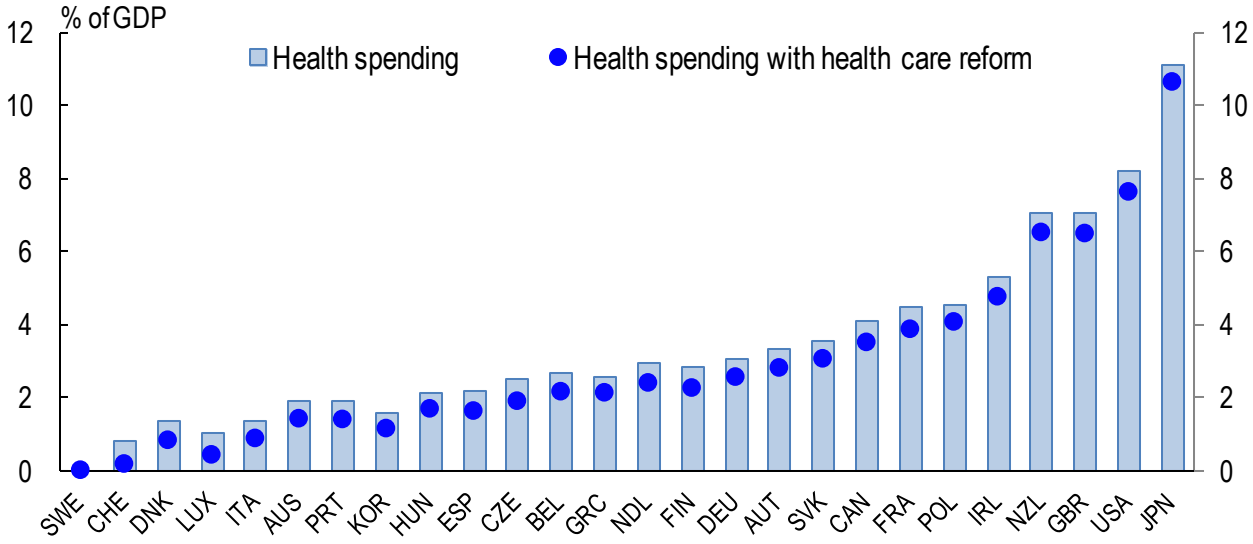

***Note***: The change is from the underlying primary balance projected for 2012.

## 4.2. Institutional reforms of the health system

Reforms to health and long-term care spending could also ease some of the pressure on budgets. Last scenario assumes that health spending increases, but policies are in place that control expenditure growth.[20] Figure 5 shows the effect of assumptions that countries are able to moderate the projected increases in health and long-term care spending.

**Figure 5. The effect of health reform on fiscal gaps**

Change in the underlying primary balance needed to bring gross financial liabilities to 50% of GDP in 2050




***Note***: The change is for primary balance projected for 2012. Spending on long-term care is included in total health spending.

[20] The OECD provides projections of health spending assuming the so-called "cost containment scenario", which incorporates the effect of efficiency gains in the provision of health services.

The possible scope for savings on health and long-term care may be larger for some countries. Recent research (see Joumard et al., 2010) suggests that reforms of health-care systems could lead to efficiency gains of almost 2% of 2017 GDP on average in the OECD countries. However, there is no particular institutional arrangement that performs systematically better than others, and cost containment strategies are therefore specific to a country's starting point, including its choice of health-care model. The research suggests that, generally, the most effective reforms include those that strengthen and broaden the role of market mechanisms, change reimbursement schemes (e.g. from fee-for-service to capitation or a mix of both), improve public management and control, and impose budget caps.

## 5. Concluding remarks

The fiscal gap calculations show that considerable differences exist across OECD countries in their need for fiscal consolidation. These large differences arise largely due to differences in underlying deficits at the starting point and to some extent the level of initial debt. While a number of countries (e.g. Korea, Luxembourg, Sweden and Switzerland) have already achieved sound fiscal balances, other countries, where underlying fiscal deficits are expected to remain substantial in 2012 (e.g. Japan, New Zealand, the United Kingdom and the United States) face much larger fiscal gaps.

The various scenarios presented in this paper suggest that in several OECD countries, the fiscal challenges are exacerbated in the long term by spending pressures related to pension, health-care and long-term care. Therefore, to assess whether the public finances are sustainable, projected health and pension costs cannot be neglected. Given the scale of ageing and health and pension costs, reforms to entitlement programmes need to be an important part of any longer-term sustainability strategy. For example, institutional reforms to the pension system, by increasing the retirement age, can boost labour utilisation, while at the same time can mitigate the budget pressures resulting from ageing populations. In addition, the institutional framework, by promoting efficiency in the provision of health services may reduce the debt-to-GDP burden without compromising growth. Institutions may hence support long-term fiscal sustainability and at the same time reduces adverse short-term effects of fiscal consolidation on growth.

The analysis presents some limitations which open the way for further extensions. The main argument in favour of fiscal consolidation is that if it is perceived as a serious attempt to reduce the public sector borrowing requirements, households and firms responded to improved confidence about the future increasing private consumption and investment (Giavazzi and Pagano, 1990). This wealth effect is reinforced by the crowding-in of private investment generated by the reduction in the risk premium: the decrease in government borrowing requirements diminishes the risk premium associated with public debt issuance, contributes to reduce real interest rates. In this context, Alesina and Perotti (1996) and Ardagna (2004) argue that the composition of the fiscal adjustment is a crucial aspect to analyze when assessing the expansionary implications of fiscal consolidation on growth, because it may have economic effects via the labour market. Therefore, feed-back effects of changes in taxes and public expenditure on labour supply decisions are another relevant aspect to take into account when assessing long-run fiscal sustainability.

One limitation of the fiscal gap approach is that it does not take into account the composition of the fiscal adjustment, whether it has to be implemented by raising taxes or by cutting public expenditures. In such a way, it is not suitable for assessing the side-effect on growth, especially those arising from the supply side. Therefore, results based on the fiscal gap approach should be complementary to those based on the analysis of fiscal multipliers.

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# Replacement demand and personnel planning on the sectoral level: challenges of an ageing workforce

*Ben KRIECHEL* [1]

***Abstract*:** Identifying key areas in which an ageing workforce will lead to skill mismatch and skill shortages is crucial in current times. We use the example of replacement demand estimates of the pan-European Cedefop model of skills needs to show the issues involved in estimating replacement demand. In the context of the Dutch sector of metal, machine building, and electro technical industry, we discuss how skills forecasts and labour market modelling can be embedded in order to address the future challenges in skills needs within a sector.

***Keywords:*** J11 – Labour Market Forecasting; Ageing; Labour market monitoring; Industry study

***JEL classification:*** J11; L6

## *1. Introduction*

Ageing is a common problem in almost all countries of the European Union, and it will be a problem in many other countries of the world. It is the result of lower birth-rates in these countries. These lower birth rates shift the relation of young to old persons in a country towards the older.

On the labour market these shifts imply a lower rate of inflow of younger workers. This shifts has many effects on institutions and systems that grew used to a steady inflow of younger workers. The often most prominent made point is the strain on the remaining younger workers that need to support an increasing number of elderly persons. Further, the outflow of older worker has to be balance, more or less, by an inflow of younger workers. But also on the more organisational level do many firms depend on a steady stream of younger workers not only to replace the outflow of older workers, but also to provide the inflow of new insights, ideas and methods through these young graduates. They can also complement the existing workforce in new knowledge versus experience of the existing older workforce.

On the level of skills we have seen a shift towards more education in younger cohort versus those that are entering retirement. The rising education levels reflect the increase in technological complexity that many occupations are facing, and hence pose also a challenge towards a continuous employability of those, young or old, with lower qualification levels that do not match the current and future requirements at the workplace.

A policy reaction to the ageing of the population has also been to extend the statutory employment age until which eligibility for (state) pensions are reached. While it was quite common to retire at ages between 60 and 65 years in many European countries in the past decade, with early retirement schemes allowing retirement at ages of 50 to 60 were also quite common in many countries. The ageing of the population, with a larger share of potential pensioners is one of the reasons that these early retirement schemes have been abolished, the statutory retirement age increased towards 65 or even 67 years of age, and the deductions and possibilities for early retirement reduced.

The reduced inflow of younger workers and the prolongation of working life until older age poses several challenges on the labour market. In this paper, I will discuss how skill anticipation

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models, to be precise replacement demand models, can be used to identify outflows from older worker. I will briefly comment on some of the shortcomings of these types of models, to then discuss in the example of a Dutch industry sector, how labour market monitoring is used that includes aspects of (national) skills anticipation and other additional sector specific data with the labour market issues of the sector. This section will hence have more of a sectoral view.

# *2. Replacing an ageing workforce*

## 2.1. Skills anticipation and labour market monitoring

Forecasting future labour market situations is a natural element of labour market monitoring. Often, labour market monitoring systems do not contain explicit forecast. Rather, they contain current and historic information on key labour market variables. These are, however, used to evaluate the current situation and to anticipate future labour market situations. Users of historic data make implicit forecasts of the labour market variables by looking at trends. More complex labour market forecasts are in a sense an extension of these implicit forecasts yielding more consistent and efficient results given all the information available.

In the past decade, many countries have adopted labour market monitoring systems that include also forecasting elements.[2] In addition, regional actors have also established labour market monitoring systems for their particular needs. Since 1998, a pan-European forecasting model has been developed that forecasts skills needs and labour market developments for all EU countries (Cedefop, 2012). These monitoring systems provide the necessary transparency about the development on that is created both for policy makers that need the monitoring to develop and pursue labour market policies, but also for other actors on the labour market. The actors are not only the workers – as the supplier of the labour – and the companies demanding labour, but also the institutions that facilitate and aid the various processes on the labour market. All these actors are in need of timely, reliable, and – if possible – forward looking information on the labour market. To reflect the current situation on the labour market, traditional labour market monitoring provides an adequate picture. However, when forward looking indicators are needed, one has to rely on more or less sophisticated models of forecasting.

While general employment trends seem easy to extrapolate, given sufficient information on both the historical development in a region and the national economic development as a whole, there are several reasons for the importance of a consistent and regular update of forecasts. A sophisticated forecasting model that incorporates the general employment trends, demographics of the workforce, and the changing structure and composition of occupation and the education within the workforce is especially important in the context of early identification of skills needs.

## 2.2. Estimating replacement demand

Projections of occupational employment typically focus on the total numbers of people that are expected to be employed in such jobs in the future. While such estimates can provide a useful indication of areas of change, highlighting the likely net 'gainers' and 'losers', they give a misleading impression of job opportunities and skill requirements. Even where the projections indicate significant employment decline over the medium term, there may nevertheless be quite good career prospects with significant numbers of new job openings. This is because, as long as significant numbers are still likely to be employed in the future, employers will need to replace those employees who leave because of retirement, career moves, mortality, or other reasons. This so called

[2] An overview of national skills anticipation systems can be found at Cedefop´s SkillsNet: http://www.cedefop.europa.eu/ EN/identifying-skills-needs/index.aspx and at their description of the EU-wide and also national forecasting systems of labour supply and demand by skills: http://www.cedefop.europa.eu/EN/about-cedefop/projects/forecasting-skill-demand-and-supply/index.aspx

'replacement demand' may often dwarf any 'structural demand' or so called 'expansion demand', resulting from growth in employment in a particular category. It can easily outweigh any negative changes due to projected employment decline.

Most work on replacement demand has tended to focus on what might be called "permanent or semi-permanent" withdrawals from the employed workforce. The main reasons for this are retirement, emigration, and, especially for women, family formation and taking care of children. Related concepts to replacement demand are turnover and churning. Turnover usually defines movements out of a firm, whereas churning is the sum of both in- and outflows. Churning is therefore a measure of gross movements. Replacement demand, as it is defined in this project, measures net flows. Furthermore, replacement demand takes the occupation or the education as the unit of interest, whereas churning and turnover take the plant or firm as the unit of measurement

In general terms, replacement demand can be seen as job openings arising because people are leaving the workforce or their occupation. Note that here a macro view of the entire labour market is taken. Thus, we only focus on net outflows. Movement across occupations are therefore only relevant if they constitute a net outflow. Within the cohort-component methodology which is used in e.g. Cedefop's EU wide skills forecast, but also on the national level in forecast in, e.g., Germany (Vogler-Ludwig & Düll, 2013; Kriechel & Vogler-Ludwig (2013), Netherlands (Cörvers et. al, 2011), and Ireland (Fox & Comerford, 2008) the net changes of repeated cross sections within age-gender cohorts are interpreted as flows.

While the basic concept of replacement demand might be simple enough to grasp, estimating it is a rather different matter. The main problem is that official statistics place much more emphasis on measuring stocks of people in particular states rather than flows from one state to another. Yet it is measurement of such flows, which is essential to estimating replacement demand. Ideally, one requires a full set of demographic accounts that traces individual's movement from one socio-economic position (e.g. employment in a particular occupation) to another (e.g. retirement). In practice, such a complete set of accounts are rare even at national level. From the labour force survey, it is possible to analyse the demographic composition of each occupation. This makes it possible to estimate specific rates of outflows for each occupational class. The key components are:

- information on the age and gender structure of occupational employment;
- information on rates of outflows.

The information on outflow rates can also be estimated using stocks of age-cohorts within occupations for several years. Using the year-to-year changes the outflow-rates by occupation-age cohort can be estimated. However, these estimates may not allow discrimination between the reasons for the outflow that leads to replacement demand.

Data on age structure are required since many of the flows, especially retirements, mortality and occupational mobility, are age specific. Age structures vary significantly by occupation. For some occupations experience is a key requirement and this is associated with age. The proportion in the older workers will therefore be relatively high, other occupations that do not necessarily require high levels of experience or seniority with higher average age are probably due to an greying of that specific occupation. This 'ageing' of an occupation can be due to shifts in the occupational structure. I.e., occupations become less attractive for new workers; hence the inflow of (younger) workers in such an occupation declines. This will lead to an increase of the mean age within that occupation. Differences in age structure across occupations influence replacement demand due to occupational mobility and retirement, which are age related. Even inter-occupational mobility is affected differently over occupations.

Retirement rates vary by gender and by age and may differ for different occupational groups. These varying rates are due to differences in occupation or industry specific (early) retirement schemes by occupations. Within replacement demand models, they will be estimated through the outflow coefficients by age and occupation. Within the model it is also possible to include a

mandatory or statutory retirement age. The assumption is then made that all employees beyond that age will leave the occupation into retirement.

Occupational mobility is another important source of replacement demand in some occupations, although not for all. The full occupational mobility flow matrix indicates that some occupations, such as managers, tend to gain employment as people are promoted from other occupations. The cohort component approach does not differentiate the replacement demand due to occupational mobility. It only identifies net mobility.

Another potential outflow is due to mortality. While losses due to death are not great for individual age groups up to the age of 65, they can cumulate to produce significant losses over an extended period. However, the current model does not explicitly incorporate differential mortality risks (not least because no significant or radical changes are expected in them). Rather the focus of the cohort component methodology is to identify overall outflows over cohorts, irrespective of the cause (sickness, death, family obligations).

The overall scale of change is obviously dependent upon the length of period considered, as well as the opening stocks and the age structure of the current workforce.

There are three components to a replacement demand model:

1. A forecast of demographic development within a country;

2. A forecast of (changes in) participation on the labour market, by gender and age groups;

3. An estimate of the outflow by occupation (education) category, gender and age group.

Most of the times, the first two components are considered external to the replacement demand model, they can be inputs from official forecasts or developed within (macro) models of future economic activity and labour market participation. They are set to be consistent with the other elements of the model. The third component is derived using the cohort-component method as described below.

The first step in modelling future replacement demand per occupational class is a description of the inflow and outflow patterns by occupational class in a historical period. The historical experience of outflow of specific (age x gender) groups within a occupation or qualification is used to predict future outflows based on the implicit assumption that past behaviour has something to tell about future outflow. Any type of outflow coefficient can be used, the better this outflow coefficient describes the true behaviour of labour markets participants, the better. Because there is no appropriate data for mobility flows on the labour market, stock data are used. With the so-called cohort components method, cohort-change rates based on the number of persons of the same birth cohort who were employed at two different times can be calculated (see Shryock and Siegel, 1980). In essence repeated cross sections are used comparing the outflow of workers through these methods. The second step in modelling is to translate these coefficients of outflow-percentages into the replacement demand by occupational class. This methodology measures only the net flow to or from an occupational class. The third step is to project the historically measured net replacement demand rates per age-gender group, measured by the estimated coefficient for a particular occupational class onto the age-gender structure of the workers at the beginning of the forecasting period and for each subsequent year.

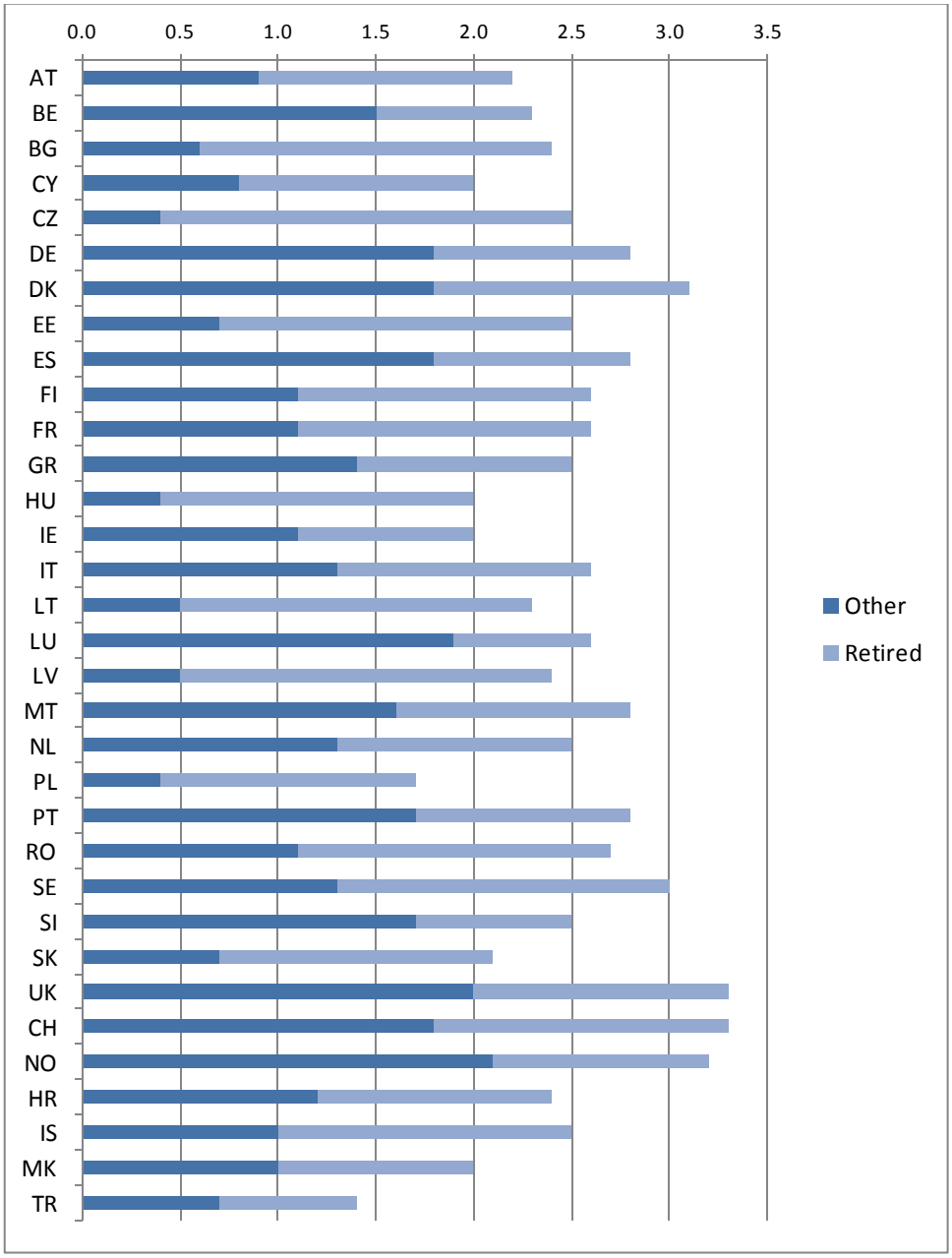
The increase in working age that is typically observed in many countries that increase the statutory retirement age can also be included in the model. This is done by correcting for participation rate changes. Longer working lives manifest themselves in higher participation rates of older worker, in which an increase of participation rates implies less replacement demand. Crucial factors in the estimation of replacement demand are the age and gender distribution of workers in a specific occupation. Reliable measures of this distribution in the base year but also over the past, make the estimates more reliable.

Figure 1 presents results of the replacement demand estimate for the Cedefop project as they were published last year. For each country the overall (average) replacement rate is given, in

which retirement and other causes are distinguished. The figure shows that retirement represents roughly half of the replacement demand in most countries. A large share of the remaining part is due to early retirement, which can only be indirectly observed through the contribution of higher age groups in the overall outflow.

Replacement demand has been rising in the last decades along with an increase in the average age of the workers within an occupation (or qualification). The replacement demand estimate allows to translate both the demographics ('ageing') and the behaviour of workers in an occupation into a statistic that allow for a quick identification and evaluation of a size of the overall replacement needs by occupation.

**Figure 1: Retirement and other replacement demand by occupation (annual %, EU27+6)**




**Notes:** 'Retirement' is defined based on the size of the age groups that reach the legal retirement age within the period of the forecast (i.e. by 2020). It does not include early retirement schemes or pre-retirement withdrawals from the labour market.

**Source:** Cedefop Skills Forecasting project, RDMOD, calculated by ROA. See: Kriechel (2012).

## 2.3. Problems and future challenges with replacement demand

The concept of replacement demand, especially using the cohort component method, has also several problems and drawbacks which we will briefly discuss.

### *Reasons for flows are unidentified*

First of all, replacement demand using the cohort component method is unable to identify flows nor reasons for flows. For example in countries like Ireland huge in- or outflows of migrants can influence the estimate of replacement demand in such a way that the cohort-component method is almost useless (Fox & Comerford, 2008). This is, however, an extreme case and often affects only a small number of occupations. It is, however, an important issue in the context of high international mobility if estimated on the national level.

### *Sampling Errors*

The methodology draws heavily on the accurate representation of the population of workers (in demographics and behaviour). The assumption is that the repeated cross sections can identify net flows, as seen in the example of migration above, this is not always the case. Also, if the number of observations is too small, hence the sampling error high, the identified net flows might not be good representations of the true flows. An alternative might lie in the use of administrative data or the (on the EU level new) panel element of the labour force survey. Through this, a worker can be followed for up to five quarters which allows for a good identification of the flow from and to different states and occupations on the labour market (see e.g. Cörvers et al., 2010b).

### *Increasing importance of continuous education*

A general challenge to skills anticipation and thus also to replacement demand is the expected increasing importance of continuous education. Skills are now often proxied by qualifications, and, in the case of replacement demand, there is an implicit assumption that the replacement demand has to be fulfilled by workers with a similar qualification. If however, the qualification that is often identified in the LFS is no longer a good proxy of the skills level, because much of the skills are added over the work life of each person, without necessarily adding to the formal level of qualification that this person holds.

This is also a reason that we should be careful about interpreting replacement demand strongly in terms of qualifications. If workers in a specific occupation of an older age cohort used to have intermediary qualification, it might well be that the current cohort of graduates entering the labour market require a higher education in order to fulfil the exact same job or occupation. This change in the occupation and qualification structure is usually modelled in the expansion demand, that includes measures of technological change. It is, however, an area in which replacement demand would benefit from observing how a specific position is filled (if at all), if workers retire from it.

# *3. Sectoral labour market monitoring*

The ageing workforce and the requirement to replace those workers that are leaving the workforce as identified by the replacement demand concept. As said above, this is a mere macroeconomic view of a future requirement to replace the outflows of workers. The real replacement will take place at the firm or organisational level. Firms will have to be prepared to replace workers that are leaving their organisation due to retirement. The challenge for many firms lies in the short supply of adequately qualified, young workers that are willing to fill the vacancies that the ageing workforce creates.

Exemplary, I will at this point examine the Dutch industry sector of the metal-processing, machine building, and electro-technical industry, for which I will use their (own) artificial name

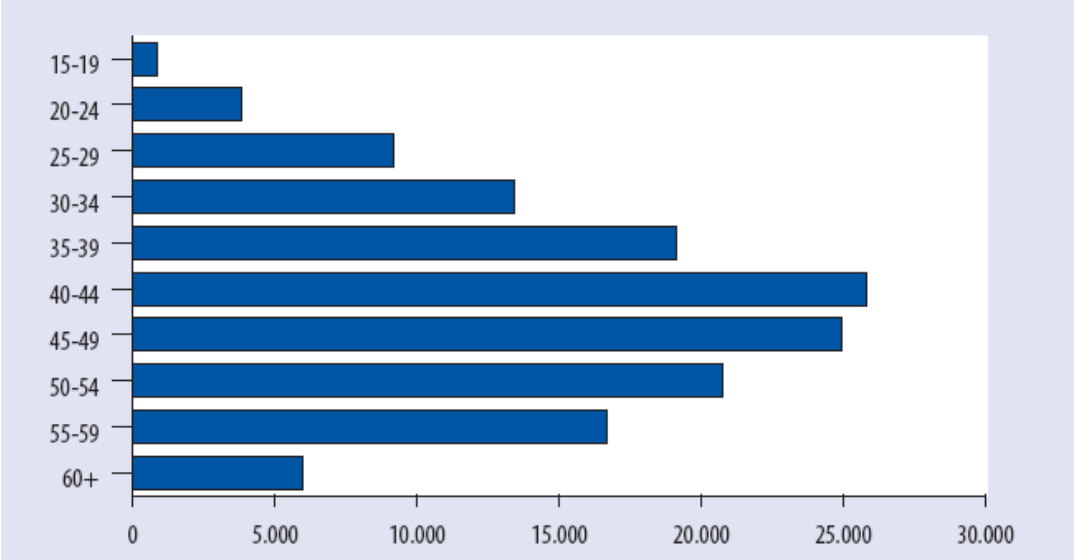
'Metalektro'. The sector encompasses more than 100.000 workers in more than 1.000 companies. It is one of the important industrial sectors in the Netherlands. The sector, combined in the sector fund stg A+O Metalektro, has commissioned an industry wide labour market monitoring system that has been developed by the Dutch Research Centre for Education and the Labour Market (ROA) since 2003. The labour market monitoring system was deemed necessary as the sector anticipated already in the early years of the millennium that the ageing of the workforce and the short supply of technically trained (young) workers will lead to challenges in the future to fulfil their specific skill needs.

In order to monitor the sector a combination of information sources have been combined since its establishment. A survey among a panel of firms provides insights into the HRM strategies and developments of the individual firms, administrative data of the pension funds (PME) is used to identify the specific age and gender structure of the sector, while the labour force survey and the national skills forecast provide the necessary background information to analyse and interpret the information while avoiding a purely sector specific analyses that neglects the overall economic developments in the country. The more quantitative information was enriched by frequent company visits and qualitative interviews among the personnel managers of the firms.

## 3.1. Ageing workforce within the sector

The sector's workforce is male oriented and, on average, old relative to the Dutch labour market. The difficulties of the sector to attract young workers starts already before employment, as the technical studies have been declining in terms of their share of total graduates, both on the higher and intermediate level. In the 1990s, the sector allowed for early retirement schemes that allowed to retire even before reaching the age of 60. However, these schemes that also made use of the social insurance system were abolished, and the Dutch pension law makes early retirement rather unattractive.

**Figure 2: Age distribution of employment in Metalektro**




**Notes:** Data is based on the population of workers that are part of the sector's pension fund (PME).
**Source:** Fouarge et. al. (2012), Chapter 1.

The key challenges to the sector with respect to the ageing workforce are to ensure sufficient inflow of technically qualified personnel to replace the outflow of the workers leaving into retirement. One of the possibilities to soften the skill shortage, is to make better and longer use of the current group of older workers. Whereas this group was left to go into early retirement, they are now left within the company for several years longer. In this work environment that can be physically demanding and at the same time technologically fast moving sector, which requires continuous

updating of skills, this requires to work extensively on the training of their workers and to ensure the sustainability of work, by providing production settings that are adequate also for the older age groups.

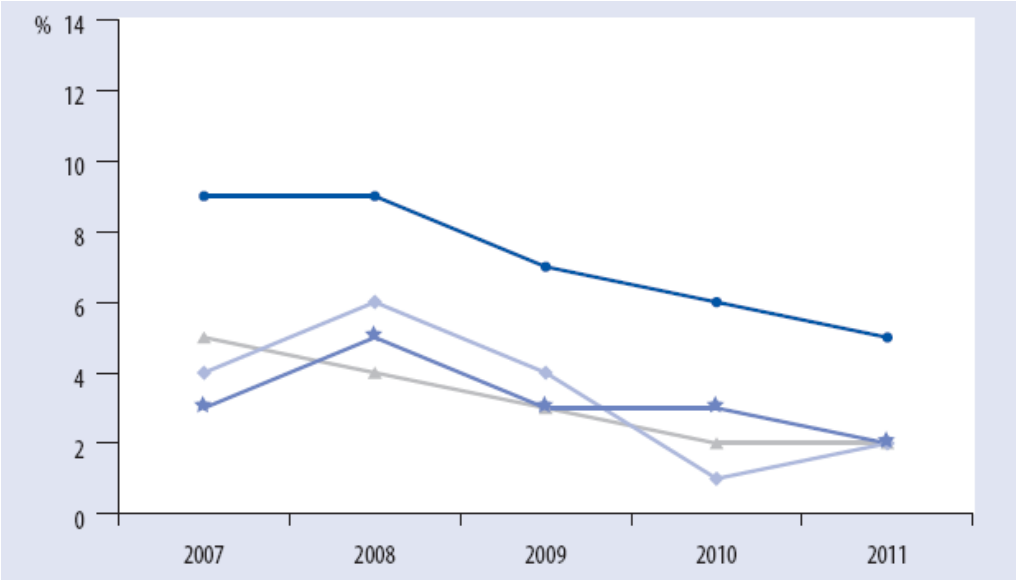
Figure 2 depicts the distribution of the age cohorts among the employed of the sector in 2011. The distribution is skewed towards the older age groups as can be seen on the figures based on the sector's pension fund.

This high average age, and the rather large number of employees with an age of 55 or older implies that the sector will face a significant demand for, mainly technical, workers in the next decade.

## 3.2. Firms expectations about future hiring difficulty

In the context of the survey, the firms are also asked about their expectations on retirement related outflows. While figure 3 depicts a significant percentage of expected outflows for the four distinct group of technical personnel, the technicians at the production level, the management level technicians, the technical salesperson, and technical support staff. The highest level of outflows is expected among the, indeed older group, of production workers. The level of outflow is, however, rather at the lower end of the real outflow of people reaching the age of 65 based on the pension outflow. It also does not include outflow because of replacement demand due to other reasons than retirement.

**Figure 3: Expected level of retirement outflows in the next five years (as % of workforce)**



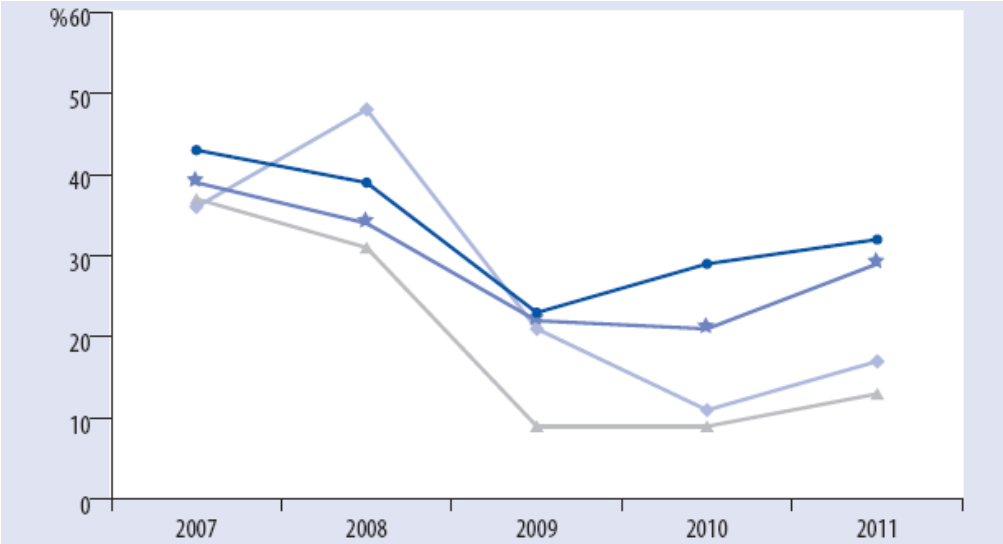

**Notes:** The line with circles denotes the technicians at the production level, which is the largest group, with squares are technical salespersons, with stars are (technical) managers, and the line with triangles denotes supporting technical functions. Data is based on annual surveys in 2007 – 2011.

**Source:** Fouarge et. al. (2012), Chapter 6.

The firms are, however, quite realistic in the expected level of hiring difficulties in replacing the retirement outflows of the next five years. Almost half of the companies expect to have higher difficulties in replacing those workers. Throughout the crisis, the firms do get more optimistic about finding replacement (see Figure 4), which is an extrapolation of the current situation on the labour market, with poor economic conditions onto the future. This is likely to be a view that is too positive in terms of hiring possibilities, which will worsen once economic conditions are better, and firms are expanding. Then both (seasonal) expansion and replacement demand will need to be fulfilled, and more firms will be competing for the supply of technically qualified workers.

What can be observed within the sector, though, is that the continuous effort to provide information on the situation on the labour market, discussion on the strategies that firms alone, or the sector as a whole, can take lead towards a better understanding of the future challenges. There is a general agreement that the sector has to work hard in order to attract the necessary skilled workforce for the future.

**Figure 4: Expected level of hiring difficulties to replace retirement outflows of the next five years (as % of firms)**




**Notes:** The line with circles denotes the technicians at the production level, which is the largest group, with squares are technical salespersons, with stars are (technical) managers, and the line with triangles denotes supporting technical functions. Data is based on annual surveys in 2007 – 2011.

**Source:** Fouarge et. al. (2012), Chapter 6.

In addition, the sector and the individual firms have addressed the issues of employability of their older workforce, the challenges that the organisation of work has on the various age groups within their employed workforce. An important factor, especially within the production setting includes also the transferal of embodied knowledge and human capital. Firms understand that the knowledge within their current workforce needs to be transferred before the workers are replaced. The size of the replacement is too big that one can rely on the organisational embodiment of knowledge to educate the younger worker in the underlying processes and issues of their work. Even in smaller companies is an understanding that good HRM practices are needed in order to overcome the challenges that the higher replacement demand with low supply of younger workers will pose on their future work.

## 4. Conclusions

Anticipating skills needs in general, and replacement demand in particular can play an important role in identifying areas in which the ageing workforce will lead to skill mismatch and skill shortages. Skill anticipation methodology are complex, and the requirements for a full model of an economy are high. The recent initiative by Cedefop, providing skill anticipation models for all EU countries provide a welcome contribution, especially for those countries that do not have a national forecast of their own. One has to use the tool of skills anticipation with care, preferably over longer periods of time in order to gain a full understanding of its meaning.

In the context of the Dutch Metalektro, we could show how embedding results of skills forecast, including elements of replacement demand, in the labour market monitoring of a specific sector, can lead to a better understanding and agreement in activities that firms and sectors can do

in order to overcome future challenges posed by the future ageing of the workforce. While the firms are not necessarily versed in understanding the details of skills anticipation, they do understand the gist of the developments that affect their sector and the occupations that are of crucial importance for the functioning of their production process. The goal of skills anticipation, to provide transparency of current and future labour market developments and challenges, are thus achieved. This is, however, nothing that a firm or sector can rely upon, it is a continuous process. Labour markets, qualifications and skills and job requirements are changing quickly. Guidance and information about developments should thus be always important to the decision makers on the firm, sectoral and policy level.

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# From pension funds to piggy banks: (perverse) consequences of the Stability and Growth Pact since the crisis[1, 2]

*Bernard H. CASEY* [3]

**Abstract:** As part of their strategy for economic and monetary union, European governments committed themselves to fiscal discipline – particularly by placing limits on annual deficits and on public debt. Subsequently, and as they sought to respond to the "current crisis", they embraced the view that only if public finances were kept under control would sustainable recovery be possible. Rules of fiscal governance were strengthened. In order to help themselves meet the conditions they had imposed upon themselves, the governments of many European Union member states made changes to their pension systems or to funds they had established specifically to pay the costs of population ageing. The intention of these actions was not to cut retirement benefits or to improve the efficiency of pension schemes and institutions in question. Rather, it was to free up resources immediately. The steps taken produced immediate cuts in public expenditure or in the borrowing requirement, and so helped fiscal targets to be met. Funded pension schemes and pension funds were merely convenient sources of money. They were treated like "piggy banks" that were raided when times became hard. Moreover, the policies pursued succeeded in meeting their objectives only because the system of national accounts according to which outcomes are judged does not recognise the way in which most of the fiscal gains are matched by future fiscal liabilities.

**Keywords:** Pensions, Europe, Stability and Growth Un-reform.

**JEL classification:** E65, F 50, H55, H63

## 1. Introduction

A key element of the attempt to achieve economic and monetary union (EMU) was the agreement by the European Union (EU) member states that they would manage public finance in an orderly way. The Maastricht Treaty of 1992 laid out the way in which countries should comply and the procedures for monitoring performance. The most frequently cited of the fiscal requirements was that governments should not run annual deficits in excess of three per cent of gross domestic product (GDP) and that total public debt should not exceed 60 per cent of GDP. In the following years, and in order to counter fears that any one member country of the monetary union might "free-ride" upon the others – enjoying the benefits of EMU without implementing the strictures required to ensure its success – the Maastricht provisions were tightened. The Stability and Growth

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[2] Previous versions of this paper were given at the conference "Rethinking the Economics of Pensions: Is there a crisis of pensions or of pensions' governance and regulation?" organised by the Knowledge Transfer Network and the University of Warwick and held in London, 21-22 March 2013 and the conference "Pension Reforms in Post-Socialist and other Countries: Comparison and Evaluation" held at Poznań University of Technology, 12-13 September 2013. Some of the ideas in this paper were discussed with András Simonovits, to whom the author is grateful. Thanks are also due to Karl-Gustaf Scherman and Robert Lindley for their comments on earlier drafts.

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Pact (SGP) of 1996 reinforced the monitoring process that had been specified in the 1992 Treaty and enabled sanctions to be imposed upon governments that ran "excessive deficits".

Fiscal discipline remained a primary concern of the EU in the years after the common currency was introduced. However, when the fiscal deficit rules were breached by both France and Germany in 2003, neither country was subject to penalty. Rather, the terms of the SGP were relaxed so that greater account was taken of conjuncture and of the intentions for remedy that any country guilty of transgression had committed itself to. It was not until the impact of the crisis that had started in 2008 was being felt, and steps were being taken to mitigate its consequences, that the importance of fiscal discipline was re-asserted. Although some countries had initially responded to the downturn with conventional counter-cyclical measures that included increased expenditure, there very quickly occurred a fundamental reorientation of policy. Fiscal rectitude was given increasing emphasis in almost all the western countries. Economies, it was argued, could only be stabilised, and growth could only recommence, if public finances were placed in order – in other words, only if a strategy of "expansionary fiscal consolidation" was pursued. In the EU this led to the adoption of the "six pack" at the end of 2010 – a set of measures that substantially tightened both the preventive and the corrective procedures set out in the SGP. Subsequently, and at the start of 2012, a yet more rigorous Fiscal Compact (the Treaty on Stability, Coordination and Governance in the Economic and Monetary Union) was signed by all but two member states. Under this, governments committed themselves to achieving balanced budgets and debt reduction and to include provisions for the attainment of these ends in their own basic laws. Even the non-signatories of the Compact declared their intent to be bound by its fiscal provisions.

This paper is concerned with how meeting the requirements of fiscal discipline had an impact upon pension systems and pension funds in the member states. It is concerned with actions that EU governments took primarily in the interest of meeting conditions set in treaties to which they were a party or achieving targets they had imposed upon themselves – whether keeping public deficit and/or debt within limits, holding down borrowing costs, maintaining the exchange rate of national currency, or generating resources to help meet other political objectives. These actions did not take the form of cuts to retirement benefits. Nor did they take the form of improving the efficiency, and so lowering the costs of operation, of the pension schemes or pension funds in question. Rather, they were directed towards eliminating fiscal costs that were associated with particular types of pension schemes or with taking control of the resources of particular pension funds – in each case, in a way that would help the government in question reduce expenditure, hold down borrowing costs and prevent debt from increasing. Indeed, the implications of the actions taken for the relevant pension schemes as providers of retirement income, or for the pensions funds as sources of wealth out of which future costs of ageing might be paid, were largely incidental and, as will be shown, might not always have been fully thought through. In other words, rather than conducting pension reform or improving the way in which the costs of population ageing might be met, the governments in question effectively treated funded pension schemes and pension funds as "piggy banks". Like piggy banks, such funded pension schemes and pension funds required feeding and, like piggy banks, they contained wealth. Although their purpose was to provide for future eventualities, like piggy banks, they were vulnerable to raids when unexpected and more immediate needs arose. And it was the crisis that gave rise to such needs.

Many of the relevant actions and measures taken have been reported in the financial media. Some have received attention as part of more general discussions on changes to pension systems that have occurred in recent years (see Casey, 2012; Drahokoupil and Domonkos, 2012; Hirose, 2011; OECD, 2012, Soto et al, 2011). In a few cases, they have been the subject of country case studies (for example, Simonovits, 2011; Milev and Nenovsky, 2012). However, to date, there have been few attempts to analyse them from a public finance perspective. Even the European Commission in its reports concerning actions taken to achieve "stability" or "convergence" or to resolve "excessive deficits" has made only passing reference to them.

For the purposes of making such an analysis it is possible to categorise the measures taken into one of four forms. In a number of cases, they comprised the (temporary) suspension of mandatory funded pension schemes in order to reduce "transition costs". In some cases, they comprised the sequestration of funds that had been built up to meet members' accumulated retirement benefits. In other cases, they comprised governments prematurely tapping the resources of pension reserve funds that had been set up to meet future costs of ageing. Last, in some cases, they comprised governments influencing or seeking to influence the investment behaviour of funds in a way that would be beneficial to public finance. These four forms of action are described in the following four sections of this paper. A final section draws conclusions.

## 2. Saving money by cutting transition costs

Pension reforms that generated transition costs were made in many of the "new" (or post-2004) member states of Central and Eastern Europe (CEE). Most of these countries sought to refashion the systems they had inherited from the "socialist" past to make them more appropriate to the "market" economies they aspired to become. One of the ways many adopted was to introduce a funded component to their pension system. This involved the introduction of mandatory, individual accounts into which a share of contribution income was diverted. Whilst the switch to private funding would, eventually, reduce the outgoings of the public social security system, in the short- and medium-term the latter system was deprived of some of its income, it its expenditure – payments to people who had built up rights under the old provision – remained unchanged. All other things being equal, making up the shortfall required additional income and/or additional borrowing. Savings might be generated by other reforms to the pension system, but these savings would have been available for other uses and so would not diminish the effective cost of transition. In fact, it was not only CEE countries that made changes to their pension schemes that generated such costs. A component of the Swedish pension reform that took effect in 2000 consisted of allocating a proportion of contributions to the public pillar pension scheme into a funded, individual account – the PPM (Sundén, 2001).

The size of the diversion from the first pillar, and so the size of the transition cost, varied between countries. Amongst those countries where a substantial amount of contributions was switched were Slovakia, where some nine per cent of earnings went to the newly established second pillar, Latvia and Hungary, where the relevant figure was eight per cent, and Poland, where it was over seven per cent. More modest were the diversions in Lithuania – five and a half per cent – and Estonia – four per cent of earnings, respectively. The smallest diversion was in Sweden – two and a half per cent of earnings.

In the reforming countries, it was generally understood that transition costs would, eventually, arise. Projections of the size of the deficit that would ensue, and of the time over which it would extend, were often too optimistic. The European Commission (EC) noted how "in some Member States, however, the net transition costs turned out to be higher than anticipated" (EPC-ESC, 2010, p58), whilst the International Monetary Fund (IMF) described in more detail the specific case of Poland where initial assumptions about economic growth and labour force participation were too high, whilst those about the number of people who would chose to switch to the funded system too low (IMF, 2011, pp. 12-13).

Under "normal" circumstances, transition costs might have been tolerable, and reforming governments might have expected forbearance to be shown. Initially, this appeared to be the case. Indeed, when in the more benign times of the early- to mid-2000s the SGP was revised to cope with the breaches to the deficit rule that were being made by France and Germany, pension-reforming countries sought and achieved a quid pro quo. The revised treaty included the provision that, from 2005, countries making pension reforms that included the introduction of a mandatory, fully-funded pillar could request that the costs of such reform be taken into account if their deficits exceeded the three per cent reference level. The caveat was that the deficit, if above three per cent, had to be

"close" to it, that account would be taken of the extent to which any excessive deficits had been corrected, and that, in any case, the amount of extra costs taken into account would fall gradually to zero over the following five years (ECB, 2005).

Estimates of the size of the impact of pension reform on the fiscal deficit have been made for a number of CEE countries. At least one estimate has also been made for Sweden. In 2007, only two countries were running deficits in excess of three per cent of GDP. However, in four countries transition costs were equal to, or in excess of, one per cent of GDP.

**Table 1: Impact of Pension Reform on Fiscal Situation in 2007 (% of GDP)**

| | Actual balance (1) | Transition cost (2) | Balance if no reform (3) = (1) – (2) | Actual balance 2009 (4) |
|---|---|---|---|---|
| Bulgaria | 0.1 | -0.7 | 0.8 | -4.3 |
| Estonia | 2.6 | -1.3 | 3.9 | -2.0 |
| Latvia | -0.3 | -0.8 | 0.5 | -9.8 |
| Lithuania | -1.0 | -0.9 | -0.1 | -9.4 |
| Hungary | -5.0 | -1.2 | -3.8 | -4.6** |
| Poland | -1.9 | -1.3 | -0.6 | -7.4 |
| Romania* | -5.4 | -0.3 | -5.1 | -9.0 |
| Slovak Rep. | -1.9 | -1.0 | -0.9 | -8.0 |
| Sweden | 3.6 | -0.8 | 4.5 | -0.7 |

* Romania, 2008, the year the reform was made

** Government debt was also in excess of 60 per cent of GDP (79.8%)

**Source:** own calculations from Soto et al, 2011; Praxis, 2008; and Eurostat

By the end of the decade, when the relief granted by the 2005 reform of the SGP was due to expire, the reforming countries sought an extension of its terms. However, by this time the economic and politic environment was very different. Three of the reforming countries had been sufficiently badly hit by the crisis that they had already been forced to seek assistance from the IMF – Latvia and Hungary in 2008, and Romania in 2009. This assistance was made conditional upon their governments adopting policies of fiscal retrenchment. Seven – all but Estonia and Sweden – were running deficits in excess of three per cent, and demands for fiscal rectitude were being intensified. The new code of conduct on the operation of the SGP both tightened excessive deficit procedures further and limited any forbearance of transition cost to countries where "as long as the general government deficit does not significantly exceed a level that can be considered close to the 3% of GDP reference value and the debt ratio does not exceed the 60% of GDP reference value, on condition that overall fiscal sustainability is maintained" (EC, 2012b, p10).

With other revenues declining, a number of CEE governments took steps to reduce, at least temporarily, some part of the payments into individual accounts and to use contribution income to help meet current expenditure needs. The government of Lithuania was the first to make such a move, but others rapidly followed suit.

Suspension of contributions to funded pension schemes was not, in fact, a peculiarly eastern European phenomenon. Two German states – Thuringia and Bavaria – stopped paying contributions into funds that were intended to finance the pensions of their civil servants. In each case, the state government cited the financial crisis, and consequent pressures on public expenditure, as the reason for their doing so (IPE 2011a).

**Table 2: (Temporary) actions taken to reduce transition costs (contributions as % of covered wages)**

| Country and year initiated | Total pension contribution | Diverted to individual account | Diverted after reform | Reversion date |
|---|---|---|---|---|
| Estonia 2009 | 20.0 | 4.0* | 0.0 | back to 2.0 in 2011 and to 4.0 in 2012; raised to 6.0 2014-17 for those who continued own contribution during suspension* |
| Latvia 2009 | 20.0 | 8.0** | 2.0 | latest proposal, back to 4 in 2014 and 6 in 2015 or 2016 |
| Lithuania 2009 | 18.5 | 5.5 | 2.0 | reduced to 1.5 in 2012, increased to 2.5 in 2013, back to 2 in 2014, but those contributing an additional 1% receive a further 1% of national average wage as contribution from govt. |
| Romania 2009 | 19.5 | 2 and rising 0.5 p.a. to 6 | frozen at 2 in 2009 | 0.5 increases restarted in 2010, to reach 6.0 by 2017 |
| Poland 2011 | 19.5 | 7.3 | 2.3 | gradually rising to 3.5 by 2017 |
| Hungary 2011 | 31.0 | 8.0 | initially to zero | subsequently, scheme nationalised |
| Slovakia 2012 | 18.0 | 9.0 | 4.0 | |

* plus additional 2 % from employee also diverted to social security

** was due to rise to 10% in 2010

**Source:** national reports, press reports, etc.

## 3. Sequestration of private pension funds

Merely suspending contributions to the second pillar funds proved inadequate for the government of Hungary. In 2011, all contributors to second pillar funds, unless they specifically chose otherwise, were switched back into the public pension scheme. Those who did not were told they would earn no further accruals under the latter. Shortly afterwards, it was announced that the assets of the pension funds – worth well over 10 per cent of GDP – were to be transferred to the government account. The monies were to be used to reduce government debt, to finance current expenditure, or, it has been suggested, to pay for the move to a (lower) flat-rate income tax. Future pensioners would be treated as if they had never left the first pillar, although they also received any positive real yields that had been earned on their second pillar accounts (Simonovits, 2011).

The Hungarian government was not the first to view pension scheme assets as a source of relief for fiscal shortfalls. Already in 2008, but before the world financial crisis had hit the country, the government of Argentina had nationalised the accounts of the supplementary pension funds (Kay, 2009). Nor was Hungary alone in Europe. At an early stage of Ireland's experience of the crisis, its government took a similar step, albeit on a more limited scale. The pension fund of the public universities and certain other public agencies was transferred to the exchequer in return for an agreement to meet future payments out of current expenditure (IPE, 2009a and b). Equally, in late 2010, the government of Portugal, which had already had to apply for a Eurozone "bailout", took over the assets of the pension fund of the national telecom company and, subsequently, the pension fund of the banks – worth, respectively, 1.5 and 3.5 per cent of GDP. According to contemporary

reports, part of the proceeds of the initial action was used to pay for two submarines that the defence ministry had purchased (IPE, 2010a and b; IPE 2011b and c).

Although not presented as a sequestration, the actions of the UK government with respect to the pension scheme of the state-owned mail delivery service had a beneficial fiscal side effect. There had been a long-standing desire to privatise the mail service – in part to meet EU competition regulations, in part to attract the capital necessary for modernisation and to reduce losses borne by the exchequer. However, attempts to realise this objective had foundered, not only because of political opposition but also because of the underfunded – in the order of 25 per cent – pension obligations any buyer would have had to take on. To smooth the way for a sale, the government agreed to take over the responsibility for paying pensions and in return pension fund assets worth nearly two per cent of GDP (Groom, 2012; IFS, 2012).

Also not presented as a sequestration was the way in which, under the Eurozone rescue package for Cyprus that was agreed in spring 2013, pension and provident funds were obliged to participate in the recapitalisation of the country's banking system. Already at the end of 2012, the Cyprus government had found itself sufficiently close to default that it had approached a series of semi-government organisations – the Telecommunications Authority, the Electricity Authority and the Cyprus Ports Authority – for temporary loans. All three acceded to the request – thereby, it was said, enabling the government to meet its end-of-year salary commitments. Whilst the Port Authority drew from its reserves, the other two organisations allocated assets from their pension funds (Cyprus Mail, 2012). When a rescue plan was finally concluded, it involved the bailing-in of "uninsured depositors" at the two large banks that had failed. The "uninsured deposits" included a substantial part of the assets of the country's pension and provident funds. The latter, unlike their counterparts in many countries, had invested much of their assets not in equities or (government) bonds but in interest bearing bank deposits (IPE, 2013b). Almost without exception, the size of their balances exceeded the €100,000 threshold that was protected in the event of bank insolvency. A "haircut" of 47.5 per cent was applied to these. A plan that would protect the provident funds – which operate on a defined contribution basis – by ensuring that they did not suffer losses in excess of 25 per cent has been offered by the government, but it will not be applied to pension funds – which operate on a defined benefit basis – leaving the sponsors of the schemes to make up any losses that ensue.

**Table 3: Size of pension funds sequestered or nationalised as % of GDP**

| | |
|---|---|
| Portugal | |
| Telecom | 1.3 |
| Banks | 4.6 |
| Ireland | |
| Universities, etc. | 1.1 |
| Hungary | |
| second pillar | 10.7 |
| UK | |
| Royal Mail | 1.8 |
| Cyprus | |
| Pension and provident funds | approx. 20 |

**Source:** own calculations from sources cited in text, own estimates

## *4. Prematurely accessing pension reserve funds*

National pension reserve funds fall into two types – social security reserve funds and sovereign pension reserve funds. The former draw their income from social security contribution income (even if this includes contributions made by government as a "third payer"), whilst the latter stand outside social security systems and rely largely on direct fiscal transfers from the government. Both types of funds are intended to smooth income and expenditure, although sovereign reserve funds tend to be more specific with respect to when they can be drawn upon – often by setting a specific date before which assets cannot be touched (Blundell-Wignall et al, 2008). Empirically, there is no difference between the two types of fund in terms of size, but both are larger than the "buffer funds" that most social security authorities have for the purposes of managing short-term fluctuations in income or expenditure.

Reserve funds are investors. They can be given mandates with respect to their investment behaviour, and how they invest can have implications for the economy of the country in which they operate. Some funds are merely required to maximise returns, others are set social objectives. However, once objectives have been set, it is considered desirable that sponsoring governments maintain a hands-off stance (Yermo, 2008).

As the impact of the crisis intensified, a number of European governments intervened in the operation of reserve funds to help meet their fiscal targets. These interventions took two forms. In some cases, governments drew down on a fund's resources. This was the case in France, in Poland and in Spain. The 2010 "Fillon Reform" of the French public pension scheme is best remembered for its raising of the pension age above 60. Less remarked upon was that it also involved the government changing the task of the Pension Reserve Fund (Fonds de Réserve pour les Retraites, FRR). This fund had been established in 1999 to help finance shortfalls in contribution income that were foreseen in the future. It has been provisioned by (temporary) surpluses in selected social security funds, additional taxes on private assets, and the proceeds of privatisations and of auctions of telecommunication licences, as well as any returns on the investments it has made. The fund was not intended to start making disbursements until 2020. However, this was changed in 2010. Disbursements started in 2011 with payments going to meet deficits currently already arising or projected in the social security system. Rather than being exhausted only in 2042, the fund will now be exhausted in 2024. The short-term benefit to public finances was not inconsiderable. In the National Reform Programme 2011-2014 that it submitted to the European Commission under the terms of the Maastricht process, the French government described the pension reform it had undertaken as reducing government debt in 2020 by 10 percentage points, of which two percentage points came from the early utilisation of the reserve fund (Govt. of France, 2011, p15.

Poland had set up a Demographic Reserve Fund (Fundusz Rezerwy Demograficznej, FRD) in 1998 that would receive both revenue from the social security system and a share of receipts from privatizations. By 2010, the fund had accumulated resources worth some two per cent of GDP. However, in that year, in order to help the country satisfy the Maastricht requirements, and to assist it in meeting a self-imposed (constitutional) requirement to keep gross debt below 55 per cent of GDP, the government dug into the FRD. A second sequestration occurred in the following year, with the two withdrawals together reducing the size of the fund by some 50 per cent.

In Spain, a Social Security Reserve Fund (Fondo de Reserva de la Seguridad Social, FRSS) rather than a sovereign pension reserve fund was put in place. It started operating in 2000. Its income came from surpluses run by the operation of the social security system and a decade later the fund was worth over five percent of GDP. Spain was one of the countries hit particularly hard by the crisis, which not only led to massive increases in unemployment and a fall in tax revenues but also exposed deficits and debts in the balance sheets of regional administrations and required the bailing-out of banks. The country's fiscal balance went from being in surplus of two per cent to deficit of over 11 per cent in 2009 and it was still near to 11 percent in 2012. The resources of the fund were drawn upon twice in late 2012 to help fill gaps in the central government's account, and a

third time in summer 2013 explicitly to meet pension payments (IPE 2013f). The sums involved were relatively small – together constituting little over 16 percent of the total that had been built up.

**Table 4: Size of "reserve" funds prematurely accessed (as % of GDP, before intervention)**

| | |
|---|---|
| France<br>Pension Reserve Fund | 2 |
| Spain<br>Social Security Reserve Fund | 6 |
| Poland<br>Demographic Reserve Fund | 2 |

**Source:** national reports of the funds and own calculations

## *5. Influencing fund investment behaviour*

The second way in which governments were able to make use of pension reserve funds (and other pension funds) was to influence the way in which their assets were invested. The Spanish FRSS was permitted to hold only government paper and only that from Spain, France, Germany and the Netherlands. Within these limits, its portfolio was fairly diversified – although the share of domestic bonds held grew over time. A dramatic change came after 2008. In that year, domestic bonds made up some 54 per cent of the portfolio, in the following year they made up nearly 77 per cent and, by 2012, over 97 per cent. Whether or not it was declared as such, selling off foreign bonds and the purchasing of domestic bonds fitted a strategy of trying to push up the price of the latter and thus to stem the rise in the rate of interest that purchasers in Spanish debt were demanding. It was certainly consistent with the government's efforts to avoid having to request bailout assistance from its Eurozone partners.

The use of a sovereign pension reserve fund to mitigate the impact of the crisis on a country's public finances that has attracted most notice has been that which occurred in Ireland. Ireland, which was recognised as benefiting from a "demographic dividend", had set up a National Pensions Reserve Fund (NPRF) in 2001. The government committed payments of one per cent of GDP into the fund each year, and the intention was to start drawing resources down in 2025. Assets were invested to maximise returns under the oversight of an independent commission, and already by 2007 the NPRF was worth over 13 per cent of GDP. However, faced with the need to recapitalise the banking sector, in 2009 the government altered the fund's mandate and "directed" it to invest in newly-issued preference shares in two major banks. These purchases were to be financed by the selling-off of other assets, the liquidation of cash reserves and by an additional allocation to the NPRF from the exchequer. This allocation supplemented the one that had already occurred when the fund became the recipient of the sequestered resources of the universities' and other pension funds (NPRF, 2010).

The initial efforts to rescue the banking sector proved inadequate, and in late 2010 the Irish government applied for assistance under Eurozone rescue procedures. The settlement that was reached included the government agreeing to commit a further tranche of national resources to bank recapitalisation, and a large share of these – €10bn of the €17.5bn in question – was provided by the NPRF. The result was that by the end of 2011, some 60 per cent of the fund's assets were in what since 2009 had been designated its "directed portfolio". Although the remaining investments, which were held in what was now termed the "discretionary portfolio", performed relatively well and recorded an increase in their value over the years 2010 and 2011, those in the "directed portfolio" recorded substantial losses as the bank share prices fell. The net result was that the fund as a whole was losing money. Equally important, whilst the assets of discretionary portfolio continued to be counted as an offset to public debt, those of the directed portfolio did not.

**Table 5: Returns on NPRF and constituent portfolios (%), 2008-2012**

| | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| discretionary | NA | 20.6 | 11.7 | 2.1 | 7.3 |
| directed | NA | 0 | -25.7 | -58.1 | 10.4 |
| total | -30.4 | 11.5 | -3.0 | -36.7 | 9.1 |
| directed as % of total at end of year | NA | 31.0 | 33.6 | 59.7 | 58.5 |

**NA = not applicable**

**Source:** NPRF annual and quarterly reports

In the end, not even the discretionary portfolio was left alone. In 2011 the government announced an initiative whereby resources from the NPRF would be channelled towards productive investment into sectors of strategic importance to the Irish economy (NPRF, 2012). Here reference was made to the small and medium-sized enterprise sector, the high-technology sector and infrastructure. Such investments were to be made on a commercial basis, and would involve private sector partners investing their own resources. The first investment decisions were made in late 2012 and early 2013. By consenting to participate in the initiative, the fund completed its transformation from being an institution that assisted the country in meeting the cost of societal ageing to one that assisted it in restoring economic stability and engendering growth. The de facto transformation became a de jure one when, in mid-2013, the government announced plans to abolish the NPRF entirely and to hand the assets that remained in its discretionary portfolio to a new Ireland Strategic Investment Fund (ISIF) under the control of the Ministry of Finance and its National Treasury Management Agency and dedicated to making investments in the domestic economy. Moreover, although resources would continue to be allocated to the ISIF at the same level as they had previously been to the NPRF, the objective of pre-funding the cost of societal ageing was formally abandoned. The government argued that, "[w]hile the need for the state to provide for social welfare and public service pensions obligations has not abated, fostering economic activity and employment is currently a greater priority" (Dept. of Finance, 2013).

Last, it is worth noting that the UK government also saw that assets of occupational pension funds might be turned to serving macro-economic objectives. The government acknowledged that projects to develop the country's physical infrastructure could give an impetus to economic growth and have an immediate employment effect. On the other hand, it was not prepared to make the expenditures required itself, because this would increase public spending. Instead, it encouraged pension funds, and particularly those of local governments (the central government scheme is "unfunded"), to allocate a greater share of their assets to activities that would serve such a purpose, and it proposed ways in which the risks that deter them from such behaviour might be mitigated (Rowley, 2011). The government's initiative received a broadly favourable response from the pension funds and the organisations representing them, and led to the latter establishing a Pension Infrastructure Platform. On the other hand, the amount of investment this aims to generate represents at best one tenth of the £20bn of spending that the government hoped to achieve.

## 6. Conclusions

It is claimed that on being asked by the trial judge why he robbed banks, the accused, Willy Sutton, answered "because that is where the money is" (Sutton, 1976). Analogously, it might be suggested that fiscally-challenged governments took to backtracking on pension reforms and exploiting the resources of pension funds because such actions provided easy access to additional income. What is more, the actions and initiatives described in this paper went largely unchallenged.

It was probably the financial services industry, and particularly asset managers and insurance companies that earned income from their role in administering and investing the assets of second pillar pension funds and pension reserve funds, which adopted the most critical stance. The smaller

the flow of contributions into such funds was, the less business for them there was and the less economical that business became. In the case of nationalisation, as occurred in Hungary, a whole line of insurance activity was closed down (IPE, 2012a, b and c). Concerns that the Hungarian policy might be repeated were expressed by pension industry representatives in both Bulgaria – in late 2012 – and Poland – throughout the first half of 2013. In the first of these two countries, the government was under political pressure to increase spending in order to alleviate some of the hardship caused by economic downturn and the austerity measures it had taken to reduce an excessive fiscal deficit (IPE, 2012e). In the second, the fact that the government was under pressure to reduce an "excessive deficit" fuelled suspicions that the resources of the second pillar funds might be used to help improve the fiscal balance and to keep debt below the limit set by the constitution (IPE, 2013a, c and d). In the case of Bulgaria, fears have not (as yet) been realised. In Poland, by contrast, the government declared it would proceed with legislation that would hold the contribution rate to the second pillar funds at just under three per cent but require those choosing to stay in it to contribute an additional two per cent of salary, prevent the funds from investing in domestic government bonds, and allow the government to take over (and retire) their entire existing domestic bond holdings. This last would lead to a once-off reduction of government debt by eight percentage points of GDP (IPE, 2013g and h). That such proposals not only continue to be made but also to be put into effect indicates that pension funds remain low hanging fruit that is ripe for picking. The closure of the Irish National Pension Reserve Fund announced in summer 2013 indicated that, in extremis, little is sacred.

The extent to which pension fund contributors were conscious of change when their contributions stayed the same but were merely directed to another recipient is difficult to judge. Participation in funded second pillars, where it had been voluntary, had proved higher than anticipated – one of the reasons why many of the initial projections of transition costs had been over-optimistic. Nevertheless, in many countries, there has also been criticism about the charges that funds are levying and upon the performance of the investments they have been making. Fund members might not have been as aware of how well or badly they were being served as were the specialists who analysed the schemes' performance for the purposes of appraising the merits and demerits of pension reforms. However, at the same time that fears for the future of the second pillar were being expressed in Bulgaria, the government was quoted as describing current arrangements as "badly managed" (IPE, 2012e). Equally, when proposals for the closure of the second pillar in Poland and the transfer of its assets back to the first pillar were first discussed, concerns about the level of charges were also being expressed (IPE, 2013g). Moreover, the Hungarian government made reference to shortcomings with respect to both charges and investment performance when justifying its abolition of the second pillar (IPE, 2013a; Simonovits, 2011). Whether Hungarian savers were thankful for what was done is less clear. There have been suggestions that the government's action diminished trust in domestic financial institutions and even precipitated efforts by holders of bank accounts to move funds abroad for fear that the assets they held there might also be taken (Eddy, 2012). The same might be said with respect to Cyprus. There are indications that the members of some provident funds, being so disenchanted by the cut in the value of the pay-out that these will make, have been successful in demanding their dissolution.

The extent to which actions taken with respect to reserve funds attracted attention is likely to have been influenced both by the prominence of the intervention and by the size of the fund. When the French government announced its proposals to access the FRR earlier than initially envisaged, it provoked the critical response that resources which had been allocated to help finance the old age of the baby boomers were now being used to finance the old age of the "papy boomers" (Bridier, 2012). On top of this came arguments that the move was symptomatic of too great a reliance being placed on a pay-as-you-go rather than a funded scheme – the reserve fund being one of the ways in which a diversification of financing was being supported (Amenc et al, 2010). Within any one reserve fund, an increasing concentration on domestic investments runs counter to the principle of diversification. The Irish NPRF, before the government started directing its investments,

had had almost none of its investments in its home country, and that had been part of a deliberate strategy. Moreover, it might be asked how prudent it was for the Spanish FRSS to have increased exposure to domestic government bonds. The price of these did, initially, rise, but it has been volatile and has fallen as confidence in the government's ability to manage a way out of the crisis evaporates. Equally, the logic of using pension fund resources to finance infrastructure can also be questioned. Certainly, with respect to the UK, it could be argued that pension funds would require a higher return on their investment than the government would have to pay were it to borrow outright. In addition, had the government borrowed outright, it could have issued the sort of long-term bonds for which pension funds are said to be hungry.

The depletion of the Polish FRD provoked repeated criticism from the Monetary Policy Council of the country's national bank, which saw the use of its resources to pay for the on-going service of old-age pension benefits as not supporting the long-term sustainability of public finance (NBP, 2010). Similarly, the head of the Spanish FRSS conceded that tapping into the reserve fund for extraordinary payments could lead to "some problems" in the future if the country's economy does not improve (IPE, 2013f). On the other hand, responses to the transformation of the Irish NPRF have been somewhat ambiguous. From its inception, there had been some who had asked why resources had been paid into the fund at the same time that public investment needs were unmet (Slattery, 2010). Once the crisis hit Ireland with its full force, there were those who pointed out it was cheaper for the government to borrow from the NPRF than from other, external sources (Moriaty, 2012). Nonetheless, the changes the government made to its remit meant that it took on the role first of supporting the banking system and then of modernising the entire economy. Whether the fund will ever be able to recoup the losses incurred on its directed portfolio is highly questionable. On the other hand, if bank recapitalisation was a necessary condition for recovery to ensue, ensuring it was achieved would enhance Ireland's ability to make acceptable provision for an ageing society in the years after 2025. Equally, the government justified the transformation of the fund into a provider of infrastructure finance with the argument that using its resources for this purpose would "put the state in a better position to meet its pensions obligations in the longer term" (IPE, 2013e).

Of greatest interest, however, are the responses to the actions and initiatives described in this paper from those who were monitoring fiscal conduct. The governments of the member states file stability or convergence reports on an annual or biannual basis with the EC, which comments upon them and uses them to prepare the recommendations issues by the European Council. It was a fear of the strictures and criticisms that might be levelled at them which had prompted countries that had undertaken pension reforms generating transition costs to press for an extension of forbearance when their fiscal deficits were being appraised. The response that they received suggested that they should, instead, pursue even stricter austerity programmes. However, when the Commission came to comment on the switching of contributions back to the first pillar of the pension system, it was remarkably uncritical. Its response to the Latvian government's convergence report is worthy of citation. Referring to the six percentage point reallocation of contributions to pillar one – one of the more substantial re-diversifications and one for which, at that time, plans for any reversal remained rather vague – it described it as "a temporary measure [that can be] excluded from the structural balance. Thus, its reversal in 2013 will affect only the nominal but not the structural balance" (EC, 2012a, p9). Indeed, in mid-2012 both the Commission and the European Central Bank were able to report that the country was satisfying convergence criteria and would be permitted to join the common currency at the start of 2014. Estonia, another country that had temporarily suspended contributions to the second pillar to improve its fiscal deficit, was deemed fit for membership in 2010. Lithuania, which was able to take advantage of the SGP provision that allowed transition costs, to be offset, exited its excess deficit procedure in spring 2013 and followed this up with a request for approval of its application to join the common currency to be speeded up.

When making its first review of Portugal's progress under the terms of the Eurozone bailout, the Commission referred to the pension fund sequestrations that its government had made, but it described these as contributing to short-term stabilisation and did not censure them (EcoFin, 2011).

Yet more noteworthy, however, was response of the Commission when it, together with the European Central Bank (ECB) and the IMF, it was constructing a rescue package for Ireland. In this case, it formally approved the recasting of the role of the NPRF, as an integral part of the programme it was signing off. Only the nationalisation of the second pillar funds in Hungary appeared to provoke concern. Here, the Commission concluded that although this "account[ed] for a large part of the sharp debt reduction in 2011, [it] significantly increase[d] the long-term implicit liabilities of the budget" (EC, 2011 p10).

What is noteworthy in the last of these judgements is the term "implicit". The actions and initiatives were undertaken because they brought about short-term fiscal relief. Although they were seen as being no more than palliative, they were not, per se, condemned. The targets set by the Maastricht process as it was initially established, and even those that were subsequently imposed, were all concerned with the short-term. Even the Medium Term Objectives that governments are supposed to fulfil refer only to the next five years. Moreover, the targets were for explicit deficits – more specifically, explicit structural deficits – and explicit debt. Despite the fact that the Commission, via its Ageing Working Group, has produced projections of pension expenditure until well in the future, it has not sought to convert the stream of expenditures into current debt and thereby to make it explicit. Yet more important, although some individual governments have reported their estimates of implicit debts when making up their own national accounts, the European System of National Accounts, which they have to apply when reporting their fiscal position, do not record such debt (European Parliament, 2011; see also Lojsch et al, 2011). Accordingly, any re-diversion of contributions to the first pillar pension is counted as a revenue gain, whilst any future first pillar pension entitlements that are built up as a consequence are not recognised as additional expenditures that have to be offset against it. The same applies when pension funds are sequestered or nationalised. Such actions can produce substantial income in the year that they occur – income that, in that year, far exceeds the costs of the pensions that will have to be paid in the future if contractual entitlements are respected.

Prematurely accessing pension reserve funds does have an impact upon a government's fiscal balance in so far as a reduction in the value of assets held is the equivalent of an increase in government debt. The smallness of the sums involved relative to total debt of the countries concerned might explain why the premature access of such funds has incurred scarcely any mention when the fiscal stance of these countries has been evaluated. So, too, might be the fact that the Maastricht debt targets have never been enforced with the same rigour as the deficit targets. What is more, in the case of Ireland, the increase in debt that resulted from the reclassification of a substantial share of the reserve fund's assets was an integral part of the rescue package that the EC, the ECB and the IMF had helped draw up and to which they gave their formal approval.

In short, there were few restraints upon governments using pension funds as piggy banks. Indeed, that they could do so was one of the perverse consequences of the Stability and Growth Pact. What is much less clear is what the wider costs and benefits of their actions were. Making judgements about these requires making projections of the retirement benefits that contributors might expect under pension schemes before and after the latest round of reform, re-reform or un-reform. The outcome of such exercises is often highly sensitive to the assumptions on which they are based. It also requires making judgements about whether using resources now to cope with current challenges is more productive than setting these resources aside to cope with projected future challenges. The decisions that are made in such cases are usually based upon the weight policymakers give to the interests of today's generations relative to those of tomorrow's generations and this, implicitly, determines the discount rate that is used. More important than this, however, making judgements about the wider costs and benefits of the actions described in this paper requires an evaluation of the appropriateness and efficacy of the overall macro-economic strategy that European governments are pursuing. All this, however, is beyond the scope of this paper, which merely aims to show what happened once governments had adopted such a strategy requiring them to concentrate attention on reducing fiscal deficits and debts. When this became the objective, and

when it was headline deficits and debt to which most attention was paid, it was hardly surprising that they were tempted to use pension funds as piggy banks.

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# Effects of demographic changes on hospital workforce in EU countries

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**Abstract:** Demographic trends and ageing are one of the main factors influencing future trends in the socio-economic development of all European countries expressed in significant changes in labour market structure. This paper analyse the influence of demographic changes on hospital health care demand based on utilization method and its direct influence on increasing demand for health care personnel. The employed methodology is based on previous work (Schultz et al., 2013) and (Schultz (a), 2013). Main driver of expected changes in demand and utilization is represented by FP7 NEUJOBS3 project tailor made demographic projection by friendly and tough scenarios. Presented cross-country comparison shows, that despite the similar demographic trends in all European countries, the situation in health care demand, especially length of stay and number of discharges (ind. trends) is significantly different. Development of expected hospital utilization is based on rather simple time series analysis. On the other side, the main purpose of this paper is to present the broader overview of possible labour force shortages in specific sector of employment. We were unable to incorporate all EU countries in this study due to incomplete data sources.

**Keywords**: Hospital workforce, ageing, hospital utilization

**JEL Classification:** I15, J23, C22

## 1. Introduction

During the last decade most of the EU countries made changes in provision of hospital services, they reduced the number of hospital facilities, as well as the number of hospital beds. In 2008 there were in Europe on average 2,6 hospitals and 530 hospital beds for 100 000 inhabitants but between 1998 and 2008 the average number of hospitals decreased by about 6 % and the total number of hospital beds per 100 000 inhabitants decreased by about 18 %. Hence in the last ten years we can observe in Europe falling numbers of hospital beds resulting in a broad reduction of acute care admissions and length of stay, as well as in improvements in the occupancy rate of acute care beds. A shift from inpatient treatment to outpatient treatment noticed within the hospitals was caused by various factors as for example relative costs, consumer preferences, technological advances, increased usage of day-hospital and day surgery and more efficient methodologies of hospital financing in order to incentivise appropriateness (e.g. the replacement of daily payments - known to encourage longer hospitalization - by prospective payment). With regard to these patterns, the forces restraining the growth of hospital employment are clearly substantial, opposing the increasing number of older people (European Hospital and Health care Federation, 2011).

In general, health care sector seems very promising in creating additional demand from labour force point of view, which is in the line with increasing labour force demand in the healthcare sector as was confirmed by the latest European Vacancy Monitor published by European Commission in September 2013. Between 2008 and 2012 employment in the EU health care sector has grown almost 2 % annually mainly due to the ageing population, advances in technology and treatments, higher expectation of service quality and greater emphasis on preventative care (European

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[3] For more details see www.neujobs.eu

Commission, 2013). More detailed analyses of employment in health care sector are provided in (Schultz, 2013(a)).

This paper is providing an overview of the situation within the horizon of 20 years how ageing population and the trends in health care utilization can influence the demand for health care services and labour force focusing on hospital health care[4]. The artide is structured as follows: in section 1 we discuss methodological approach, in section 2 we discuss demographic trends in EU countries based on NEUJOBS demographic scenarios and in section 3 we deal with trends in hospital care utilization based on length of stay and ratio of discharges during period of 2002 to 2010. We summarise and discuss the results of net effect on additional demand for hospital services in section 4.

## 2. Methodology

In this paper we assume a group of main drivers resulting in a change of demand for hospital workforce. An overview of methods for estimating demand and supply for health workforce can be found in (Schultz et al., 2013). As we focus only on demand side (we assume, that current demand is met and any current shortages are not incorporated into the estimation), we can utilize one of four available methods of estimation[5]:

- *need based approach* – comprehensive method based on estimation of health status of all persons in the community and their prevalence to disability and diseases,
- *utilization method* – estimation based on current observed trends of service utilization,
- *economic estimation method* –method based on incorporating observed relation of demand for health services and any other indicator into the econom(etr)ic model,
- *benchmarking method* – method based on setting workforce-to-population ratio of best performing country as optimal (benchmark) ratio in relation to analysed country.

All approaches have several pros and cons. Preferred method in terms of data availability is an utilization method. For estimating the effect of ageing on demand for hospital health care we are using two crucial indicators – change of total treatment days and change of population. To indicate the changes we are using 5-year age groups. We will estimate the effect of population change in 2025 in respect to two demographic NEUJOBS scenarios – tough and friendly. Total number of treatment days will be differentiated by two approaches. Static scenario will consider actual utilization – both average length of stay and average number of discharges by 1000 people will remain stable over forecast period and purely change of population within 5-year age groups will have effect. Dynamic scenarios will consider the current trends in average number of discharges as well as in average length of stay. As initial period to indicate trends we have selected period from 2002 to 2010, for which data were available for most of the countries[6]. This approach shows the need of constraint, where past trend is steep, simply because estimated value in 2025 was negative, or too positive with comparison to other countries. Therefore, we have appended the constraint to yearly growth (both positive and negative) to 1 % of actual value. Indicative trend and threshold value for constraint is presented at Figure 1. As a result, we provide four different scenarios of

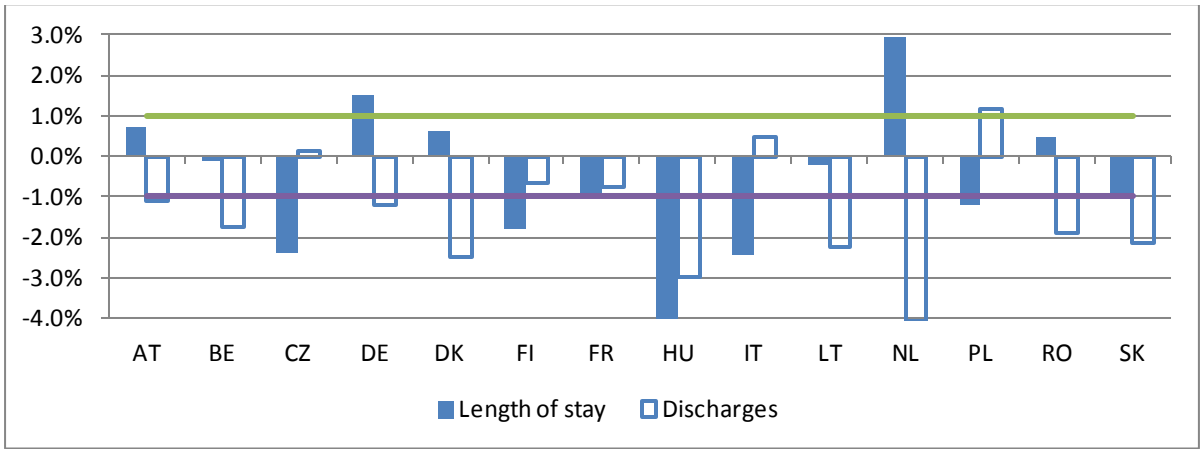
[4] More details about the impact of ageing population on curative health care workforce for particular countries (e.g. Germany – Schultz, E., 2013a; Denmark - Schultz, E., 2013b; Poland – Golinowska, S., Kocot, E., Sowa, A., 2013, Slovakia – Radvansky, Dováľová 2013) could be found on NEUJOBS project webpage: http://www.neujobs.eu/publications.

[5] For estimation of supply there are in (Schultz et al., 2013) indicated three abailable methods – time series approach, stock and flow method and top down approach

[6] If shorter period was available but not more that three data was missing, we have used this shorter period.

demand for hospital services. Main assumption of these estimation is, that the demand relation between number of treatment days and needed employment will remain constant, in other words one nurse is able to cover similar number of treatment days over time.

**Figure 1 – Indicative growth of indicators of utilization and constraint value**

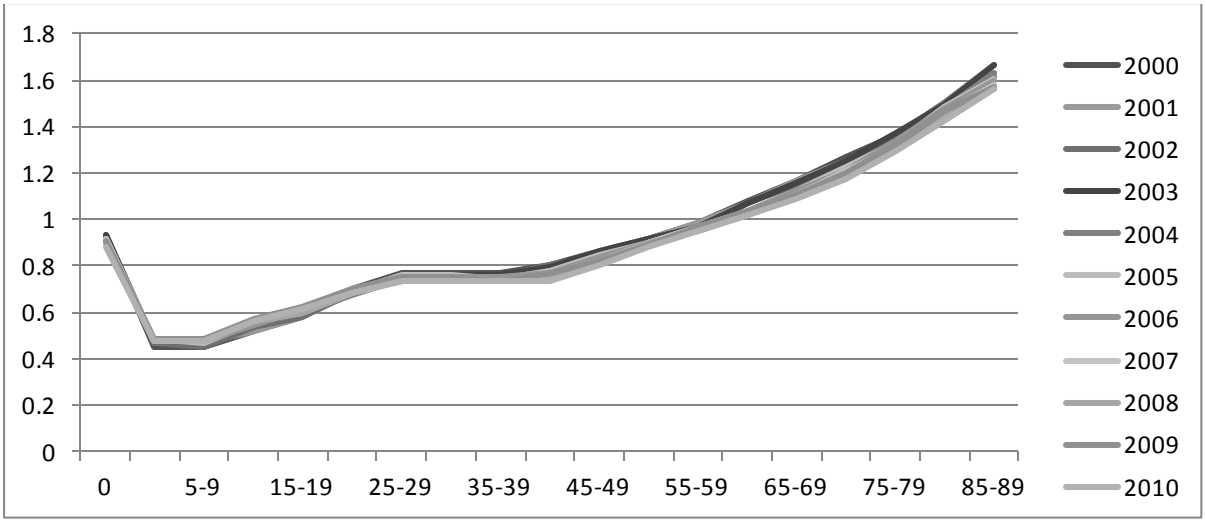



**Source: Author**

For analysis of the effect of ageing, there is one important factor. Relation of length of stay of particular age group to country average remains over time pretty stable (see Figure 2), even when patterns between countries are different (Figure 4). Similar observation could be done in relation to number of discharges. In case of decreasing (increasing) average value of utilization indicator, the changes are almost proportional in relation to all age groups. Therefore, the trend analysis for country average in dynamic scenarios was sufficient and average distribution between age groups was applied afterwards.

Generally we can say that national patterns in health care utilization within age groups are strong and we could not observe cross country effect in initial period. In any case, this assumption should be under surveillance.

**Figure 2 – Ratio of length of stay within age group to country average over time (France)**




**Source: Author**

## 3. Ageing in EU countries

Past changes in dynamics processes that led to the current demographic profile of Europe as well as the contemporary and ongoing trends carry significant consequences in terms of European

population demographic structure and in terms of the dynamics pertain to the total population change.

In the following tables we can see the development of main demographic indicators for selected member countries of the European Union from 2010 till 2025. Calculations are based on NEUJOBS demographic scenarios (tough and friendly). In tough scenario authors assume a constant fertility rates and a moderate increase in life expectancy in comparison with friendly scenario where authors assume an increase in fertility rates and a higher increase in life expectancy, which can cause that total dependency ratio, old dependency ratio and young age dependency ratio are higher in case of friendly scenario (Huisman, C., Joop de Beer et al., 2012).

**Table 1 Main demographic indicators for selected EU countries in 2010**

| | Young population under 20 years as a % of total pop. | Working age pop. (15-64) as % of tot.pop. | Elderly population (65 +) as a % of total pop. | Very elderly population (80+) as a % of total pop. | Yound age dependency ratio | Total age dependency ratio | Old –age dependency ratio |
|---|---|---|---|---|---|---|---|
| AT | 20,8% | 67,5% | 17,6% | 4,8% | 22,0% | 48,1% | 26,1% |
| BE | 22,9% | 65,9% | 17,2% | 4,9% | 25,6% | 51,7% | 26,0% |
| BG | 19,1% | 68,9% | 17,5% | 3,8% | 19,7% | 45,1% | 25,4% |
| CZ | 20,1% | 70,6% | 15,2% | 3,6% | 20,2% | 41,7% | 21,6% |
| DE | 18,8% | 65,9% | 20,7% | 5,1% | 20,5% | 51,8% | 31,4% |
| DK | 24,4% | 65,6% | 16,3% | 4,1% | 27,6% | 52,4% | 24,9% |
| EE | 21,2% | 67,8% | 17,1% | 4,1% | 22,3% | 47,5% | 25,2% |
| FI | 22,9% | 66,4% | 17,0% | 4,6% | 25,0% | 50,6% | 25,6% |
| FR | 24,5% | 64,8% | 16,8% | 5,3% | 28,3% | 54,3% | 25,9% |
| HU | 20,8% | 68,6% | 16,6% | 3,9% | 21,5% | 45,7% | 24,2% |
| IT | 19,0% | 65,7% | 20,2% | 5,8% | 21,4% | 52,2% | 30,8% |
| LT | 22,2% | 68,9% | 16,1% | 3,6% | 21,8% | 45,0% | 23,3% |
| NL | 23,7% | 67,1% | 15,3% | 3,9% | 26,2% | 49,0% | 22,8% |
| PL | 21,8% | 71,3% | 13,5% | 3,3% | 21,2% | 40,2% | 19,0% |
| PT | 20,5% | 66,9% | 17,9% | 4,5% | 22,7% | 49,4% | 26,7% |
| RO | 21,0% | 69,9% | 14,9% | 3,1% | 21,7% | 43,0% | 21,4% |
| SE | 23,4% | 65,3% | 18,1% | 5,3% | 25,4% | 53,1% | 27,7% |
| SK | 22,1% | 72,4% | 12,3% | 2,7% | 21,2% | 38,1% | 16,9% |
| SL | 19,2% | 69,4% | 16,5% | 3,9% | 20,2% | 44,0% | 23,8% |
| UK | 23,8% | 66,1% | 16,5% | 4,6% | 26,4% | 51,3% | 24,9% |

**Source: based on Huisman et al., 2012**

The comparison of demographic indicators from 2010 (Table 1) with those in 2025 (Table 2) shows that the challenge and extend of the population ageing is different for particular countries. Looking at the data it is no doubt that almost all European societies are getting older, but the difference is that some societies are ageing faster than others. The ongoing process of ageing European population can be illustrated by changes in the proportions of the main age groups to the total population. According to the prognosis, it can be noticed that from 2010 till 2025 (friendly scenario) the share of older people (aged 65+) in the total population will increase at a much faster rate for countries like Poland (6.7 p.p.), Finland (6.3 p.p.), Netherland (5.9 p.p.), Slovakia (5.8 p.p.) and Czech republic (5.3 p.p.) than for the countries like Sweden (2.6 p.p.), Lithuania (2.8 p.p.), United Kingdom and Belgium (3.1 p.p.). This trend will be accompanied by shrinking proportion of working age group to the total population which will be most significant in Poland, Finland (-6.7 p.p.), Czech Republic (-6.0 p.p.), Slovenia (-5.9 p.p.) and Slovakia (-5.7 p.p.) with the projected fairly constant proportion of young population under 20 years in most of the countries.

Different trends among particular age-groups lead to higher old-age dependency ratio (people aged 65 or above relative to those aged 15-64) in most countries, especially in Finland (13.4 p.p.), Poland (12.3 p.p.), Netherland (11.1 p.p.), France (10.6 p.p.) and Czech and Slovak Republic (10.2 p.p.) with even higher growth of total age dependency ratio in general (people aged below 15 and above 65 relative to those aged 15-64).

**Table 2 Main demographic indicators for selected EU countries in 2025; friendly scenario**

| | Young population under 20 years as a % of total pop. | Working age pop. (15-64) as % of tot.pop. | Elderly population (65 + ) as a % of total pop. | Very elderly population (80+) as a % of total pop. | Youndage dependency ratio | Totalage dependency ratio | Old – age dependency ratio |
|---|---|---|---|---|---|---|---|
| AT | 19,5% | 64,3% | 21,1% | 6,4% | 22,6% | 55,4% | 32,9% |
| BE | 23,0% | 62,5% | 20,3% | 5,5% | 27,6% | 60,0% | 32,4% |
| BG | 19,4% | 64,5% | 21,4% | 4,8% | 21,9% | 55,0% | 33,1% |
| CZ | 20,5% | 64,5% | 20,5% | 4,8% | 23,2% | 55,0% | 31,8% |
| DE | 17,7% | 62,4% | 24,3% | 7,7% | 21,2% | 60,2% | 39,0% |
| DK | 23,1% | 62,4% | 20,4% | 5,4% | 27,7% | 60,3% | 32,6% |
| EE | 22,2% | 63,2% | 20,2% | 6,0% | 26,3% | 58,2% | 32,0% |
| FI | 22,5% | 59,7% | 23,3% | 6,0% | 28,6% | 67,6% | 39,0% |
| FR | 23,7% | 60,2% | 22,0% | 6,5% | 29,7% | 66,1% | 36,5% |
| HU | 18,9% | 65,0% | 21,2% | 5,7% | 21,1% | 53,8% | 32,7% |
| IT | 18,0% | 63,5% | 23,4% | 7,8% | 20,6% | 57,4% | 36,8% |
| LT | 21,8% | 64,5% | 18,8% | 4,8% | 25,9% | 55,1% | 29,2% |
| NL | 21,9% | 62,4% | 21,2% | 5,3% | 26,3% | 60,2% | 33,9% |
| PL | 20,3% | 64,6% | 20,2% | 4,3% | 23,5% | 54,8% | 31,3% |
| PT | 18,8% | 65,1% | 21,3% | 5,7% | 20,8% | 53,5% | 32,7% |
| RO | 19,8% | 66,9% | 18,5% | 4,4% | 21,7% | 49,4% | 27,7% |
| SE | 24,2% | 60,8% | 20,7% | 6,1% | 30,5% | 64,6% | 34,1% |
| SK | 20,4% | 66,7% | 18,1% | 3,7% | 22,9% | 50,0% | 27,1% |
| SL | 19,8% | 63,6% | 21,6% | 5,7% | 23,3% | 57,3% | 33,9% |
| UK | 24,0% | 62,4% | 19,6% | 5,7% | 28,8% | 60,1% | 31,3% |

**Source: based on Huisman et al., 2012**

The total population in five countries (Bulgaria, Germany, Hungary, Lithuania and Romania) decreases in both tough and friendly scenarios, but the decrease in tough scenario is stronger than in the friendly scenario. In tough scenario there is expected, that population will decrease also in countries like Austria, Czech Republic, Estonia, Poland, Portugal and Slovakia. Working age population decreases even faster in most of the selected EU countries, in friendly scenario it is expected moderate growth only in six of these countries (Austria, Belgium, Denmark, Italy, Sweden and United Kingdom) but on the other hand in tough scenario only Bulgaria, Sweden and United Kingdom will experience moderate growth. The distinction between two scenarios in this case is mainly caused by different assumptions on migration.

**Table 3 Main demographic indicators for selected EU countries in 2025; tough scenario**

| | Young population under 20 years as a % of total pop. | Working age pop. (15-64) as % of tot.pop. | Elderly population (65 + ) as a % of total pop. | Very elderly population (80+) as a % of total pop. | Youndage dependency ratio | Totalage dependency ratio | Old – age dependency ratio |
|---|---|---|---|---|---|---|---|
| AT | 19,1% | 65,3% | 20,7% | 5,7% | 21,4% | 53,0% | 31,7% |
| BE | 23,1% | 63,2% | 19,5% | 4,7% | 27,3% | 58,2% | 30,9% |
| BG | 19,0% | 65,1% | 21,5% | 4,2% | 20,7% | 53,7% | 33,0% |
| CZ | 20,3% | 65,4% | 20,1% | 4,1% | 22,3% | 53,0% | 30,7% |
| DE | 17,3% | 63,4% | 23,9% | 6,9% | 19,9% | 57,7% | 37,7% |
| DK | 23,3% | 63,1% | 19,6% | 4,6% | 27,4% | 58,4% | 31,0% |
| EE | 22,2% | 63,1% | 20,7% | 5,6% | 25,7% | 58,4% | 32,7% |
| FI | 22,7% | 60,5% | 22,4% | 5,2% | 28,2% | 65,3% | 37,1% |
| FR | 23,9% | 60,7% | 21,3% | 5,8% | 29,6% | 64,6% | 35,0% |
| HU | 18,3% | 66,6% | 20,5% | 5,1% | 19,4% | 50,2% | 30,7% |
| IT | 17,4% | 64,5% | 23,1% | 7,1% | 19,2% | 55,0% | 35,9% |
| LT | 21,7% | 65,4% | 18,2% | 4,1% | 25,1% | 53,0% | 27,9% |
| NL | 21,9% | 63,1% | 20,6% | 4,6% | 25,9% | 58,5% | 32,6% |
| PL | 19,8% | 65,7% | 19,8% | 3,7% | 22,1% | 52,2% | 30,1% |
| PT | 17,9% | 66,6% | 20,8% | 4,8% | 19,0% | 50,2% | 31,3% |
| RO | 19,4% | 67,4% | 18,7% | 3,9% | 20,6% | 48,3% | 27,7% |
| SE | 24,4% | 61,4% | 20,0% | 5,3% | 30,2% | 62,8% | 32,6% |
| SK | 19,9% | 67,8% | 17,6% | 3,2% | 21,6% | 47,6% | 26,0% |
| SL | 19,6% | 64,3% | 21,2% | 5,1% | 22,5% | 55,5% | 33,0% |
| UK | 24,3% | 63,0% | 18,8% | 5,0% | 28,9% | 58,8% | 29,9% |

**Source: based on Huisman et al., 2012**

Also in tough scenario in most of the selected EU countries, grey pressure, which can be expressed as the number of people aged 65+ divided by working age population (15-64 year old) increases quite substantially till the end of 2025. The highest shares of inhabitants aged more than 80 years will be registered in countries like Denmark, Estonia, Italy, Slovenia and Hungary. These demographic changes will be able to have a strong impact on the future design of health care systems in Europe as well as on employment in this sector.

# 4. Estimating the demand for hospital care

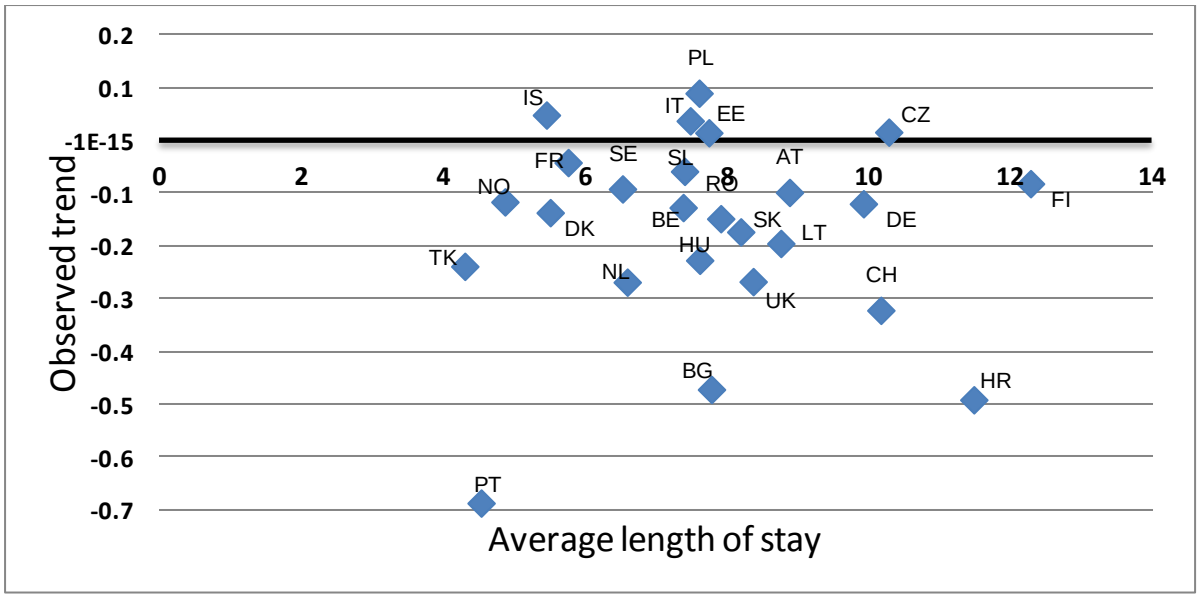
Future demand for health care and hospital care can be affected by various factors, such us prevalence to diseases, age structure, climate conditions, etc.. Hospital utilization can be most appropriate illustration by number of care days. Total care days consists from two components – average length of stay (can be divided by age group) and number of hospital discharges[7] (related to number of hospital cases). These indicators of hospital activities could be influenced by a number of factors as increasing demand for hospital services caused by ageing population.

Average length of stay in hospitals[8] is very often used as an indicator of efficiency or indicator of technological development. A shorter stay in hospital can reduce the cost per discharge and it can shift health care from inpatient to less expensive post-acute settings, but on the other hand shorter stays tend to be more service intensive and more costly per day. In the cases when length of stay is too short, it could negatively affect health outcomes, comfort and recovery of patient. In general, the trend in OECD countries has decreasing tendency as the average length of stay in hospitals has fallen over the past decade in nearly all OECD countries – from 8.2 days in 2000 to 7.2 days in 2009 on average across OECD countries (OECD, 2011). Trends in discharges are not so obvious and clear, they vary across OECD countries.

## 4.1. Average length of stay

Overview of average length of stay and observed trend is ilustrated at Figure 3.

**Figure 3 Average length of stay (in days) vs. average past trend between 2002-2010**




**Source: Authors**

[7] Number of people who need to stay overnight in hospital each year (OECD, 2010).

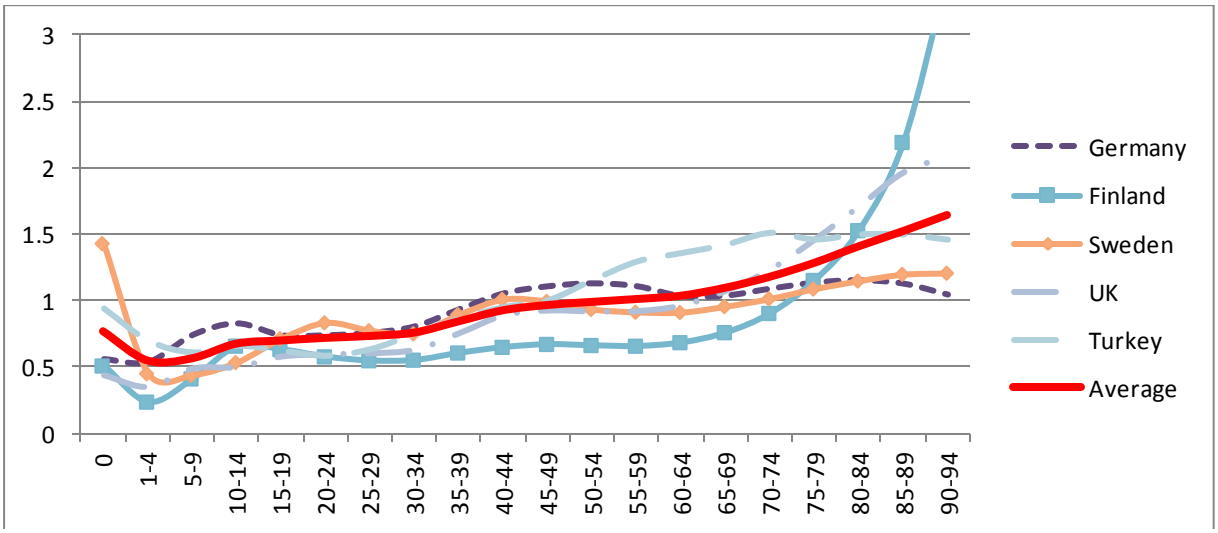
[8] Average length of stay refers to the average number of days that patients spend in hospital. It is generally measured by dividing the total number of days stayed by inpatients during a year by the number of admissions or discharges (OECD, 2011).

We can observe, that between the years 2002-2010 the decreasing trend of length of stay in hospitals was observed across the European countries, with the only exception being in Island, Italy, Estonia, Czech Republic and Poland. Most of the countries fit into the average length of stay interval of more than 4 and less than 10 days. Declining average length of stay is connected with the pressure to more efficient health care systems, technological change and reforms of existing social models.

Development of this indicator among the selected countries shows different patterns when considering the age structure of the patients.

The average length of stay was relatively high for the newborn patients but then declined to lowest numbers for the category of 1-4 years old patients. Overall, the average trend during the years 2002-2010 was increasing length of stay corresponding with rising age of the patients. This trend was particularly strong for the patients 60 years and older, as was observed in Finland and United Kingdom, with moderate growth in Sweden and even decline in Germany.

**Figure 4 Different patterns of average length of stay in selected countries by age groups, (2002-2010)**



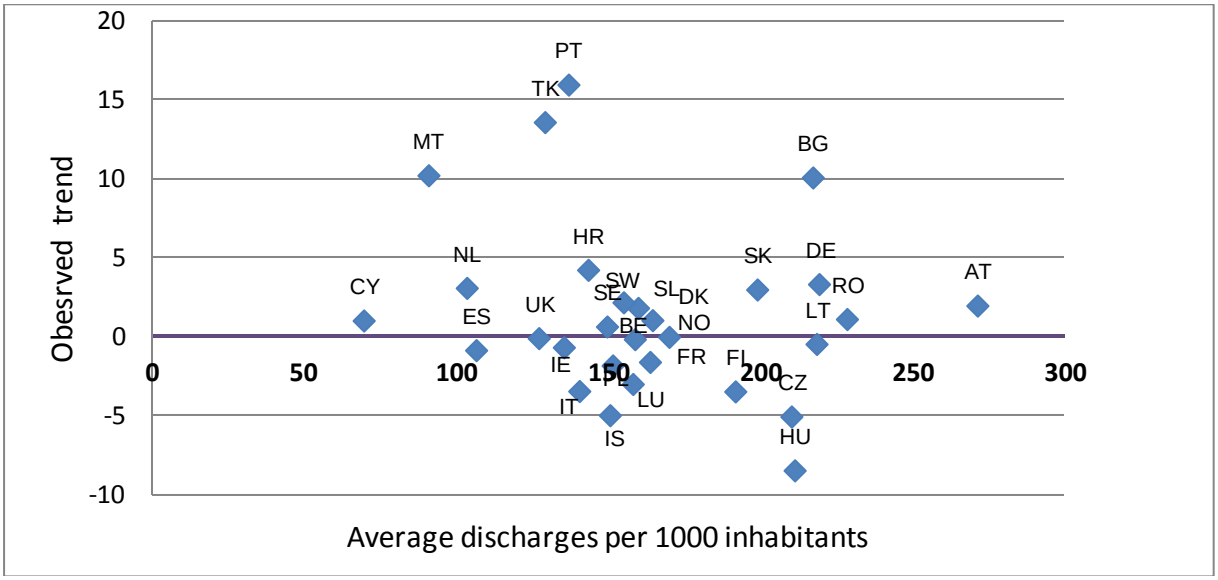

**Source: Authors**

## 4.2. Hospital discharges

Trends in average discharges per 1 000 inhabitants are in European countries more heterogeneous (Figure 5) than in the category of length of stay mentioned above, when there are several countries which experienced increasing discharge rates (including e.g. Bulgaria, Portugal, Germany), several countries with decreasing discharge rates (including e.g. Czech republic, Hungary, Finland) and on the other hand there is also group of countries with relatively stable rates in this indicator (including e.g. Sweden or Norwegian).

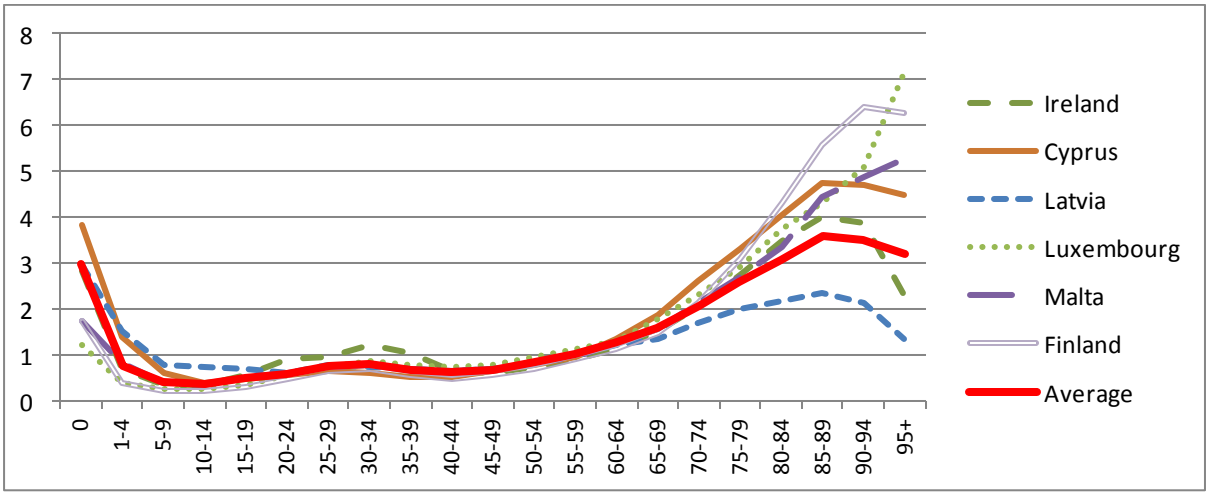
When considering development of average discharges according to the age structure of patients, the trend was varying during the life time. On the average, discharges were staying relatively flat for patients between 5-60 years old and showing relatively high numbers for newborn or very young patients and also for the patients older than 60 years. These patterns are connected with demand for more health care within the categories of new born and older and are similar to the development of average length of stay indicators when considering the age structure of the patients. In the future the demand for hospitalization can grow due to the ageing population, since older people account for disproportionately high percentage of hospital discharges in all countries (Figure 6).

**Figure 5 Average rate of discharges vs. average past trend between 2002-2010**




**Source: Authors**

**Figure 6 Different patterns of rate of discharges in selected countries by age groups, (2010)**



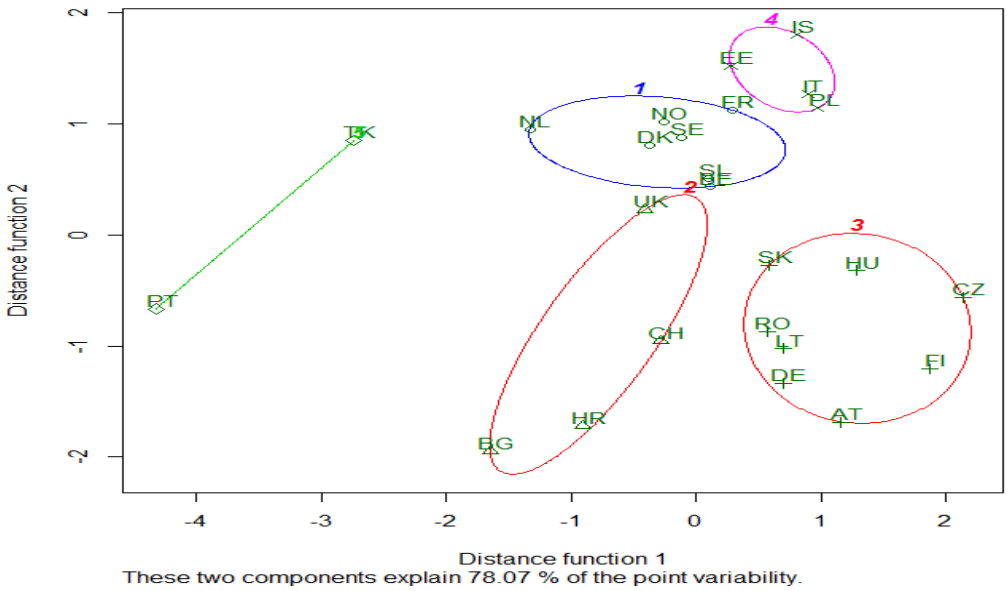

**Source: Authors**

## 4.3. Similarities in hospital health care trends

A multidimensional clustering method is applied to divide selected countries into groups with similar hospital health care utilization profiles characterized by average number of discharges per 1 000, average length of stay in hospitals (days), and trends for both of these indicators during the period 2002-2010. This method provides more comprehensive understanding of the characteristics of different trends of hospital health care utilization. On Figure 7 we can see five clusters with different size and utilization patterns. From the data analysis it can be seen that clusters 1 and 2 have relatively high average number of discharges per 1 000 persons with positive trend and relatively high average length of stay in hospitals with negative trends. Cluster 5 has the same trends development as above mentioned clusters but on the other hand the average values of indicators are much lower. Countries in third cluster have on average the highest utilization rate characterised by discharges per 1 000 persons as well as one of the highest utilization rate characterised by length of stay in hospitals but with decreasing trends in both indicators. Countries in cluster 4 have on average

relatively low initial situation in these two indicators with negative trend in number of discharges and positive trend in length of stay.

**Figure 7 Clusters with similar hospital health care utilization profiles (2002-2010)**

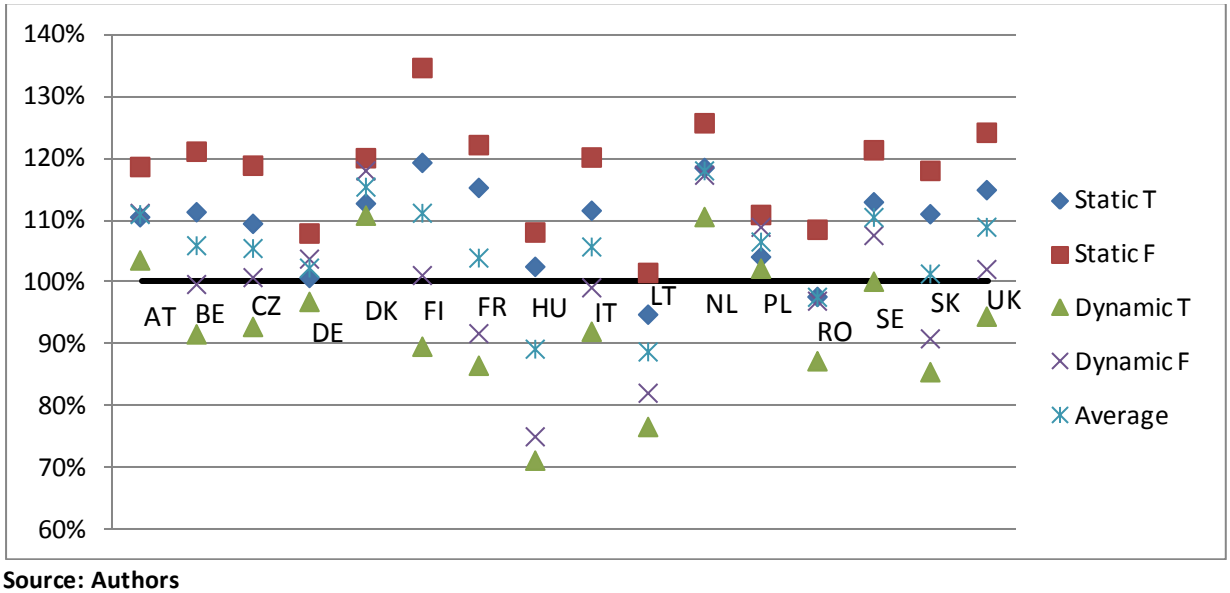



**Source: Authors**

## 5. *Estimating demand for hospital workforce*

After applying above described methods and population forecast by 5 year age groups we have obtained results for labour demand in hospital care. When we assume, that in 2010 there were no shortages in hospital labour, we can see that the expected demand in 2025 will be in selected countries significantly different (Figure 8).

**Figure 8 Demand for hospital workforce in 2025, all scenarios and average value**



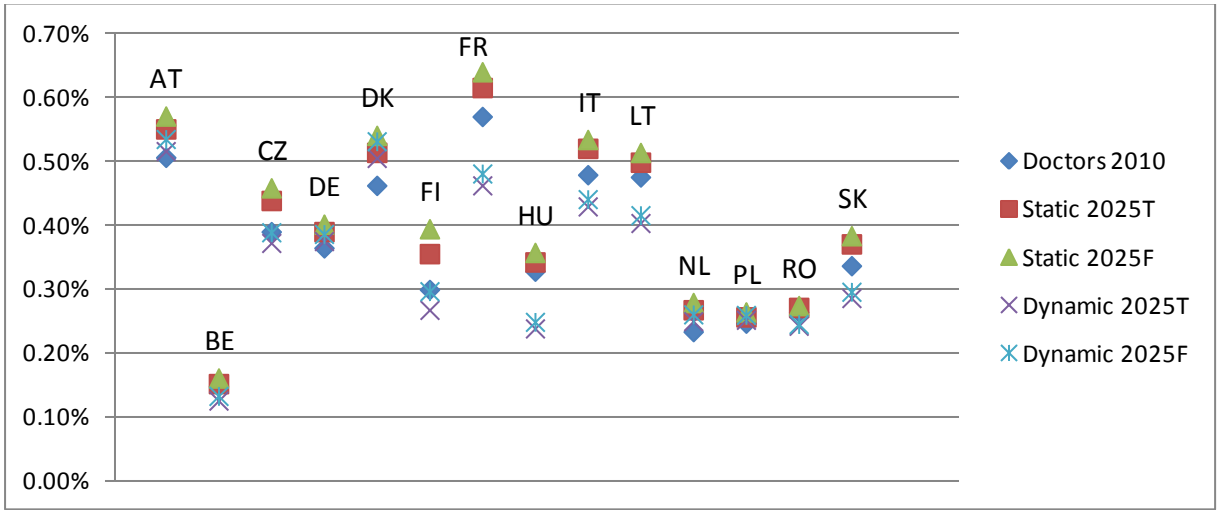

**Source: Authors**

The most positive scenario for all countries was static friendly scenario, in which crucial factors were positive demographic development in terms of total population, as well as significant ageing and constant hospital utilization over time. All factors plays pro-demand role and leads to increase demand for hospital workforce in all countries. On the other side, most negative scenario in

terms of labour demand is dynamic tough scenario. In some cases this scenario leads to significant decrease of total population together with general decrease of individual needs for healthcare services. In this case is in most of the country's sufficient current employment level and in some even significant decrease of total demand. When considering average value of these scenarios as most appropriate and probable, there are only three countries with expected decrease of demand for hospital services – Hungary, Latvia and Romania.

Both friendly and tough NEUJOBS population scenarios come with projection of total labour force. Very interesting result of this analysis is, that due to the change in total labour force, the share of doctors in some countries remains almost identical for all scenarios (for example Poland and Belgium) in Figure 9.

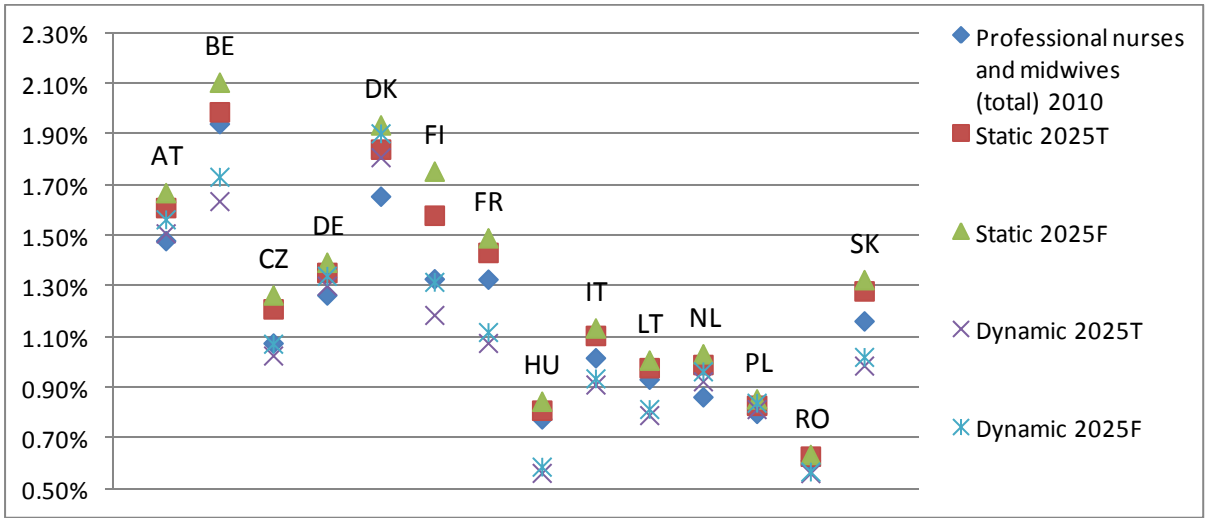
**Figure 9 Share of doctors on total labour force within all scenarios (2025) and current status (2010)**




**Source: Authors**

More chalenging is the situation with nursing personnel in hospitals (Figure 10), which has similar trends. The expected share of nurses on total labour force differs between 0,5 % to 2,3 %. In most countries is the difference of employment levels between static and dynamic scenarios more significant than between tough and friendly scenarios. These results are caused by different labour force forcecast, but on the other hand these results show much more significant role of utilization trends contradictory to the importance of ageing process.

**Figure 10 Share of Professional nurses and midwives on total labour force within all scenarios (2025) and current status (2010)**




**Source: Authors**

In Figure 8 we can see the gross effect of ageing on hospital workforce. In this calculation not only effects of pure change of population age structure on demand for service and workforce but also a change of total population was included. In Tables 4 and 5 we present gross and net effect of ageing on demand for workforce. The change of total population is eliminated in net demand colume. In that case the difference between tough and friendly scenario is partially diminished. Similar elimination of population effect was presented in cased of considering the change of labour force in Figure 9 and 10.

**Table 4. Net effect of ageing on demand for hospital workforce – static scenario**

| | | AT | BE | CZ | DE | DK | FI | FR | HU |
|---|---|---|---|---|---|---|---|---|---|
| Though | Gross | 10% | 11% | 9% | 1% | 13% | 19% | 15% | 2% |
| | Net | 11% | 4% | 11% | 9% | 10% | 16% | 10% | 9% |
| Friendly | Gross | 18% | 21% | 19% | 8% | 20% | 34% | 22% | 8% |
| | Net | 13% | 10% | 15% | 10% | 15% | 29% | 14% | 11% |
| | | IT | LT | NL | PL | RO | SE | SK | UK |
| Though | Gross | 11% | -5% | 18% | 4% | -3% | 13% | 11% | 15% |
| | Net | 10% | 6% | 15% | 9% | 8% | 3% | 12% | 8% |
| Friendly | Gross | 20% | 1% | 26% | 11% | 8% | 21% | 18% | 24% |
| | Net | 12% | 7% | 19% | 11% | 9% | 8% | 14% | 14% |

**Source: Authors**

**Table 5. Net effect of ageing on demand for hospital workforce – dynamic scenario**

| | | AT | BE | CZ | DE | DK | FI | FR | HU |
|---|---|---|---|---|---|---|---|---|---|
| Though | Gross | 3% | -9% | -7% | -3% | 11% | -11% | -14% | -29% |
| | Net | 4% | -15% | -6% | 5% | 8% | -13% | -18% | -23% |
| Friendly | Gross | 11% | -1% | 1% | 4% | 18% | 1% | -8% | -25% |
| | Net | 6% | -11% | -3% | 6% | 13% | -5% | -16% | -22% |
| | | IT | LT | NL | PL | RO | SE | SK | UK |
| Though | Gross | -8% | -24% | 10% | 2% | -13% | 0% | -15% | -6% |
| | Net | -10% | -12% | 8% | 7% | -2% | -9% | -14% | -13% |
| Friendly | Gross | -1% | -18% | 17% | 9% | -3% | 7% | -9% | 2% |
| | Net | -9% | -12% | 11% | 9% | -3% | -6% | -13% | -8% |

**Source: Authors**

## 6. Conclusions

This paper presents brief analysis of expected employment in hospital sector in 2025. We have provided estimation of four scenarios, two of them were related to population forecast and rest of them to change of utilization patterns in hospital care services. Initial analysis shows, that uncertainty about future demand for health care is pretty high and can be affected by many different factors. Current decreasing trends in average length of stay couldn't be kept in long term, thus some constraints have been adopted. Countries overview has two main conclusions. Firstly, the utilization trends across countries are different and cluster analysis provide information, that we can find 5 groups, which best fits similar trends. Secondly, the age distribution of hospital care remains more stable over time and we couldn't find significant cross border influence. Therefore, the trends are distributed rather proportionally. In average in most of the countries we can expect a moderate growth in demand for hospital workforce. Additionally, we have been able to provide information about pure influence of ageing on labour demand. In that case, the differences in population development play significantly lower role than utilization patterns.

Generally we can say that in relation to static scenario (without significant changes in utilization) substantial growth of labour demand can be expected almost in all countries. In dynamic scenario with typically decreasing trend in needs for hospital care only one third of observed countries shows expected increase of demand for hospital care (incl. Germany). We should keep in mind, that only additional demand is analyzed. (Schultz, 2013(a)) shows, that average age of medical and nursing personell is in average over 50, and we can expect also significant role (in some countries even the most significant) of replacement demand in total demand for health care workforce.

Initial assumtions play a strong role in the presented analysis. During the following years some of them should be carefully observed. Healthy ageing preventive care, increasing retirement age etc. should play significant role in changing utilization patterns between age groups, even when these are not yet observable in significant way.

Provided paper does not take into consideration other trends in healthcare labour force. Initially, we have assumed that there are not any current shortages in labour force. On the other hand, most significant role will play cross-country migration. We can expect more significant movement of medical and care personnel in the future between countries. Therefore the minimal qualification needs have to be carefully watched and unified. In any case, language issues in LLL can play the crucial role. Currently, we can observe high flow of medical workers in relation to low wage competitiveness of new member states and respected expectation about more significant shortages in new member states.

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# The Optimal Decision Strategy in the Second Pillar of the Slovak Pension System

*Zuzana MÚČKA*[1, 2]

**Abstract:** The aim of this study is to determine and analyse the optimal investment strategy that faces any participant of the defined-contributions based private scheme of Slovak pension system when deciding about the proper pension fund selection combining two pension funds – Index Fund and Bond Fund - that would lead to the maximal possible expected future income. We formulate this problem of optimal risk-sensitive dynamic portfolio construction in terms of the Hamilton-Jacobi-Bellman equation, approximate its solution employing double asymptotic and provide the solution qualitative and quantitative analysis. The key message of our study is a general advice for an average participant of the Second Pillar: it is optimal to allocate the wealth into the Index Fund for the first ¾ of accumulation period and then gradually move towards the Bond Fund. The allocated wealth can be considerably increased by raise in contribution rate and/or liberated legislative restrictions.

**Keywords:** Hamilton–Jacobi–Bellman equation, asymptotic expansion, stochastic dynamic programming, pension savings accumulation model.

***JEL classification:*** K55, H20, C15, B16.

## 1. Introduction

How to save optimally and safely for a pension in the private defined contribution scheme of the Slovak pension system? Nowadays this question is posed not only by private scheme managers but also by currently active population, participants of the Slovak pension system; and emerges as really relevant mainly due to two ticking time bombs – demography problem and long-term public finance sustainability. As this private scheme is based on defined contribution idea - benefits depending on returns of the pension fund's portfolio financed via fixed regular contributions of future pensioners who borne financial risk associated with investment – good private scheme individual's pension at retirement is extremely sensitive to preferred investment strategy preferred and hence the optimal wealth allocation policy is the key issue of this study.

In order to solve the optimal wealth allocation puzzles both a foreseeing future pensioner and a portfolio manager ask the subsequent questions. How to optimize the portfolio allocation policy in the long-term investment made by a specific individual for the purpose of his/her future pension providing that the decision made can be changed anytime up to the investor's retirement date? And how this strategy evolves in time to retirement and how it is affected by the amount of resources already allocated or by financial market data? How to deal in this problem with a natural investor's risk-aversion and his/her personal characteristics while the existing legislative norms imposed by the government are taken into account? When to allocate the wealth into risky securities and when to supersede them by more conservative investment? How is the optimal investment strategy affected by the regular contribution rate, individual's risk attitude, wage growth; financial market data, or fees charged by the private asset management companies? And what is the role of

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legislative regulation? Are not the limitations prescribed by the government too strict or even contra productive?

Therefore the purpose of this study is to answer these questions in terms of the fund composition and selection problem solution for any private scheme participant seeking for optimal investment strategy. Based on an individual characteristics, legislative regulations and financial market data we formulate the optimal decision about investor specific fund selection given their time to retirement and the amount of resources already allocated. Technically, this issue is known as an optimal portfolio construction problem that faces a risk sensitive investor on an arbitrage-free market with an unlimited amount of continuously traded financial assets with different risk profiles. Such an optimization problem often emerges in optimal dynamic portfolio selection when the performance of a portfolio relative to the performance of a given benchmark is considered and with fixed regular contributions and benefits depending on portfolio's return as deeply discussed by Merton (1971), Bodie (2003), Sharpe (1999), Gao (2008), Noh (2011), Melicherčík & Ševčovič (2006) or Macová & Ševčovič (2010) . The problem continuous-time version arises as the solution to the Hamilton-Jacobi-Bellman equation (see Bertsekas (1987), or Shreve (2008)) which is finally estimated using the technique of asymptotic expansion (deeply discussed in e.g. Holmes (1995) or O'Malley (1975)).

Finally, why do we prefer a continuous (even smooth) solution to the discrete one thought the latter is straightforwardly numerically obtainable in terms of simple recursive dynamic programming algorithm? Evidently, first of all a smooth and simple formula that for any time to retirement and wealth3 allocated on an individual's account explicitly provides the approximated optimal allocation policy hence given various model parameters[4] it determines such composition of the investment risk-sensitive portfolio that would lead to the maximal possible future income considering the investor's portfolio volatility aversion[5]. Next, this approach is really convenient as we want a tractable solution that can be analysed immediately and its properties and dependence of various model parameters can be derived straightforwardly. Finally the discrete solution[6] underestimates[7] the optimal solution to the portfolio construction problem studied, hence following such sub-optimal strategy induces expectation of smaller future portfolio wealth. Therefore, our smooth solution approximation leads to higher expected returns.

This paper is organized as follows: firstly we briefly describe the private scheme of the Slovak pension system and the investment decision mechanism. Next we sketch the technique utilized in order to obtain the optimal allocation policy approximation which is applied in Section 2 where the optimal investment policy is derived and its quantitative analysis provided. In Section 3 we present the numerical and graphical results of our model which are summarized in Section 4 with the main conclusions and policy advices formulated.

## 1.1. Private Pensions

The private scheme of the Slovak pension system, so-called the Second Pillar commercially supervised by private asset management companies (hereafter PAMC)[8] establishes a fundamental change in the pension system of Slovakia as it is fully funded from a saver's (i.e. future pensioner)

[3] Measured relatively to an investor's gross wage

[4] That include legislative norms (contribution rate, investment restrictions), financial market data (distributions of securities), and investor-specific characteristics (gross wage growth rate, relative risk aversion coefficient and portfolio volatility aversion factor)

[5] The maximal expected portfolio wealth with respect to given portfolio volatility aversion measured at the end of the accumulation period.

[6] Hence a solution obtained by means of numeric dynamic programming approach

[7] This is due to properties of the portfolio value function

[8] Six pension asset management companies offer the services in Slovakia: AEGON d.s.s.; Allianz d.s.s; AXA d.s.s; DSS Poštovej banky; ING d.s.s; and VÚB Generali d.s.s.

regular contributions[9] and introduces an alternative to save for a pension on an private pension account. Financial resources accumulated on pension account, a saver's hereditable property possess the ability of value appraising by making investment into the pension funds designed and managed by the PAMC and strictly regulated by the legislative norms. As pension funds are managed using defined contribution scheme (hereafter DC) with fixed regular contributions of individuals and benefits depending on returns of the pension fund's portfolio, the financial risk associated with investment is borne by investors, i.e. future pensioners.[10] Any pension fund consists of various more or less risky securities in different weights and so it represents the portfolio with a certain risk profile. Hence they differ especially by an investment strategy, with which the investment tools allowed by law relate, which it is possible to acquire within the restrictions for a property investment for the subsequent particular funds[11]:

(1) *Bond Fund:* investment strategies are restrained to highly rated short-term bonds and money instruments;
(2) *Mixed Fund:* the portfolio is limited to be composed of at least 50% of bonds and money investments, up to 50% of stocks and up to 20% of precious metal investment instruments;
(3) *Stock Fund:* the portfolio is formed by stocks (at most 80%), precious metal investments (not more than 20%) and up to 80% of the fund property by bonds and money investment instruments;
(4) *Equity-Linked Index Fund:* benchmark of this passively managed fund tracks the performance of one or more selected equity indexes and there are no restrictions imposed on exchange traded funds, assets or derivatives when replicating the benchmark formed initially.

The investment decision of any saver already registered in one of PAMC is made by selecting at most two of the funds mentioned above - providing that two funds are chosen, one of them must be Bond Fund. On the other side, each PAMC as a part of their investment decision specifies a benchmark for each of the fund except the Bond Fund that would satisfy the prescribed restrictions imposed by the government and it is the only one fund which has guaranteed returns. It is evident that PAMC implements their investment decision by constituting such portfolios that would copy or outperform in their return the corresponding benchmark - otherwise the fees charged on savers for management services provided by the company are lowered by the law. Furthermore, the pension fund choice of investors is regulated by legislative norms: the saver's decision about fund choice is unrestricted (i.e. free choice of at most two pension funds) unless the age of 50, when at least 10% of the accumulated wealth must be allocated in the Bund Fund and each following year this share rises by 10 p.p. so that in the age 59 all the wealth is kept in the Bond Fund only.

Therefore our aim is to derive the selection of funds – i.e. for any time to retirement and wealth allocated on an individual's private pension account determine the optimal decision of a representative future pensioner about the weights of the funds introduced above in his/her portfolio –the evolution of that fund selection[12] and the effect of other model parameters (contribution rate, risk aversion, financial data, gross wage growth, legislative norms). In our study we will show that for

[9] The Second Pillar contribution is defined as a certain percentage (currently 4%) from a saver's gross wage that pays another 5% of their gross wage to the public scheme (the First Pillar). Furthermore, an employer subsidizes the public scheme by of another 14% of the employee's gross wage.

[10] On the contrary defined benefit scheme (hereafter DB) is based on fixed benefits defined in advance by the system boosters who face the investment financial risk. Contributions are established and gradually adjusted in order to preserve the fund balance.

[11] Each PAMC has to create and manage at least two funds – one of them must have guaranteed yields above prescribed benchmark (the Bond Fund) and at least one must be without guaranty of returns.

[12] i.e. how does this decision changes in time and space – wealth already allocated measured relatively to the investor's gross wage

any participant of the Second Pillar the optimal investment strategy is fully replicable by only two of four available pension funds, namely the Equity-Linked Index Fund and the Bond Fund; the remaining two are redundant.

## 1.2. Used Methodology

In order to investigate the optimal portfolio creation problem that encounters the investor making a decision about their resource allocation strategy at a certain time from a finite time horizon and given wealth already gathered during the accumulation of pension saving we proceed as follows.

Firstly, the decision is made in perspective of the investor interested in the portfolio terminal value, via their specific utility criterion where for a given portfolio both the terminal expected portfolio utility and the portfolio risk are combined. At this stage the concrete investor is taken into account in terms of his/her utility function choice and the portfolio risk level consideration[13] so that the resulting increasing and concave utility function is formed as a linear combination of two CRRA[14]-like utility functions. Such type of decision criterion is widely discussed in Pratt (1964) or Sharpe (1999). Then the key problem of our study is reformulated by means of the discrete stochastic dynamic optimization model (see e.g. Bertsekas (1987) or Kwok (1998)) and the concept of value function measuring the maximal terminal portfolio value arranged by following the optimal strategy adapted at that specific time is presented. Making the time-step infinitesimally small, we derive its continuous version established in terms of the fully nonlinear Hamilton-Jacobi-Bellman (HJB) equation (Shreve (2008), Noh (2011) or Gao (2008)) for the value function, as discussed by Bodie (2003), Browne (1995), Ishimura & Mita (2007), or Macová & Ševčovič (2010).

Since the resulting HJB, the fully non-linear parabolic partial differential equation cannot be solved analytically; we introduce a concept of regular double asymptotic expansion (see O' Malley (1975) or Holmes (1995) for further details) of the portfolio value function by means of weakly nonlinear analysis. Even though the set of all admissible investment strategies assumed in the HJB equation can be restrained by various government rules, we relax from these restrictions and allow for a ban on short selling and borrowing. Hence we seek a solution to the unconstrained HJB equation[15] in the form of infinite power series with respect to two small parameter symbolizing the investor's level of portfolio risk consideration and the contribution rate. This procedure divides the original problem into the series of sub-problems which are gradually solved using the Riccati transformation (Abe & Ishimura (2008), Macová & Ševčovič (2010)) so that the corresponding terms of the linear approximation of the double asymptotic expansion are obtained. For the purpose of simplicity we employ only linear approximation of the solution and the corresponding optimal allocation policy the though applying the approach described above the optimal solution can be approached arbitrarily precise by means of the asymptotic expansion series.

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[13] Markowitz in his portfolio theory (see e.g. Pflug (2007)) established the concept of the efficient frontier expressing the curve of all optimal solution to this problem, i.e. portfolios with maximal return and minimal risk where the relationship between portfolio return and its variance. Our modification lies in employing investor-specific utility function to obtain the maximal expected utility portfolio having deviation not surpassing the considered investor's risk aversion attitude. Obviously, an arbitrary risk measure can be used in order to construct the efficient frontier (see Pflug (2007)).

[14] Constant relative risk aversion function

[15] Actually, the specific form of the HJB equation leads to the value function domain division into two disjoint subregions: on the first subdomain the optimal investment strategy is simply reduced to one security portfolio - the one promising the highest expected returns since in this region the portfolio value function rises above any limits as it violates the concavity condition and so the prohibition of short selling and borrowing is natural. Hence our objective is to solve the HJB on the second region with concave portfolio value function. Notice that the requiring concave and increasing value function is consistent with the utility function properties.

Furthermore we provide a simple explicit formula to calculate at each time the optimal investor's resource allocation for a given level of wealth - the ratio of their wealth that should be invested to each traded security. Finally the deeper insights into the structure of the optimal value function and the associated portfolio allocation policy enable us to describe their behaviour and influence of various model parameters – hence perform the solution sensitivity analysis. We emphasize that the analytic investment allocation formula we derive is "better" than a solution obtained via numeric dynamic programming approach as it leads to higher intermediate and terminal portfolio wealth measured via its value function.

## 2. Optimal Portfolio Selection

We presuppose that at any time $t \in [0,T]$ the arbitrage-free market consists of $N+1$ continuously traded securities with multivariate normally distributed returns,

$$R_t^{(i)} \sim \mathcal{N}\left(\mu^{(i)}, \left(\sigma^{(i)}\right)^2\right) \qquad (1)$$

for all $i = 0, \dots, N$ and $t \in [0,T]$. The investment strategy at time $t$ is given by the vector $\theta_t \in \mathbb{R}^{N+1}$ satisfying $\theta_t^T \cdot 1 = 1$ where each $\theta_t^i$ symbolizes the portion of invested wealth allocated in the $i$th traded security. So, at time $t$ the market portfolio return $r_t$ is normally distributed with positive definite covariance matrix $\Sigma_t$, i.e.

$$r_t = \theta_t^T \cdot R_t \sim \mathcal{N}\left(\mu_t(\theta_t), \sigma_t^2(\theta_t)\right), \qquad \mu(\theta_t) = \theta_t^T \cdot \boldsymbol{\mu}, \qquad \sigma^2(\theta_t) = \theta_t^T \cdot \boldsymbol{\Sigma} \cdot \theta_t . \qquad (2)$$

The investor regularly, on short time intervals $[0,\tau], [\tau,2\tau], \dots, [T-\tau, T]$, where $0 < \tau \ll 1$ is a small time increment and $T$ is known terminal (retirement) time, deposits a small portion of his/her salary with a deterministic growth rate $\beta$, of size $\varepsilon\tau$ to the portfolio of traded securities. The quantity of investor's yearly contribution rate $\varepsilon$ plays a crucial role and will be subject of our investigation in this text.

Denote $\Delta_t^{t+\tau}$ the set of all strategies allowed within time interval $[t, t+\tau)$. Furthermore, since the investment decision $\theta_t$ is taken in the beginning of time interval $[t, t+\tau]$ and the securities returns $R_{t+\tau}^{(i)}$ are realized in its end, the considered portfolio return at time $t+\tau$ is $r_{t+\tau}(\theta_t) = \theta_t^T \cdot R_{t+\tau}$ . Then employing (2) and the random variable $Z \sim \mathcal{N}(0,1)$, for any $0 < \tau \ll 1$ the stochastic change in portfolio return $dr_t(\theta_t)$ satisfies

$$dr_t(\theta_t) \equiv r_{t+\tau}(\theta_t) - r_t(\theta_t) = \mu(\theta_t)\tau + \sigma(\theta_t) Z \sqrt{\tau}, \qquad Z \sim \mathcal{N}(0,1).$$

Therefore, assuming that time-dependent investor's wealth-to-salary ratio[16] $y_t$ taken at time $t \le T-\tau$ is known and utilizing the relationship for investor's transfers, for small enough time increment $\tau$ and $Z \sim \mathcal{N}(0,1)$, the dynamics of the wealth-to-salary ratio $y_t$ is driven by the subsequent random process (see Kwok (1998), or Shreve (2008))[17]

$$y_{t+\tau}(\theta_t) \equiv F_t^\tau(\theta_t, y_t, Z), \; F_t^\tau(\theta, y, z) = y \exp\left\{\left[\mu(\theta) - \beta - \frac{1}{2}\sigma^2(\theta)\right]\tau + \sigma(\theta) z \sqrt{\tau}\right\} + \varepsilon\tau \qquad (3)$$

Our aim is to determine the optimal strategy for any time $t$ i.e. the policy vector $\theta_t$ that maximizes the contributor's utility from the terminal wealth-to-salary ratio $y_T$ allocated on his/her

[16] The share of wealth already allocated on an individual's private pension account and salary obtained in the latest time period

[17] The idea behind the relationship (3) above is straightforward: assuming regular yearly contributions, the balance $Y_t$ of an individual's pension account with yearly salary $B_t$ follows $Y_{t+1} = (1+r_t)Y_t + \varepsilon B_{t+1}$ for $t = 1, \dots, T$ and $Y_1 = \varepsilon B_1$. Supposing the wage growth $\beta_t$ is known then $B_{t+1} = (1+\beta_t)B_t$ represents the relation between two consecutive yearly salaries. Therefore, in terms of the wealth-to-salary factor $y_t = Y_t/B_t$ the budget constraint equation can be reformulated as $y_{t+1} = \frac{1+r_t}{1+\beta_t} y_t + \varepsilon$, for $t = 1, \dots, T-1$, $y_1 = \varepsilon$. Hence, if we prefer arbitrarily short time intervals $[0,\tau], [\tau, 2\tau], \dots, [T-\tau, T]$, and the contributions of size $\varepsilon\tau$ the relationship (3) is obvious.

private pension account. The contributor's utility from the investment process is represented by chosen utility criterion $\mathcal{K}$.

## 2.1. Utility Criterion and Portfolio Value Function

Our financial decisions have two tight-knit dimensions: a value dimension, typically expressed in terms of the investment return expectation $\mathbb{E}$, and a risk dimension measured by a suitable translation-invariant deviation risk functional $\mathbb{D}$, in our case variance functional. We modify the Markowitz' efficient frontier concept (see Pflug (2007)) by considering repulsion of an investor to uncertainty in portfolio returns. Hence we employ an investor-specific utility function $\mathrm{U}$ to obtain the maximal expected utility portfolio having deviation not surpassing the considered investor's uncertainty aversion coefficient $\lambda$ and launch the wealth criterion by a functional $\mathcal{K}$ defined for random variable $\mathrm{Y}$ as follows:

$$\mathcal{K}(Y) \equiv \mathcal{K}_{\lambda}(Y) = \mathbb{E}[U(Y)] - \tfrac{\lambda}{2}\mathbb{D}[Y]. \tag{4}$$

We must emphasize that the utility function may vary across investors as it represents their attitude to risk - the issue of its proper choice is deeply argued in a large amount of economic literature, e.g. Pratt (1964), or Sharpe (1999). Since we are aimed on including the individual uncertainty aversion coefficient $\lambda$ in the utility function representation, our decision about the appropriate utility function proposal lies in its subsequent formulation in terms of composition of two constant relative risk aversion (hereafter denoted as CRRA) utility functions so that the final utility function $\mathrm{U}$ will be perfectly consistent with the utility criterion $\mathcal{K}$ given by (4).

$$U(y) \equiv U_0(y) + \lambda U_1(y) = -y^{1-d} + \tfrac{\lambda}{2}y^{2(1-d)}, \quad \text{for } d \gg 1, \quad \text{and} \quad y \in \mathcal{D}^U \equiv \{y > 0 \,|\, y^{d-1} > \tfrac{2d-1}{d}\lambda\} \tag{5}$$

We remark that our choice of utility sub-functions is in accordance with a common assumption on average investor's utility function reflecting his/her tendency to hold a constant proportion of the wealth in any class of risky securities as the wealth varies constant relative risk aversion (see Pratt (1964)). Furthermore $\mathrm{U}$ remains monotonously increasing and strictly concave on the domain $\mathcal{D}^{\mathrm{U}}$.

Reflecting the utility criterion $\mathcal{K}$ at any time $\mathrm{t} \in [0, \mathrm{T}]$ we are aimed on maximizing the terminal time investor's utility generated by the portfolio and represented by the terminal wealth-to-salary ratio $\mathrm{y_T}$

$$\max_{\theta \in \Delta_t^T} \mathcal{K}[\mathrm{y_T}(\theta_t) \,|\, \mathrm{y_t} = \mathrm{y}], \qquad \mathrm{y} > 0, \ t \in [0, T].$$

Thus at time $\mathrm{t} \in [0, \mathrm{T}]$ we choose such admissible allocation policy for given level of wealth-to-salary ratio $\mathrm{y}$ that would induce maximal terminal investment portfolio wealth with respect to established utility criterion $\mathcal{K}$.

As a consequence[18] we launch the portfolio value function $\mathrm{V(t,y)}$ embodying the maximal terminal portfolio value utility arranged by applying the optimal strategy made at time $\mathrm{t}$ given the ratio $\mathrm{y}$. Notice that in our pension planning model any investor aimed on maximizing the uncertain terminal year $\mathrm{T}$ portfolio wealth has to deal with the dilemma about the choice of a particular admissible policy repeatedly with an arbitrarily small time period $0 < \tau \leq 1$. Therefore, applying the Bellman's optimality principle (see Bertsekas (1987) or Kwok (1998)) the optimal strategy for the problem of stochastic dynamic programming can be formulated as subsequently:

$$\mathrm{V(t,y)} = \begin{cases} \mathrm{U(y)} & \mathrm{t = T, y > 0;} \\ \max_{\theta \in \Delta_t^{t+\tau}} \mathcal{K}[\mathrm{V(t+\tau, y_{t+\tau}(\theta))} | \mathrm{y_t = y}] & 0 \leq \mathrm{t} < t + \tau \leq T, y > 0; \end{cases} \tag{6}$$

[18] The prescription is well defined as the utility criterion $\mathcal{K}$ satisfies the Tower Law property (see Kwok (1998)).

Notice that the portfolio value function recurrent relationship (6) holds for any choice of $0 < \tau \leq 1$. Thus employing the utility criterion $\mathcal{K}$ properties and rearranging terms in (6) for $t < T$ we may easily derive the following natural condition:

$$0 = \max_{\theta \in \Delta_t^{t+\tau}} \left\{ \frac{\mathcal{K}\left(V(t+\tau, y_{t+\tau}(\theta))\right) - V(t, y_t)}{\tau} \right\}; 0 \leq t < t + \tau \leq T, \quad \forall\, 0 < \tau \leq 1. \tag{7}$$

## 2.2. Hamilton-Jacobi-Bellman Equation

First of all we concentrate our effort on discrete to continuous transformation of the fluctuation in the value function. We suppose that there exist functions $A_\varepsilon(\theta, t, y)$ and $B(\theta, t, y)$ such that the random process $\{y_t\}_{t\in[0,T]}$ is driven by the following stochastic differential equation,

$$dy_t = A_\varepsilon(\theta, t, y_t)dt + B(\theta, t, y_t)dW_t;$$

where $\{W_t\}_{t\in[0,T]}$ is a Wiener process. Then applying Itô's lemma[19] on the equation above we obtain the expression for the differential $dV_t^{\theta_t}$ as a continuous version of the incremental alternation in the portfolio value function established for an infinitesimally small $\tau \equiv dt \leq 1$, in the form of a function of two independent variables $t$ and $y$ for $V \equiv V(t, y_t)$:

$$dV_t^{\theta_t} \equiv V\left(t + dt, y_{t+dt}(\theta_t)\right) - V(t, y)$$
$$= \left[\frac{\partial V}{\partial t}(t, y_t) + A_\varepsilon(\theta, t, y_t)\frac{\partial V}{\partial y}(t, y_t) + \frac{1}{2}B^2(\theta, t, y_t)\frac{\partial^2 V}{\partial y^2}(t, y_t)\right]dt + B(\theta, t, y_t)\frac{\partial V}{\partial y}(t, y_t)dW_t$$

Considering independency of stochastic variables $dW_t$ and $B(\theta, t, y_t)\frac{\partial V}{\partial y}(t, y_t)$ and Wiener process properties, then taking $dt \to 0^+$ to reformulate (8) in terms of $dV_t^{\theta_t}$ and apply Itô's lemma[20] one can easily derive the subsequent result:

***Theorem 1:*** *The portfolio value function $V = V(t, y)$ satisfies the Hamilton-Jacobi-Bellman equation:*

$$0 = \frac{\partial V}{\partial t} + \max_{\theta \in \Delta_t}\left\{H(\theta;\, t, y) \equiv A_\varepsilon(\theta, t, y)\frac{\partial V}{\partial y} + \frac{1}{2}B^2(\theta, t, y)\left[\frac{\partial^2 V}{\partial y^2} - \lambda\left(\frac{\partial V}{\partial y}\right)^2\right]\right\}; \quad \begin{matrix} 0 \leq t < T, y > 0; \\ V(T, y) = U(y) \end{matrix} \quad \begin{matrix} \\ t = T, y > 0. \end{matrix} \tag{8}$$

$$where \qquad A_\varepsilon(\theta, t, y) = \varepsilon + [\mu(\theta) - \beta]y; \qquad B(\theta, t, y) = \sigma(\theta)y. \tag{9}$$

In order to determine the best possible – unconstrained - solution of problem (8) we relax from all government restrictions[21] placed on available strategies. The set of all admissible strategies is given as:

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[19] Ito's Lemma states that for any drift-diffusion process $dX_t = \mu_t dt + \sigma_t dB_t$ and any twice differentiable scalar function $f(t, x)$ of two scalar variables t and x, it follows that
$df(t, X_t) = \left[\frac{\partial f}{\partial t} + \mu_t\frac{\partial f}{\partial x} + \frac{\sigma_t^2}{2}\frac{\partial^2 f}{\partial x^2}\right]dt + \sigma_t\frac{\partial f}{\partial x}dB\_t,$
where $\{B_t\}_{t\geq 0}$ is the Brownian motion, i.e. $B_0 = 0$; $B_t$ is almost surely continuous with independent increments for any time $t \geq 0$, and $B_t - B_s \sim \mathcal{N}(0, t - s)$ for any $0 \leq s \leq t$. For further details see e.g. Kwok (1998).

[20] Notice that the concrete form of the functions $A_\varepsilon(\theta, t, y_t)$ and $B(\theta, t, y)$ driven by the stochastic process for $y_t$ can be derived by applying Itô lemma (the previous footnote) on the differential $dy_t = y_{t+dt} - y_t$ for $0 < \tau \leq 1$ to obtain:
$dy_t = \varepsilon\, dt + y_t\,[(\mu(\theta) - \beta)]dt + \sigma(\theta)dW_t].$

[21] Though the natural government limitations posed on pension fund allocation policy -- no short selling is allowed -- is desired, first of all we are intended on unconstrained solution revelation. Then, when some other suppositions on model parameters are taken for granted, we are able to show that each component of the optimal investment policy obtained is nonnegative.

$$\Delta_t = \{\theta \in \mathbb{R}^{N+1} \mid \theta^T \cdot \mathbf{1} = 1\}. \quad (10)$$

Next, under two crucial attributes[22] but natural required from any correct value function $V(t,y)$ - monotonously increasing and strict concavity – in order to determine the optimal policy $\tilde{\theta}$ we employ the standard approach of Lagrange function $L(\theta,k)$ with Lagrange multiplier $k$. Hence, there exists a unique optimal allocation strategy[23] $\theta = \arg\max_{\theta' \in \Delta_t}\{H(\theta'; t, y)\}$ given by the following formula:

$$\theta(t,y) = \frac{1}{a}\Sigma^{-1}\{1 + [a\mu - b1]\Pi(t,y;\epsilon,\lambda)\} \qquad t \in [0,T],\ y > 0 \quad (11)$$

$$\Pi(t,y;\epsilon,\lambda) = y^{-1}\frac{\partial V}{\partial y}(t,y)\left[\lambda\left(\frac{\partial V}{\partial y}\right)^2 - \frac{\partial^2 V}{\partial y^2}\right]^{-1} \quad (12)$$

where $a = 1^T \Sigma^{-1} 1$, $b = 1^T \Sigma^{-1}\mu$ and $c = \mu^T \Sigma^{-1}\mu$. The optimal policy associated portfolio value function follows the subsequent parabolic partial differential equation for

$$0 = \frac{\partial V}{\partial t}(t,y) + [\varepsilon + p(y)]\frac{\partial V}{\partial y}(t,y) + q(y)\left[\frac{\partial^2 V}{\partial y^2}(t,y) - \lambda\left(\frac{\partial V}{\partial y}\right)^2(t,y)\right] - \frac{r(y)\frac{\partial V}{\partial y}(t,y)}{y\left[\lambda\left(\frac{\partial V}{\partial y}\right)^2 - \frac{\partial^2 V}{\partial y^2}\right]},\ t < T$$

$$V(T,y) = U(y), \text{ and } \quad p(y) = py = \left[\frac{b}{a} - \beta\right]y, \quad q(y) = qy^2 = \frac{y^2}{2a}, \quad r(y) = r = -\frac{ac-b^2}{2a}. \quad (13)$$

Notice that (13) is solved only in region $\mathcal{D}$ where $V(t,y)$ strictly concave and monotonously increasing is.

## 2.3. Asymptotic Solution and its Properties

In order to approximate the solution to (13), for small $\lambda$ both $V(t,y)$ and $U(y)$ can be written in terms of their asymptotic expansions (see Holmes (1995) or O'Malley (1975)) with respect to parameter $\lambda$ as follows:

$$V(t,y) = \sum_{n=0}^{\infty}\lambda^n V_n(t,y), \qquad U(y) = \sum_{n=0}^{\infty}\lambda^n U_n(y).$$

Hence, we divide the original problem (13) into the infinite sequence of sub-problems that can be solved iteratively and approach the exact solution arbitrarily precise. For the purpose of this study we are satisfied with its linear approximation and so our aim is to solve sequentially two PDEs for unknown $V_0(t,y)$ and $V_1(t,y)$:

$$[P_0]: \begin{cases} 0 = \frac{\partial V_0}{\partial t} + [\varepsilon + p(y)]\frac{\partial V_0}{\partial y} + q(y)\frac{\partial^2 V_0}{\partial y^2} + r_0\left(\frac{\partial V_0}{\partial y}\right)^2\left[\frac{\partial^2 V_0}{\partial y^2}\right]^{-1} & (t,y) \in \mathcal{D}; \\ V_0(T,y) = U_0(y) = -y^{1-d} & (t,y) \in \mathcal{D}, t = T. \end{cases} \quad (14)$$

$$[P_1]: \begin{cases} 0 = \frac{\partial V_1}{\partial t} + [\varepsilon + p_1(t,y)]\frac{\partial V_1}{\partial y} + q_1(t,y)\frac{\partial^2 V_1}{\partial y^2} + r_1(t,y) & (t,y) \in \mathcal{D}; \\ V_1(T,y) = U_1(y) = \frac{1}{2}y^{2(1-d)} & (t,y) \in \mathcal{D}, t = T. \end{cases} \quad (15)$$

$$p_1(t,y) = p(y) + 2r\frac{\frac{\partial V_0}{\partial y}(t,y)}{\frac{\partial^2 V_0}{\partial y^2}(t,y)};\ q_1(t,y) = q(y) - r\left[\frac{\frac{\partial V_0}{\partial y}(t,y)}{\frac{\partial^2 V_0}{\partial y^2}(t,y)}\right]^2;\ r_1(t,y) - q_1(t,y)\left[\frac{\partial^2 V_0}{\partial y^2}\right]^2.$$

[22] These two requirements imposed on any problem potential solution - value function - induce consistence of problem solution with its terminal condition, i.e. utility function chosen which obviously possesses those characteristics.

[23] Technically, forasmuch as $A_\varepsilon(\theta,t,y_t)$is linear in $\theta$, $B^2(\theta,t,y_t)$ quadratic in $\theta$ the solution exists and it is unique. Furthermore, as $V(t,y)$ is assumed to be strictly concave and monotonously increasing, the solution is a global maximizer of $H(\theta;t,y)$.

To solve $[\mathbf{P_0}]$ we firstly introduce the change of variables mapping $(t,y)\in\mathcal{D}$ to $(s,x)\in\mathcal{D}'$ employing the Riccati transformation[24] (see Abe & Ishimura (2008), Macová & Ševčovič (2010) or Songzhe (2006))

$$\psi(s,x)=\gamma y\varphi(t,y)\quad\text{for}\quad s=T-t, x=\ln y,\ \varphi(t,y)=-\frac{\partial^2 V_0}{\partial y^2}\left[\frac{\partial V_0}{\partial y}\right]^{-1},\ \gamma=[ac-b^2]^{-\frac{1}{2}} \quad (16)$$

Thus we reformulate (14) to $[\mathrm{P}_0']$ in terms of unknown $\psi(\mathrm{s},\mathrm{x})$ for $(\mathrm{s},\mathrm{x})\in\mathcal{D}'$ as subsequently:

$$[\mathbf{P_0'}]:\begin{cases}\frac{\partial\psi}{\partial s}=\frac{1}{2a}\frac{\partial}{\partial x}\left\{\left[1+\frac{\partial}{\partial x}\right]\left[\psi-\frac{1}{\psi}\right]+\psi\left[2a\left(\varepsilon e^{-x}+p\right)-\frac{\psi}{\gamma}\right]\right\} & (s,x)\in\mathcal{D}';s\in(0,T]\\ \psi(0,x)=\gamma d & (s,x)\in\mathcal{D}',s=0.\end{cases} \quad (17)$$

In order to find a solution $\psi$ to $[\mathbf{P_0'}]$ rewrite $\psi(s,x)$ by means of asymptotic series with respect to $\varepsilon$ as follows:

$$\psi(\mathrm{s},\mathrm{x})=\sum_{\mathrm{n}=0}^{\infty}\varepsilon^{\mathrm{n}}\psi_{\mathrm{n}}(\mathrm{s},\mathrm{x}),\qquad(\mathrm{s},\mathrm{x})\in\mathcal{D}'$$

Notice that by this act we actually perform double $(\lambda,\varepsilon)$ regular perturbation of the value function $\mathrm{V}(\mathrm{t},\mathrm{y})$ as the problem character is retained for both $\lambda,\varepsilon\to 0$. Recalling the power-like character of the utility function zero term $\mathrm{U}_0(\mathrm{y})=-\mathrm{y}^{1-\mathrm{d}}$, $\psi_{\mathrm{o}}(\mathrm{s},\mathrm{x})$ must be constant (see Macová & Ševčovič (2010) for further details), so

$$\psi_o(s,x)=\gamma d\,;\qquad(s,x)\in\mathcal{D}'. \quad (18)$$

The linear term of the $\varepsilon$-asymptotic expansion $\psi_1(s,x)$is given as the solution to the subsequent Cauchy problem where $\delta=\mathrm{p}-2\mathrm{q}$:

$$\begin{cases}\frac{\partial\psi_1}{\partial s}=\frac{1}{2a}\left[1+\frac{1}{\psi_0^2}\right]\frac{\partial^2\psi_1}{\partial x^2}+\frac{1}{2a}\left[1+\frac{1}{\psi_0^2}+2a\delta\right]\frac{\partial\psi_1}{\partial x}-\psi_0 e^{-x} & (s,x)\in\mathcal{D}';s\in(0,T]\\ \psi_1(0,x)=0 & (s,x)\in\mathcal{D}',s=0.\end{cases}$$

Hence, the unique solution to the problem above has the forthcoming time-space separable form for any $(s,x)\in\mathcal{D}'$:

$$\psi_1(s,x)=\Phi_1(s)e^{-x}\ ;\ \text{where}\ \Phi_1(s)=\frac{d\gamma}{\delta}[\exp(-\delta s)-1];\ \text{for}\ \gamma=1/\sqrt{ac-b^2}. \quad (19)$$

Combining (18) – (19) we derive the problem $[\mathbf{P_0'}]$ solution linear approximation in terms of $\psi_0+\varepsilon\psi_1(s,x)$. Then, for small $0<\varepsilon\ll 1$ reusing the Riccati transformation and integration of $\varphi$ definition one may approach as follows:

$$\varphi(\mathrm{t},\mathrm{y})=\frac{\mathrm{d}}{\mathrm{y}}\left[1-\frac{\varepsilon}{\mathrm{y}}\omega(\mathrm{t})\right];\qquad\text{for}\qquad\omega(\mathrm{t})=\delta^{-1}[1-\exp[-\delta(\mathrm{T}-\mathrm{t})]]$$

Then, after come tedious calculations one see that the linear asymptotic approximation with respect to parameter $\varepsilon$ of the solution to problem $[\mathrm{P}_0]$ is given by the forthcoming expression:

$$\mathrm{V}_0(\mathrm{t},\mathrm{y})=-\mathrm{y}^{1-\mathrm{d}}\mathcal{A}(\mathrm{t})+\varepsilon\mathrm{y}^{-\mathrm{d}}\mathcal{B}(\mathrm{t});\qquad(\mathrm{t},\mathrm{y})\in\mathcal{D}$$

$$\mathcal{A}(\mathrm{t})=\exp[-\mathcal{R}(\mathrm{d}-1)(\mathrm{T}-\mathrm{t})];\ \ \mathcal{B}(\mathrm{t})=(\mathrm{d}-1)\mathcal{A}(\mathrm{t})\omega(\mathrm{t});\ \ \mathcal{R}=\mathrm{p}-\mathrm{dq}-\frac{\mathrm{r}}{\mathrm{d}}>0. \quad (20)$$

Now we introduce the $\varepsilon$-expansion of $\mathrm{V}_1(\mathrm{t},\mathrm{y})$ the solution to problem $[\mathrm{P}_1]$ associated with the linear term of $\lambda$-expansion:

$$V_1(t,y)=\sum_{n=0}^{\infty}\varepsilon^n V_1(t,y),\qquad(t,y)\in\mathcal{D}.$$

Plugging back the $\varepsilon$-expansion into problem $[\mathbf{P_1}]$ we achieve the subsequent problem for the zero $\varepsilon$- and linear $\lambda$-expansion term of the value function $V_{10}=V_{10}(t,y)$:

$$[\mathrm{P}_{10}]:\begin{cases}0=\frac{\partial\mathrm{V}_{10}}{\partial\mathrm{t}}+[\varepsilon+\mathrm{p}_{10}(\mathrm{t},\mathrm{y})]\frac{\partial\mathrm{V}_{10}}{\partial\mathrm{y}}+\mathrm{q}_{10}(\mathrm{t},\mathrm{y})\frac{\partial^2\mathrm{V}_{10}}{\partial\mathrm{y}^2}+\mathrm{r}_{10}(\mathrm{t},\mathrm{y}) & (\mathrm{t},\mathrm{y})\in\mathcal{D};\\ \mathrm{V}_{10}(\mathrm{T},\mathrm{y})=\mathrm{U}_1(\mathrm{y})=\frac{1}{2}\mathrm{y}^{2(1-\mathrm{d})} & (\mathrm{t},\mathrm{y})\in\mathcal{D},\mathrm{t}=\mathrm{T}.\end{cases} \quad (21)$$

[24] Since $\Sigma$ is positively definite, a and c are positive and truly $\mathrm{ac}>\mathrm{b}^2$. Therefore the transformation is correctly defined.

$$\text{with } p_{10}(t,y) = \left[p - 2\frac{r}{d}\right]y = \mathcal{P}y; \quad q_{10}(t,y) = \left[q - \frac{r}{d^2}\right]y^2 = \mathcal{Q}y^2;$$

$$r_{10}(t,y) = -(d-1)^2\mathcal{Q}\{y\exp[\mathcal{R}(d-1)(T-t)]\}^{-2(d-1)}; \quad \mathcal{R} = \mathcal{P} - d\mathcal{Q}.$$

Considering the time-independence of $p_{10}$, and $q_{10}$, time--exponential behaviour of $r_{10}$, and the aspect of their power-like nature with respect to $y$, taking into account the obvious solution consistency necessity with the terminal condition, we are allowed to make the surmise on the absolute term $V_{10} = V_{10}(t,y)$solution separability in time and space.[25]

We summarize the results derived above in the following statement:

**Theorem 2:** The first order $(\varepsilon,\lambda)$ −approximation of the solution $V(t,y)$ to the coupled Problems $[P_0]$ and $[P_1]$ given by (14) – (15) is defined as

$$V^*(t,y) = -y^{1-d}\mathcal{A}(t) + \varepsilon y^{-d}\mathcal{B}(t) + \frac{\lambda}{2}y^{2(1-d)}\mathcal{A}^2(t); \qquad (t,y) \in \mathcal{D}. \tag{22}$$

Now we determine the approximate value function $V^*$ domain $\mathcal{D}$. Thus, differentiating twice $V^*$ with respect to $y$ one can easily deduce that strict concavity $V^*$ implies its monotonous increase[26]. Hence, we establish the value function acceptance region subsequently:

$$\mathcal{D} = \left\{(t,y) \mid 0 \le t \le T, y^{d-1} - \varepsilon(d+1)\omega(t)y^{d-2} - \lambda\frac{2d-1}{d}\mathcal{A}(t) > 0\right\}. \tag{23}$$

Next, remark that $V^*$ decreases monotonously on $\mathcal{D}$ with $t \in [0,T]$ and same holds for the value function domain boundary $\partial\mathcal{D}$ time-behaviour[27].

Likewise we proceed when analysing the effects of other model parameters and so finally we conclude that the first order $(\varepsilon,\lambda)$ −approximation $V^*(t,y)$ from Theorem 2 is correctly defined on the domain $\mathcal{D}$ and furthermore it exhibits the subsequent properties on $\mathcal{D}$:

- monotonous increase and concavity in y;
- monotonous decrease in both t and β;
- monotonous increase in ε, λ and d.

## 2.4. Optimal Smooth Allocation Policy

Let us remind you the optimal investment allocation strategy given by (11)–(12). Providing that both the denominator and numerator are approximated using the regular linear $(\varepsilon,\lambda)$ - **perturbation** in terms of (22) from Theorem 2 one may identify the approximate optimal weights of securities in the pension fund portfolio established only on $\mathcal{D}$ as follows:

$$\tilde{\theta}(t,y) = \frac{1}{a}\Sigma^{-1}\{1 + [a\mu - b1]\widetilde{\Pi}(t,y;\epsilon,\lambda)\}, \ (t,y) \in \mathcal{D}$$

$$\widetilde{\Pi}(t,y;\epsilon,\lambda) = \frac{1}{d}\left\{1 + \frac{\xi(t,y,;\varepsilon,\lambda)}{1-(d+1)\xi(t,y,;\varepsilon,\lambda)}\right\}, \xi(t,y,;\varepsilon,\lambda) = \frac{\varepsilon\omega(t)}{y[1-\lambda y^{1-d}\mathcal{A}(t)]}. \tag{24}$$

A straightforward analysis shows us that $\widetilde{\Pi}$ possess the following attributes on $\mathcal{D}$[28]:

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[25] Indeed employing the time-exponential nature of $r_{10}$, we look for a time-space separable solution possessing the form of $V_{10}(t,y) = W(y)\exp\{-2\mathcal{R}(d-1)(T-t)\}$ for some function $W(y)$ to be determined. Plugging the assumed form $V_{10}(t,y)$ into $[P_{10}]$ we come to the second order ordinary differential equation (ODE) for $W(y)$

$\mathcal{Q}y^2W''(y) + \mathcal{P}yW'(y) + 2\mathcal{R}(d-1)W(y) - \mathcal{Q}(d-1)^2y^{-2(d-1)} = 0.$

As the solution to this ODE must be consistent with the terminal condition $y^{-2(d-1)}$, hence when we substitute $W(y) = cy^{-2(d-1)}$in the ODE we deduce that $c = 1/2$.

[26] Observe that both $\mathcal{A}(t)$ and $\mathcal{B}(t)$ are positive and monotonously increasing for all $0 \le t \le T$ providing that $\mathcal{R}(d-1) > 0$. Then in order to define the value function domain we only need to determine where $V_{yy}$is positive.

[27] This conclusion can be straightforwardly achieved using the implicit function theorem.

- monotonous decrease and convexity in y;
- monotonous decrease in t and d;
- monotonous increase in ε, λ and β;
- bounded from below by $d^{-1}$.

Next, since $\widetilde{\Pi}$ rises sharply and tends to infinity as $(t,y)$ approaches to $\partial\mathcal{D}$, we stake out the forthcoming goal: obtain the smooth function defined for all $t \in [0,T]$ and $y > 0$ (hence, not only on $\mathcal{D}$) that approximates the solution to original Hamilton-Jacobi-Bellman Equation (8) – (9) launched in Theorem 1 with an arbitrarily precision.

So in order to achieve smooth solution defined globally for all $t \in [0,T]$ and $y > 0$ as first we need to restrain the region $\mathcal{D}$ in order to have $\widetilde{\Pi}$ bounded on it from above by some constant $\bar{c}$ – its choice is based on short positions ban prescribed by the legislative and so it must guarantee that each component of the vector $\Sigma^{-1}\{1 + [a\mu - b1]\bar{c}\}$ is nonnegative. Hence, on the region where the value function is convex assuming that the stable market conditions[29] are met the Hamilton-Jacobi-Bellman equation maximizer arising from (8) (see Theorem 1) is the unit vector $e_i$ with the unique nonzero component corresponding to the traded security with the highest return and volatility. Then providing that the ith financial asset is the one attaining the highest return $\mu_i$,

$$\bar{c} = \frac{a - \sum_{j=0}^{N} \tilde{\sigma}_{ij}}{a\sum_{j=0}^{N} \tilde{\sigma}_{ij}\mu_j - b\sum_{j=0}^{N} \tilde{\sigma}_{ij}}, \tag{25}$$

where the elements of $\boldsymbol{\Sigma^{-1}}$ are represented by $\tilde{\sigma}_{ij}$ and $a = \mathbf{1}^{\boldsymbol{T}}\boldsymbol{\Sigma^{-1}}\mathbf{1}$, $b = \mathbf{1}^{\boldsymbol{T}}\boldsymbol{\Sigma^{-1}}\boldsymbol{\mu}$. Then, $\bar{c}d > 1$and we are allowed to redefine the initially considered region $\mathcal{D}$ to $\widetilde{\mathcal{D}}$ as follows:

$$\widetilde{\mathcal{D}} = \left\{(t,y) \mid 0 \le t \le T, y^{d-1} - \varepsilon d\frac{(d+1)\bar{c}-1}{d\bar{c}-1}\,\omega(t)y^{d-2} - \lambda\mathcal{A}(t) > 0\right\}. \tag{26}$$

Therefore, we define the optimal policy $\bar{\theta}(t,y)$ for all $t \in [0,T]$ and $y > 0$ such that it coincides with $\tilde{\theta}(t,y)$ on $\widetilde{\mathcal{D}}$ and the unit vector $e_i$ with nonzero component corresponding to the security with the highest return. Next, we extend $\widetilde{\Pi}$ given by (24) continuously over whole $[0,T] \times \mathbb{R}^+$:

$$\overline{\Pi}(t,y;\varepsilon,\lambda) = \begin{cases} \widetilde{\Pi}(t,y;\epsilon,\lambda) & (t,y) \in \widetilde{\mathcal{D}}; \\ \bar{c} & (t,y) \in [0,T] \times \mathbb{R}^+ - \widetilde{\mathcal{D}}. \end{cases}$$

Then, $d^{-1} \le \overline{\Pi}(t,y;\varepsilon,\lambda) \le \bar{c}$ on $[0,T] \times \mathbb{R}^+$and so the optimal investment strategy is bounded on $[0,T] \times \mathbb{R}^+$. Furthermore, in order to smooth out $\overline{\Pi}$ we use the standard technique of mollifiers and so for any small $0 < \epsilon \ll 1$ we establish the integral transform

$$\Pi^*(t,y;\varepsilon,\lambda) = \int_{[0,T]\times\mathbb{R}^+} \bar{\varsigma}_\epsilon(t-s,y-z)\widetilde{\Pi}(s,z;\epsilon,\lambda)\,ds\,dz \tag{27}$$

for a standard symmetric normalised mollifier[30] $\bar{\varsigma}_\epsilon$ defined on $[0,T] \times \mathbb{R}^+$. Thus besides the properties of $\widetilde{\Pi}$ smoothness and boundedness of the function $\Pi^*$ on $[0,T] \times \mathbb{R}^+$are guaranteed.

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[28] Truly, observe that that both $\partial^2\widetilde{\Pi}/\partial\xi^2$ and $\partial\widetilde{\Pi}/\partial\xi$ are positive; $\partial\xi/\partial y$ is negative and $\partial^2\xi/\partial y^2$ remains positive on $\mathcal{D}$. Similarly, negativity of $\partial\xi/\partial t$ and positivity in $\partial\xi/\partial\beta$, $\partial\xi/\partial\lambda$, and $\partial\xi/\partial\varepsilon$ may be deduced.

[29] For any two securities it must hold that $\mu_1 > \mu_2$ iff $\sigma_1 > \sigma_2$, i.e. higher expected returns are associated with higher volatility of returns

[30] Notice that $\bar{\varsigma}_\epsilon(t,y) = \|\varsigma_\epsilon\|^{-1}\varsigma_\epsilon(t,y)$ and $\varsigma_\epsilon(t,y) = \begin{cases} \exp[-[1-(t^2+y^2)]] & t^2+y^2 < 1 \\ 0 & t^2+y^2 \ge 1 \end{cases}$

## 2.5. Case Study: Slovak Pension System

The goal of this paper is to establish the optimal private scheme pension fund choice strategy that should follow a participant of the Slovak pension system private scheme, conditioned primarily by their time to retirement, intermediate wealth-to-salary ratio and other model parameters.

Referring to Slovak pension system private defined-contribution based scheme presented earlier in Section 1.1 from the saver's point of view the investment decision essence lies in detecting the best fitting ratio between resources allocated to the Equity-Linked Index Fund (symbolizes stocks31) and the Bond Fund (depicts bonds). Hence the question is how we should design the optimal investment portfolio consisting of bonds and stocks that would generate the maximal possible expected future return given the investor's attitude to uncertainty in such portfolio return.

Henceforth, recalling the investment portfolio parameters introduced in (1) – (2) for $N = 1$ and the stock-to-bond proportion $\theta^*(t,y)$, we employ the super-indices $(b),(s)$ to denote bonds (zero index) and (the first index) stocks, respectively and use $\rho$ to depicts the correlation coefficient between them measured at time $t$

$$\mu(\theta_t) = \mu^{(b)}\theta_t^{(b)} + \mu^{(s)}\theta_t^{(s)}, \quad \sigma^2(\theta_t) = \left[\sigma^{(b)}\right]^2\left[\theta_t^{(b)}\right]^2 + \left[\sigma^{(s)}\right]^2\left[\theta_t^{(s)}\right]^2 + 2\rho\sigma^{(b)}\sigma^{(s)}\theta_t^{(b)}\theta_t^{(s)}$$

Next, assume the subsequent structural assumptions on bond and stock average yields, namely the financial market stability and opposite behaviour of bonds and funds returns (see Macová & Ševčovič (2010)), i.e. at any time,

$\Delta\mu \equiv \mu^{(s)} - \mu^{(b)} > 0$, and $\sigma^{(s)} > \sigma^{(b)}$;

$-1 < \rho < 0$.

Then,

$$a\mu - b1 = \frac{\Delta\mu}{\left[\sigma^{(b)}\right]^2\left[\sigma^{(s)}\right]^2(1-\rho^2)}\begin{pmatrix}\sigma^{(b)}\left[\sigma^{(b)} - \rho\sigma^{(s)}\right]\\ \sigma^{(s)}\left[\sigma^{(s)} - \rho\sigma^{(b)}\right]\end{pmatrix} \quad \text{and} \quad \bar{c} = \frac{\sigma^{(s)}}{\Delta\mu}\left[\sigma^{(s)} - \rho\sigma^{(b)}\right].$$

Moreover, as discussed earlier due to stable financial market condition, outside the region $\widetilde{\mathcal{D}}$ it is optimal to invest all the wealth already accumulated on an individual's private pension account whereas inside the region $\widetilde{\mathcal{D}}$ the optimal policy is driven by (11), (24) and (27) as summarized below.

**Theorem 3:** *The optimal stock-to-bond ratio approximation $\theta^*(t,y)$ defined for all $(t,y) \in [0,T] \times \mathbb{R}^+$ as*

$$\theta^*(t,y;\ \varepsilon,\lambda) = \frac{1}{\left[\sigma^{(b)}\right]^2 + \left[\sigma^{(s)}\right]^2 - 2\varrho\sigma^{(b)}\sigma^{(s)}}\begin{pmatrix}\sigma^{(s)}\left[\sigma^{(s)} - \rho\sigma^{(b)}\right] - \Delta\mu\,\Pi^*(t,y;\varepsilon,\lambda)\\ \sigma^{(b)}\left[\sigma^{(b)} - \rho\sigma^{(s)}\right] + \Delta\mu\,\Pi^*(t,y;\varepsilon,\lambda)\end{pmatrix} \qquad (28)$$

*for $\Pi^*$ defined in terms of (27), under the stable market conditions exhibits the subsequent behaviour32*

- *smoothness and boundedness by $[0,1]$ on $[0,T] \times \mathbb{R}^+$*
- *constancy $\theta^* = \left(\theta^{(b)}, \theta^{(s)}\right) = (0,1)$ outside $\widetilde{\mathcal{D}}$*
- *monotone decrease in both $y$ and $t$ on $\widetilde{\mathcal{D}}$, and strict convexity in $y$*
- *monotone increase in all $\varepsilon$, $\lambda$ and $\beta$ on $\widetilde{\mathcal{D}}$*
- *monotone decrease in $d$ on $\widetilde{\mathcal{D}}$*

*Furthermore under the stable market conditions $\theta^{(s)}$ increases with $\Delta\mu$ and decreases with $\Delta\sigma^2$ on $\widetilde{\mathcal{D}}$.*

Moreover, by formula (28) we have shown how to replicate this optimal investment strategy by selecting the investor-specific dynamic portfolio composing of investments into only two existing

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[31] Even the Equity-Linked Index Fund allocation strategy applied when replicating the performance of the benchmark prescribed by the pension fund management, is unlimited in the choice of stocks, financial derivatives or exchange traded funds, we assume the fund investment decisions restricted in stocks only.

[32] Mollifying procedure transforming $\overline{\Pi}$ into $\Pi^*$ is applied close to boundary $\partial\widetilde{\mathcal{D}}$.

pension funds of given returns and volatility profiles - the Index Fund with the portfolio weight $\theta^{(s)}$ and the Bond Fund with the portfolio weight $\theta^{b} = 1 - \theta^{(s)}$.

## *3. Results*

We have tested the proposed optimal investment strategy model estimated by (28) in Theorem 3 applied on the Slovak pension system private scheme.

According to recently changed Slovak legislature the regular contribution of a private scheme participant is prescribed as 4% of his/her gross wage. Hence, we use the effective contribution rate $\varepsilon = 3.96\%$ since each PAMC charges fund management fees defined as 1% of an investor's contribution. As $\varepsilon$ plays the key role not only in this model, but in its actual application to Slovak pension system, we have tested several $\varepsilon$ values to scrutinize the model outcomes. We have assumed the accumulation period $\mathrm{T} = 40$ the investor's attitude to portfolio return uncertainty (individual's risk aversion attitude) $\lambda = 0.05$ and set the Arrow-Pratt related relative risk aversion coefficient $\mathrm{d} = 10$. The average gross wage growth rate has been adopted from the Slovak Statistical Office and estimated on $\beta = 0.024$.

Regarding market data, we pay attention to the recent time periods 2009-2012 and 2003-2012. Within the latter period, 2009-2012, the MSCI All Country World Index representing stocks yielded the average return $\mu^{(s)} = 0.1053$ with the standard deviation achieving $\sigma^{(s)} = 0.1423$ whereas the longer period (2003-2012) is characterized by moderate returns and higher volatilities in compare to 2009-2012 period since the average stock return drops to $\mu^{(s)} = 0.0763$ and the deviation raised at $\sigma^{(s)} = 0.2050$. Notice that the statistics for the MSCI World index data have been borrowed from MSCI index official web page. As the modelling of bond returns is concerned we have considered the term structure of harmonised long-term interest rates for Slovakia observed by ECB (data available on ECB official web page) in the same time periods 2009-2012 and 2003-2012. For the shorter time period (2009-2012) we considered the average yield $\mu^{(b)} = 0.0439$ with the standard deviation $\sigma^{(b)} = 0.0036$ while during the longer period (2003-2012) is characterised by average yield of $\mu^{(b)} = 0.0447$ with the higher standard deviation $\sigma^{(b)} = 0.0047$. Based on observations the correlation between stock and bond returns for shorter periods 2009-2012 was significantly negative and estimated as $\varrho = -0.8344$ while for the longer period 2003-2012 securities were slightly positive correlated with $\varrho = 0.0687$. The descriptive statistics obtained are summarized in the table below:

**Table 1: Descriptive characteristics (mean and standard deviation) for Slovak long-term rates and MSCI World index**

| Security | 2009-2012 | | 2003-2012 | |
|---|---|---|---|---|
| | mean | stdev | mean | stdev |
| MSCI All Country World | 0.1053 | 0.1423 | 0.0763 | 0.2050 |
| Slovak long-term rate | 0.0439 | 0.0036 | 0.0447 | 0.0047 |

Alternatively, we may test the optimal investment policy on different sets of financial securities pairs, e.g. 10-year US Treasuries and S&P500 Index, or German harmonised long-term interest rate and DAX.

**Figure 1: 3D graph (left) and contour plot (right) of the optimal allocation policy given the baseline scenario and 2009-2012 time period market data.**

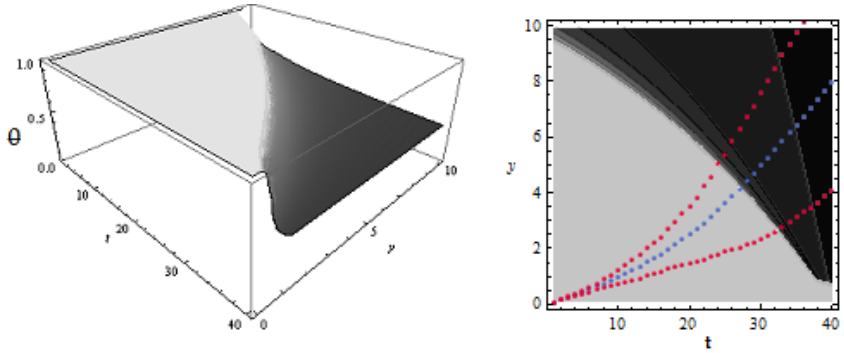
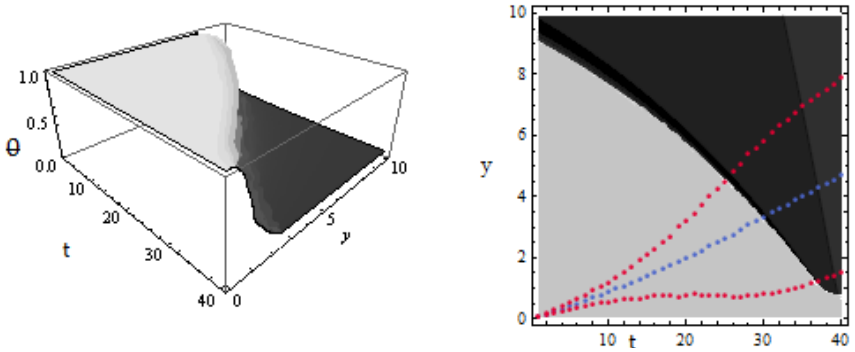



Figure 1 presents the baseline scenario illustrated by the 3D plot and the associated contour plot of the optimal stock-to-bond ratio $\theta^*(t,y)$ second component $\theta^{(s)}$ – index weight in the portfolio - as a function of time $t \in [0,T]$ and level $y > 0$ of yearly saved yearly salaries. As for the approximate value of $\theta^*(t,y)$ we considered the double first order expansion given by (28) and apply period 2009-2012 financial market data.

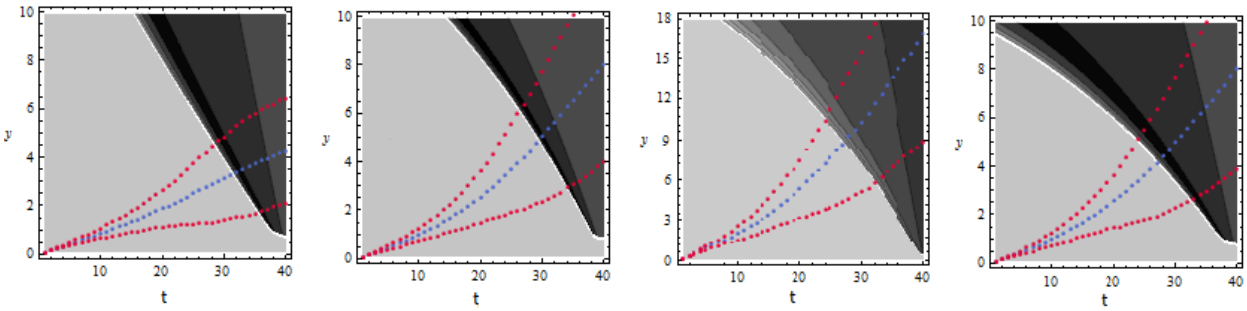
The mean portfolio wealth $\mathbb{E}(y_t)$ (blue dot line) is obtained by 10 000 Monte-Carlo simulations of random paths $\{y_t\}_{t=1}^{T}$ calculated according to the recurrent equation (3) with one year period $\tau = 1$. The red dot lines depict the mean wealth plus/minus one standard deviation of the random variable. The simulations were attained employing the optimal stock-to-bond ratio $\theta^*(t,y)$ depending on the value of simulated yearly accumulated wealth $y_t$ at time $t$ and at the terminal time $t = T$, $\mathbb{E}(y_T) \approx 8.2$ meaning that a saver following the optimal strategy given by $\theta^*(t,y)$ has accumulated 8.2 multiples of his/her last yearly salary. Furthermore for an average future pensioner it is optimal to invest all the resources into index (i.e. $\theta^{(s)} = 1$) during the first 28 of the accumulation period and then in last 12 years gradually transfer a share of the wealth into bond investment such that finally approximately 40% of wealth is still allocated in index.

**Figure 2: 3D graph and contour plot of the optimal allocation policy given the baseline scenario and 2003-2012 time period market data.**



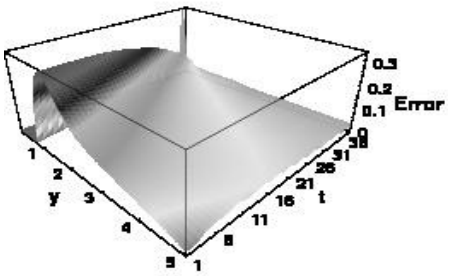

Likewise, Figure 2 shows the 3D plot and the corresponding contour plot of the optimal stock-to-bond ratio $\theta^*(t,y)$ provided that the longer period 2003-2012 for financial market data is assumed. In this case an individual saver following the optimal strategy given by $\theta^*(t,y)$ the character of recommendations about the proper choice of index and bond investment remain unchanged – an investor is advised to allocate all his/her wealth in the Index Fund for the first ¾ of the accumulation period. Moreover, following this strategy an average private pension scheme participant has accumulated approximately 4.8 multiples of his/her last yearly salary which is comparably less than for 2009-2012 time period due to MSCI index lower average return and higher volatility and positive correlated securities.

**Figure 3: Contour plots of the optimal allocation policy with varying structural parameters - gross wage growth $\beta$ (change form 2.4% to 5%), relative risk aversion coefficient $d$ (change from 10 to 12), contribution ratio $\varepsilon$ (change from 4% to 9% - notice the different scale on $y$-axis used) and portfolio return uncertainty attitude coefficient $\lambda$ (change from 0.05 to 0.1), respectively.**




Next, on Figure 3 we propose the illustration of the optimal policy behaviour under the crucial model structural parameters variation: we change the gross wage growth β from 2.4% to 5%; relative risk aversion d from 10 to 12; contribution rate ε from 3.96% to 9%; and portfolio return uncertainty attitude coefficient λ from 0.05 to 0.1, respectively. Though for an average Second Pillar participant these changes have no remarkable impact on his/her optimal fund switching policy (only a slightly longer period with purely index optimal portfolio of an average investor) they have a serious effect on the amount of accumulated multiples of investor's last year salary – evidently, it can be doubled in compare to baseline scenario (8.4 to 17.2, see the third subfigure) by the increase mentioned in the contribution rate ε. As stated before, fees charged by PAMC reduce proportionally the effective contribution rate so that they have the same effect on investment decision and allocated wealth as the decrease in contribution rate. Furthermore observe that higher raise in nominal wages β imposes lower terminal amount of accumulated multiples of investor's salary.

**Figure 4: The difference between continuous and discrete-time space of optimal strategies**




Finally due to properties of portfolio value function the solution obtained via discrete dynamic stochastic programming underestimates the optimal solution to the portfolio construction problem studied, hence following such sub-optimal strategy induces expectation of smaller future portfolio wealth – the evolution of the error term (measured as the difference between the continuous and discrete strategies) is illustrated by Figure 4. Therefore, our smooth solution approximation leads to higher expected returns.

## 4. Discussion

We emphasize the main result of our study – it is optimal for an average investor with a certain risk profile to choose in the first 30 years of his/her participation in the Slovak pension system private scheme (Second pillar) the dynamic strategy by investing in portfolio consisting only of assets (indices). Then, as time approaches the retirement age and the wealth already allocated on an pension account appreciates, the proportion of risky assets in an investor's portfolio smoothly descends and less risky assets (government bonds) take place so that in an investor's retirement age approximately 70% of wealth is held in low risk security. Furthermore, an average saver following the optimally designed strategy has accumulated 8 multiples of his/her last yearly salary.

Then to be consistent with the Slovak legislative norms, the best choice for an average participant of the Second pillar is to keep 100% of the financial resources allocated on his own pension account in the Index Fund for the first 25 years of the accumulation period and gradually decrease this percentage by allocating a proper share of wealth in the Bond Fund simultaneously so that in last five years before retirement all the wealth is allocated in the Bond Fund only. Therefore referring to sensitivity analysis provided in order to increase the amount of wealth allocated on the pension account in the end of accumulation period we recommend to lower the PAMC fees, increase the contribution rate and/or liberate the legislative norms (e.g. allow for investment into Index Fund in the last 5 years before pension age, shift the age when the legislative norms applied on pension fund decision take place on 55 years and associate it the expected pension age).

## *Conclusion*

We have analysed a continuous dynamic stochastic accumulation model for determining the optimal investment strategy in the pension saving decision that a future pensioner should follow in order maximize his/her expected future pension income with respect to their specific risk aversion. Given an investor's time to retirement, amount of wealth already allocated on a pension account already allocated and based on an individual's characteristics, legislative regulations and financial market data we formulated his/her optimal investment strategy by designing the best-fitting dynamic portfolio and detected an investor-specific pension fund choice employing the stock-to-bond proportion.

We demonstrated how the problem can be treated in terms of a solution to the fully nonlinear parabolic Hamilton-Jacobi-Bellman equation and approached by its double asymptotic expansion to obtain a useful first order approximation used in the optimal investment strategy estimation and qualitative analysis of dependence of the optimal policy on various model parameters using real data of Slovak pension system. Furthermore, using the optimal investment strategy estimated by this procedure we formulated the main policy implications and recommendations briefly summarized in previous section.

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# Occupational mobility in the ageing society - Changing occupation in the Czech and Slovak labour markets in 2003-2012

*Hana ŘÍHOVÁ*[1], *Tereza VAVŘINOVÁ*[2]

***Abstract***: The paper uses labour force survey panel data to study the level and patterns of occupational mobility in the Czech Republic and Slovakia in the period of 2003-2012. Occupational mobility can serve as an adaptive mechanism of the labour markets on structural changes of the economy. The level of occupational mobility in the country is influenced by economic cycle, by the employment protection regulation and by other factors such as values attributed to various aspects of jobs. At the individual level the most important characteristic is age. Younger workers under 30 have much higher rates of mobility and the share of upward mobility is also higher among them. There is however evidence that a certain level of mobility is necessary in the labour market and in the ageing society the older people will have to be also prepared to change their occupations to a greater extent in the future.

***Keywords:*** occupational mobility, panel data, labour market, labour force survey, vertical mobility.

***JEL classification:*** J62

## 1. Introduction

Current labour market is ever more frequently characterized by dynamic trends and it is often claimed that people need to be prepared for changes of jobs and occupations during their career. Flexibility and willingness to change the occupation on the side of the workers and flexible employment legislation serve as an adjusting mechanism in the labour market to balance structural changes. An optimal level of mobility is necessary for the functioning of labour market in the knowledge based economy, which brings significant and in some segments rapid structural changes in terms of sectoral as well as occupational composition of the workforce.

Flexibility is a characteristic which is often perceived as an attribute of younger workers. Although this can be also misused as a discriminating factor during hiring processes if applied at the individual level, the statistics show that the mobility in the labour market is much more frequent in the young age groups. This may be both a result of higher flexibility of the young workers as well as of their worse situation in the labour market which does not enable them to find a suitable long-term job after graduation. As has been said a certain level of occupational mobility in the labour market is necessary to adopt on structural changes in the economy. In the ageing society this means that not only the young workers can be mobile but the older workers will also have to be able to change occupations in order to catch up with the dynamic labour market.

Occupational mobility may take many different forms. Former shop sales assistant who got promoted to retail manager is an example of intra-firm mobility, which sources mostly from employer´s decision. In contrary inter-firm occupational mobility is usually motivated by individual´s

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decision about his or her career. Sectoral changes, different wage conditions among occupations or macroeconomic conditions can very often be a motivation for this decision.

In their paper Kambourov and Manovskii (2004, [7]) pointed out on an important issue related to labour market mobility. According to their research, 10 year occupational tenure (with all other factors held constant) increases wages by at least 19 %. This leads them to the conclusion that human capital is not exclusively industry specific (Parent, 2000, [12]) or firm specific (Topel, 1991, [18]) but also occupational specific. Xiang (2008, [19]) focused on evaluating occupational changes from the loss of human capital point of view. His conclusions confirm that occupational changes connected with the loss of human capital, when the experience gained in the previous occupation is not valorized in the new occupation, are predominant. This suggests that the change of one´s occupation in a course of life is mostly unwanted and involuntary and connected with difficult situation on individual or macroeconomic level (Longhi, Brynin; 2010, [9]). If this is true, the yearly occupational mobility rates of average of 18% at the 2-digit level presented by Kambourov and Manovskii (2004, [7]) seem to be very high. On the other hand positive occupational change should not be ruled out completely. As Xiang (2008, [19]) points out, less than 4 percent of overall occupational mobility is tied with moving up the career ladders and switching between occupations requiring almost the same knowledge and skills. But even occupational switches connected with loss of certain amount of human capital might be positively evaluated by workers. Longhi and Brynin (2010, [9]) using British household panel data argue that over 45 percent of workers who recently overcame occupation change evaluate it as an improvement. Another argument added by Chen, Fugére and Lin (2008, [1]) suggests that average wage increase resulting from occupational change is 17%, while corresponding wage increase of workers who stay in their job is 7%. Conflicting evidence on the nature of occupational change leads us to investigation of the scope of downward and upward labour force mobility in the fourth section of this paper.

This paper focuses on measuring the scope of occupational mobility and comparing patterns associated with its occurrence in the Czech Republic and Slovakia in the period of 2003-2012.

The main questions on which the paper focuses are:

- What is the volume of occupational mobility in the Czech and Slovak labour market in comparison with other labour markets? How is it related to the employment protection legislation in the country?
- How the economic cycle influences the patterns of occupational mobility?
- What share of occupational mobility leads to a better position in the labour market and what can be attributed to an involuntary fluctuation?
- Which characteristics of an individual are related to higher mobility and to different types of mobility? How do the mobility patterns differ by gender, age, education attainment and occupation?

The paper is organized as follows. The second chapter describes our methodology and data. In the third chapter the overall occupational mobility is characterized. Three occupational mobility types based on their vertical direction are distinguished in the fourth section and their relative occurrence in both countries is described.

## 2. Used methodology

### 2.1. Data

In this paper, data from Czech and Slovak labour force surveys (LFS) were used, which are harmonized with Eurostat LFS methodology and provide comparable data. They are household sample surveys carried out quarterly and cover population living in private households. The sample consists of 25 thousands households in the Czech Republic (approx. 49 thousands of individuals aged

15 years or more) and 10 thousands of households in Slovakia (approx. 22 thousands of individuals aged 15 years or more). [3]

The sample has a form of a rotating panel. Each quarter one fifth of the sample is changed and each household remains in the sample for five consecutive quarters. The panel character of the LFS data was used in this paper to carry out a longitudinal analysis tracking people at five consecutive quarters. This methodology of analyzing LFS data is still not very frequent, most studies use the LFS data as cross-sectional. In the international research the panel LFS data was used for example by Lalé (2008, [8]). A methodology of longitudinal analyses of Canadian LFS was prepared in 2004 [14]. Only a few papers used this character on Czech data, mostly to track the unemployed (Jarošová, 2006, [6]; Stupnytskyy, 2011, [17]). Brief longitudinal analysis was prepared by Czech Statistical Office in 2011 [2].

In our paper we used data from the Labour Force Survey (LFS) from the period of 2003-2012, more specifically national microdata sets provided by Czech and Slovak statistical offices. The data were broken down by waves (order of visit) and merged again in order to allow us to study changes in individual´s occupation during his or her participation in panel. The data for the final analysis were weighted by the quarterly weights for the first visit. In some cases we focused on analyzing trends and used yearly data separately, in others we used the entire pool of respondents in the file regardless the year in order to make a more detailed breakdown by socioeconomic characteristics.

The sample was restricted to correspond the needs of the analysis of mobility in the labour market. At first, respondents who drop out from the panel during the year and therefore had missing observation in any of the waves were excluded. Further we restricted the sample to people who were employed both at the time of first and last interview (when entering the panel and a year after). We also excluded students of formal education to prevent the situation when switching between unqualified and part-time student job would be measured as a standard mobility in the labour market.

The LFS uses ISCO classification of occupations and this is a key variable for the definition of occupational mobility. In Czech and Slovak LFS ISCO-88 was used until 2010 and ISCO-08 from 2011 on. We had to exclude the respondents who entered the survey in 2010 because they had their occupation classified in ISCO-88 in the first wave but in ISCO-08 in the last wave. Even though there are available correspondence tables between the two versions of occupational classifications they cannot be used for measuring the occupational mobility. There are too many relations of other than 1:1 character between the classifications and comparison between 2010 and 2011 would report a high share of pseudo mobility.

## 2.2. Measurement of occupational mobility

There are several forms how the occupational mobility can be approached. The most straightforward solution is a change of occupation as defined by a standard classification. The main concern is at what level of classification the mobility is measured. The choice is often driven by what data is available, 4 digit and/or 2 digit levels are used by majority of authors. Apparently, the more detailed coding is used, the higher rates of occupational mobility are recorded.

Various procedures to clean the data from a pseudo mobility caused by miscoding or to improve the definition of the mobility have been applied by the authors. Lalé (2012, [8]) measured the mobility at the 4-digit, 2-digit and 1 digit ISCO codes. On the 2- and 1- digit levels he discards all switches between occupations which are not accompanied by a change of employer. Moscarini and Thomsson (2007, [10]) recognize the occupational mobility only if there is a coincident change of industry, social class or if the respondent searched work in the last months. Longhi, Brynin (2010, [9]) only focused on occupational mobility if accompanied by a change of employer. These may be considered as cautious methodologies which probably underestimate the level of occupational

[3] [3], [15]

mobility. It discards promotions within one company, which may be real and go across the broader occupation groups[4].

Various authors` concern about detecting pseudo mobility by data cleaning procedures is closely connected with the issue of dependent and independent occupational coding (i.e. translating respondent´s description of his or her occupation into ISCO code). Coding is independent if coder doesn´t have any knowledge about the respondent´s occupational code during his previous participation in panel. On the contrary, dependent coding means that coder knows how respondent´s occupation was coded in previous wave of LFS and evaluates whether there was or wasn´t any change. Apparently, dependent coding is more appropriate for measuring occupational change because it reduces possible coding errors. Dependent coding used in both Czech and Slovak datasets is a reason why we didn´t take any special measures to cope with pseudo mobility issue.

The second main methodological concern is related to the measurement period. When comparing results of studies on occupational mobility, the period between observations has to be taken into consideration because of the probability of change which is growing with the measurement period. Authors decided for various time periods for measuring the occupational change according to the data they have available. Another issue connected with the measurement period is time aggregation. Time aggregation problem includes possible multiple undetected occupational transitions in between the beginning and the end of measurement as well as the increased probability of attrition of the panel. The longer the frequency between two interviews is, the most severe time aggregation problem we have to face. Common strategy (e.g. Kambourov and Manovskii, 2004, [7]; Lalé, 2012, [8]) is to measure occupational changes in a year period with possible extension in case of respondents who were unemployed during their first participation (t) in the panel, but stated they were employed both a year before they joined the panel (t-1) and at the end of the measurement period (t+1). If different occupation is reported in t-1 and t+1, respondent is labeled as occupational switcher. In this paper one year measurement period was used without abovementioned modification including career breaks because of data availability. The result of this strategy is a slight underestimation of mobility rates compared to Kambourov and Manovskii (2004, [7]) and Lalé (2012, [8]).

In our paper we applied two approaches to measure mobility of employed people between jobs.

1. Occupational mobility was defined as a change of occupation between the first and the last visit (in one year). More specifically, the rate of occupational mobility used in the third section of this paper is defined as a number of individuals employed both at the beginning and at the end of their stay in panel, who reported different 2-digit occupation at the beginning and at the end of their participation in the survey, divided by all survey participants employed during their first and fifth panel participation with exception of formal education students. The change was measured at 2-digit level to ensure comparability of the Czech and Slovak dataset. The Czech data enabled measurement of mobility at 4 digit level as well. The rate of mobility was 3.1 at the two-digit level and 4.1 at the four-digit level. The difference between two-digit and four-digit mobility was somewhat lower than these identified in France (4.7 at two-digit and 7.4 at four-digit; Lalé, 2012, [8]).
2. The second concept applied in the paper is focused on the vertical direction of the mobility. It distinguishes between 3 categories: upward mobility, downward mobility and horizontal mobility and an implicit fourth category “no mobility”. Figure 1 presents a decision tree used to

[4] These may include for examples switches to management jobs in ISCO 1 or switches from junior to senior positions or between technicians and specialists (e.g. information and communication technicians – ISCO 35 and Software and applications developers and analysts – ISCO 25). It may be signifiant especially among graduates who often get less qualified jobs after thein graduation but may move quickly up.

categorization of respondents into the four groups. The upward/downward mobility can be caused by four major changes in the job characteristics:

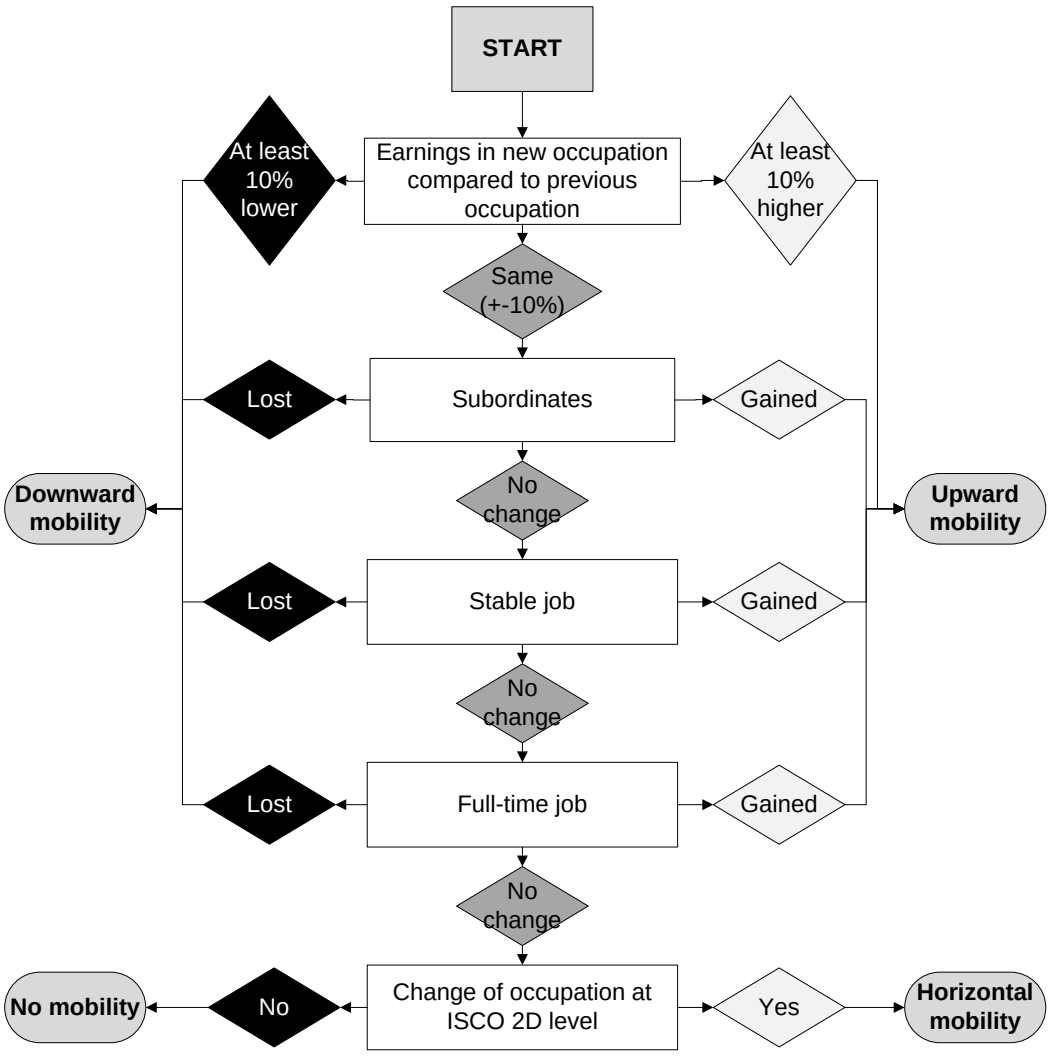
a. Transition to an occupation with at least 10 % higher/ lower average earnings than the initial occupation. The LFS data do not provide direct information on the actual earning level of the employer. We used external information on average wages for ISCO 2 digit levels from the information systems on average earnings conducted by Trexima for ministries of labour in both countries [21, 22, 28, 29]. The information on average wage in the initial and final occupation had been imputed into the LFS dataset and these were compared. Even though the person may not actually get a 10% or more higher wage in the final occupation we can treat this as an upward shift because s/he has a job which is in general better paid and which may improve his/her future career prospects. Similar approach using average earning by ISCO 1 digit level has been applied by Dex, Lindley, Ward (2007, [4]). If there was no difference in occupations or the difference in earnings was lower than 10% the vertical mobility has still been attributed if the person:

b. Gained/lost subordinates in their job.

c. Switched between temporary (fixed-term) and permanent contract. The change was only perceived as vertical mobility if the temporary job was involuntary.

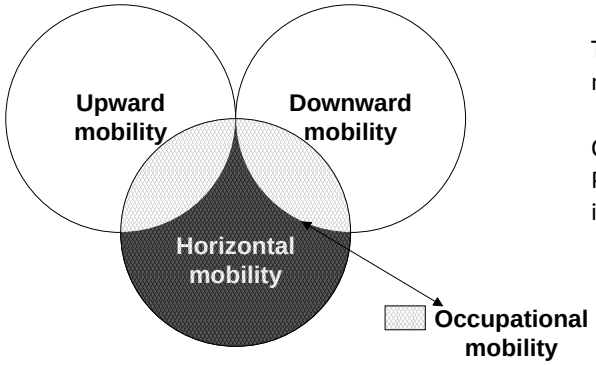
d. Switched between full-time and part-time job. Similarly to previous case the change was only perceived as vertical mobility if the part-time job was not the worker`s preference.

**Figure 1: Decision tree**



The figure 1 suggests that there is a possibility of identification of upward or downward mobility for a person even if s/he did not change the occupation. The sum of upward, downward and horizontal mobility is therefore higher than the occupational mobility. The relation among these categories is shown at figure 2.

**Figure 2: Relations among vertical dimensions of mobility and occupational mobility**




Total mobility = Upward mobility + Downward mobility + Horizontal mobility

Occupational mobility = All horizontal mobility + Parts of upward and downward mobility which include change of occupation

# *3. Results*

## 3.1. Volume of occupational mobility

### *3.1.1. Rate of occupational mobility in the international context*

According to the methodology described above the overall occupation mobility over the period of 2003-2012[5] occurred in 3.1 percent of cases in the Czech Republic and in 2.2 percent of cases in Slovakia. The mobility rates in the Czech Republic were exceeding rates of Slovakia in the whole period we focused on. Mobility rates of the Czech Republic and Slovakia can be with several limitations compared to similar studies performed in the USA, Canada and some European countries. To achieve the highest possible comparability only studies using LFS data were chosen as benchmarks. Dex, Lindley and Ward (2007, [4]) identified the mobility rate of 9 percent in 1997 and 9.8 percent in 2000 for the US population from 18 to 65 years. Similar study performed on French LFS data by Lalé (2012, [8]) came up with the average occupational mobility rate of 4.7 percent in between 1982 and 2009. Although different methodological approaches[6] have to be taken into consideration while comparing results of studies, the Czech and Slovak rates of occupational mobility seem to be exceptionally low in this context. For the Czech Republic this conclusion can be confirmed even on more detailed 4 digit level of the classification of occupations. The mobility rate defined by change of the four digit occupation code within the period of respondent´s participation in LFS panel reached 4.1 percent compared to 7.4 percent in France. When considering results of other studies, low mobility rates in the Czech Republic and Slovakia turn out to be even more exceptional[7].

[5] Respondents who joined the LFS panel in 2010 were removed from analysis due to changes of classification of occupations in both Slovakia and the Czech Republic.

[6] While our sample is restricted to those who were employed both at the beginning and at the end of measurement period, Lalé includes those who were unemployed during the first visit. Overmore, in French study workers employed in public sector were excluded. Occupational rates are thus not fully comparable.

[7] 15% occupational mobility on 2-digit level measured in the USA by Kambourov and Manovskii (2004), 20% occupational mobility on 4-digit level measured by Chen and Fougére (2008) in Canada, 29,4% mobility measured on 2-digit level by Longhi and Brynin (2010) in the United Kingdom.

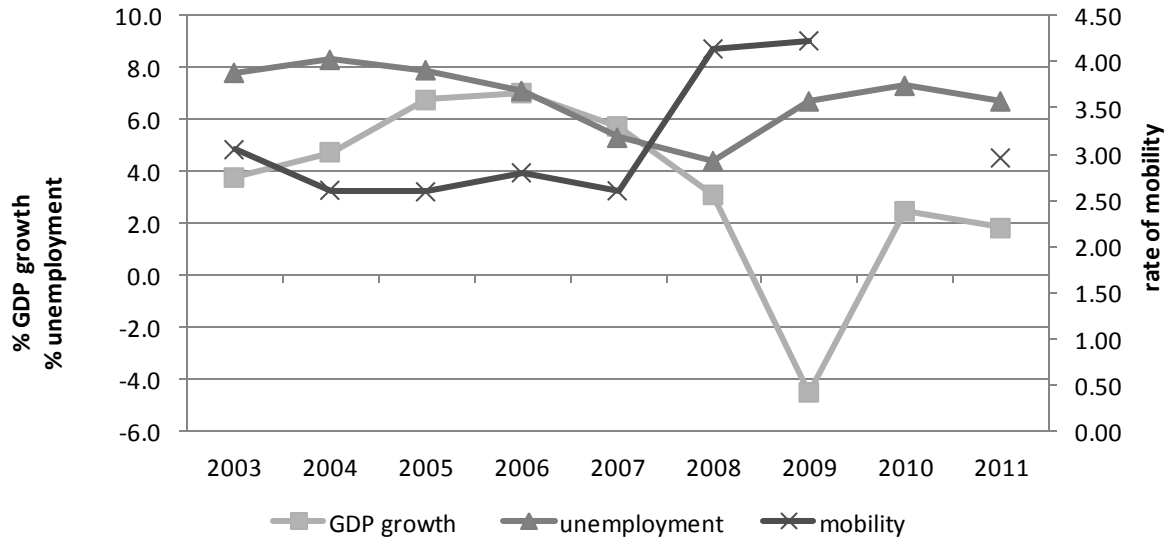
There can be several explanations of different rates of mobility in different countries. Lalé (2012, [8]) explains lower mobility rates in France as opposed to USA by less flexible labour markets in continental Europe. In countries with strict employment protection legislation the overall labour mobility is expected to be lower. OECD indicator designed to compare employment protection legislation stringency[8] confirms that countries with evidence of very high levels of occupational mobility (USA, United Kingdom or Canada) are the least regulated countries in the domain of employment protection. Similarly in France and the Czech Republic, i.e. countries where the employment protection is very strict, significantly lower occupational mobility rates have been detected. According to Gangl (2003, [5]) stringent employment protection legislation should reduce both voluntary and involuntary (employer induced) mobility. However, labour market flexibility is far from being the only unemployment rates resulting in lack of willingness to quit a job voluntarily in Slovakia might be an explanation.

The level of mobility can also be related to the value which is attributed by workers to different aspects of the job. The surveys of work values such as International Social Survey Programme from 2005 [26] or European Values Study from 2008 [25] show that workers in the Czech Republic and Slovakia put more emphasis on job security while career aspects of the job (such as opportunities for promotion or having a responsible job) are not as important as in the old EU member countries or the US. This general work values can negatively influence the willingness to occupational mobility in Czech Republic and Slovakia as another factor. Several authors suggested that these are related factors and people in countries with stringent regulations are less satisfied with jobs security (Postel-Vinay, Saint-Martin, 2005 and Clark, Postel-Vinay, 2009 as quoted in OECD, 2013, [11]).

### *3.1.2. Relation between occupational mobility and the economic cycle*

Figures no. 3 and 4 present the evolution of occupational mobility rates in the Czech Republic and Slovakia since 2003 to 2012. Our first conclusion is that unlike in study of Kambourov and Manovskii (2004, [7]) no overall trend in occupational mobility has been identified in our data over time.

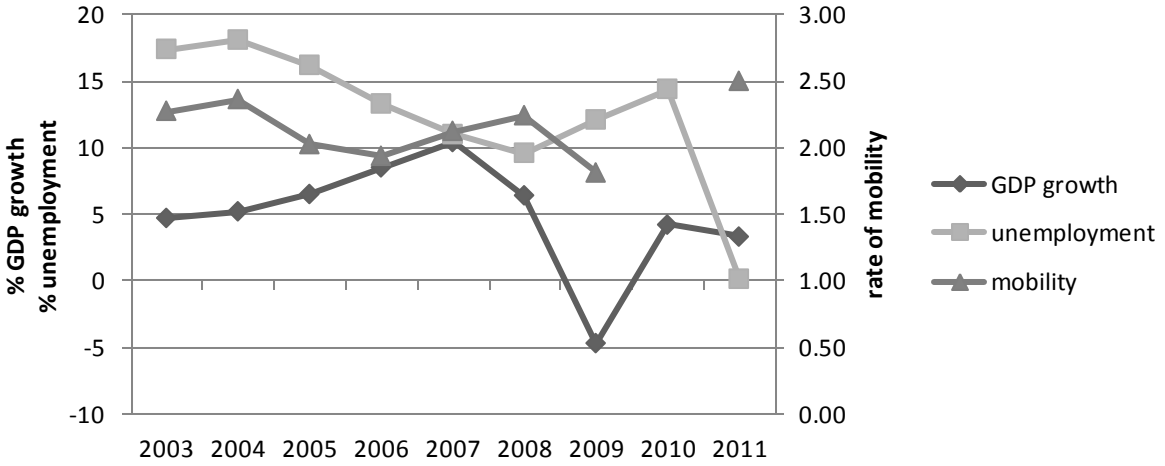
**Figure 3: Mobility rate and economic cycle in The Czech Republic**




***Source: LFS* [20]**

[8] The OECD indicators on Employment Protection Legislation 2013, [11]

**Figure 4: Mobility rate and economic cycle in Slovakia**




***Source: LFS* [27]**

Figures 3 and 4 enable us to analyze the connection of occupation mobility and the development of the economic cycle[9]. Empirical evidence (Dex, Lindley, Ward, 2007, [4]; Moscarini, Thomsson, 2007, [10]; Kambourov, Manovskii, 2004, [7]; Lalé, 2012, [8]) suggests a pro-cyclical pattern of occupation mobility, i.e. increasing rates of mobility during the periods of economic expansion and decrease in recessions. The evidence from our data is not clear. While in case of Slovakia, the development of occupation mobility rate can be at least from 2006 considered as pro-cyclical, the peak of occupational mobility in 2009 in the Czech Republic coincides with beginning of economic recession, suggesting rather counter-cyclical character of mobility in this country. As a result the relation of occupational mobility and economic development in Slovakia is in accordance with previous studies while the development of occupational mobility in the Czech Republic seems to be unusual in the context of other studies.

Considering the short time series of available data, the estimates of the relation of mobility rates and economic cycle are very rough. However, our data cover the transition into economic recession and provide us with information about development of mobility during massive decrease of economic performance that occurred in both countries in 2009. In Slovakia the economic recession had only limited impact on mobility rates and the period of 2008-2009 doesn't show any specific pattern in the overall development of mobility. In the Czech Republic mobility rates have sharply increased as a reaction to economic recession. The growth of occupational mobility was noticeable in all educational and age groups. Growth of mobility rates during inconvenient situation on the labour market are in line with the hypothesis of mostly involuntary nature of occupational change. Workers threatened by loss of their job take up every possible step including occupation change in order to avoid unemployment.

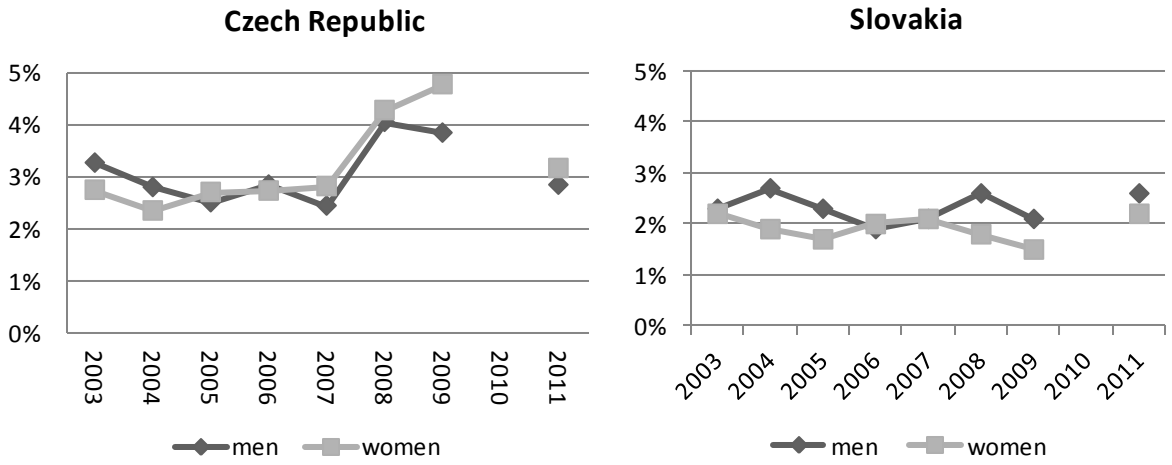
Only moderate growth of mobility rates as a reaction to economic recession in Slovakia seem to have connection with sharp increase of unemployment rates in the same period. In the Czech Republic, where unemployment rates are significantly lower, workers who lost their jobs as a result of decline of economic performance might have taken up less qualified jobs, i.e. change occupation. In Slovakia less such possibilities were available.

[9] While reading figures depicting the development of mobility rates in time we must take into consideration that the year corresponds with the moment when respondents joined the panel. That means that rates for year 2009 reflect occupational changes that occurred in between January 2009 and December 2010, when all the respondents who took part in the LSF in 2009 left the panel.

### *3.1.3. Gender differences in occupational mobility*

The rate of occupational mobility of men and women in the Czech Republic is comparable (average 3.1 percent in case of men, 3.2 percent for women). The difference of 0.1 p.p. is not statistically significant, therefore we can rule out the hypothesis of gender determined tendency to change occupation. However economic recession seems to have more severe impact on women´s mobility rate. While the increase in occupational mobility in 2008 was equal for both genders the development in 2009 was contradictory. Women´s mobility rates continued to grow, men´s mobility rates were slowly heading to steady state usual for the previous period.

**Figure 5: Mobility rates for men and women (%)**[10]




***Source: LFS* [20, 27]**

In Slovakia almost entire 2003-2012 period can be characterized by higher mobility rates of male workers. The average mobility rates were 2.3 percent for men and 1.9 percent for women and the difference of 0.4 p.p. is statistically significant (p = .000). Higher mobility of men is in accordance with evidence from France (Lalé, 2012, [8]) and the USA (Parrado et al., 2007, [13]). Differences between men and women are especially significant among the young workers. Approximately from the age of 40 the mobility rates of both genders tend to equalize.

### *3.1.4. Occupational mobility by age*

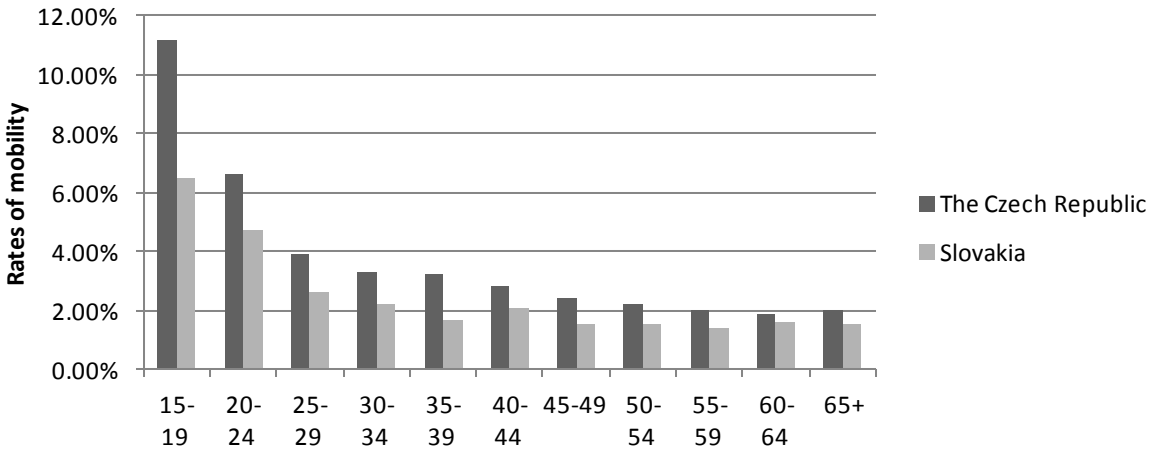
Young people are among the most mobile groups in the labour market. All available studies on occupational mobility confirm that young age is an attribute most tightly associated with mobility (e.g. Lalé, 2012, [8]; Kambourov, Manovskii, 2004, [7]). Data from the Czech Republic and Slovakia do validate such hypothesis. The mobility rates in different age groups in both countries are shown in figure 6. In the first age group from 15 to 19 years the rate of mobility is in both countries more than three times higher than the average mobility rate. Mobility rates are exceptionally high up to the age of 25. When it comes to the development of mobility in relation to economic cycle we didn´t find any specific patterns of workers in different age groups. The theory of occupational specific human capital can be very useful in explaining this. Because human capital is dependent on occupational tenure, the costs of mobility for workers who didn't build their stock of occupational specific human capital yet are much lower than in case of experienced workers. Older workers don't switch their occupations as often simply because they have more to lose. Also on the employer side firing older workers may mean losing more investments into their skills and a part of the younger workers` mobility can be a result of the "last in-first out" effect.

Although the workforce became older in the observed 10 years period the level of mobility did not decrease. This can be considered as a sign that a certain level of mobility is necessary in the

[10] See footnote n. 8

labour market and that it is not only a specifically individual characteristic (in which case the overall level of mobility would change with changing structure of the workforce). Even though mobility may be more widespread among the younger workers the older people will have to be also prepared to change their occupations to a greater extent in the future as the workforce will get older in general.

**Figure 6: Mobility rates in age groups (%)**

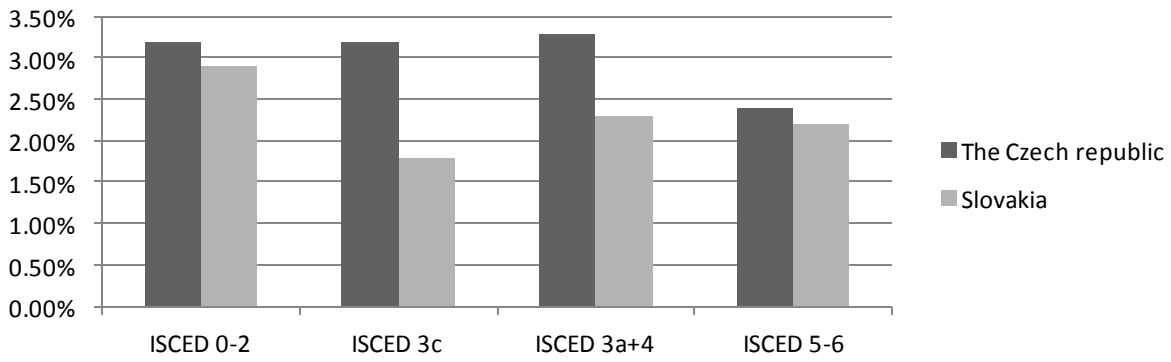



***Source: LFS* [20, 27]**

### *3.1.5. Occupational mobility by education attained*

The empirical evidence focusing on the patterns of mobility in different educational groups is inconsistent. Lalé (2012, [8]) and Parrado et al. (2007, [13]) did not recognize any significant education related mobility patterns, Kambourov and Manovskii (2004, [7]) have discovered lower mobility rates of workers with higher education. Different evidence in the two countries is also a result of our analysis. In the Czech Republic the mobility of tertiary educated workers is significantly lower than in other educational groups. Possible explanations might be connected with investment into human capital that results in the structure of skills which is less transferable among occupations (Kambourov, Manovskii; 2004, [7]). However results from Slovakia indicate that such an explanation is not generally valid. On one hand workers with the lowest education level do exhibit the highest occupational mobility; on the other hand no apparent trend can be identified for other educational groups. Lower mobility rates of workers with university degree might be connected with measuring mobility by change of 2 digit code of occupation. One might say that tertiary educated workers change their occupation as often as others, but due to their specific human capital this change is more likely to happen within extensively defined 2-digit occupational code. We have examined this possibility on 4-digit codes available for the Czech Republic and came to the same conclusion about lower mobility rates of workers with university degree.

**Figure 7: Mobility rates in educational groups (%)**

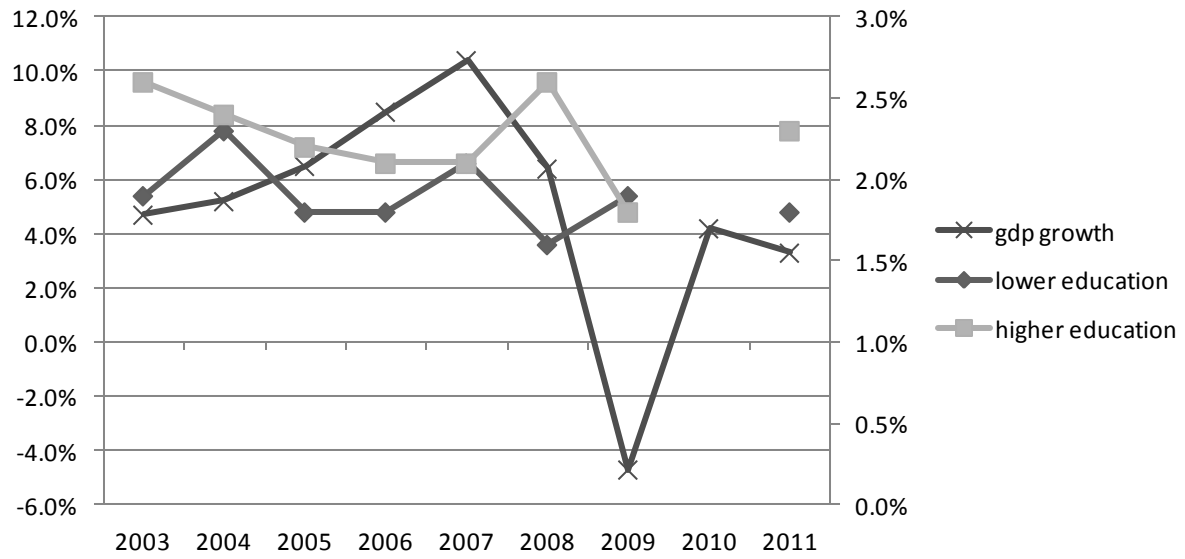



***Source: LFS* [20, 27]**

Differences in between the patterns of occupational mobility in the Czech Republic and Slovakia are confirmed when drawing conclusion about relation of the economic cycle and the development of mobility in various educational groups. In Slovakia we can hardly find any relation between the performance of economy and the mobility rates of workers with lower education (i.e. without maturita exam corresponding with obtaining ISCED 3a level), but in case of workers with higher education there seems to be countercyclical pattern which is even more robust while evaluating workers with college degree exclusively. During the whole 2003-2007 period connected with the acceleration of economy the mobility rate of workers with higher education has been decreasing; the beginning of the economic recession is associated with significant increase of mobility within this group. In the period when the economic growth has been re-launched, mobility of more educated groups decreased again. This evidence is in line with the explanation mentioned above. Compared to their less educated competitor, the more educated segment of population affected by economic crisis has a better chance to take up less qualified jobs, therefore their occupational mobility increased. On the other hand, less educated workers were more often stayed in unemployment as a result of the crisis.

In the Czech Republic the mobility of different educational groups has been following the same trend, the only exception is the separate decrese in mobility in the group of workers with high school with maturita (ISCED 3a+4) in 2009.

**Figure 8: Development of mobility rates in educational groups in Slovakia (%)** [11]




***Source: LFS* [27]**

### *3.1.6. Mobility across occupational groups*

The theory of human capital suggests that the occupational mobility rates depend on the extent to which human capital is specific for the certain occupation. Therefore mobility rates should be higher in case of occupations whose skills are easily transferable and very low in case of occupations that demand specific skills. In the Czech Republic as well as in Slovakia managers, clerks and elementary occupations were major groups most likely to experience the change in occupation. The lowest frequency of occupational mobility was identified in case of technicians and associate professionals in Czech data. In Slovakia professionals and craft workers were among the most stable workers.

[11] See footnote n. 8

**Table 1: Mobility rates by initial occupational groups**

| ISCO-88/ISCO-08 | CZE | SK |
|---|---|---|
| Legislators, senior officials and managers | 4,6% | 2,9% |
| Professionals | 3,2% | 1,6% |
| Technicians and associate professionals | 2,1% | 1,8% |
| Clerks | 3,8% | 2,6% |
| Service and sales workers | 3,4% | 1,8% |
| Skilled agricultural, forestry and fishery workers | 2,9% | 2,8% |
| Craft and related trades workers | 2,6% | 1,6% |
| Plant and machine operators, and assemblers | 2,8% | 2,1% |
| Elementary occupations | 5,3% | 2,8% |

***Source: LFS* [20, 27]**

The mobility can occur within the major occupational groups or workers can switch into different group. Tables 2 and 3 show the occurrence of possible transitions and identifies most frequent occupational changes.

**Table 2[12]: Mobility across major occupational groups in the Czech Republic**

| | | Final occupational group | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Initial occupational group | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | Total |
| | 1 | 19% | 13.3% | 29% | 11.7% | 15.6% | - | 6.2% | 2.7% | 2.3% | 0.2% | 100% |
| | 2 | 8.7% | 8.4% | 55.4% | 17.0% | 3.7% | 1.1% | 2.9% | 2.2% | 0.6% | - | 100% |
| | 3 | 14.6% | 15.3% | 16.9% | 14.4% | 16.9% | 0.7% | 8.5% | 8.4% | 3.8% | 0.4% | 100% |
| | 4 | 7.1% | 5.5% | 28.7% | 8.7% | 20.4% | 1.2% | 4.0% | 13.7% | 10.3% | 0.4% | 100% |
| | 5 | 5.5% | 3.6% | 18.6% | 12.4% | 14.3% | 1.5% | 8.8% | 17.8% | 17.2% | 0.3% | 100% |
| | 6 | 1.3% | 5.1% | 11.4% | 3.8% | 11.4% | 2.5% | 13.9% | 24.1% | 26.6% | - | 100% |
| | 7 | 1.5% | 2.2% | 12.1% | 4.2% | 12.1% | 1.9% | 21.6% | 30.1% | 13.8% | 0.6% | 100% |
| | 8 | 1.3% | 0.3% | 10.6% | 8.4% | 10.7% | 2.7% | 31% | 16.6% | 18.1% | 0.3% | 100% |
| | 9 | 0.5% | 0.7% | 8.3% | 9.8% | 18.7% | 3.7% | 19.8% | 23.3% | 15.3% | - | 100% |
| | 0 | - | 5.3% | 14% | 3.5% | 15.8% | 1.8% | 28.1% | 21.1% | 10.5% | - | 100% |

***Source: LFS* [20]**

Transitions into the group of technicians and associate professionals are among the most frequented in the Czech Republic. Technicians and associate professionals are a target group for

[12] Tables consist of cases that overcame occupational change during their remaining in LFS panel. Rows of the table represent the code of respondent´s occupation in the time he participated the LFS panel for the first time, columns represent the code of his occupation during his last participation. Cell mn represents percent of workers who changed their occupation from major groups m into major group n. For example in the table X+1, 19 percent of those who initially worked as managers and changed their occupation, remained in the group of managers and 13, 3 percent of them switched into occupation coded as professionals. Occupational groups are defined as 1. Legislators, senior officials and managers 2. Professionals 3. Technicians and associate professionals 4. Clerks 5. Service workers and shop and market sales workers 6. Skilled agricultural and fishery workers 7. Craft and related trade workers 8.Plant and machine operators and assemblers 9. Elementary occupations 0.Armed forces

more than half of the professionals and almost third of managers and clerks who experienced the occupational change, but surprisingly the share of workers who switch into this group from less qualified occupations (groups 5, 6, 7 and 8) is not negligible either. Another important target occupational group in the Czech Republic are service workers, which very often attracts former clerks or workers from elementary occupations. Transitions between craft workers and plant and machine operators are very frequent too. Occupational mobility within the major occupational groups is most likely to happen in case of craft workers, managers and technicians and associate professionals, the probability of changing the major occupational group is highest for agriculture workers, professionals and clerks.

In Slovakia, the switch into the group of technicians and associate professionals is similarly frequent in case of more qualified occupations, but it is quite rare for less qualified workers. Occupational groups of craft workers and elementary occupations are target groups for workers from other less qualified occupations very often. In accordance with the Czech Republic occupational switch within the major ISCO group is most likely to happen in case of craft workers and managers. Due to a lesser sample size, the Slovakian table of transitions is less reliable, especially in case of agriculture workers and armed forces, whose representation in sample is insufficient for this kind of analysis.

**Table 3[11]: Mobility across major occupational groups in Slovakia**

| | | Final occupational group | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Initial occupational group | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | Total |
| | 1 | 27.6% | 21.6% | 24.1% | 5.2% | 11.2% | - | 4.3% | 3.4% | 2.6% | - | 100% |
| | 2 | 13.6% | 11.9% | 46.6% | 4.2% | 10.2% | - | 8.5% | 0.8% | 4.2% | - | 100% |
| | 3 | 9.6% | 13.5% | 9.6% | 17.5% | 15.7% | 0.4% | 7.0% | 18.8% | 7.4% | 0.4% | 100% |
| | 4 | 3.7% | 6.5% | 31.8% | 14.0% | 20.6% | - | 3.7% | 7.5% | 12.1% | - | 100% |
| | 5 | 6.7% | 4.8% | 9.7% | 13.3% | 17.6% | 0.6% | 9.1% | 12.7% | 21.8% | 3.6% | 100% |
| | 6 | 5.6% | 0.0% | 0.0% | 5.6% | 11.1% | - | 22.2% | 16.7% | 38.9% | - | 100% |
| | 7 | 1.6% | 2.6% | 5.2% | 5.7% | 9.3% | 1.6% | 24.9% | 26.4% | 20.7% | 2.1% | 100% |
| | 8 | 1.5% | 0.0% | 6.4% | 7.9% | 13.8% | 2.0% | 22.7% | 16.7% | 28.6% | 0.5% | 100% |
| | 9 | 1.8% | 3.0% | 4.2% | 7.2% | 22.9% | 3.6% | 20.5% | 18.7% | 17.5% | 0.6% | 100% |
| | 0 | 47.4% | 1.3% | 13.2% | - | 5.3% | - | 1.3% | 2.6% | 1.3% | 27.6% | 100% |

***Source: LFS* [27]**

## 3.2. Upward occupational mobility and influencing factors

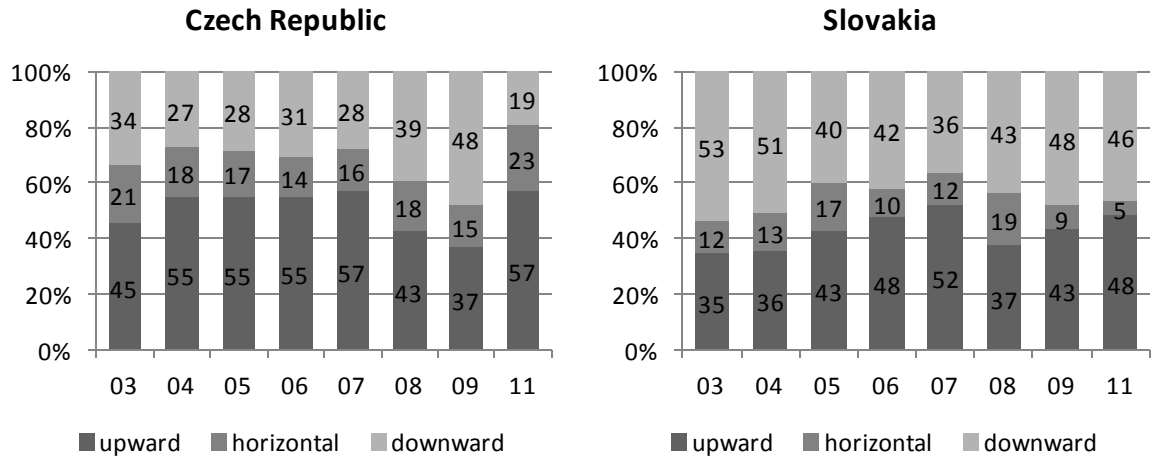
This part of the paper focuses on vertical dimension of mobility in the labour market. The analyzed population is restricted to people who experienced upward, downward or horizontal mobility (see figures 1 and 2). This group is called total mobility in the following text and consists of 7.528 respondents in the Czech Republic and 1.866 in Slovakia. The total mobility rate was 4.9 % in CR and 3.0 % in SK. It is higher than the occupational mobility (3.1 in CR and 2.2 in SK) because it includes some shifts up and down which are caused by other factors than occupation change (e.g. switch from temporary to permanent job).

In the analyzed period in average about half of the total mobility was upward in the Czech Republic, in the Slovakia it was 42%. About a third of mobility in Czech Republic and 44% in Slovakia was downwards; the rest was a horizontal mobility.

Figure 10 shows how the ratios between upward, downward and horizontal mobility changed over time. The economic crisis in 2008 influenced the upward mobility significantly. People who lost their job were more willing to take a job at a lower level than their former one in the recession because there was a higher risk of unemployment. The drop in the upward mobility was significant in

both countries. In Slovakia the upward mobility started to grow already in the next year, in the Czech Republic there was a lag in recovery.

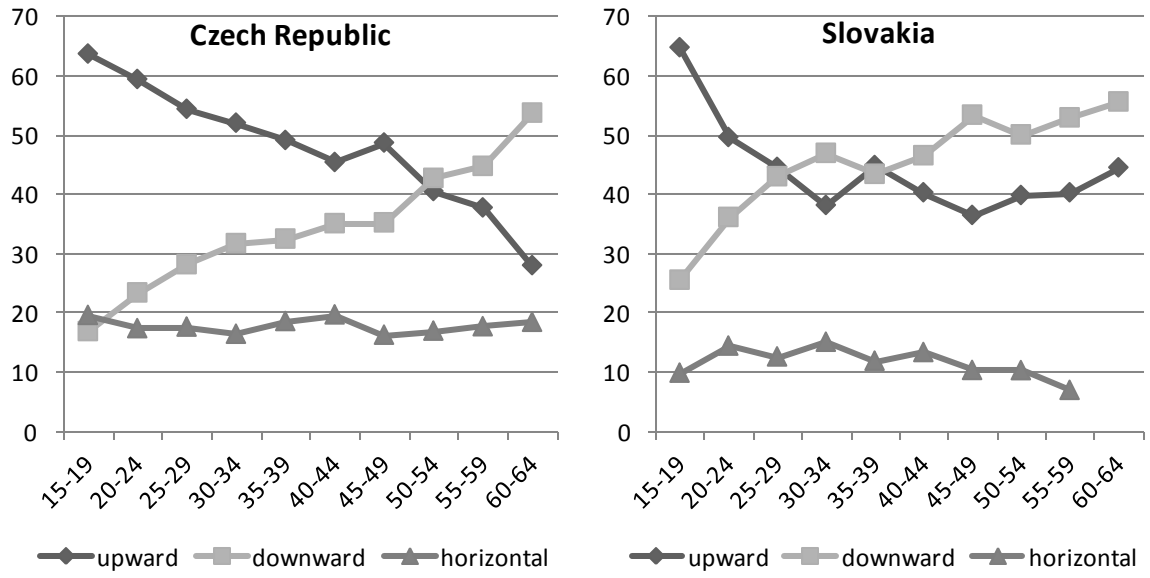
**Figure 10: Shares of types of mobility (2003-2012, %)**




***Source: LFS* [20, 27]**

The upward mobility is highest among young workers. This indicates that the graduates tend to start their career in lower jobs and then improve their status in the labour market. Among older workers building the career takes other forms than the mobility (actual earnings increase related to worker`s experience and higher productivity or quality of work is not identified as mobility if it does not coincide with job changes). In the CR the trend of decreasing upward mobility with age is balanced, in Slovakia it is somewhat faster in the younger age. The unemployment of younger people in the Slovakia is almost twice as high as in the CR and the differences are significant also for qualified people13. It is likely that the graduates in Slovakia more often tend to accept a job at the lower level after their graduation but have good chances for an upward mobility in a couple of months or years.

**Figure 11: Shares of types of mobility by age (%, total for 2003-2012)**



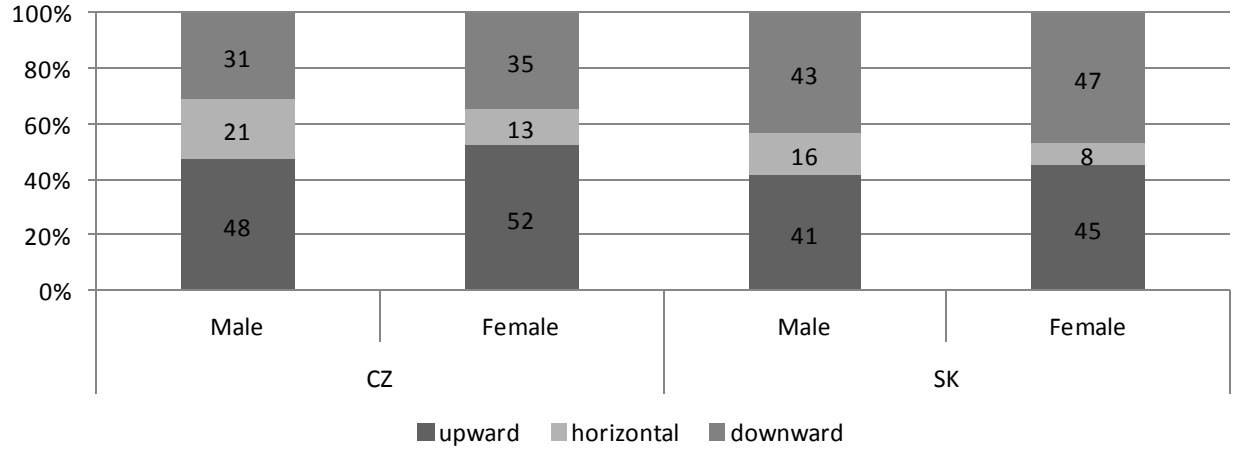

***Source: LFS* [20, 27]**

[13] The unemployment rate of people aged 15-24 was 34% in SK and 19.5 in CZ (2012, Source: Eurostat database, tsdec460).

The share of downward mobility not surprisingly goes in the opposite direction to the upward. In the CR the growing trend of downward mobility starts to be somewhat faster after the age of 50. This could be related to the acceptance of less demanding jobs before full retirement.

Women experience in both countries higher share of upward as well as downward mobility compared to men who tend to have higher shares of horizontal mobility. The differences in upward mobility are highest in the younger age groups under 35 and they are most probably related to switches from less time consuming jobs which the women do while caring of children at the same time (part-time jobs, short-term jobs etc.). The highest differences in the downward mobility are observed after the age of 50. The earlier retirement age of women cause that more of them switch to part time jobs before and shortly after the retirement compared to men[14].

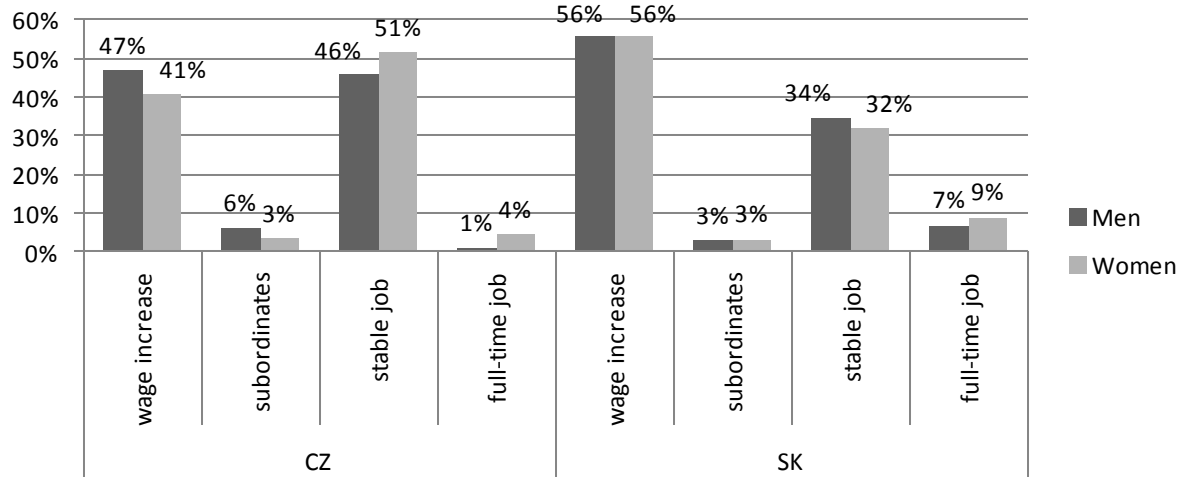
**Figure 12: Shares of types of mobility by gender (%, total for 2003-2012)**




***Source: LFS* [20, 27]**

This is reflected also in the causes of upward mobility. For women switch from temporary to a stable job and from part-time to full-time is more often the reason compared to men. Men get better jobs more often through higher wages and through obtaining a supervisory role over subordinates. For women these types of upward mobility are much less frequent in the Czech Republic, in Slovakia the differences between men and women are smaller.

**Figure 13: Causes of mobility of men and women**

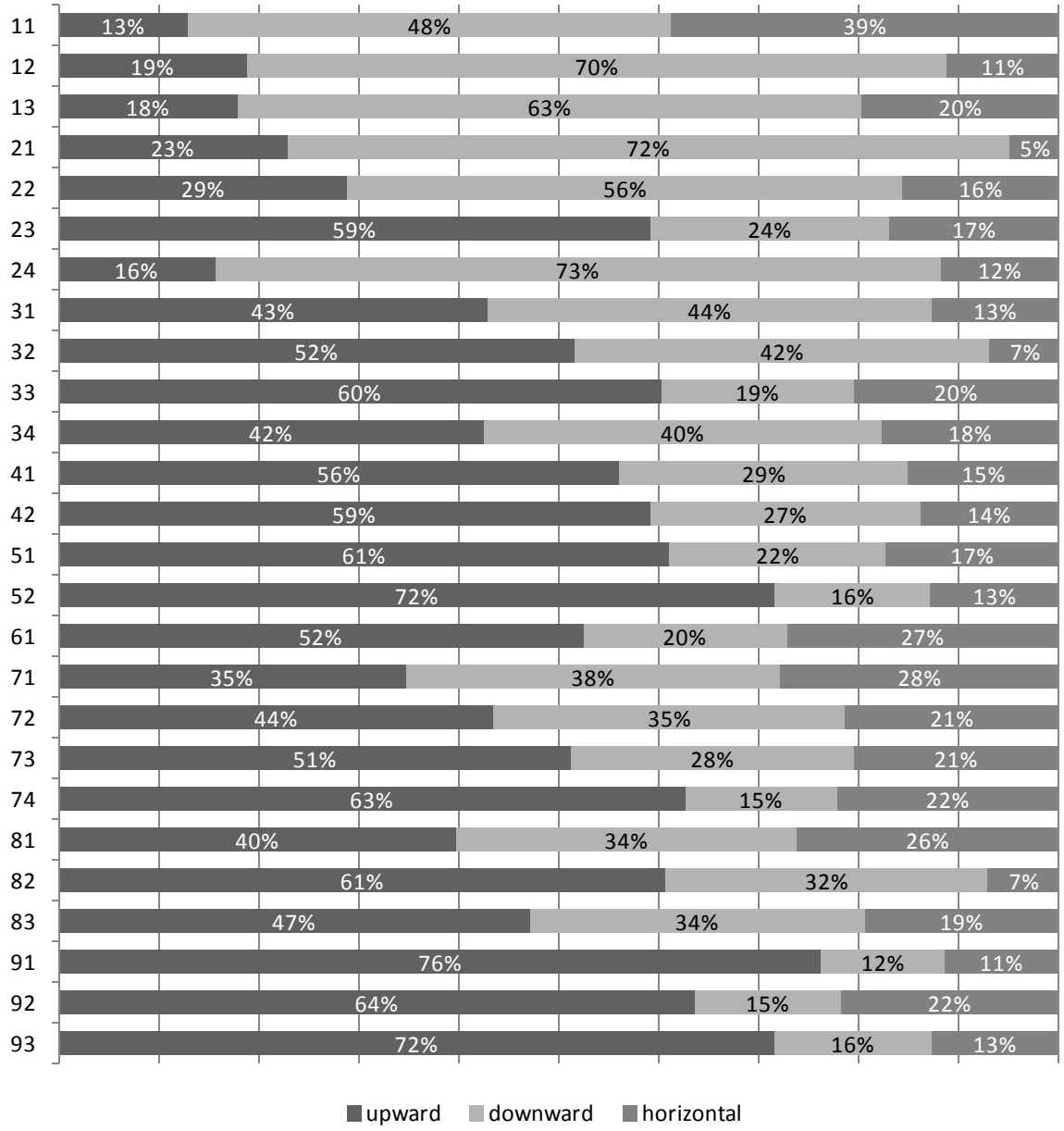



***Source: LFS* [20, 27]**

[14] Only the cases when part-time jobs and temporary jobs were not preferred by women were counted as causes of upward and downward mobility

The level of education influences the patterns of mobility to some extent in the CR. People with tertiary education were in total for the whole period significantly less likely to suffer from downward mobility. In Slovakia the differences were not significant. In 2003-2008 the share of upward mobility in the total mobility was very similar for all education categories. It was significantly influenced by the economic crisis. In 2009 the share of upward mobility among people with tertiary education grew while for people with maturita it significantly decreased.

**Figure 14: Shares of types of mobility by occupation in the Czech Republic (%, total for 2003-2010)**




***Note:*** *2-digit ISCO-88 codes. The Slovak data show similar occupational trends but due to the sample size the breakdown is less reliable.*

***Source: LFS*** **[20]**

The opportunity of switching to a better job depends to a large extent on the occupation in which the person works. Higher shares of upward mobility can be found among less qualified professions (ISCO 8 a 9) and among clerks and occupations in trade and services. Among the higher

qualified occupation higher shares of upward mobility are observed for teachers where the switch to a better job is usually related to getting a permanent position after the yearly fixed-term contracts which teachers usually get in the beginning of their career. The higher share of upward mobility for the less qualified occupation may be caused by the fact that these occupations do not provide many career opportunities themselves and getting a better job more often means changing the occupation. More qualified occupations on the other hand offer other types of career prospects which are not related to changes of occupations. These may include responsibilities for more projects, more qualified work in the same occupation, managing a bigger team etc. which are related with higher actual wages which we are not able to capture by our methodology. Sicherman and Galor (1990) suggest that the occupations with more specific human capital experience lower interfirm mobility but a higher intrafirm mobility (as quoted in [16]).

People who experienced unemployment between jobs are less likely to move to a better job. People who were unemployed needed to accept any job. People who are employed change their occupation mostly if the new option is better than their current job which usually leads to an upward mobility. There are however also other causes of this fact.

Some people may become unemployed because they had not been able to perform well in their job and after a period of unemployment they got a job for which they were qualified enough.

In the competitive labour markets the period of unemployment can be observed as a stigma and the employers hire more likely people who are currently working in a lower position than people who are currently unemployed. The differences in chances for upward mobility between people who experienced unemployment and those who did not are higher in the Czech Republic than in Slovakia. The stigmatization caused by unemployment may be higher in the Czech Republic than in Slovakia because of much lower unemployment rate. There can also be a direct influence of the period of unemployment. People lose their skills while they are not working and this can then be an obstacle for acception of. In our sample we only worked with respondents who were employed in the beginning and in the end of the one year period therefore we are not able to verify this hypothesis.

## 4. Discussion

The analysis of occupational mobility patterns brings some interesting findings about its level, characteristics and influencing factors. It is however important to keep in mind that the definition of the occupational mobility itself is a conceptual construct and the results may be influenced by the way how the mobility is defined and measured. The definition is strongly predetermined by the availability of data. The level of mobility may be influenced especially by following aspects of the methodology:

- The level of occupational classification used
- The period among observations
- The way how occupations are coded in the survey (dependent/independent coding)
- The way how inter/intra company (or sector) mobility is counted
- The subsample used for analyses (if only people employed both at the beginning and the end were analyzed or the unemployed as well etc).

There are not many studies which measure the occupational mobility using the panel or longitudinal data and these which are available usually differ from each other at least in some aspects of the methodology. It is therefore difficult to evaluate the factors which influence the level of mobility in the country and among individuals and their character. The low share of mobility may be caused by stringent labour market legislation in the Czech Republic but for other reasons even lower level of mobility can be observed in Slovakia where the labour market regulation is more flexible. As the number of studies on occupational mobility from different countries is very limited it is not possible to construct a comprehensive international model or at least comparative analyses which would analyze how these factors work together.

It is also difficult to distinguish between voluntary mobility related to career building as opposed to involuntary fluctuation between jobs. We are able to only use the concepts upward and downward mobility as a rough proxy for this although there may be many cases where this concept would not work properly.

The study faces many of these methodological challenges. It can be perceived as one of the first attempts to measure the occupational mobility in the Czech and Slovak Republic and it brings some interesting findings summarized below which can be used in further research.

## 5. Conclusion

In our paper we made an attempt to measure the occupational mobility in the Czech Republic and in Slovakia and examine how the level and character of the mobility is influenced by the characteristics of the labour market, by the phase of the economic cycle and finally by the characteristics of an individual. The analysis showed that the occupational mobility can hardly be easily explained by one of these factors and that the factors co-influence it in quite a complex way.

In both the Czech Republic and Slovakia the rate of occupational mobility is relatively low compared to other countries for which some more or less comparable data were available (United Kingdom, France, Germany, Canada, US). This is in line with a commonly known experience of low mobility of the workforce also in geographical sense. In the Czech Republic one of the main contributing factors can be strong employment protection legislation. In Slovakia the labour market is more flexible but other factors may contribute to low mobility rates, in particular high unemployment level which discourages workers from voluntary quit of their current job. In both countries the work values surveys confirm a relatively high importance of job security and lower expectations related to work aspirations and career building which reflects in general a lower tendency of the workforce to build their careers through occupational mobility (European Values Survey, 2008).

Studies from other countries envisaged a pro-cyclic trend of occupational mobility. The Slovak data seem to be relatively consistent with these findings. The Czech mobility patterns differ from this, they maintained a very stable trend between 2003 and 2008 and the economic crisis caused a very high increase of mobility in 2009. In Slovakia the crisis did not influence the mobility rate so extremely. There are no studies available which would allow compare the development of occupational mobility in crisis and post-crisis years but the Czech and Slovak data show that the relation of occupational mobility to the economic cycle is not straightforward.

There is always some share of voluntary and involuntary mobility in the labour market. About a half of the mobility is upward which can be perceived as voluntary or at least positively evaluated in the retrospective. Still a not negligible (about a third in the CR and even more in SK) share of mobility leads to a worse job that the previous one. This is more often for people who experienced unemployment between the jobs than those who switched directly from one job to another.

From the individual characteristics age works as the predominant factor which influences both the level of mobility as well as its type. Younger workers under 30 have much higher rates of mobility than people above 30 and the share of upward mobility is also higher among them. In Slovakia the mobility patterns seem to reflect difficult positions of graduates in the labour market. The upward mobility is high for people under 30 and then remains almost stable. This may be caused by the fact that graduates have to accept positions under their qualification in their first jobs. In the Czech Republic a disadvantaged group may be observed among people over 50 when the increase of downward mobility begins to accelerate.

Although the workforce became older in the observed 10 years period the level of mobility did not decrease. This can be considered as a sign that a certain level of mobility is necessary in the labour market and the older people will have to be also prepared to change their occupations to a greater extent in the future.

The mobility levels and patterns are influenced also by other characteristics but their trends across countries and time are not as clear as in the case of age. Women have higher share of both upward and downward mobility and the upward mobility is for them more likely caused by switch from temporary job to permanent or from part-time to full time. The economic crisis caused increase of occupational mobility of people with higher education in the Czech Republic and decrease of mobility among people with lower education. This was not the case in Slovakia.

In the further research the relation of the general mobility and mobility of different subgroups to the economic cycle can be examined which would be in particular interesting after longer time series from the recovery period are available. A more extensive international comparative research examining both patterns at the micro level as well as macro factors such as labour legislation in the country will be important to reveal how various factors co-influence the level of occupational mobility.

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# Future Changes in Age and Household Patterns: Some Implications for Public Finances[1,2]

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**Abstract:** Using stochastic forecasting techniques, this paper assesses the consequences for public finances of changes in age and household structures in Denmark over the period 2008-2037. Focusing on components of welfare provisions and tax payments with noticeable differences across age and household status, we show that, based on a point forecast, the fiscal impact of changes in household structures amounts to an annual negative effect of 0.6% of GDP, and the effect of changes in age structures is forecast to worsen the public budget by 3.6% of GDP per year. While subject to a considerable amount of uncertainty, the prospect of such a dramatic weakening of public finances is likely to trigger demands for welfare reforms characterized by a more individualized system of public transfer and tax payments, in addition to measures already taken to address the fiscal effects of population ageing.

**Keywords:** Public finance, welfare programs, changing demographics, stochastic forecasts

**JEL codes:** H31, H53, H55, J11

## 1. Introduction

Household structures are changing throughout Western economies (see, e.g., OECD, 2011). This development is characterized by couples postponing childbearing, increasing shares of divorced and other single mothers and fathers, more people in old-age living alone, etc. The observed emergence of new family patterns is concurrent with population ageing, driven by falling fertility rates and increasing longevity, as well as with larger volumes of migration. Such demographic changes may have substantial economic consequences.

The magnitude of past and projected changes in the age structure of the population has been documented in several studies (see, e.g., EU Commission, 2011). There is also a large literature addressing the fiscal (and wider economic) effects of population ageing (see, e.g., Kotlikoff, 2006; Davig et al., 2010; Weale, 2008). This literature has pointed to a fiscal "overhang" posed by the uncovered expected financial liabilities associated with public pension schemes, health costs etc. A recent paper (IMF, 2009) has put this problem into dramatic form by showing that the financial stress caused by the great financial crash of 2007-10 was probably only about 10% of that likely to be caused by future age related spending in economies with a shrinking labour force.

In this paper we focus on the sensitivity of public finances to changes in the household structure. From a Scandinavian perspective, the link between demographic transition and welfare expenditures may be of particular relevance. Indeed, many of the central features of the

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Scandinavian welfare model are related to households and families: public spending on child care and education, means-tested cash payments, early retirement benefits, publicly provided health and eldercare services, old-age pensions etc. (see, e.g., Esping-Andersen, 1990). Moreover, certain tax revenues might be sensitive to changes in family structures.

As a case study we use Denmark which is an archetype of a Scandinavian welfare state (Andersen et al., 2008). The first part is a demographic analysis, aimed at quantifying changes in household structures in Denmark. To form a benchmark, we briefly examine the extent to which people have actually "jumped" between different household positions over a past period of 25 years (1982-2007). Following the approach set out in Alho and Keilman (2010) we then combine a probabilistic population forecast with a model for random shares, with the random shares model assigning the population randomly in any future year to different household positions by age and gender.

The second part of the paper offers an empirical assessment of the implications of changes in household structures for some selected components of welfare expenditures and public revenues. Our focus is on components with noticeable differences in unit costs between individuals living as singles and couples, and for couples living as married or cohabiting (OECD, 2010). Specifically, we construct a counter-factual scenario, showing what the (different categories of) welfare costs and tax revenues would have been if the household structure prevailing in 2007 remained unchanged throughout the years 2008-2037. We also assess the budgetary implications of the fact that the projections are subject to much uncertainty.

The methodological approach of the paper is interdisciplinary, drawing heavily on demographics, stochastic forecasting techniques, social policy and (public) economics. In fact, the contribution of the paper can be seen as an extension of existing studies focusing on the significance of changes in age structures for public finances. The gap this paper seeks to fill is to investigate the fiscal implications of another dimension of demographic changes, namely changes in household structures. How strong are those demographic effects, do they tend to aggravate or counteract each other, and what can be said about the uncertainty surrounding forecasts of their future significance? To our knowledge, such a study has not yet been undertaken on a systematic basis.

From here the paper proceeds as follows. In Section 2 we identify different types of households, and observed and projected changes are reported. Section 3 outlines a method for calculating the budgetary effects of changes in age and household structures. In Section 4 we use this method to quantify the empirical significance of those changes for the period 2008-2037, and Section 5 addresses uncertainty associated with the forecasts. Section 6 concludes and suggests some policy implications for the future financing of the welfare state.

## 2. Demographic developments: 1982-2037

This section provides the demographic background to the fiscal studies performed in subsequent sections. Two distinct data sources are used. First, registers from Statistics Denmark contain information about the entire Danish population every year, including demographic data such as age, gender, marriage status, family linkages and immigration status. Second, a probabilistic forecast of the Danish population broken down by age, gender, and household status is performed, following the methodology set out in Alho and Keilman (2010). This forecast results in 3,000 paths for the population size in each of the household types and in five-year age groups from age 0-4 to age 95+. The medians of these 3,000 values will be denoted as the point forecast for the population. The presentation in what follows uses the values for 2017, 2027 and 2037.

In 1982 the Danish population was 5.12m. With a modest population growth, driven primarily by net migration, the total population had increased to 5.45m in 2007. The projection in the present paper has a point forecast for the total population in 2037 of 5.98m which is very close to Statistics Denmark's (2012) official projection (6.02m). Thus, the total increase from 1982 to 2037

amounts to an annual growth rate of less than 0.3%. However, like most developed countries, Denmark is subject to population ageing over the projection period. The number of individuals aged 70+ is thus projected to more than double from 1982 to 2037, whereas the number of individuals aged 15-64 is projected to increase by a mere 0.14m. This clearly leaves Denmark with a significant challenge to finance an increasing amount of public expenditures to the elderly, mainly health care and pensions.

We next explore how differences in the age and gender composition of the population can be supplemented by demographic projections where the population is also divided into different household categories. Following the practice in Alho and Keilman (2010), the population may be divided into 7 household types, with each individual being assigned to one and only one of the following groups: (A1) Married in a couple with or without children; (A2) Cohabiting with or without children; (A3) Lone parent; (A4) Children; (A5) Persons living alone; (A6) Others in private households, including adults living with other adults but not forming a couple (roommates and similar); and (A7) Living in institutions, which primarily include elderly living in care facilities and persons with mental or physical disability that requires them to receive around-the-clock care.

In our empirical work below we have chosen not to report the numbers for the categories A6 and A7. The former is a mixed and small group of individuals, such as persons living more than one family on the same address, and children aged more than 25 still living at home. The latter is unfortunately, not well measured in our data. For example, the registration of persons living in institutions changed over the years 1982-2007, which form the basis for our projection, and therefore the number of individuals living in institutions is not correct, especially for older individuals living in nursing homes etc.

Table 1 shows the size of three age groups in the five different household types (A1-A5) in 2007 and 2037, respectively. Panel A reports the population in 2007 indexed to the population in 1982, thus giving comparable growth numbers between the different age groups and the different household types. Panel B shows the similar numbers from the point projection for 2037 indexed to the 2007 level.

**Table 1 Comparison of population development 1982-2007 and projected 2007-2037**

| | Married | Cohabiting | Lone parent | Children | Single | Total |
|---|---|---|---|---|---|---|
| | | | *A. Population 2007 (1982 = 100)* | | | |
| 0-14 years | 0 | 0 | 0 | 99 | 0 | 99 |
| 15-64 years | 91 | 165 | 154 | 78 | 176 | 107 |
| 65+ years | 125 | 136 | 399 | 0 | 131 | 112 |
| | | | *B. Population forecast 2037 (2007 =100)* | | | |
| 0-14 years | 0 | 0 | 0 | 107 | 0 | 106 |
| 15-64 years | 81 | 107 | 104 | 123 | 105 | 97 |
| 65+ years | 157 | 265 | 115 | 0 | 169 | 169 |

**Note:** Numbers for 2037 are point forecasts. The development for 'others' and 'institutions' is not shown.

It is remarkable that while the number of old-age individuals grew only slightly more than the number of working-age individuals (12% vis-à-vis 7%) during the 1982-2007 period, the old-age population is projected to increase very strongly (69%) during the period 2007-2037, whereas the working-age population is projected to shrink by 3% during the same period. This confirms that the Danish population is likely to age significantly over the coming 2-3 decades. The numbers also suggest that the household composition has changed since 1982 and is expected to continue to do so over the projection period.

In Table 2 we report the population share for 5 of the 7 household types for 1982, 2007 and 2037. The largest change occurs for the working-age group: the share of individuals being married

will decrease from 51% in 1982 to 36% in 2037, with approximately half the loss jumping to the group "cohabiting" and the other half to "single". In absolute terms this corresponds to roughly 0.5m individuals between 15 and 64 that are not married in 2037, but would have been so had the household type distribution followed the same pattern as in 1982.

Another development worth noticing is that the share of individuals who are cohabiting, but not married, is increasing. The share of cohabiting individuals of working age thus rose from 10% in 1982 to 15% in 2007 and is expected to rise further to 17% in 2037 according to the point forecast. It is interesting that this development due to generational effects has no impact on the share of cohabiting individuals aged 65+ between 1982 and 2007, but will increase the share from 2007 to 2037. During the projection period the generations moving in together when young, but never married, will cross the 65-year threshold and thus add to the share among the elderly.

**Table 2 Composition of the population according to household types, 1982-2037, %**

| | Married | Cohabiting | Lone parent | Children | Single |
|---|---|---|---|---|---|
| | | | *A. Population 1982* | | |
| 0-14 years | 0 | 0 | 0 | 100 | 0 |
| 15-64 years | 51 | 10 | 3 | 14 | 10 |
| 65+ years | 44 | 3 | 0 | 0 | 36 |
| | | | *B. Population 2007* | | |
| 0-14 years | 0 | 0 | 0 | 100 | 0 |
| 15-64 years | 44 | 15 | 5 | 10 | 17 |
| 65+ years | 49 | 3 | 1 | 0 | 43 |
| | | | *C. Population forecast 2037* | | |
| 0-14 years | 0 | 0 | 0 | 100 | 0 |
| 15-64 years | 36 | 17 | 5 | 13 | 18 |
| 65+ years | 46 | 5 | 1 | 0 | 43 |

**Note:** Numbers for 2037 are point forecasts. The development for 'others' and 'institutions' is not shown.

In sum, demographic changes of the magnitude reported here are likely to have a crucial impact on public expenditures and revenues. The fiscal effects of changing age structures have already attracted a lot of scholarly attention, but the importance of changing household structures has not been explored to a similar extent. For example, how sensitive are public finances to changing household structures when (a) welfare benefits are means-tested for married couples but not for co-habiting couples and (b) married couples are allowed to transfer certain unused tax deductions between spouses, but cohabiting couples are not? In the remainder of this paper we take a closer look at the extent to which changes in the age and household structure of the population have an impact on public expenditures and revenues over the period 2008-37.

# 3. Computing the fiscal effects of changing age and household structures

## 3.1. Methodology

The method for calculating the fiscal effects of changing age and household structures takes as its starting point the actual level of expenditures from a number of different areas (individualized public consumption and income transfers) and the actual income tax revenue. Both taxes and expenditure data are from year 2007. In what follows we only use the word 'expenditure', but the method for calculating the income tax revenues is identical.

Total expenditures in year 2007 can be decomposed into:

$$T^{2007} = \sum_a \sum_s \sum_h E^{2007}(a,g,h) \times n^{2007}(a,g,h) \quad (1)$$

In the above formula, E2007(a,g,h) expresses average expenditure per person within an age-gender-household type group, and n2007(a,g,h) is the number of persons in the age-gender-household type. Adding up over all age groups, both genders and all involved household types thus produces the total expenditure.

Now, define

$$n^y(a,g) = \sum_h n^y(a,g,h) \quad (2)$$

as the total number of persons in age group a and of gender g in the year y. This is the simple aggregation over household groups and so changes in this variable reflect changes in the age-gender composition of the population, but not the household composition, since this has been aggregated out.

We use the unit expenditures in 2007 for the calculations for year 2037. This can be interpreted as an "as if"-calculation in the sense that the calculated total expenditures in year 2037 represent the hypothetical expenditure level if the set of rules, the overall price and wage level and the behavior within each age-gender-household group will be the same in year 2037.

Hence, we can calculate the total expenditures in year 2037 given the rules and price/wage-level and behavior from year 2007 as

$$T^{2037} = \sum_a \sum_g \sum_h E^{2007}(a,g,h) \times n^{2037}(a,g,h) \quad (3)$$

To calculate the unit cost based only on age and gender, and not on household type, sum total expenditure over all 7 household types for a given age-gender group and divide by the total number of individuals in that age-gender group:

$$e^y(a,g) = \frac{\sum_h E^{2007}(a,g,h) \times n^y(a,g,h)}{\sum_h n^y(a,g)} \quad (4)$$

We calculate e in the above equation for 2007. The next step is to find the hypothetical level of expenditure if the household composition does not change from 2007 to 2037:

$$TH^{2037} = \sum_a \sum_g e^{2007}(a,g) \times n^{2037}(a,g) \quad (5)$$

Finally, we define the pure age-gender composition effect (ACE) as the change in expenditures due to the change in the age-gender composition of the population from the 2007 to 2037:

$$ACE = TH^{2037} - T^{2007} \quad (6)$$

and the household composition effect (HCE) as the change in the expenditure due to changes in the household structure from year t to year y:

$$HCE = T^{2037} - TH^{2037} \quad (7)$$

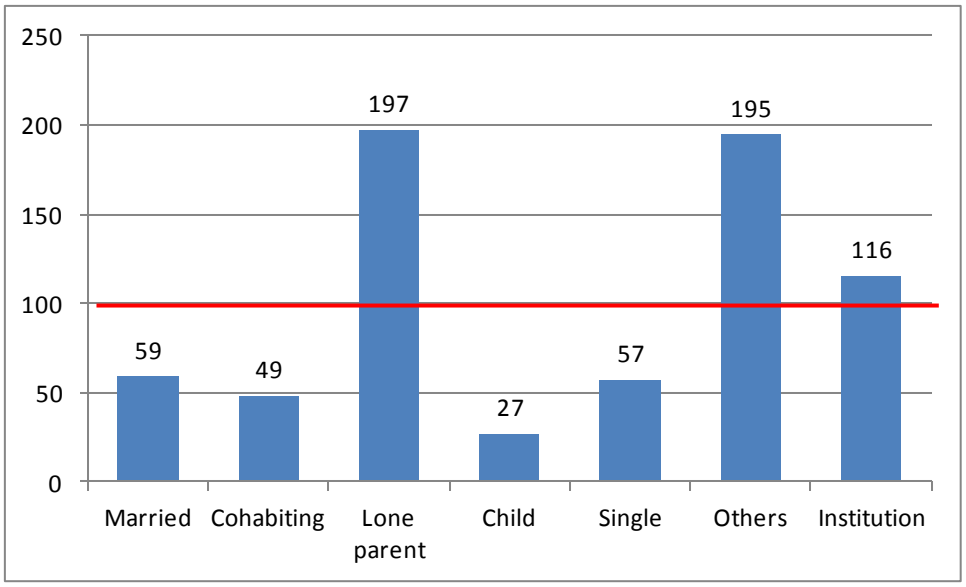
## 3.2. Data

By international comparison, the Danish register data offer excellent opportunities for measuring the provision of public services, the receipt of public transfers and payment of taxes at the individual level. Specifically, we utilize the fact that this unique information may be merged with demographic data that allow us to identify each individual in Denmark as being in one (and only one) of the seven household types referred to above. In each "cell", defined by a particular age, gender and household type, we can then calculate, for example, the average cash benefit receipt and use this for our projection. In a similar fashion, we can calculate the average income tax payment, early retirement benefit, number of visits to a general practitioner etc. and use these numbers for the projection.

The public expenditure components included in this study constituted 23% of the total public expenditures in 2007, whereas the income tax revenue made up 48% of total public revenues. Of the expenditures not included, a large part is collective public spending such as expenditures allocated to research, administration, infrastructure, defense, police etc. Public education expenditures are also kept under collective spending, even though a major part may be broken down at the individual level. However, we have assumed that education expenditures are less related to household types than the other types of expenditures included in the study.

In order to get an indication as to the sensitivity of fiscal variables to changes in the composition of households, Figure 1 shows that there are pronounced difference in the receipt of social benefits across household types.[5] Indeed, lone parents and "others" receive almost twice the average in social benefit, whereas cohabiting, singles and married individuals receive approximately 60% of the average. Interestingly, married individuals receive more than cohabiting individuals on average. Clearly, with unchanged eligibility criteria and benefit rates, changing household structures would have implications for social expenditures.

**Figure 1 Indexed social benefit receipts per person (total average = 100)**




Finally, as to demographic data, for 2007 we use the actual population data for Denmark while for the projection period we use the point forecast from the Danish population projection.

[5] The distribution across household types of other components of public expenditures is available upon request.

# 4. Public expenditure and revenue effects of changing household structures, 2007-2037

This section presents the forecasts of income taxes and selected public expenditure components using the point forecast of the Danish population projection presented in section 2. For each expenditure and revenue component, the baseline assumption is that rules, eligibility criteria etc. as defined in 2007 remain unchanged over time.[6]

The results are summarized in Table 3 which is divided into two main parts. The top panel contains the results concerning income tax revenue, and the bottom panel contains the results for the various expenditure elements divided into three groups: Group A with four types of public transfer payments (old age pensions, early retirement benefits, cash benefits and sickness benefits); Group B with the health care expenditures (GP services, specialist practitioner services and hospital admissions); and Group C with child care information (pre-school childcare and after-school care for schoolchildren).

The numbers in the first column (denoted "Base, 2007") show the actual levels of each component in year 2007. The age/gender composition effect (ACE) is reported in column two and the household composition effect (HCE) is shown is column three. Both effects have been calculated using the formulas outlined in the previous section. The numbers in the last column (denoted "Forecast 2037") represent the calculated revenues/expenditures using the 2007 values of unit costs and using the point forecast of the population in 2037, as split into the seven household types, 19 age groups and 2 genders. All numbers are shown in absolute amounts in DKK.[7]

The net fiscal effect of the ten elements included is DKK -61.4bn (equal to -3.6% of GDP) for the age composition effect and DKK -9.9bn (equal to -0.6% of GDP) for the household composition effect over the period 2007-2037. Below, we discuss these numbers in greater detail.

First, we find that a positive age/gender composition effect and a negative household composition effect with respect to the income tax revenue are expected for the projection period. This is in line with a finding in a companion paper (Jacobsen and Jensen, 2013) for the historical period 1982-2007. Although the projection period is not expected to include an increase in women's labour force participation, the age of the average worker will continue to increase, and hence the average income tax revenue also continues to increase.[8] The negative fiscal impact of the household composition effect for income taxes is due to a continued increase in the number of persons living alone and the number of single parents as individuals in these two groups on average pay less in income taxes.

Second, based on the bottom panel, we see that among the public transfers listed in group A, the most dominating effect is the large age composition effect of DKK 53bn for old age pensions. This reflects the population ageing shown in Table 1 above. The household composition effect is in this

[6] However, in several policy areas this assumption does not hold. For example, income taxes have been lowered, and a new but not yet implemented tax reform will also change the income tax system. Also, the official retirement age will be indexed to longevity after 2020, thereby presumably lowering the overall pension expenditures. Neither of those reforms is expected to have a particular impact on the difference between different household types, so we would not expect those changes to substantially affect the overall conclusions of this paper.

[7] On June 10th, 2013 the official DKK/USD exchange rate was 5.645 according to the Danish Central Bank.

[8] Here the assumption is that wages continue to rise over the life cycle. This is in line with studies which have found evidence that although productivity may fall in the latter half of the working life, wages continue to rise. This may be associated with an increasing gap between productivity and wages, where younger workers are underpaid and older workers are overpaid relative to their productivity.

case very modest, amounting to an increase of only DKK 0.4bn. The reason for this minor effect is that most old-age pensions in Denmark are given as a personal pension that is not means-tested. Some supplements are based on household income, but with no difference between married and cohabiting couples. Therefore, the total household composition effect in this case remains minor.

**Table 3 Age and household composition changes 2007-2037 in selected areas of the public budget, DKK bn. (2007-level)**

| | Base, 2007 | ACE | HCE | Forecast, 2037 |
|---|---|---|---|---|
| | | ------ *Revenue* ------ | | |
| **Income taxes** | 402.3 | 13.7 | -5.8 | 410.2 |
| | | ------ *Expenditures* ------ | | |
| **A. Public transfers** | | | | |
| Old age pension | 77.1 | 53.0 | 0.4 | 130.5 |
| Early retirement | 36.3 | -2.4 | 1.5 | 35.4 |
| Cash benefits | 8.0 | -0.1 | 0.6 | 8.5 |
| Sickness benefits | 10.3 | -0.4 | 0.5 | 10.3 |
| **B. Health care** | | | | |
| GP services | 7.0 | 0.6 | 0.7 | 8.3 |
| Spec. practitioner | 2.6 | 0.4 | 0.0 | 3.0 |
| Hospital admissions | 57.3 | 21.4 | 0.5 | 79.2 |
| **C. Care for children** | | | | |
| Preschool | 20.3 | 2.3 | 0.0 | 22.6 |
| After school care | 5.4 | 0.3 | 0.0 | 5.7 |

Starting from a level of DKK 36.3bn in 2007, the expenditures on early retirement benefits are expected to decrease slightly to DKK 35.4bn. However, it is striking that the age composition effect is negative whereas the household composition effect is positive. The main reason for the positive contribution from changes in household structures is that the share of singles in the working age population is expected to increase, and since a somewhat larger share of singles receives early retirement benefits, this will increase the overall expenditure level. The reason for the negative age effect is primarily that the number of persons aged 50-60 is expected to be smaller in 2037 compared to 2007. Since the share of recipients of early retirement benefits is particularly high within this age group, a fall in the size of the population will mean a fall in public expenditures allocated to early retirement benefits. The total projected change in cash benefit expenditures is DKK 0.5bn. The age composition effect is in itself negative with a contribution of DKK -0.1bn. However, the household composition effect is positive with a contribution of DKK 0.6bn, largely driven by an increase in the number of lone parents, especially women, who on average receive quite a significant amount of welfare benefit.

Moving on to group B, the health care variables, we observe that the projection predicts a small positive age composition effect and a small, but positive household composition effect for both GP services and Specialized Practitioner services. The household composition effect mainly stems from an increase in the number of persons in institutions, especially among the elderly. Hospital admissions show a large expected age composition effect due to the continued increase in the average age of the population, while the household composition effect is expected to be relatively modest.

As to care of pre-school children and school-aged children (group C), Table 3 shows positive age composition effects, but only very small household composition effects. This is primarily due to a decrease in the number of children and an increase in the number of children in single-parent households. Also, an important factor in determining the small household composition effect is the

fact that almost all Danish children attend day care and after-school care, irrespective of their social background.

Table 4 reports the relative numbers for the age composition effects and the household composition effects for the projection period 2007-2037.

**Table 4 Age and household composition changes 2007-2037 in selected areas of the public budget (2007 = 100)**

| | Level, 2007 | ACE | HCE | Forecast, 2037 |
|---|---|---|---|---|
| | | ------ Revenue ------ | | |
| **Income taxes** | 100.0 | 3.4 | -1.4 | 101.9 |
| | | ------ Expenditures ------ | | |
| **A. Public transfers** | | | | |
| Old age pension | 100.0 | 68.7 | 0.5 | 169.2 |
| Early retirement | 100.0 | -6.7 | 4.2 | 97.5 |
| Cash benefits | 100.0 | -1.4 | 6.9 | 105.5 |
| Sickness benefits | 100.0 | -4.3 | 4.6 | 100.3 |
| **B. Health care** | | | | |
| GP services | 100.0 | 9.1 | 9.6 | 118.7 |
| Spec. Practitioner | 100.0 | 15.4 | -0.3 | 115.2 |
| Hospital admissions | 100.0 | 37.4 | 0.8 | 138.2 |
| **C. Care for children** | | | | |
| Preschool | 100.0 | 11.2 | 0.0 | 111.2 |
| After school care | 100.0 | 6.3 | 0.1 | 106.4 |

The key message from this table is that large age composition effects for a number of areas are to be expected over the projection period. This is true in particular for old age pensions (69%) and hospital admissions (37%), but also specialist practitioners (15%) exhibit a large effect. All these effects are due mainly to population ageing as could be seen in Table 1. At the same time negative age composition effects are to be expected for early retirement benefits (-7%) and sickness benefits (-4%), mainly due to the fact that fewer persons will be of working age in 2037.

Finally, Table 4 shows that large household composition effects are projected for the use of GPs and for cash benefits with both higher than 6%. Smaller, yet non-negligible, effects are found for early retirement benefits and sickness benefits, while household composition in relative terms matters only little for the old age pension expenditures and the income tax revenue. For the care of children the household composition effects are negligible. As already mentioned above, the main reason for this is the protected continued increase in the number of persons living alone and the number of single parents.

## *5. Addressing uncertainty*

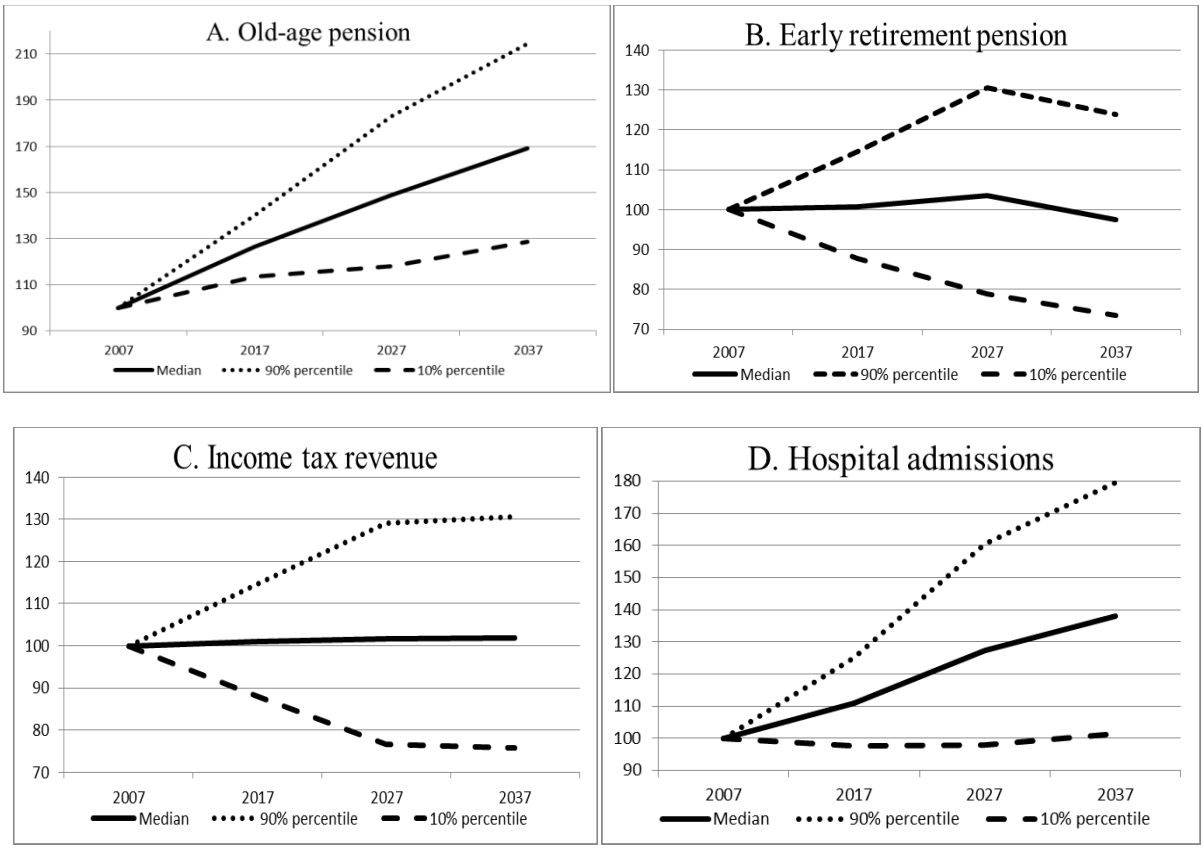
While the previous sections have focused on the point projections, in this section we address the stochastic element and show the importance of uncertainty in the forecasts of the future expenditures and income tax revenues. Despite the different methodologies used in the production of stochastic forecasts, it turns out as an empirical regularity that the level of uncertainty in demographic forecasts is much higher than generally believed (Alho, Cruijsen and Keilman, 2008). We would clearly expect this finding to translate into economic variables, by making the variability in public finances as well as in broader macroeconomic outcomes much larger than often recognized.

As stated above, the stochastic population forecasts made in this study included a total of 3,000 paths for the Danish population during the period 2007-37. Below we present an illustration of

what uncertainty in population forecasts means for the projection of public revenues and expenditures, focusing on the same categories as in the previous section.

Figure 2 shows the projection of four of the public budget components.[9] Each figure contains three curves, with the center curve corresponding to the point projections, and the lower and upper curves showing the 10th percentile and the 90th percentile of the population projection, respectively. Due to space constraints, we only report the consolidated demographic and household composition effect.

**Figure 2 Forecast, expenditures on old-age pensions (2007-level), 2007 = 100**




Panel A of Figure 3 exhibits the projection of expenditures allocated to public old-age pensions. As we saw above, the pension expenditures are expected to have increased by almost 70% by 2037. However, the figure illustrates the large uncertainty embedded in these numbers as the 10th percentile shows pension expenditures rising less than 30% from 2007. Similarly, there is a probability of 10%, as shown 90th percentile, that those expenditures would more than double until 2037.

In the same fashion, Panel B shows the projection of the expenditures for early retirement benefits. The point forecast indicates a slight decrease in that component, but the lower and upper percentiles shown illustrate that the uncertainty in this number is large, with the 10th percentile showing expenditures falling by a quarter, while the 90th percentile roughly projects expenditures rising by a quarter by 2037.

[9] More figures illustrating the importance of demographic uncertainty in the projection of public sector expenditures are available upon request.

Panel C shows the projection of income tax revenues going forward to 2037. The projection shows that the development in income tax revenues may vary between an increase of 30% and a fall of 15% in 2037, a difference amounting to well above 10% of the level of GDP in 2007.

Finally, Panel D exhibits the projection for expenditures on hospital admissions. The median projection is an increase of just under 40%, but the span of uncertainty within the 10th and the 90th percentiles is from an almost unchanged level of expenditures to a level that is almost the double of the level in 2007. This corresponds to a difference of more than DKK 40bn between the top and bottom 10th percentiles.

The figures in this section are witnessing that adding uncertainty to the population projection yields important information not just about the size of the future population, but also about the future level of public revenues and public expenditures. It should be stressed, however, that although the uncertainty span large sums of money relative to the level of GDP in the base year, the per capita expenditures and revenues do not exhibit equally large variations. The 10th and the 90th percentiles of the population projections of course also span a large population difference in 2037. Although, the specific composition of the population with respect to age and gender is important for the total production in the economy, it is fair to assume that if we had made similar projections for GDP-levels and looked at uncertainty therein, these would also have shown a large span of possible outcomes.

## 6. Concluding remarks

Recent demographic trends show signs of substantial changes in age and household structures. In particular, the share of singles tends to increase, and more couples seem to prefer to live together as unmarried. This is a development which may have considerable implications for public finances in countries with extensive welfare arrangements. In particular, this is the case if the provision of welfare services is associated with noticeable differences in unit costs between individuals living as singles and couples.

In this paper we have focused on Denmark, where the household structure is closely integrated with the tax and transfer system. We have singled out those components of taxes and welfare services where revenues and outlays are likely to be sensitive to changes in the household structure. Using stochastic forecasting techniques, we have assessed the consequences for public finances of changes in age and household structures over the period 2008-2037. Our key finding is that the two demographic factors both tend to worsen public finances in the future: based on a point forecast, the fiscal impact of changes in household structures amounts to an annual negative effect of 0.6% of GDP, and the effect of changes in age structures is forecast to worsen the public budget by 3.6% of GDP per year. While subject to a considerable amount of uncertainty, the prospect of such a dramatic weakening of public finances is likely to have important implications for fiscal policy:

First, it may trigger demands for welfare reforms characterized by a more individualized system of public transfer and tax payments, in addition to measures already taken to address the fiscal effects of population ageing. In fact, Hatland (2001) find evidence that steps have been taken toward a more individualized system for pension rights in Denmark, where benefits depend less on household type. Social policy may also be modified in order to address concerns about poverty. Thus, in a study on shifts in the distribution of incomes following changes in household structure in France, Germany, Italy and the UK, Quintano og D'Agostino (2006) shows that the growing share of single-person households is associated with an increased risk of poverty. Similar results are obtained in a study by Palmer (2006) for England and Wales.

Second, the high degree of uncertainty associated with the point forecast may lead to new ways of communicating the future challenges to fiscal policy, by explicitly addressing these uncertainties. This could take the form of, say, reporting of predictive distributions of forecasts, so rather than merely publishing the point forecast, a broader quartile set, including also the 10th and

90th percentile, or a narrower range, would be made publicly available. By capturing the uncertainties involved in forecasts, policy-makers, the business community and the general public would be better informed and thereby better equipped to taking decisions. Such a new practice of transparency would sharpen the fact that there are several likely outcomes in the future that policymakers should prepare for, rather than just design policies in anticipation of a single (or a few) outcomes, and it would strengthen the need for ability to adjust policy instruments flexibly to a new contingencies.

In future work we plan to integrate the framework developed in this paper with intertemporal macroeconomic frameworks. One important extension would be to investigate the role of changing household structures for evaluations of fiscal sustainability. For example, the Scandinavian model is characterized by high female participation rates in the labour market, and continued high participation rates are widely regarded as essential for the sustainability of the Scandinavian welfare system. Since participation decisions depend, among other things, on the household situation, new family structures may have an important effect on the stance of fiscal sustainability. Another extension is to include more budget elements in the analysis, including expenditure components such as use of day care, public education for children, child benefits etc.

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# Labour market mismatch and skill requirements – How strong is the trade influence?

*Anke MÖNNING*[1], *Gerd ZIKA*[2], *Tobias MAIER*[3],

***Abstract***: Demographic change and the on-going ageing process of the German society leads to a smaller but also in average older labour force. The "demographic walk" through the peer groups imputes an increasing supply of academics; and especially medium skilled workers are expected to leave the labour market (Helmrich et al 2012 p. 2). Hence, skill mismatches are likely to emerge and are expected to hit especially those jobs that require medium-skilled workers. The "right skills for the jobs of today and tomorrow" are not only a problem for labour supply but also for labour demand. The matching process is vulnerable to trade: trade leaves a footprint on the labour market with trickle-down effects on skill requirements. It is expected, that a higher export orientation leads to an earlier shortage in labour supply with appropriate qualification levels.

***Keywords:*** labour market mismatch, trade effects, skill requirements, demographic change.

***JEL classification:*** J11, J2, F16

## 1. Introduction

Demographic change and the on-going ageing process of the German society leads at the same time to a smaller but also in average older labour force. Whereby the positive migration balance in the past two years has led to a current delay of this development, the population projection of the medium variant still forecasts a declining total population in the long run (Destatis 2009). With respect to skill endowment, the "demographic walk" through the peer groups imputes on the one hand an increasing supply of academics due to the observed trend towards higher education amongst younger population groups (Helmrich et al 2012 p. 2). On the other hand, especially medium skills are expected to leave the labour market as a result of the upcoming retirement wave of the baby boomer generation (Helmrich et al 2012 p. 2). Due to these developments, skill mismatches on the German labour market are likely to emerge and are expected to hit especially those jobs that require medium-skilled workers. The matching process of the "right skills for the jobs of today and tomorrow" are therefore not only a problem for labour supply but also for labour demand.

In an open economy such as Germany, the matching process might be further vulnerable due to its specific trade patterns. The exposure of a country to trade flows and their specific structure impacts the demand for labour on industry level and alters the need for certain occupations. Consequently, the requirements on skill levels are affected as well and trade leaves a footprint on the labour market with trickle-down effects on skill requirements.

The present analysis tries to shed light on the effects of trade on the skill requirements on the German labour market by applying a model-based approach. A baseline scenario is compared with a scenario that assumes a more rapid growth path for leading trading partner countries of Germany. The focus of the analysis rests on the comparison of labour supply and demand by qualification levels.

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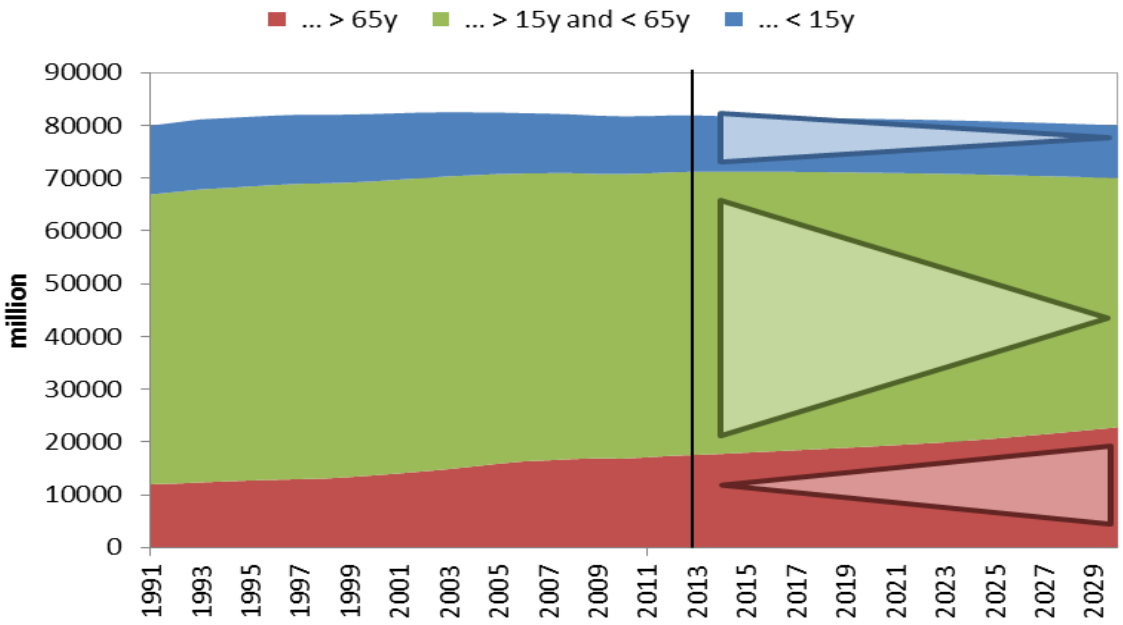
## 2. The German Labour Market – an Existence between mutual forces

In the past years, labour economics were mostly concerned about how to overcome unemployment and how to increase labour demand. Scarcity of labour was not recognized as a problem. Only recently, shortage of labour supply in certain branches is of growing concern. Especially in Germany, a country that is facing major demographic shifts in the near future, the adequate endowment of human capital has reached the agendas of politics, enterprises and society. The competition for skilled labour is most likely to get more intense (Ehing & Moog 2013 p. 168).

### 2.1. Labour Supply

Demographic change is a leading determinant for the future development of the German labour market. Its future projection depends strongly on assumptions concerning the fertility rate, the life expectancy rate and net migration. Graph 1 shows the German population projection by age groups for the medium population variant using the upper limit of net migration. Accordingly, total German population is expected to decline from currently 81 916 (2012) to 79 868 persons by 2030. At the same time, the population is growing older. By 2030, nearly 30% of all people are over 65 years old. The number of persons in working age, instead, is declining from currently 66% to 59% in 2030. Consequently, the German population is declining and ageing although a positive net migration of 200,000 persons per year is assumed. Additionally, the number of labour active persons is declining as well.

**Graph 1: Population – yearly average, by age groups (Variant 1-W2)**[4]




**Source: Destatis 2009**

Latest observation claims the need for future adjustments of the population projection of the Federal Statistical Office (Destatis 2009). The sample census of 2011 shows that German population is 1.5 million people lower than expected. Also, the latest figures on cross-border movements have shown that net migration is higher than assumed in the population projection. In 2011, net migration to Germany was recorded to be 369 thousand people and, thus, nearly twice as high as the upper limit of the population variant assumes. Although it can be assumed that the currently observed high

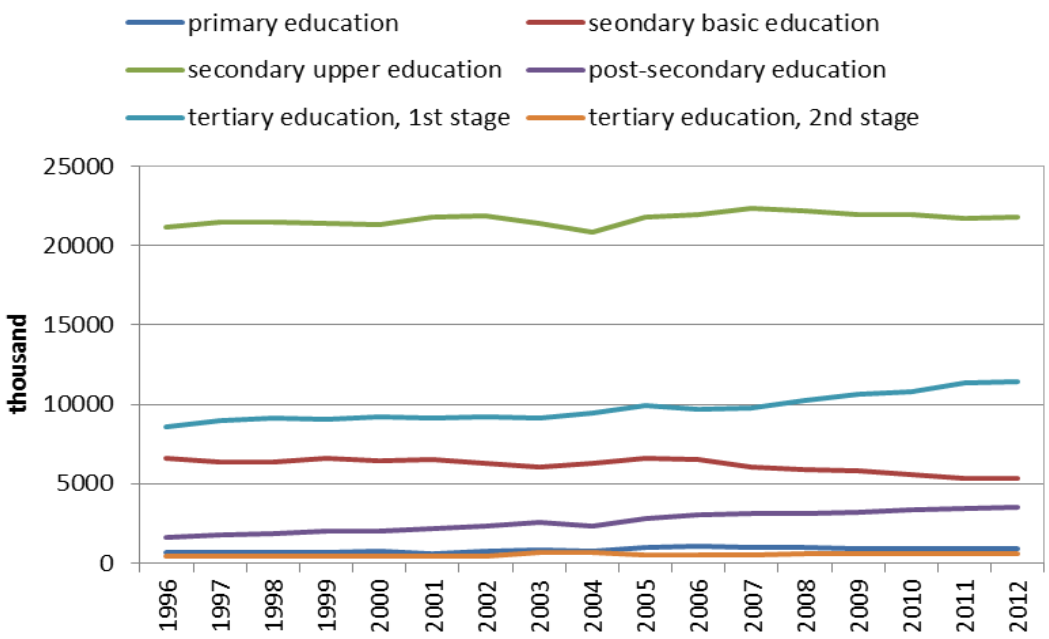
[4] Variant 1-W2: total fertility rate (children per woman) nearly constant at 1.4; life expectancy of new-born children in 2060 male 85.0 female 89.2; gradual increase to an annual net migration of 200 000 people from 2020

net migration is a reaction on the present European crisis (Bertoli et al. 2013), it seems to be justifiable that Germany's net migration is likely to stabilize on a higher level than in the past decades.

Although the population projection claims an ageing of the German society, this does not necessarily mean that the labour force is declining as well. The age of retirement and the labour force participation rate determine – among others[5] – the development of the effective number of total labour supply. Although the retirement age has been increased from 65 to 67 years – the adaptation process is long and slow. The first age group that has to work until 67 is born 1964. Changes can be also observed with respect to labour force participation rate. Especially among older people (age 60 to 65 years), the participation rate has considerably increased in the past. By 2010, the participation rate has nearly reached 50%. At the same time, the participation rate of people in their thirties remained on a constant level of about 86%. Additionally to an increase of the participation rate due to an increased number of older-aged persons, the participation rate can be also stabilized by an increase in female labour (Ehing & Moog 2013 p. 179). The share of females to total labour force is still considerably small compared to the male participation rate. Still, a growing rate can be observed in the past.

Generally, the growing participation rate of older people and female persons may compensate the demographic induced reduction of labour supply. In the long term, it can be expected that under present conditions, the demographic effects exceed the participation rate effect, leading to a decline in overall labour supply.

**Graph 2: Labour supply by qualification**




**Source: qube-projekt**

Parallel to the demographic change and change in the labour force participation rate, a change in the qualification level of labour supply can be observed. In Graph 2, the qualification level by ISCED classification[6] for the German labour supply is shown. Half of labour supply holds a secondary education degree (ISCED 3), that permits work within a certain occupational field or permits the entrance for higher education (access to ISCED 5). In Germany, ISCED 3 represents the

[5] Other options might include an earlier age of entry to labour force or migration (Ehing & Moog 2013 p. 179).
[6] ISCED 1997

dual education system or the secondary school. In the past years, people with ISCED 3 qualification level has declined, mostly shifting to higher qualification levels. Especially the tertiary education level (ISCED 5) has gained significance. Latest figure suggest that by now about 26% of labour supply hold a university degree or an equivalent degree.

## 2.2. Labour demand

Depending on the underlying theoretical school of thinking, the transmission mechanism of production towards labour demand differentiates, yet the positive correlation between production and labour demand exists in both approaches. Whereas in a Keynesian world, effective demand for goods determines the supply of goods which appropriates production and which, finally, approximates labour demand. The neoclassical theory, in contrast, argues in accordance to Says' theorem that labour demand is determined by prices and, thus, wages. Increasing costs induced by rising wages lower production and hence lead to lower demand in labour.

In the past year, the correlation between production and employment has been softening in some industries. Whereas in 2000, the growth rates of production and employment still indicated in the same direction for all industries, by 2012, a growing employment and a simultaneously declining real production rate can be observed for branches like the construction or manufacturing industry. This development can be partially explained by external factors such as securing high-potential employees or policy measures like short-time work support.

In an open economy such as Germany, specifically export-induced production impacts the demand for labour. In the past, export-induced growth impact to GDP was mostly positive and dominating to the other determinants of GDP. Only in 2009, the vulnerability of an export-dependent economy became obvious with a fell in real GDP by 5%. But the recovery process in the following years was again mostly driven by export growth.

High export-dependency can be especially found in the manufacturing industry. Industrial branches such as the automobile industry (64%), the chemical industry (60%) or the machinery producers (62%) earn most of their turnover from exports.[7] These three branches alone determine nearly 40% of all exports in Germany.[8] The exposure to export flows is much larger and more wide-spread across sectors when indirect effects are considered as well (Maier et al. 2013, Prognos 2011). Business-related service sectors such as the labour leasing industry, the transport or the whole sale sector show a strong and mostly indirect export-induced production and employment dependency (Maier et al. 2013 p. 19).

German exports are concentrated on specific regions and single economies. Over 60% of all exports are bound for countries of the European Union and over 80% of all exports are traded with industrialized countries of the OECD. France and the United States are with 7% on total exports the most important trading partners for Germany.[9] The fast developing economies of the BRICS-group bundle 12% of all exports – with China as the dominant part. Albeit the export share is still comparatively small, the growth impact of the BRICS countries to Germany's export growth rates are at a constant and high level. Although the growth impact of the industrialized economies of the G7-group used to be significantly higher, statistics show that the downswing in Germany's exports in 2009 are the result of the trade to industrialized economies and that the upswing in the years after are due to trade to the fast developing countries (Maier et al. 2013 p. 14).

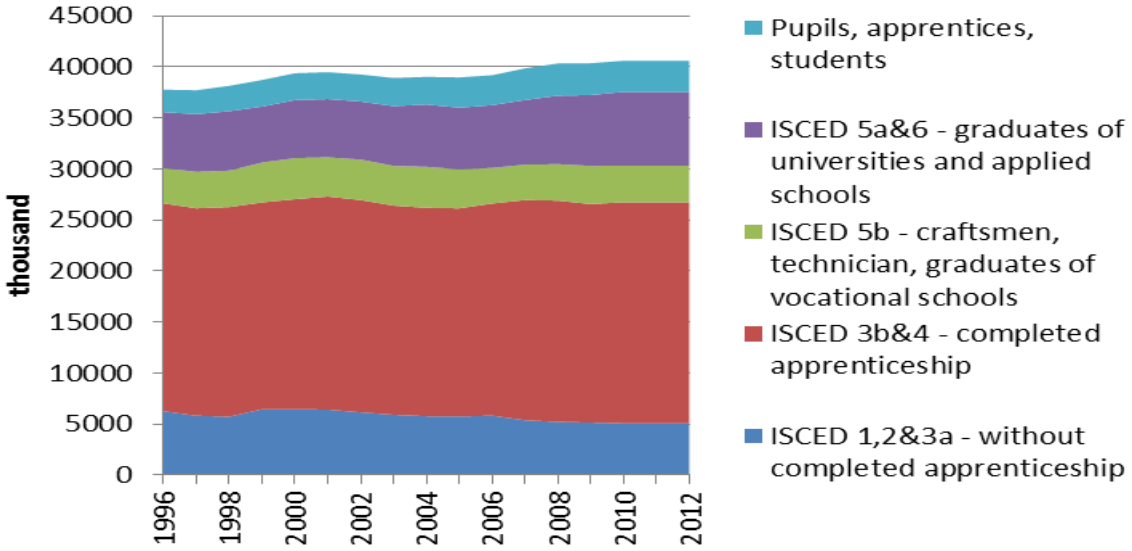
Labour demand is increasingly concerned with manpower recruitment. In the light of globalization and the increasing competitiveness of the fast developing economies of the world, the German industry more and more shifts towards highly specialized, high-quality production. Instead of producing bulk goods, many industries become specialized in certain niches - producing high-end,

[7] Figures taken from Destatis (2013a). Export rate as share to total turnover for 2012.
[8] Destatis (2013)
[9] OECD (2013)

customized products. But not only globalization, also technological changes foster the shift towards high-skilled workers in Europe (Dunkel 2010: 237). Communication or information technologies, for instance, require high educated workers and, at the same time, promote productivity increases: "At the same time, less educated workers become relatively less productive, less in demand and this reduces their wages or increases their likelihood of unemployment" (Dunkel 2010: 237). This skill-biased technological change (SBTC) hypothesis has found empirical support in several studies (e.g. Chennels & Van Reenen 1999; Cedefop 2011: 12). Other studies (Autor et al. 2006; Goos & Manning 2007; Goos et al. 2009; Cedefop 2011) observed that workers with routine tasks, who generally occupy the middle of the wage ranking are substituted by technological progress, whereas jobs with abstract and non-routine tasks at the top and at the bottom of the wage distribution are either complemented with technological innovations or simply not substitutable.

Hence, globalization and technological change has initiated a high sensitivity in human resources towards manpower requirements. The need for more high-skilled personnel can be observed in the past (compare Figure 4): The share of high-skilled employees, that hold a university degree, is with 18% relatively small, but is growing rapidly. At the same time, medium-skilled personnel are still as much required as in the past. Employees with a completed apprenticeship represent the majority of Germany's employees with a high and constant share of 53%. In-firm training, hence, is still the most favorable choice for recruiting personnel.

**Graph 3: Employment by qualification**




**Source: qube-projekt**

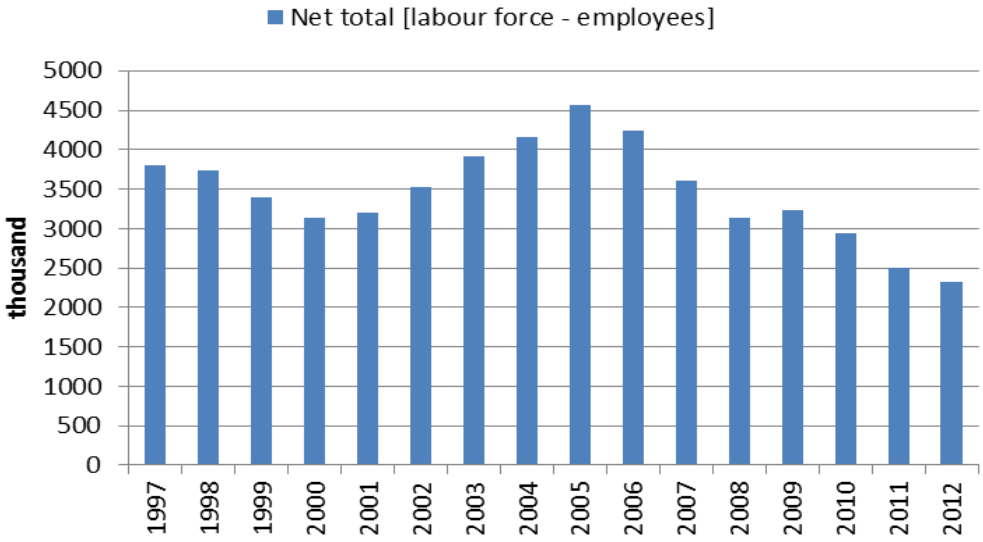
## 3. Net total: balancing labour supply and demand

Altogether, German labour supply is characterized by different trends and observations. Whereas the population is declining and ageing, the labour force participation rate of older people are increasing significantly. Simultaneously, the trend towards higher qualification remains unchanged. Thus, with more people leaving the labour market, the remaining and subsequent people tent to be higher educated. But that also poses the question if there are "the right qualification for the right job?". Due to globalization and technological advancement, labour demand is characterized by a shift in qualification requirements. High-skilled labour is increasingly required, although, at the same time, in-firm-training remains the dominant and leading factor.

The comparison of labour supply and labour demand is shown Figure 6. The German labour market is still characterized by a surplus in labour supply with 2,3 million people (2012). But since 2005, a clear trend towards a narrowing of the gap between labour supply and labour demand can be observed. In 2005, the gab was with 4,5 million people nearly twice as high as in 2012. The

economic crisis in 2009 delayed the process only for a little bit. The process is mainly driven by the developments on the demand side of the labour market. The number of employees is increasing continuously since 2005 – although in different pace. The labour force, instead, remained more or less on a constant level.

**Graph 4: Net total of labour supply and labour demand**




**Source: Destatis 2013**

The balancing factor of labour demand and supply becomes more intense, when both sides are separated in formal qualification levels. For all ISCED[10] levels, net total is positive which equals a surplus in labour supply. For the medium-high and high qualification levels 5 and 6, the surplus level is rather small. A shortage of labour is not yet immanent, but already in sight distance. In contrast, low and medium-low skilled levels 1 to 4, labour scarcity is not an issue in the near future. Instead, the high surplus of labour force without a completed apprenticeship demands for action of how to shift those people into higher qualification levels.

# *4. Methodology*

For the analytical part, this paper applies a quantitative modeling approach. It uses the macro-econometric input-output model QINFORGE (**Q**uBe **In**terindustrial **For**ecasting **Ge**rmany) (Maier et al. 2013b, Ahlert et al. 2009). The current version of QINFORGE differs in two important areas to previous model versions:

- The foreign trade module (Maier et al. 2013 p. 9ff.) is extended and updated with new data.
- The labour demand module (Maier et al 2013b) has been extended in order to integrate labour scarcity indicator in the wage estimation function.

## 4.1. The trade module

The trade module is described in Maier et al. (2013 p. 9ff.) at length. The principle methodology of how trade is handled in QINFORGE remains the same. Notably are the extended dataset and the updated economic forecasts integrated into the model. Exports are still exogenous in principle. The economic forecasts are obtained from international institutions and organization from updated publications (IMF 2013, EC 2013, IEA 2013). Bilateral trade matrices (OECD 2013) are still used for determining the shares of Germany in each country's import function. The updated databank of the OECD allows now to extend the number of countries to a total of 67 trading partners

[10] ISCED 1997

of Germany. This includes two regions (rest of world and unspecified). The differentiation by product level remains the same with 43 different product types.

### 4.2. Labour demand by occupational fields and qualification levels

Labour demand by occupation and qualification is explained as described in Maier et al. 2013, 2013b by labour demand dynamics on industrial fields. The current version of QINFORGE uses now a more sophisticated conversion approach that accounts not only for a stronger influence of structural changes on the labour market but also includes a labour scarcity factor in the wage function.

The scarcity factor is included in the wage function by occupational fields (w_oc). Wages by occupational fields are not only a function of the overall wage level (W), but also of the quotient of labour demand (ld_oc) to labour supply (ls_oc). The ratio is positively correlated to wages. A faster growing demand than supply of labour leads to increasing wages because the factor labour is getting scarce.

$$w\_oc_{oc} = \beta_1 + \beta_2 * W + \beta_3 * \frac{ld\_oc_{oc}}{ls\_oc_{oc}} \quad (1)$$

The influence of the scarcity factor cannot be observed in all occupational fields. Several reasons can explain this shortage: On the one hand, a shortage of labour cannot be observed in the past. On the other hand, the specific occupational field is just not affected by labour shortage. Or, the influence of overall wage level (W) compensates the effect of labour scarcity.

The wage development of an occupational field in a specific industrial sector (w_oc_i) is than explained by including sectoral productivity (y/e) in the estimation function.

$$w\_oc\_i_{oc,i} = \beta_1 + \beta_2 * w\_oc_{oc} + \beta_3 * (y_i/e_i) \quad (2)$$

The hours worked by occupational fields and by economic activities (h_oc_i) are estimated under the precondition to include occupation-specific and industry-specific wages as explanatory variable. The demand for labour, hence, should be also influenced by wages and, indirectly, by the mismatch of labour demand and labour supply on the labour market. The hypothesis is that labour demand by hours worked is declining when the occupational wages at a specific industry are increasing fast than the averaged paid wage in the specific occupational field. Additionally, a time trend (TIME) is included in the wage function which represents an autonomous influence of technological change on labour demand.

$$h\_oc\_i_{oc,i} = \beta_1 + \beta_2 * w\_oc\_i_{oc,i} + \beta_3 * TIME \quad (3)$$

Labour demand by head (e_oc_i) is a definition function of labour demand by hours worked (h_oc_i) and annual working time (t_oc_i). The latter is driven by annual working time observed in industries alone.

$$e\_oc\_i_{oc,i} = w\_oc\_i_{oc,i} / t\_oc\_i_{oc,i} \quad (4)$$

Labour demand by qualification resembles basically the approach described in Maier et al. (2013b p. 10ff.). But the extrapolation of the qualification shares (q_oc_qu) in each occupation is improved by including the wage level of each occupational field (w_oc) in the estimation function.

$$q\_oc\_qu_{oc,qu} = \beta_1 + \beta_2 * w\_oc_{oc} + \beta_3 * TIME \quad (5)$$

It is assumed, that the shares are approaching asymptotically the saturation level. An important side condition is, that the qualification shares of a specific occupational field have to sum-up to 1 at all time.

## *5. The scenario: export-induced growth*

The sensitivity analysis rests on a baseline (BASELINE) scenario which is compared to export-induced growth scenario (SIM) that assumes a higher growth path for major trading partners of Germany. Table 2 summarizes the assumptions: the annual GDP growth rate is increased by 1%-points for the

NAFTA countries, by 2%-points for the BRICS countries and by 0.5%-points by the Eurozone economies.

**Table 2: Overview of additional GDP growth impact in the scenario**

| | |
|---|---|
| USA, Canada, Mexico | +1,0%-points each year 2019-2013 |
| Brazil, Russia, India, China, South Africa | +2,0%-points each year 2019-2013 |
| Eurozone | +0,5%-points each year 2019-2013 |

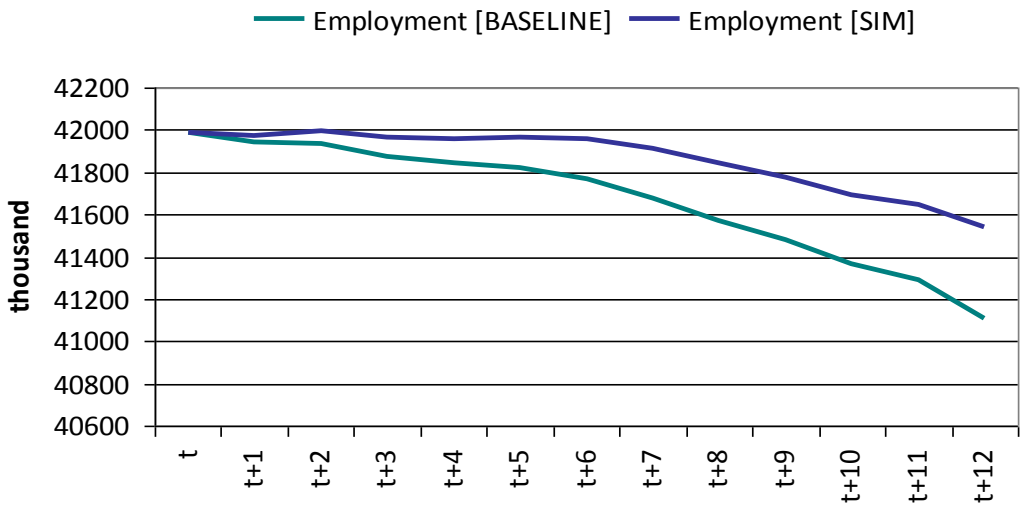
In a scenario, in which Germany's trading partners are performing better than expected, Germany's real GDP exceeds GDP of the baseline scenario by 4.2% after twelve years after the shock. A summary of the major deviations to the baseline scenario are given in Table 3. Exports are increasing significantly over time and affect the rest of the economy positively. Export-induced production affects the labour market positively which lowers unemployment and extends overall employment. More employed people and fast growing income stimulates private consumption. Public expenditures are declining due to lower pressure on the social security system. At the same time, more resources are available to increase public consumption. Export-induced growth leads to more investments especially in exporting industries such as the automobile industry. The positive impact on the economy is partially lowered due to simultaneously increasing imports.

**Table 3: Percentage deviation to baseline scenario**

| | t | t+1 | t+2 | t+3 | t+4 | t+5 | t+6 | t+7 | t+8 | t+9 | t+10 | t+11 | t+12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Real GDP | 0,0 | 0,3 | 0,6 | 0,9 | 1,2 | 1,6 | 1,9 | 2,2 | 2,5 | 2,9 | 3,3 | 3,7 | 4,2 |
| Private consumption | 0,0 | 0,1 | 0,3 | 0,5 | 0,7 | 0,9 | 1,1 | 1,2 | 1,4 | 1,7 | 1,9 | 2,2 | 2,5 |
| Public consumption | 0,0 | 0,0 | 0,1 | 0,2 | 0,3 | 0,4 | 0,5 | 0,6 | 0,7 | 0,8 | 0,9 | 1,0 | 1,1 |
| Investments | 0,0 | 0,3 | 0,7 | 1,1 | 1,5 | 2,0 | 2,5 | 3,0 | 3,5 | 3,9 | 4,4 | 4,9 | 5,6 |
| Construction | 0,0 | 0,0 | 0,1 | 0,1 | 0,1 | 0,2 | 0,2 | 0,3 | 0,3 | 0,3 | 0,4 | 0,4 | 0,5 |
| Change in inventories | 0,0 | 0,1 | 0,2 | 0,3 | 0,2 | 0,2 | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 | 0,3 |
| Export | 0,0 | 0,5 | 1,1 | 1,6 | 2,2 | 2,8 | 3,4 | 4,1 | 4,7 | 5,3 | 6,0 | 6,6 | 7,4 |
| Import | 0,0 | 0,3 | 0,7 | 1,1 | 1,4 | 1,8 | 2,4 | 3,0 | 3,5 | 3,9 | 4,3 | 4,8 | 5,5 |

**Source: QINFORGE**

**Graph 5: Total employment – BASELINE and SIM scenario**

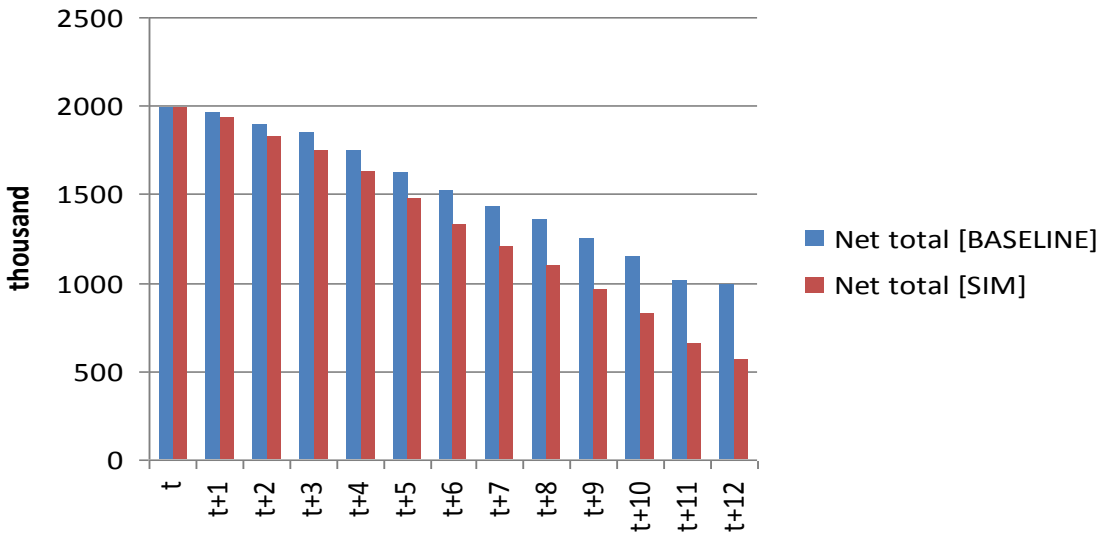



**Source: QINFORGE**

The positive growth impact of a faster growing world economy also leaves its footprint on the German labour market. Compared to the baseline scenario, overall employment remains on a stable level for a longer period. The decline in employment is delayed for a couple of years. The overall trend of an employment reduction remains (Graph 5). Twelve years after the shock, additional 430 thousand people are employed compared to the baseline scenario.

Under the assumption that labour supply is not been affected by the additional growth impact in the simulation, net total of employment is reduced faster than in the baseline scenario (Graph 6). The slowing reduction in employment meets a continuously declining labour supply. The gap between total labour force and total employment is narrowing more rapidly than expected under the baseline scenario. Overall, net total of employment also remains positive also after twelve year of higher growth rates. By the end of the projection, the surplus of labour is at 500 thousand persons. That is nearly half of the labour surplus recorded in the baseline scenario.

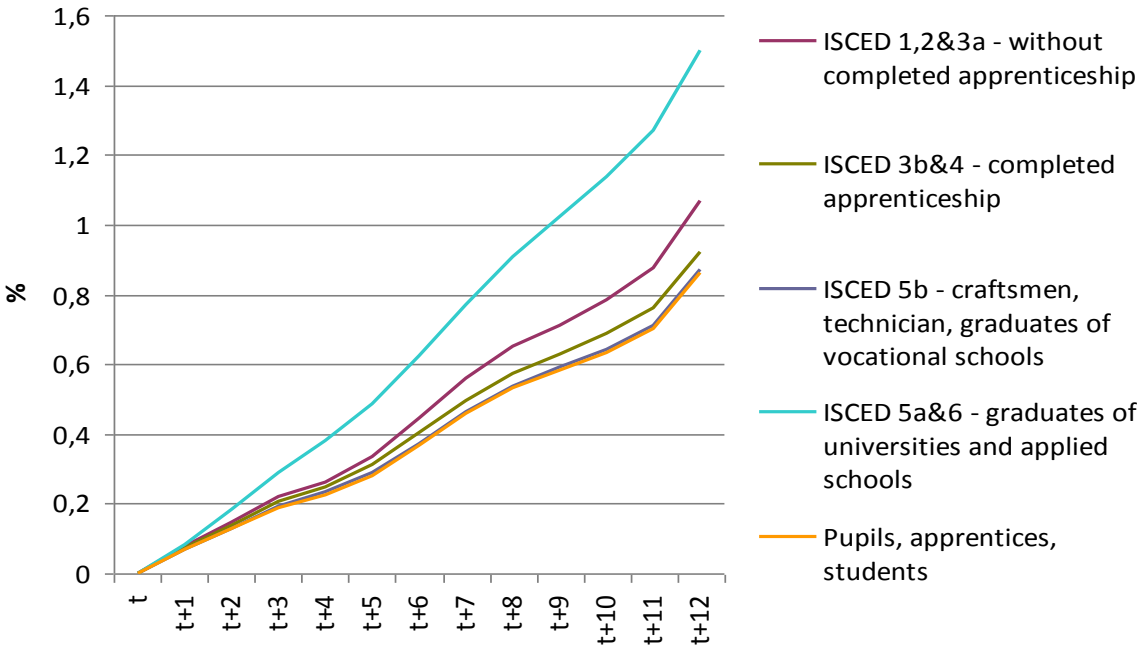
**Graph 6: Net total of employment**




**Source: QINFORGE**

The differences emerge more rigorouse when going into structural details. The export-induced growth impact affects employment differently when looking on the qualification level. In Graph 7, the deviation of employment by qualification levels to the baseline scenario are represented. It shows, that especially high-skilled employees (academics) are profiting from additional export-growth. At the end of the projection, 1.5% more academics are employed than in the baseline scenario. The percentage change is abover average (1%) and equals around 130 thousand persons. Quantitatively, the strongest impact is observed at the medium-low skilled qualification level. Twelve years after the shock, an additional 200 thousand persons of an ISCED level 3b or 4, people with a completed apprenticeship, are employed. The effects on medium-high skilled qualification level – craftsmen or technicians – are the lowest. Employment at this qualification level increases below average with 0.9% or by 30 thousand persons by the end of the projection. Altoghether, export-induced growth impacts especially those people with a high (academics) or with a medium-low (apprenticeship) formal qualification level.

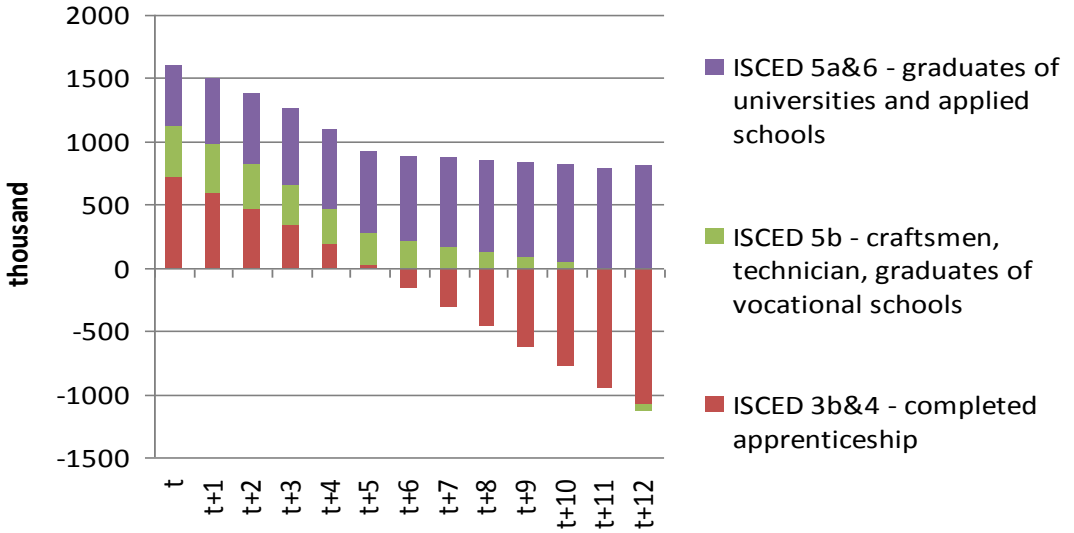
**Graph 7: Deviation to baseline scenario in % - employment by qualification levels**




**Source: QINFORGE**

The impact on employment by qualification level is intensified. Although the gap between total labour supply and labour demand is narrowing, a surplus of labour supply also exists at the end of the simulation. But when looking in detail, especially the group with a medium-low qualification level is expected to face a mismatch between labour supply and demand. Export-induced growth especially raises the need for medium-low skilled employment. The raising demand of academics can be better matched as the tendency to higher education remains constant. By the end of the projection, also the demand for medium-high skilled labour cannot not be adequately matched.

**Graph 8: Net total by formal qualification level**




**Source: QINFORGE**

## 6. Conclusions

The sensitivity analysis has shown that export-induced growth stimulates Germany's economy with positive effects on the labour market. Total employment increases as more products are exported. But the positive effects on the labour market increases, in the long run, the pressure on the labour market when labour supply remains unchanged at the same time. The gap between labour supply and labour demand is narrowing much faster when additional export-induced production is realized but remains positive in total. With respect to qualification requirements the picture changes. Especially medium-skilled employment becomes scarce in the long run. Craftsmen and technicians as well as people with apprenticeships are increasingly demanded. Hence, if Germany remains on its export-induced growth path, personnel planning become more of a challenge for some industries. High-skilled employees are also increasingly demanded but face no such shortages in the long run.

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# Is it possible to compensate for the decreasing labour supply by increasing working hours?

*Susanne WANGER*[1], *Brigitte WEBER*[2], *Johann FUCHS*[3]

***Abstract***: Due to the demographic trend, in all probability the German labour force will be confronted with a radical change: The mean age is projected to rise and the number of people is expected to decline. Because of the extreme importance and strength of the demographic component it is possible to forecast this change even for the long run. The current discussion in Germany about the skills shortage includes the question as to how the labour force can be expanded. In the centre of this discussion are migration, a higher labour participation of women and a longer working lifetime. In contrast, the annual working time is not extensively being discussed. Although increasing the working time will not reverse the trend in the number of workers, it would perhaps stabilize the macro economically important volume of work. This article examines to which extent the working time can be increased and whether there are possibilities for any enlargement.

***Keywords:*** demographic trend, labour force potential, annual working time, labour volume

***JEL classification:*** F22, J11, J21, J22

## 1. Introduction

In the long term, the German labour market is likely to be shaped by the megatrend "demographic change". The German Federal Statistical Office predicts a decline in population of 21 % by 2060.[4] The working age population, defined as persons aged 15 to 64, could even be cut by up to 35 %. The decline would turn out stronger without the supported net immigration of 100,000 per annum.

In this context, one has to bear in mind that the demographic change is embedded in a general economic and social structural change. Beside the demographic base, the employment behaviour changes as well. The following sections show, on the basis of data and projections of the German Institute for Employment Research (IAB), how the labour supply in Germany may develop over the coming decades.[5]

The article lays emphasis on the question as to whether it is possible to compensate for the expected decline in labour force. To answer this question, some scenarios with extreme assumptions concerning the labour market participation of women and elderly were provided. These scenarios were supplemented by calculations which are based on a volume of work concept instead of a per capita view. Apart from expansion of labour market participation of women and the elderly (keyword: working life) the effects of a longer annual working time were studied. This provides us with a better basis for concluding whether and under what fundamental conditions it might be possible to stop the demographically determined decline in labour force.

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[4] Statistisches Bundesamt (2009).
[5] This article does not address the question as to whether there is a corresponding need for labour as well; see Fuchs/Zika (2010), Helmrich/Zika (2010), compared to Brenke (2010) as well as Brunow/Garloff (2011).

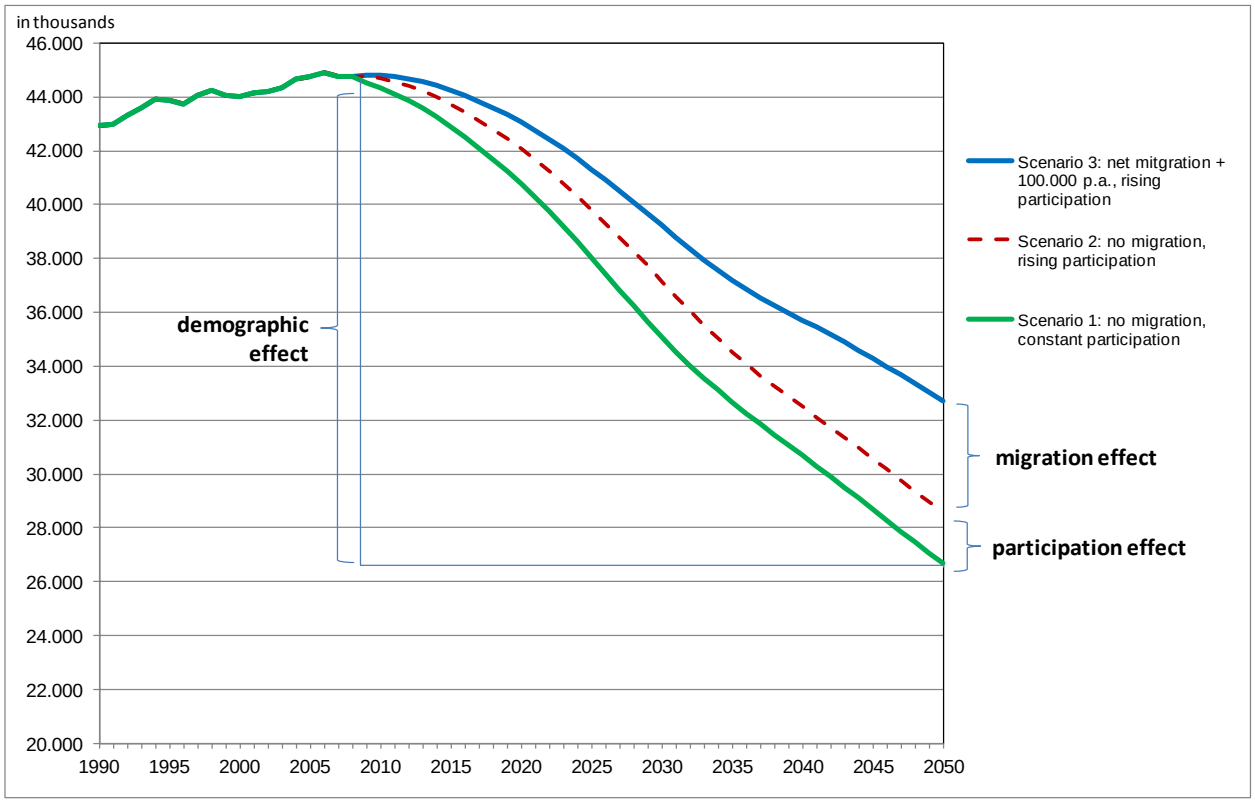
## 2. Projection of working population until 2050

The labour supply[6] will suffer massive reversals during the next decades. This is also confirmed by the newest projections of the IAB. In the future, firms will no longer have a wide choice of personnel, and the employees will be older than today.[7]

Until the 1990s, the labour force was increasing even though the demographic trend has already been negative since the late 1980s. Rising labour force participation of women in Western Germany as well as net immigration could, however, more than offset the negative population trend.[8] Nevertheless, the labour force stagnated in the last decade. In 2011, with 44.7 million the labour force was as high as in 2005.

Assuming an average annual net immigration of about 100,000 people over the next 15 years, the labour force is expected to decline to 42.8 million workers by 2020 and 41.1 million by 2025.[9] All in all, this trend will continue in the years beyond 2025. The labour force is expected to decrease to less than 33 million persons in 2050 (see scenario 3 in Fig. 1).

**Figure 1 Alternative Labour Force Scenarios in Germany, 1990 – 2050**




***Source: IAB and author's calculations***

[6] The IAB estimates a labour force (labelled as labour force potential) that comprises employed and unemployed persons as well as the hidden labour force. The hidden labour force (hidden unemployment, discouraged workers) includes those people who are willing to work in principle but for various reasons no longer appear in official statistics when the labour market situation is poor. When the labour market situation improves, people in the hidden labour force have at least the same chances as unemployed people (Holst/Schupp 2000). The hidden labour force should therefore be understood as part of the labour supply. This potential labour force equals the ceiling regarding the number of workers available for the firms in Germany under given framework conditions.

[7] Fuchs/Söhnlein/Weber (2011).

[8] Thon/Bach (1998).

[9] Fuchs/Söhnlein/Weber (2011).

The change in the labour force can be broken down into several components, each operating in isolation: demography, labour participation and migration.[10] Separating their influences on the projected labour force allows for assessing how sensitive the projection is in respect of the assumptions.

The demographic component includes the effect of declining population and ageing on the labour force.[11] This effect adds up to about 18 million persons being part of the labour force by 2050. If the labour force potential were determined solely by the demographic component, then it would decline by this value by 2050. The demographic component has a high level of prognostic certainty, as a considerable part of the demographic process is obviously already laid down in the age distribution of today's population. In other words, all persons who will count to the labour force in 2025 are already alive. But even a much wider forecasting horizon, say 2050, has a high probability. For example, a much higher fertility rate (+ 50 %, i.e. a birth rate of 2.1 children per women) could stabilize the trend in the labour market-relevant age groups (15 to 64 years) at the earliest in about 30 years – on a clearly lower level as today.[12]

Changes in the labour participation rates form the participation component. In contrast to popular expectations, the increase in the participation rates makes only a small contribution to weaken the demographic effect. This is because the activity rate of women in Germany has reached a high level by now. In 2010, the labour force included 88 % of 30-to-49-years-old German women. It is estimated that this share will amount to 90 % in 2025 and 94 % in 2050.

With the "pension at 67" scheme, the IAB projection considers the consequences of a postponement of the statutory retirement age in Germany and the associated higher participation of older workers.[13] This leads, however, to a higher average age and an even higher proportion of older workers in the workforce. At present, a good quarter of the labour force is aged between 50 and 74 years, this proportion will rise gradually and will settle at around one third in the long run. All in all, the increasing employment of women and longer working lives result in a labour participation effect of 1.8 million persons by the year 2050.

Besides the participation component, migration reduces the negative demographic effect, too. Assuming 100,000 net migrations annually, the size of the labour force potential will rise to about 4.3 million by the year 2050 (so-called migration effect). Even immigration at a higher level, for example 200,000 persons per year, cannot compensate for the demographic influence on the labour force.[14]

By combining the assumptions concerning labour participation and migration, the IAB formed a multitude of projection variants. On the basis of three scenarios, the isolated influence of the components on the labour force potential is quantified as shown in Figure 1. Scenario 3 appears to

[10] Fuchs (2009).

[11] The IAB's assumptions concerning the population projection follow the assumptions of the Federal Statistical Office; see Fuchs/Söhnlein (2006) and Statistisches Bundesamt (2009).

[12] Fuchs/Söhnlein (2006).

[13] The retirement age in Germany will increase from 65 to 67 between 2012 and 2029.

[14] Migration statistics cover all in- and out-migration, not only workers. A net immigration of 100,000 people per year means that 100,000 more persons immigrate than move away. Doubling net migration does not double the effect on the labour force (Fuchs 2009). The reason is the young age structure of migrants. For example, nearly three quarters of immigrants in the year 2009 were younger than 40 years, while only two thirds of emigrants were so. Since 2004, the net immigration of people of 35 years of age and older has been negative every year and positive only among younger people. This leads to positive effects in the medium and long term for the level of population and for participation, too.

be most realistic. In addition to increasing activity rates, it assumes a positive annual net immigration of 100,000 persons per annum.[15]

# 3. Domestic human resource reserves: strategies and potentials

It is likely that the decrease in labour force will not be without economical and social difficulties. Shortages of skilled workers, increasing social security costs, regional disparities, etc. are some conceivable undesirable effects. If it were possible to soften the downward trend of labour supply, it would be easier to cope with the negative impacts.

The development of the German labour force is dominated by the demographic component. By comparison, the participation effect has a weaker impact. As explained below, there is additional potential for the expansion of labour force potential by activating domestic human resource reserves.[16] Focus will be placed on the increase of labour force participation of women as well as longer working lives.

## 3.1. Raising labour force participation of women

In the past, there was a strong rise in participation rates of German women: for example the potential activity rate[17] of West German females aged 40 to 44 years rose from 48 % in 1970 to 73.5 % in 1990. This trend, representative for the middle-aged, slowed down slightly afterwards. After all, 88.6 % of this age group was part of the labour force potential in 2008.

Consequently, the age-specific labour force participation rates of women are expected to further increase. For the middle-aged a trend increase in activity rates is assumed. Furthermore, considerably higher activity rates among older workers are expected, following a stepwise rise in the statutory pension's age. In contrast, the activity rates of young women are expected to decline due to an increase of secondary education.

Despite the projected increase, the age-specific activity rates of women remain lower than the rates for men of the same age (Table 1). If the activity rates of women had been equal to the rates of men, the labour force potential of women between 30 and 49 years would have been 1.5 million persons higher in 2008. Assuming this for all women between 15 and 64 years, there would have been an additional labour force of about 3.2 million workers.

**Table 1: Potential activity rates for selected (age) groups in %**

| | Women | Men | Average potential activity rates for women and men | | | | |
|---|---|---|---|---|---|---|---|
| | 30-49 | 30-49 | 30-49 | 50-54 | 55-59 | 60-64 | 65-69 |
| 2010 | 88.2 | 98.5 | 93.4 | 90.2 | 82.2 | 45.1 | 12.2 |
| 2025 | 90.6 | 98.7 | 94.6 | 90.8 | 84.3 | 57.8 | 15.9 |
| 2050 | 93.5 | 98.7 | 96.1 | 92.4 | 86.0 | 67.2 | 16.8 |

***Source: IAB and author's calculations***

[15] Regarding the influence of opening the German labour market for workers from the new EU Member States on 1 May 2011 see Baas/Brücker (2011).

[16] The mobilisation of unemployed people and the hidden labour force, who also count to labour force potential, are not further addressed. Implicitly, this assumes that the future labour force potential will be used in full. Underemployment would have disappeared and fallen to zero.

[17] The potential activity rate includes employed and unemployed persons and the hidden labour force. In 2008, about 81 % of the above-mentioned women were employed, 5 % unemployed and 2.5 % belonged to the hidden labour force.

However, the effect becomes smaller due to the demographic development. The same assumptions for activity rates of women and men will result in an additional potential of 2.69 million in 2025 and only 1.56 million persons in 2050 compared to the predicted potential (see column "scenario reconciliation" in Table 2).

As the activity rates of women are already quite high, another rise or even catch-up on the activity rates of men are not unfounded. After all, the activity rates of women in the former GDR were higher than the underlying activity rates in the projection of IAB.[18] Overall, there are still substantial potentials regarding the employment of women. However, some constraints must be taken into account.

In general, well-known improvements are needed to balance family and working life. A strong rise in labour participation can only be expected if fundamental adjustments in the tax system, the school system and childcare are made. Therefore, a rise in employment of women is not self-evident.

Foreign females constitute a special category. They are further away from the labour market than German women. Being at 68 % in 2008, the employment rate of foreign women was 20 percentage points below that of West German women of the same age.[19] If foreign females had the same employment behaviour as West German women, the labour force potential would comprise 450,000 more persons. Over the projection horizon, the participation effect regarding the participation assumptions of foreign women will increase temporarily to over 500,000 persons. One should keep in mind that such a high additional potential requires considerable integration efforts.

Finally, the potential of a better educated workforce is clearly limited. Only 1.2 million of almost 2.1 million women without vocational qualification were gainfully employed in 2008 (56 %), compared to 73 % of men.[20] The employment situation of women with a medium-level education looks more favourable. 79 % of 7.9 million females with school or vocational training were in work (men: 91 %), nearly 490,000 (6 %) of this group were seeking work and about 1.1 million (15 %) were inactive according to the German Labour Force Survey. Thereby, an inactive potential of about 1.6 million qualified women lies untapped. The labour force potential of the highly qualified has been exhausted for the most part. For example, 84 % of all female graduates aged 30 to 49 years were employed in 2008. The remaining 16 % (300,000) female graduates had no working place; about 80,000 of them were actively seeking work.

**Table 2: Effects of extreme higher activity rates of women and the elderly in 1,000 persons (or in % of 2008)**

| | Reference scenario | Additional potentials compared with reference scenario | |
|---|---|---|---|
| | (increasing activity rates and positive net immigration of 100,000 persons p.a.) | *"Reconciliation" scenario* (same labour force participation of women and men) | *"Working life" scenario** ("pension with 70") |
| 2008 | 44,748 (= 100 %) | | |
| 2025 | 41,325 (= 92.3 %) | +2,694 | +5,964 |
| 2050 | 32,733 (= 73.1 %) | +1,560 | +4,267 |

*** Note:**"Working life" scenario: Activity rates of persons aged 60 to 64 correspond to those of persons aged 50 to 54 and activity rates of persons aged 65 to 69 correspond to those of persons aged 55 to 59.

***Source: IAB and author's calculations***

[18] Fuchs/Weber (2004).
[19] Fuchs/Söhnlein/Weber (2011).
[20] Own calculations based on the Scientific Use File of the 2008 German Labour Force Survey.

### 3.2. Raising labour force participation of the elderly

The participation of older workers in employment has risen sharply in recent years.[21] Participation rates of persons aged 50 to 54 years and 55 to 59 years moved closer to those of the middle-aged (see Table 1). Labour participation rates of persons aged 50 to 54 were only slightly lower than those of 30-to-49-years-old persons. However, there are still higher labour market problems among the elderly (60+). This pattern becomes even more obvious considering that in 2010, only one in four of them worked in a job where social security contributions are mandatory.

With the gradual introduction of the "pension with 67" scheme, older workers will become more important in the labour market. The proportion of persons older than 50 years will increase in the selected IAB scenarios from currently (2010) about 29 % to almost 37 % in 2050. The labour market participation of 60-to-64-years-old persons increases in the projection by almost half from 45 % to 67 %, that of 65-to-69-years-old persons from 12 % to 17 % starting from a clearly lower level. (Persons affected by the "pension with 67" scheme belong to the age group of 65-to-66-year-olds; whereas those aged 67 years and older are not affected.)

The employment potential of the older population cannot be enlarged readily. Especially preventative policies are necessary to improve the employability of older people. This includes among other things the increasing participation of older people in training activities, health promoting measures or appropriate workplace designs.[22]

Particular attention will have to be paid to the formal qualification at the beginning of working life. Data of the 2008 micro census show that activity rates of persons aged between 50 and 54 years do not differ much from those of other groups if they have a formal education, which means that they have successfully completed professional training, vocational school, master school, college or higher education. A clear increase of the activity rate of older workers with a low formal qualification is less realistic. In 2008, not even a quarter of older persons without (formal) vocational training were still employed.

The proportion of older people (50+) in the labour force is expected to increase from currently 29 % to 43 % in 2050. In that case, every second working person is 50 years or older. This underlines the importance of connected measures to enable older persons to work longer.

All in all, a weakening of the negative trend in labour force potential should be possible, but it requires an enormous expansion of labour participation of women and/or elderly from today's perspective. Furthermore, even high rates of growth are not enough to completely compensate for the demographic change in the very long term. As Table 2 ("additional potentials" column) indicates, the positive effect of a higher participation diminishes because the additional potential for 2050 is below that for 2025. The reason for this is that the demographic basis – the working population – will be shrinking more and more.

## *4. Working time potentials*

Labour as an important economic production factor will not necessarily shrink due to the declining labour force participation. By increasing the annual working time it would not be possible to stabilize the number of persons but perhaps it would stabilize the volume of work. This chapter examines to which extent the working time might be expanded to stabilize the volume of work and whether there are possibilities for any enlargement.

[21] Dietz/Walwei (2011).
[22] Ibid.

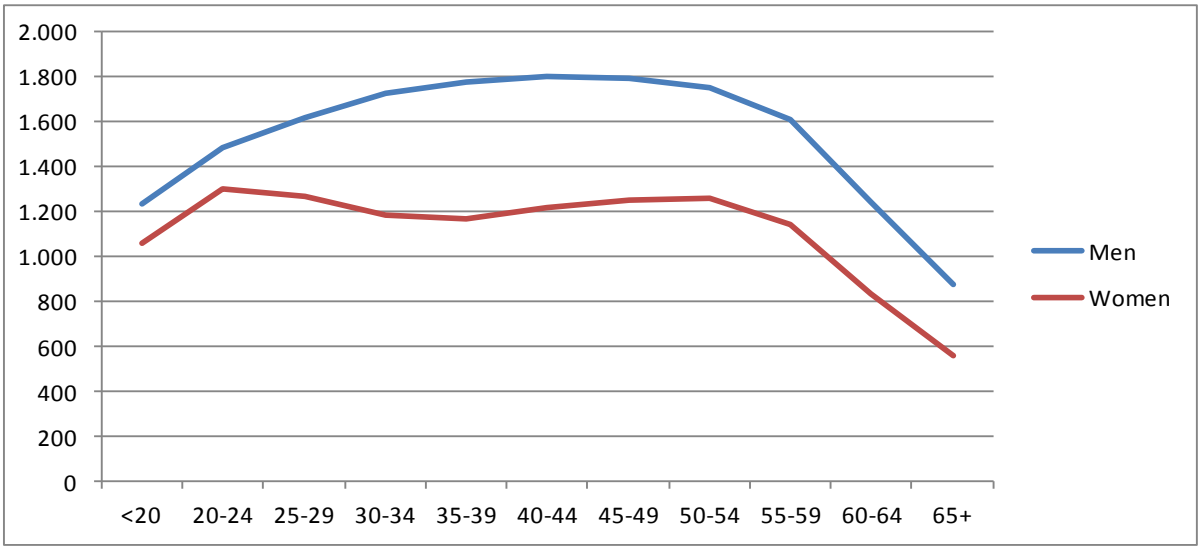
## 4.1. Differences in working time by gender and age groups

The volume of work also referred to as labour volume comprises the hours actually worked by all persons in employment in an economy. In Germany, the measurements are continually compiled for national accounting purposes by the IAB. The IAB working time measurement concept (AZR) forms the basis for the analyses of the development of working hours and their causes.[23] In 2010, hours worked amounted to about 57 billion hours, almost 3 billion hours less than in 1991. The long term decline in labour volume is mainly determined by the strong reduction of employees' average annual working time as a result of the strong growth in part-time work.

Hence, the part-time rate increased from 16.4 % in 1991 up to 34.7 in 2010 (+18.3 percentage points).[24] The rising employment of women has contributed to this development, as women frequently work below collectively agreed full-time standards. That is why the participation in labour volume differs strongly between men and women. Even though almost half of the employees in Germany were women, women participation in labour volume reached only 40 %. In 2010, nearly one in two women worked part-time (this means in regular or marginal employment), compared to one in six men.[25] The average annual working hours of women are only 70 % of those of men because of the higher part-time rate, in particular during the period in which women bring up children.

There are great differences in the length of working time not only between the genders but also among age groups. Men often work part-time when entering the labour market, for example during school or studies or when withdrawing from the labour market, for instance in form of partial retirement[26]. As a result, the working time of men under 25 and over 55 is especially low. Conversely, part-time work plays an important role over the entire working life of women – that is why the differences in women's working hours between age groups are not that distinctive than for men. However, the average working time of women aged 55+ decreases as well, here again partial retirement but also marginal employment has a major impact (see Figure 2).

**Figure 2 Average working hours of employed persons in 2008 by gender and age groups**




***Source: AZR 2008***

[23] Wanger (2013).
[24] See table on the website: http://doku.iab.de/arbeitsmarktdaten/AZ_Komponenten.xlsx.
[25] Wanger (2011).
[26] Since the end of the 1990s, part-time work has increasingly been used by older workers as a means of withdrawal from the labour force (Wanger 2009).

## 4.2. The potential labour volume approach

Besides the labour volume of persons in employment it is also possible to determine a potential labour volume that takes also into account the additional potential hours unemployed or people in hidden labour force would be prepared to work if they could enter the labour market. This labour volume approach is based on the concept of labour force projections of the IAB. To calculate a potential labour volume we use various sources. The basis for the hours worked of persons in employment is the AZR. For the group of unemployed persons and people in hidden labour force we need additional information on their employment preferences. Therefore, we analyzed the 2008 German Socio-Economic Panel Study (SOEP)[27]. On the basis of this survey, we are able to analyze the employment preferences of such persons – that means if they would prefer to work part-time or full-time. A high share of unemployed women and women in the hidden labour market only want to work part-time. Especially in the hidden labour force, there are particularly women who care for children or other dependent persons.[28] Therefore, their availability for the labour market is further limited. Men prefer full-time jobs more often and rarely state that they have time restrictions.

Although the employment preferences of unemployed persons and people in hidden labour force are known there is no number of preferred hours specified in the questionnaire. We assume these correspond with the hours worked of actually employed persons and therefore take the results from the AZR differentiated by full- and part-time, gender and age groups.

After weighting with the number of people in the labour force we obtain an estimated number of 1,428 hours per person and year belonging to labour force. This is close to the average number of hours worked per employee in 2008 (1,422 hours). By multiplying the annual hours worked with the amount of labour force we obtain a potential labour volume of 64.6 billion hours for 2008. Of this amount, 57.4 billion hours relate to the labour volume of all persons in employment and 7.2 billion hours to unemployed people and persons in the hidden labour force. In other words: the labour volume would be higher by about 13 % if also unemployed and persons in the hidden labour force were in work. The major portion (8 percentage points) of it accounts for unemployed persons.

## 4.3. Different scenarios for working time

In the following, the scenarios of labour force (measured in persons) and the estimations for hours worked, based on AZR and GSOEP, are combined. If it would be possible to stabilize the "potential labour volume" (labour force x hours worked, measured in hours) by the expansion of working time, the economic consequences of a decline in labour supply could be mitigated.

The most realistic scenario for labour force projections in the long run is scenario 3 (see Figure 1) with increasing activity rates and a positive net immigration of 100,000 persons annually. We choose this reference scenario with our base scenario of potential labour volume as the underlying scenario. Regarding the working time of labour force, we start from the current age- and gender-specific structures. These present working time structures are extrapolated until 2050. Under these assumptions, the potential labour volume would decrease from currently 65 billion hours to 46 billion hours by 2050. This corresponds to a share of 72 % of today's potential labour volume (see Table 3).

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[27] The German Socio-Economic Panel Study (SOEP) is a wide-ranging representative longitudinal study of private households, located at the German Institute for Economic Research, DIW Berlin. Every year, there are nearly 11.000 households and more than 20.000 persons sampled by the fieldwork organisation TNS Infratest Sozialforschung. The data provide information on all household members, consisting of Germans living in the old and new German States, foreigners, and recent immigrants to Germany. The panel was started in 1984.

[28] Böhm/Drasch/Götz/Pausch (2011).

It is, however, unlikely that there will be no changes in working time. In addition to individual preferences and the company's particular requirements, also collective agreements, labour market policies and institutional frameworks have an impact. To quantify the effects of a longer annual working time on the potential labour volume, we exemplarily calculate three scenarios which have different underlying assumptions concerning the development of working hours and labour force.

The first scenario "working time preferences" considers present preferences of part-time workers with regards to longer working hours. In the GSOEP study, employed persons are also questioned on how many hours they would want to work if they could choose their own working hours (taking into account that their income would change according to the number of hours). The analyses based on GSOEP show that two thirds of the employed men and half of the employed women would like to extend their working time. On average, part-time men would increase their working time to 30 hours and women to 25 hours per week. If it were possible to realize these desires for longer working hours, the working time of all part-time-workers would amount to 26 hours on average (before: 20 hours). Since there are no data available on the number of hours concerning the working time preferences of unemployed and persons in the hidden labour force, we made the same assumptions regarding the preferred hours for persons with part-time preferences in this group. Although working hour preferences vary slightly over time, due to changes in the individual situation, tariff changes or the economic situation, the results of the time series of the number of hours by which persons want to increase their working time were in particular very robust.

**Table 3: Potential volume of work under different scenarios for working time, in % of base year 2008**

| | **Labour force** | **Different scenarios for potential labour volume (labour force x working hours)** | | | |
|---|---|---|---|---|---|
| | ***Reference scenario*** (compare Table 2) | ***Base scenario*** (constant working time, reference scenario for labour force) | ***"Working time preferences" scenario*** (realisation of working time preferences of part-time workers) | ***"Reconciliation" scenario*** (same activity rates and working hours of women and men) | ***"Working life" scenario*** (increasing activity rates and working hours of older workers)* |
| 2025 | 92 % | 91 % | 95 % | 111 % | 104 % |
| 2050 | 73 % | 72 % | 76 % | 87 % | 81 % |

***Note:** "Working life" scenario: Activity rates of persons aged 60 to 64 correspond to those of persons aged 50 to 54 and activity rates of persons aged 65 to 69 correspond to those of persons aged 55 to 59, this means a shift of ten annual steps, the working hours are shifted in five annual steps.

***Source: Own calculations***

The underlying assumptions for the second scenario "reconciliation" are same activity rates of men and women (see scenario 2 in Table 2) and moreover an increase in women's working time to the level of that of men. As actually the annual working hours of women average only 70 % of those of men, this scenario holds great potential. This scenario corresponds to a strong reduction of women's part-time rate. Additionally, the working time of women in full-time jobs will be longer, in part-time jobs shorter (same structure as men).

The third scenario "working life" refers to scenario 3 (see Table 2) of labour force and further increases the working time of the elderly, however "just" postponed in five annual steps (that means working time of 60-to-64-year-olds equals that of 55-to-59-year-olds; working time of 65+ persons equals that of 60-to-64-year-olds). Currently, the working time of the elderly is still determined by the high proportion of non-active employees in partial retirement (release period), with a working time of zero hours but still counting as employees (see Figure 2). Though the possibilities for

utilisation of partial retirement were greatly reduced in the previous year, it is expected that the hours worked in the relevant age groups (55 to 64 years) will increase over the next few years.[29]

When applying the "working time preferences" scenario (= realisation of extending preferences regarding the working time of part-time workers), the volume of work in 2050 would be four percentage points higher than in the base scenario. This equals about 2.4 billion hours and a labour volume of 48.7 billion hours (see Table 3). Thereby, it must be considered that different qualifications can lead to a mismatch between supply and demand. Educational policies, e.g. continuing professional training could help at an early stage to counteract this problem. This is especially important against the background that part-time workers show lower participation in continuing education than full-time workers.

This also applies to the second scenario “reconciliation”. If it were possible to fully tap the potential of women, this would represent an increase in volume of work in comparison to the base scenario by 15 percentage points in the long run. In 2050, the potential labour volume would amount to about 87 % of the current level (see Table 3). Measures helping women to re-enter the labour market after children have grown up are another central starting point for tapping the potential of female participation at least partly as already mentioned in Chapter 3. This also includes improvements in combining work and family, especially expanding adequate childcare facilities as well as support when caring for relatives. Furthermore, the traditional division of labour in families must change. As a consequence, men could reduce their working time.[30] This would diminish the actual effect of this scenario.

The simulation of a longer working life and higher working hours for the age group 65+ would lead to a potential labour volume which is higher by 9 percentage points as compared to the base scenario. In the meantime, the potential labour volume will be considerably above the current value (see Table 3). This implies changes in several areas, e.g. health-promoting measures. Therefore, this scenario appears to be realistic only in the very long run.

Besides the different scenarios for potential labour volume, Table 3 additionally shows the reference scenario for the development of the labour force. As can be seen, the development of the labour force and the volume of work on a percentage basis are not entirely identical. According to this, the future adjustments of labour force are not neutral concerning working time. In the base scenario, the share of women and elderly increases strongly – both groups have low working hours. This structural shifts within the labour force lead to a lower base scenario for the potential labour volume, even though both base scenarios start from the same assumptions concerning the number of “heads”. The development, the scenarios forecasting the labour force and the volume of work are limited according to all variants until 2025. The level, estimated for 2050, apparently shows how much the demographic component gains strength after the withdrawal of the baby boom generation from working life after 2025.

In the medium term, there are some feasible possibilities to counteract the demographic-caused decline in labour supply by rising working hours of part-time workers and increasing activity rates of women and elderly people at least when combined. But the labour volume potential forecast shows that in the long term an increase in working hours cannot fully compensate for the decline in labour supply.

## 5. Conclusions

The activity rates of women and older workers increase drastically in the presented scenarios. Nevertheless, the decline in Germany's working age population – caused by the demographic change – can only be partly offset. Also an enormous expansion of annual working

[29] Wanger (2009).
[30] Wanger (2011).

hours will reverse this trend just for a certain time. Germany has to face a significantly smaller labour force particularly in the long term.

No doubt, the presented scenarios map extreme situations. It is not likely that the activity rates of women will fully align within the next 10 to 20 years. Also the "pension with 70" scheme is likely to be considered for the long run.

On the other hand, the measures are combinable. If these politically and socially discussed improvements for higher activity rates and working hours go hand in hand, it would be reasonable to expect a win-win situation: in combination, higher activity rates and longer working hours would not have to rise as much as forecasted to weaken the demographic trend clearly. And at least one would buy time to implement the necessary social and economic adjustments. In addition, it should be mentioned that many of the measures would have desired and intended consequences: recognition of older people in society, gender equality, social integration of migrants and others. The social costs of adjustments may keep within limits.

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# The power of elderly consumers – How demographic change affects the economy through private household demand in Germany

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***Abstract*:** The needs and desires of young and old people differ due to their living environment and habits. Hence their respective consumer behaviour and expenses are different as well. An ageing population is faced with a changing consumption structure compared to a population with stable age distribution. The objective of this paper is to quantify the impact of age specific consumer behaviour and demographic change on production and GDP components. It shows that the overall consumption expenses are lower. Next to that service sectors, especially household related health services, gain importance relative to industries providing consumer durables (e.g. furniture, consumer electronics). The changing consumption structure affects the whole economy but the direct effects on consumption expenditures are higher than the secondary effects on production and GDP components.

***Keywords:*** Private consumption, age coefficients, demographic change, impact analysis

***JEL classification:*** C51, C53, E21

## 1. Introduction

*"Old men in the bad old days used to renounce, retire, take to religion, spend their time reading, thinking – thinking!" (Alduous Huxley)*

The reduced or changing propensity to consume when growing old was prohibited in Aldous Huxley's "Brave new world" by preserving " [the] powers and tastes [at sixty] what they were at seventeen" (Huxley, 2008, p. 68). This was accomplished by indoctrination and conditioning all people on consumption, sex and the drug Soma. As we are not living in that kind of utopic society most industrial economies are faced with an ageing population and its changing needs and desires.

Demographic change challenges the economy in many ways. The impact on pension systems, health care, labour force etc. has already been widely analysed. An ageing population directly increases the number of retired persons, the need for nursing places and the contribution rates for social security systems for example. It also indirectly influences the production structure by shifts in the composition of final demand through changes in consumer behaviour.

The objective of this paper is to quantify the impact of age specific consumer behaviour and demographic change on production, employment and GDP components. Consumption functions for consumption purposes on COICOP-2-level depending on the age structure of the German population are implemented in the macro-econometric input-output model INFORGE (INterindustry FORecasting Germany) developed by GWS. The model structure gives the opportunity to trace impact and linkages of changes in the structure of private household demand on production and other parts of the economy.

Two different scenarios are calculated and compared in order to quantify the impact of age induced changes in demand. The first scenario bases on the future population composition given by the population projection of the Federal Statistical Office. The results will be used as baseline. In the

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second scenario it is assumed that the population composition does not change, i.e. the shares of the single age groups stay the same over the projection period.

Due to demographic change shares of older age groups increase giving the specific consumption structure of elderly more weight. The result is a lower GDP compared to an economy with a stable population composition. Other characteristics are a demand shift from durable goods to services. Generally the direct effects on consumption expenses are considerably higher than the indirect effects on production. Production sectors are much more dependent on foreign demand showing hence higher reactions to changes in exports.

The paper is structured as follows. The next section starts with a short description about the calculation of consumption coefficients for age dependant consumer expenditures. The general structure of the model is then introduced and the scenario assumptions are given. Section 3 gives the scenario results. Section 4 concludes.

## 2. *Measuring the impact of elderly consumers – The methodology*

### 2.1. Coefficients for age dependant consumption expenditures

The estimation of consumption functions that take into account age specific behaviour are the main component for the simulation. The estimation procedure bases on the concept and method described in Fair and Dominguez (1991) and Erlandsen and Nymoen (2008).[2] The methodology is refined and adapted as follows. The coefficients resulting from the regressions base on quarterly data and have to be implemented into a model with annual data[3]. The implementation of generalised least squares including AR processes in order to overcome the problem of autocorrelation has to be discarded as lags during the year cannot be considered in the model with annual data. Hence, the former estimations are re-estimated and evaluated with bootstrapping.[4] The standard errors are not much disturbed and the t-values, i.e. the significance of the coefficients, stay almost the same. The OLS estimators remain – despite the autocorrelation in the disturbances – unbiased. The inefficiency can be assumed to be minor referring to the bootstrapping results. The bootstrapped regressions functions are carried out with annual data as well. The resulting annual coefficients prove to be very similar to the quarterly coefficients. Nevertheless, the quarterly coefficients are preferred over the yearly coefficients as the quality of the regressions with annual data is worse due to the short observation period (1991-2011).

Another discrepancy between consumption coefficients and model is the level of detail regarding consumption purposes (COICOP, Classification of individual consumption by purpose). The consumption functions basing on quarterly data encompass information on a 1-digit-level whereas the economic model uses information on a 2-digit-level. Summarising, the following steps are taken:

1) The main data source is the system of national accounts (SNA).
2) The age specific consumption shares on total consumptions are estimated on a 1-digit-level by ordinary least squares using quarterly SNA data. The estimation functions are of the general form $c_{it} = \alpha_0 + \beta_1 nicc_t + \beta_2 wicc_t + \beta_3 uer_t + \beta_4 (p_{it}/p_{jt}) + \delta_1 Z_{1t} + \delta_2 Z_{2t} + \varepsilon_t$ varying according to the significance of the parameters and the relative price elasticities. [5]

[2] A more profound description is part of the doctoral thesis that will be published in 2014.

[3] The model description follows in the next section.

[4] For a description of the bootstrapping method see e.g. Chernick (1999) or Davison and Hinkley (1997).

[5] $c_{it}$: consumption share i on total consumption$C_t$, $nicc_t$: non-wealth income, $wicc_t$: wealth income, $nicc_t + wicc_t =$ disposable income, $uer_t$: unemployment rate, $(p_{it}/p_{jt})$: cross price elasticity between good i and j, with $i \neq j$, $Z_{1t} = \sum_{k=1}^{8}(k * pop_{kt}) - 1/8 \sum_{k=1}^{8} k \sum_{k=1}^{8} pop_{kt}$, $Z_{2t} = \sum_{k=1}^{8}(k^2 * pop_{kt}) - 1/8 \sum_{k=1}^{8} k^2 \sum_{k=1}^{8} pop_{kt}$,

The values are in logarithms, real terms and per capita.[6] $Z_{1t}$ and $Z_{2t}$ indicate the age effects on the consumption shares. It is an indirect estimation of $\sum_{k=1}^{8} \gamma_k \, pop_{kt}$ subject to the restrictions $\sum_{k=1}^{8} \gamma_k = 0$ and $\gamma_k = \delta_0 + \delta_0 k + \delta_2 k^2$.[7]

3) For the age specific shares on 2-digit-level the Household Budget Survey (HBS) was used as additional data source. The HBS gives information on the average monthly household expenditures by age groups for the year 2008.[8] It is assumed that the single age groups keep their age group specific distribution of 2-digit-consumption purposes on the superior consumption purpose. Adding up the respective budget shares weighed by the age group shares gives the age dependant share of the 2-digit on the 1-digit consumption purpose: $c_n/C_N = \sum_{k=1}^{8} (c_{nk}/C_N * pop_k)$.[9]
4) Thus, the 2-digit-consumption shares are influenced in two ways: directly by a shift in the age group weights and indirectly by changes in the estimated age dependant consumption shares on the 1-digit-level.

The resulting age dependant consumption shares on 2-digit-level were integrated into the economic model INFORGE (INterindustry FORecasting Germany) developed by GWS. The model structure gives the opportunity to trace impact and linkages of changes in the structure of private household demand on production and other parts of the economy. The effect of ageing consumers and their specific behaviour on the economy can be simulated. The model is shortly described in the following section.

## 2.2. Model environment

INFORGE is a macro-econometric input-output model designed by GWS. The model has been used for economic forecasts and simulation or scenario analysis in many projects and studies. Amongst other features its structure follows the ideas of bottom up and full integration (Almon 1991). It bases on the system of national accounts and balancing items (SNAB) and incorporates interindustry relations on a high level of detail. Demand as well as the supply side is equally considered taking the interacting relationship between production sectors and private household demand as well as price effects into account. Irrationality and imperfect markets are allowed. It is annually updated and often combined with modules for specific projections and simulations (e.g. Maier et al. 2012, Ulrich et al. 2012, Drosdowski et al. 2010). The model projects until the year 2030. The complete structure and methodology of the model is for example described in Ahlert et al. (2009) or as version for Austria in Stocker et al. (2011).

Overall, the model structure provides a good possibility to trace the effects of changing private demand on all parts of the economy. The impact on macroeconomic quantities as well as single industrial activities can be equally quantified.

## 2.3. Scenario Assumptions

In order to show the impact of ageing consumers and their specific consumer behaviour on the economy a benchmark has to be set. Thus, two different settings are calculated with the economic model and compared with each other: a baseline and a scenario.

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[6] Per capita refers to the population aged 18 or older. Children are indirectly included in the consumption assuming that "they are part of their parents' consumption" (Samuelson 1958, p.468).

[7] $pop_{kt}$ is the share of age group k on total population, with $\sum_{k=1}^{8} pop_{kt} = 1$.

[8] 2008 is the latest edition. The HBS is updated every five years, i.e. the Federal Statistical Office conduct at the moment the survey for 2013. The results will be published most probably in 2015.

[9] $c_n$: consumption expenditures by purpose n on 2-digit-level, $C_N$: consumption expenditures by purpose N on 1-digit-level with $\sum c_n = C_N$, $c_{nk}$: consumption expenditures by purpose n by age group k.

The baseline shows the economic development under the on-going demographic change. The ageing process develops according to the 12th coordinated population projection (Statistisches Bundesamt 2012) published by the Federal Statistical Office. The variant V1W2 is chosen which assumes a total fertility rate of 1.4 children per woman, a life expectancy of new-born babies in 2060 of 85 years for males and 89.2 years for females and a migration balance of 200,000 people per year from 2020 on.[10]

In the scenario the shares of the single age groups stay the same over the projection period. The total population will reduce according to the baseline in order to exclude any effects of quantity.

The simulation solely focuses on changes in consumption expenditures due to a changing population composition. The aim is to show the effects on production, employment and the whole economy resulting only from different consumer behaviour. As the effects would be minor compared to income effects, changes in the saving behaviour are not considered.

## 3. Scenario Results

The projection including an ageing population (BAU) is compared to the projection considering a constant population composition (SIM). The results are given in current prices. Table 4 shows the percentage deviation between the projections for the variables Gross Domestic Product (GDP), its components, production and employment for 2012, 2018, 2024 and 2030. The absolute deviations are displayed in Figure 5. In general, the percentage deviation of all variables is relatively small in the first year of the simulation (2012) and increases when the differences in the population composition become more apparent. With an ageing population GDP is 1.2% lower in 2030 than with an unchanging population composition which corresponds to nearly 43 bn Euros. This is mainly due to the fact that private households consume 3.8% or 71 bn Euros less with an older population. Other sectors showing high deviations in 2030 are gross fixed capital formation (GFCF) in machinery and equipment as well as imports being 2.9% and 2.2% lower than with a constant population composition. In absolute terms this means a reduction of 9.6 bn Euros for GFCF in machinery and equipment and 53 bn Euros for imports. Imports are negatively affected in two ways: firstly consumer goods are characterised by a high amount of imports, so that the overall reduction in consumption expenditures reduces the need for imports. Secondly there can be identified a shift towards services that are less import intensive (see below). The government sector reduces its expenditures by 1.5% or nearly 11 bn Euros. The deviation for production and GFCF in construction lies quite low with 1.0 and 1.1%. Nevertheless accounts the difference of production for 72 bn Euros. Almost no changes can be recognised for exports.

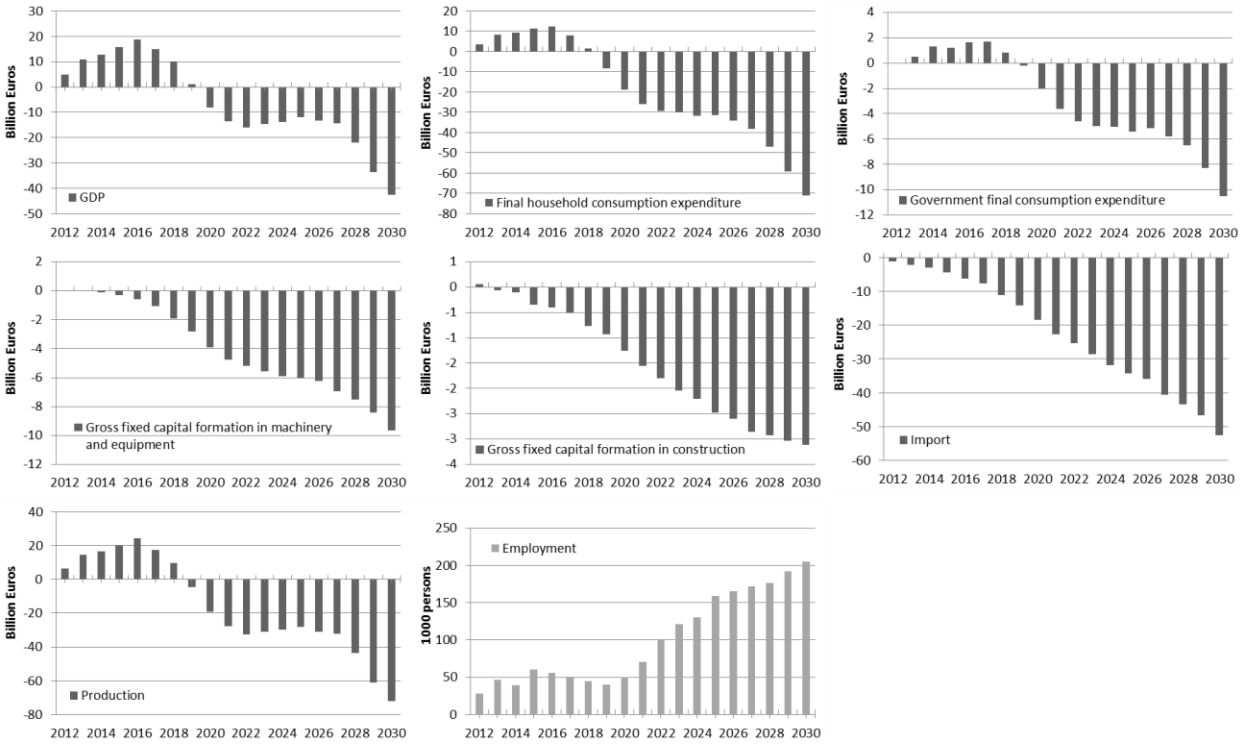
**Table 4 – Percentage deviation for economic sectors, production and employment**

| | %-deviation baseline from scenario | | | |
|---|---|---|---|---|
| | 2012 | 2018 | 2024 | 2030 |
| GDP | 0.2 | 0.3 | -0.4 | -1.2 |
| Final household consumption expenditure | 0.2 | 0.1 | -1.8 | -3.8 |
| Government final consumption expenditure | 0.0 | 0.1 | -0.8 | -1.5 |
| Gross fixed capital formation in machinery and equipment | 0.0 | -0.8 | -2.1 | -2.9 |
| Gross fixed capital formation in construction | 0.0 | -0.3 | -0.8 | -1.1 |
| Export | 0.0 | 0.0 | 0.0 | 0.0 |
| Import | -0.1 | -0.7 | -1.6 | -2.2 |
| Production | 0.1 | 0.2 | -0.5 | -1.0 |
| Employment | 0.1 | 0.1 | 0.4 | 0.6 |

**Source: own calculation**

[10] The assumption regarding the migration balance means that the migration surplus is increasing until it reaches 200,000 people in 2020. After that it stays at that level.

**Figure 5 – Absolute deviation for economic sectors, production and employment**




**Source: own calculation**

When going into more detail the highest negative impulses for private demand are caused by the consumption purposes communication (aggregate of the first three negative entrees in

Table 5), furniture etc. as well as tools and equipment for house and garden. In 2030 they are less consumed by about 56%, 21% and 20% due to the higher number of older consumers. This corresponds to absolute terms that start very low with 0.9 bn., 0.2 bn. and 0.04 bn. Euro in 2012 and reach 30.5 bn., 8.4 bn. and 1.7 bn. Euros in 2030 (see Figure 6). The first (communication) indicate a reluctance to adapt to the fast technological change in information and communication technologies. The other two can be motivated with an increasing degree of equipment the longer the household exists. Hence, older households have low needs for new furnishings etc.

**Table 5 – Highest and lowest percentage deviation in 2030 for consumption expenditures**

| | %-deviation baseline from scenario | | | |
|---|---|---|---|---|
| | 2012 | 2018 | 2024 | 2030 |
| Out-patient services | 3.1 | 20.5 | 43.6 | 67.6 |
| Hospital services | 3.1 | 20.5 | 43.6 | 67.6 |
| Medical products, appliances and equipment | 3.2 | 19.9 | 41.5 | 64.2 |
| Accommodation services | 2.1 | 15.8 | 23.0 | 26.2 |
| Maintenance and repair of the dwelling | 2.1 | 10.8 | 13.3 | 11.0 |
| Telephone and telefax equipment | -2.3 | -23.2 | -43.7 | -57.1 |
| Postal services | -2.3 | -22.9 | -43.1 | -56.4 |
| Telephone and telefax services | -2.3 | -22.9 | -43.1 | -56.4 |
| Furniture and furnishings, carpets and other floor | -0.4 | -6.6 | -14.5 | -21.2 |
| Tools and equipment for house and garden | -0.5 | -6.7 | -14.4 | -19.8 |

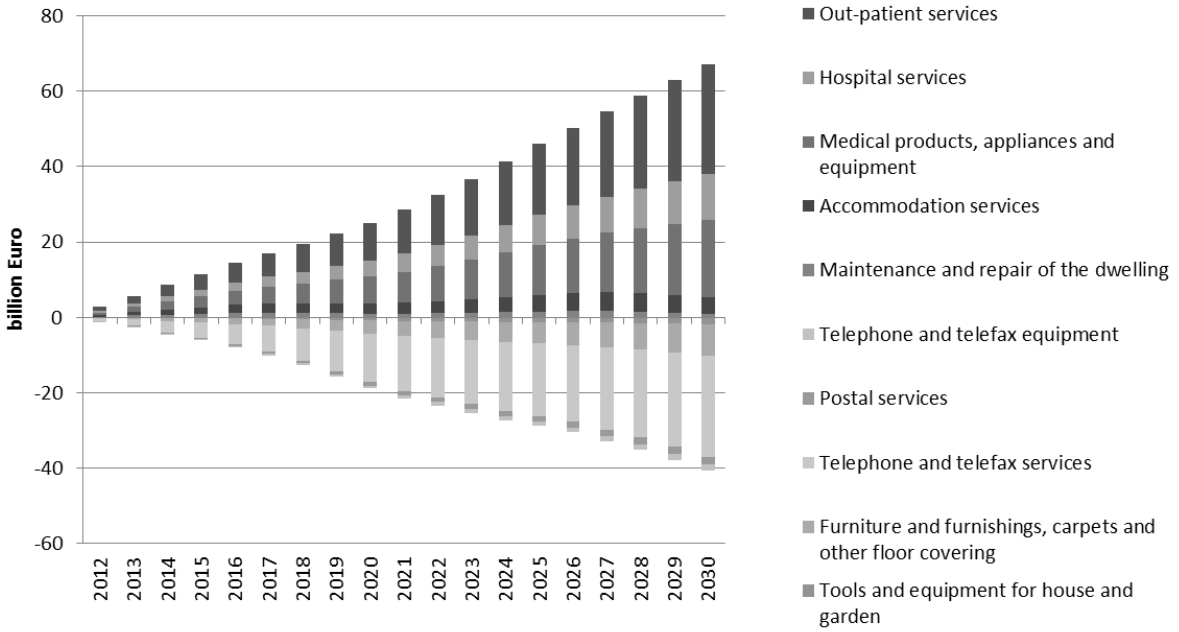
**Source: own calculation**

Contrary to that, especially goods and services related to health (out-patient and hospital services, medical products, appliances and equipment) are consumed more in an ageing population. The expenses are 66% or 62 bn. Euros higher in 2030 compared to a stable population composition. With increasing age the probability of physical handicaps or diseases increases. Other consumption purposes that are very much positively affected by older consumers are accommodation services and maintenance and repair of the dwelling. With the retirement there is much more leisure time that can be spend at home or for excursions, leave and eating out. In 2030 26% (4.4 bn. Euros) and 11% (1.0 bn. Euro) more is spent for these consumption purposes. The complete deviation process is given in

Table 5 and Figure 6.

**Figure 6 – Absolute deviation in billion Euros for the consumption purposes of**

**Table 5**




**Source: own calculation**

The age induced changes in private household demand transfer to production affecting some sectors positively and others negatively. Economic activities that profit most from an ageing population are those that are more or less directly related to the positively affected consumption purposes: human health activities, the manufacture of basic pharmaceutical products and pharmaceutical preparations as well as accommodation and food service activities. In 2030, their output is by 15%, 6% and 4% higher compared to a situation with a constant population composition (see Table 6). This corresponds to 37.8 bn., 3.2 bn. and 3.8 bn. Euros.

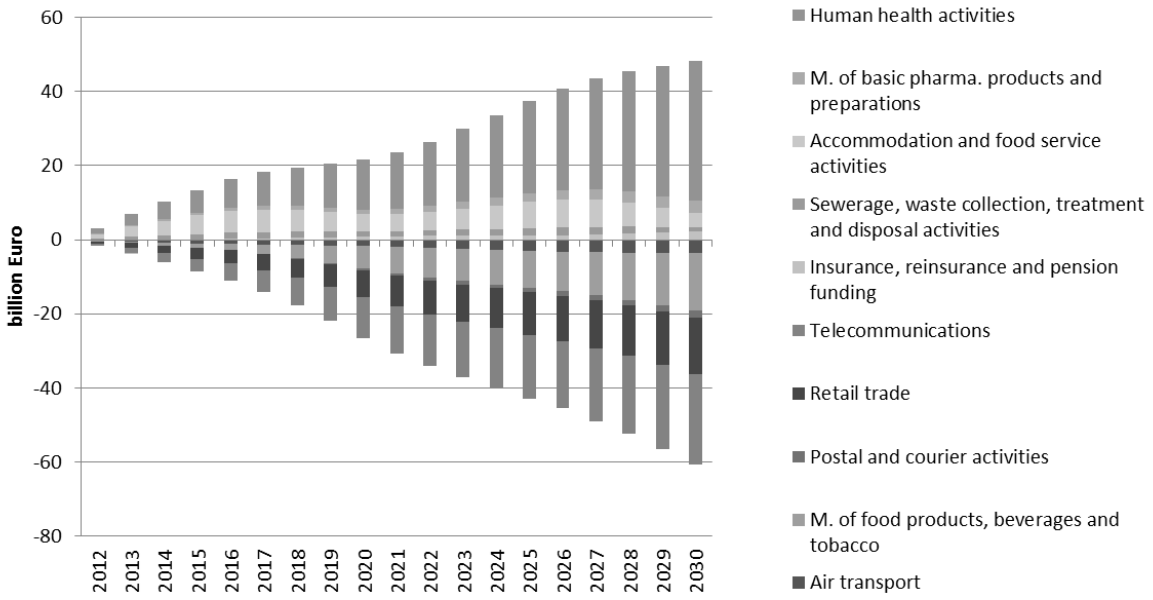
**Table 6 – Highest and lowest percentage deviation in 2030 for production**

| | %-deviation baseline from scenario | | | |
|---|---|---|---|---|
| | 2012 | 2018 | 2024 | 2030 |
| Human health activities | 0.8 | 5.0 | 9.7 | 14.8 |
| M. of basic pharma. products and preparations | 0.6 | 2.4 | 4.3 | 6.0 |
| Accommodation and food service activities | 1.4 | 6.6 | 7.0 | 4.3 |
| Sewerage, waste collection, treatment and disposal activities | 0.9 | 4.1 | 4.1 | 2.9 |
| Insurance, reinsurance and pension funding | 0.1 | 0.6 | 1.3 | 2.2 |
| Telecommunications | -0.9 | -9.6 | -19.1 | -25.7 |
| Retail trade | -0.3 | -3.1 | -5.9 | -7.4 |
| Postal and courier activities | 0.0 | -1.0 | -4.3 | -7.1 |
| M. of food products, beverages and tobacco | -0.1 | -1.9 | -4.6 | -6.9 |
| Air transport | -0.8 | -3.7 | -5.4 | -5.9 |

**Source: own calculation**

The opposite is true for telecommunications, retail trade and postal and courier activities. These economic activities would produce 26%, 7% and 7% or 24.4 bn., 15.1 bn. and 1.9 bn. Euros more if the population composition did not change. Additional results for the highest/lowest deviations and the development from 2012 to 2030 are given in Table 6 and Figure 7.

**Figure 7 – Absolute deviation in billion Euros for the economic activities of Table 6**




**Source: own calculation**

The changes in the production also call for different employment structures. Economic activities with positive deviations tend to have a higher labour demand whereas lower output implies usually less labour input. Thus, considerably more people are employed in human health activities when demographic change is under way. The number of employed persons is 13% higher in 2030. Put differently, 10.1 thousand persons are extra employed in the health sector in 2012 and the difference increase up to 305.0 thousand persons in 2030. Other positive differences can be noted for water collection, treatment and supply as well as insurance, reinsurance and pension funding.

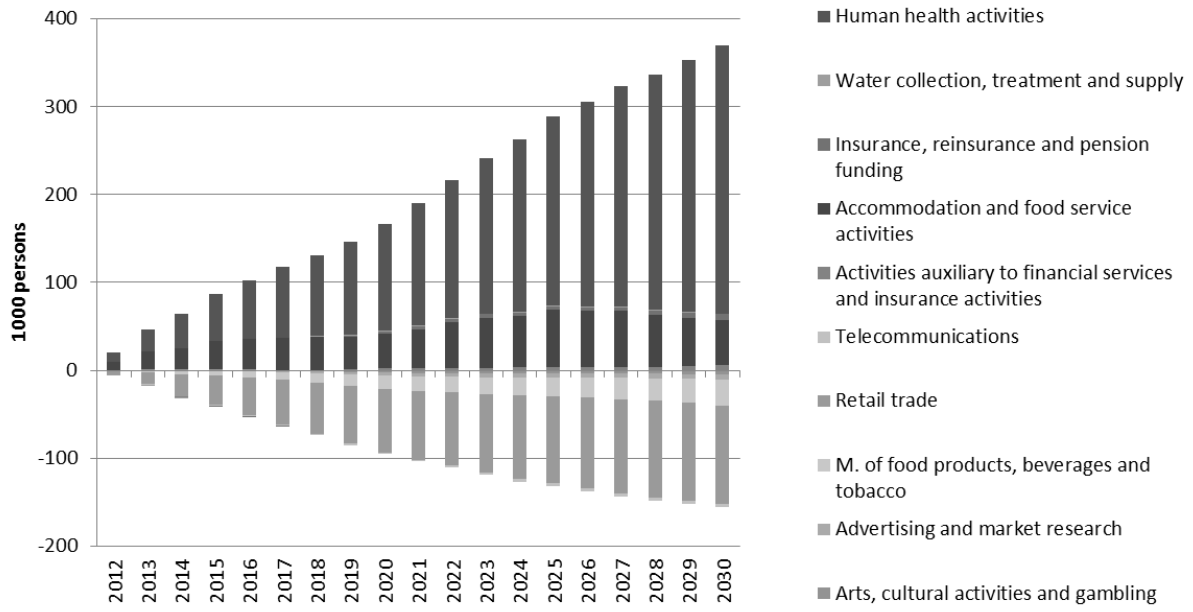
**Table 7 – Highest and lowest percentage deviation in 2030 for employment**

| | %-deviation baseline from scenario | | | |
|---|---|---|---|---|
| | 2012 | 2018 | 2024 | 2030 |
| Human health activities | 0.5 | 4.1 | 8.6 | 13.3 |
| Water collection, treatment and supply | -0.9 | 2.1 | 3.0 | 5.2 |
| Insurance, reinsurance and pension funding | 0.1 | 0.3 | 2.7 | 5.0 |
| Accommodation and food service activities | 0.7 | 2.4 | 3.9 | 3.5 |
| Activities auxiliary to financial services and insurance activities | 0.1 | 0.3 | 1.6 | 2.9 |
| Telecommunications | -0.1 | -1.4 | -2.8 | -4.1 |
| Retail trade | -0.2 | -2.0 | -3.4 | -4.1 |
| M. of food products, beverages and tobacco | -0.1 | -1.2 | -2.4 | -3.5 |
| Advertising and market research | 0.0 | -1.0 | -1.8 | -2.0 |
| Arts, cultural activities and gambling | 0.2 | -0.3 | -1.3 | -1.8 |

**Source: own calculation**

Around 5% or 1.1 thousand and 7.0 thousand persons are additionally employed due to the ageing induced consumption expenses. Economic activities that employ considerably less workers are telecommunications, retail trade and the manufacturing of food products, beverages and tobacco. Their number of employees is reduced by about 4% in 2030. This corresponds to a decline of 3.4 thousand, 112.0 thousand and 29.6 thousand persons. More details are given in Table 7 and Figure 8.

**Figure 8 – Absolute deviation in 1000 employed persons for the economic activities of Table 7**




**Source: own calculation**

## 4. Conclusion

An ageing population consumes differently compared to a population with stable age distribution. The overall consumption expenses are lower. Concerning the kind of goods and services consumed the expenditures shift from durables like furniture to services especially connected to health. Overall, the changing consumption structure affects the whole economy. However, the direct

effects on consumption are much higher than the secondary effects on production and the other components of GDP.

It has to be noted that the paper solely concentrated on the domestic point of view, i.e. sectors that produce mainly for export are barely affected from changes in private household demand. But Germany is not the only country with an ageing population. Important trade partners also are in different stages of demographic change and will experience changes in the consumer behaviour. Similar to Germany their imports will alter as well, giving a feedback to the German export-oriented industries. Taking the global development into account could possibly produce much higher changes for the production sectors and the GDP.

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# Analyzing the Income Distribution of the Households' in Slovakia (An Empirical Evidence)[1]

*Tomáš DOMONKOS[2], Miroslava JÁNOŠOVÁ[3], Filip OSTRIHOŇ[4]*

***Abstract*:** Fighting against poverty is currently an often discussed issue on EU level. According to the EU 2020 strategy the member states decided to decrease the number of people at or in risk of poverty and social inclusion by 20 million by 2020. The income distribution is often analyzed along with other poverty and inequality indicators. The aim of the presented paper is analyzing and determining the distribution of income over time in Slovakia. Subsequently, we identify several probability distribution families and their parameters which fit the income distribution data and may be used for forecasting of the future development.

***Keywords:*** Income distribution, Income inequality, Inclusive growth, Distribution fitting.

***JEL classification:*** C16, I32, J31

## 1. Introduction

Poverty is currently one of the intensively discussed issues all around the world. On European level its importance is highlighted in the EU 2020 strategy which is one of the key documents defining the targets the community has to achieve (European Commission, 2010). This research aims to analyze the distribution of income in Slovakia over the time period from 2004 to 2009. Later we identify several distribution families and their parameters which might fit the real income distribution in Slovakia.

There is a long tradition in modeling income distribution of society as a random variable. According to Kakwani (1980) throughout the history of examination of income distribution process there were three main schools of thought which dealt with the subject. First the statistical school (which dwelled on stochastic models), secondly socio – economic school (which explained distribution process by institutional factors) and third the supply and demand school (which utilized the market models to determinate the distribution of income).

Kakwani (1980) also suggests multiple probability density functions as suitable candidates for modeling the income distribution. The first mentioned is the Normal distribution, as one of the oldest distributions devised by the theory of probability. It has certainly been successfully used for modeling various phenomena, which satisfy the probability behavior of large numbers. For income distribution this is rejected due to the fact that Normal distribution is symmetric and bell shaped, while the observed distribution of income is positively skewed with a long tail. Therefore the Normal distribution is deemed as unsuitable for describing the frequency distribution or generation of income.

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Income distribution was therefore modeled by other common distributions such as Lognormal distribution defined as a distribution of a variable, whose logarithm is normally distributed. The distribution is positively skewed and property of normality is useful during the estimation procedure. It is important to mention that for the practical modeling of income data some modifications had to be introduced. The main shortage is that the practical use showed poor fit towards the tails. The model tends to overcorrect skewness and logarithmic transformation can be used only for positive values (Kakwani, 1980).

Other well-known distribution which was used for describing the income distribution is the Gamma distribution. The empirical use for the purpose of income distribution fitting shows that Gamma distributions provides better fit than the Lognormal distribution. On the other hand it tends to exaggerate the skewness of the date, even more than the lognormal distribution (Kakwani, 1980).

Additionally, there were probability distributions, which were formulated specifically for the purpose of modeling the income distribution as a random variable. One of the first such probability distributions was developed by scholar Pareto in 1897 (Kakwani, 1980), based on inductive reasoning. The density function of Pareto distribution is monotonously decreasing for all values of income, greater than initial income, with elasticity parameter. Pareto presumed that his distribution is able to describe the income distribution of every country of the world. Unfortunately it has been later proved that the so called Pareto law is only valid for less than a half of real income distribution. Therefore the law was subsequently relaxed by Champernowne, to envelope greater part of the distribution. Additionally Mandelbrote developed the weak Pareto law, which converges to Pareto law as the sample of distribution rises and Levy constructed family of stable laws which satisfy the weak Pareto law, later defined by Mandelbrot as Pareto – Levy law (Kakwani, 1980).

Due to the finding of weak Pareto law property, it is possible to verify whether certain probability distribution satisfies this property. Unfortunately none of the previously described theoretical distributions satisfies the weak Pareto law, except the Pareto distributions which also satisfies the strong Pareto law property. Therefore several probability distributions were developed for the purpose of fitting the income distribution and simultaneously satisfying aforementioned property. For instance the Burr distribution, Pareto distribution of second kind and the whole family of Champernowne's distributions all satisfy the weak Pareto law property. Subsequently a limit case of Champernowne's distribution was derived by Fisk, which can be also viewed as additional distribution satisfying the same property (Kakwani, 1980).

## 2. Income distribution analysis

The key task our research has to face is the identification of the distribution families and their parameters, which fit the collected household income distribution data. Along the visual test of the histogram of income data we followed a four-step approach presented by Banks et al. (2005). We also used EasyFit, a software tool for automated identification of distribution families and parameters, which we subsequently used for plotting the density functions and computing the goodness of fit tests' criteria. The aforementioned four steps recommended by Banks et al. (2005) are as follows:

1. Data gathering and preparation
2. Identification of a distribution family by using visual test of the histogram which likely describes the input data
3. Selecting the parameters of the distribution family
4. Evaluation of the fit of the distribution by using one or more goodness of fit tests[5].

The four step approach is an iterative procedure, i.e. if the selected distribution fails the goodness of fit tests, then the identification continues with the second step. This is repeated until an

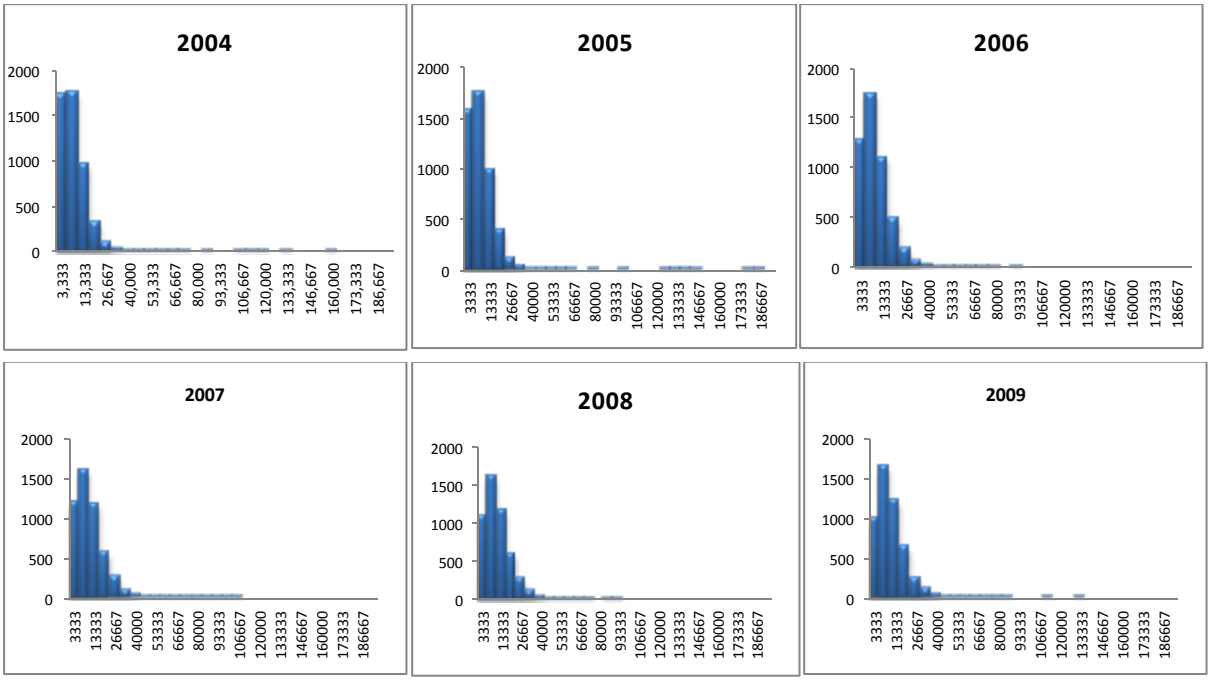
[5] Goodness of fit tests are e.g. Kolomogorov - Smirnov test, Chi-Square test or Andesron - Darling test.

appropriate fit is achieved. According to Banks et al. (2005) it is recommended that the final decision about the best distribution is not relying only on the results the goodness of fit tests. Also graphical methods and expert knowledge should be considered during the selection procedure.

## 3. Income distribution data analysis for Slovakia

The Source of the data used for the analysis is the European Union Statistics on Income and Living Conditions (EU – SILC), which is a harmonized survey. In Slovakia the survey is performed on the basis of internationally comparable methodology allowing mutual comparison of living conditions of households throughout the European Union. We have chosen total gross household income as the variable for our analysis. It is an aggregated indicator, which contains labor income, social income and other incomes of households (Súkenníková, 2012) . The unit is the national currency in nominal values, which reflects the total annual income of selected households. For the purposes of this paper we will analyze data regarding the period 2004 – 2009. For the conversion from the former Slovak currency – Slovak crown (SKK) we used the fixed converse course 30.126 SKK for 1 EUR. We have addition adjusted the data for inflation using Consumers price index, using 2009 as base year. The number of used observations varies between 4,900 – 5,000. Later these data were used for estimation of density functions, particularly of Generalized Gamma distribution and Generalized Pareto distribution.

**Figure 1 Income distribution based on EU-SILC data, frequencies on the vertical Y axes and income in euros on the horizontal X axis.**




**Source: Authors' own calculation, EU-SILC data.**

The presented Figure depicts the histograms of EU-SILC income data. We analyzed the basic statistical characteristics of the real observed data for Slovakia which are:

- the measures of central tendency (mean, mode and median),
- measures of statistical dispersion (variance, std. deviation),
- higher central moments (skewness and kurtosis).

Following Table contains the values of mentioned characteristic for every examined year. These information provide us deeper insight into the issue of income distribution and will support

the identification and quantification of the best fitting distributions not only based on the goodness of fit tests but also taking into account expert knowledge.

**Table 1 The main statistical characteristics computed for the actual income distribution of Slovakia during the years 2004 - 2009**

| | Mean | Median | Mode | Max | Min | Variance | Std. Dev. | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|
| 2004 | 11,157 | 9,252 | 912 | 166,382 | 787 | 86,163,438 | 9,282 | 4.69 | 47.2 |
| 2005 | 11,871 | 9,764 | 5,681 | 187,984 | 468 | 105,888,153 | 10,290 | 5.49 | 62.78 |
| 2006 | 12,802 | 11,101 | 5,439 | 95,858 | 58 | 77,485,924 | 8,795 | 1.9 | 6.95 |
| 2007 | 13,788 | 11,936 | 13,158 | 111,897 | 88 | 94,245,668 | 9,707 | 2.09 | 10.13 |
| 2008 | 14,320 | 12,364 | 7,085 | 98,509 | 84 | 97,594,775 | 9,879 | 1.78 | 5.96 |
| 2009 | 14,596 | 12,606 | 6,975 | 137,300 | 72 | 97,029,655 | 9,850 | 2.17 | 11.89 |

**Source: Authors' own calculation, EU-SILC data.**

Value of the mean has a steadily growing tendency throughout the observed years. The lowest mean was in the year 2004 on the level of 11,157 €. In the following year the mean grew by 714 € to the value 11,870 €. The difference between the years 2005 – 2006 was 931 € and between the years 2006 – 2007 was 985 €. The 2007 value of mean achieved 13,787 €. The highest mean income among all of the observed years was in the year 2009 at the value 14,595 €, although the growth of the mean of total household gross income between the years 2008 and 2009 was the lowest, at the value 276 €. The relatively high annual increase in the years 2004 – 2008 was the result of high economic growth experienced in Slovakia, which was affected by the EU accession and the growing production in industry, mainly in the automotive industry. This growth pulled the real income not only in the industry but also in the services. The moderate increase of mean income in the year 2009 was affected by the beginning of the global economic crisis which had negative impact on the growth.

The mode indicates the most frequent value among the sample. Its value was in the year 2004 on the level of 912 €. Subsequently in the years 2005-2009 mode value was significantly higher and varies in the range from 5,400 to 13,000. The highest mode was in 2007 which was one of the years with the most remarkable economic growth experienced in Slovakia. The result from the year 2004 is likely to be biased by the selection of the sample. The median splits the distribution of total household gross income into two equally large groups. Observations on the right side are then lower and on the left side are higher than the median value. As it was in the case of the mean, the median also increased steadily over the analyzed years. Regarding the annual changes of the median income similar pattern can be seen as it was in the case of the mean. The impact of crisis was conspicuous in the year 2009 and the high increase in the years 2004-2008 was mostly affected by high economic growth.

We further analyzed the characteristics of variability for which we used the variance, which is the most often used measure of variability. Generally speaking, the higher the variance the more the observed data deviate from the mean. In case of income the variance can be considered fairly high, although the data were adjusted by removing extreme outliers. For instance in 2004 the variance was on the level of 86,163,438. In other years the variance is even higher, with the exception of the year 2006 for which the variance is 77,485,924. Other measure of variability, the standard deviation can be interpreted as a mean difference among the observed values and the mean assumed that the sign of values is ignored (Chajdiak, 2003). The standard deviation for Slovakia in the period 2004 – 2009 vary from 8,785 to 10,290.

Another important attribute used when the distribution is identified is the symmetry of the data. For this purpose we used the measure of skewness, which is based on the comparison of concentration of low values and concentration of high values. The mentioned characteristic is positive in each analyzed period therefore the data are positively skewed. This skewness is caused by the fact that in each period the mean is greater than the median and therefore the majority of the

values are lower than the mean which is typical for the income data. We also performed the analysis of shape of the distribution, which is done through the measure of kurtosis, by measuring the frequency (density) of the tails of the distribution (Chajdiak, 2003). Based on the results of this analysis we can characterize the occurrence of extremely high and extremely low values among the observations. The obtained results are compared with the normal distribution, for which the value of kurtosis is 3. The value of kurtosis for the historical data is higher than 3 in every observed year, which means that the income distributions has more dense tails, higher peak and are more steep. Given fact also indicates that that higher kurtosis is caused by concentration of the values along the center and therefore by lower variability among the data.

For the given actual income distributions we are able to compute the relative poverty measure, known as "At-risk-of-poverty" indicator (Eurostat, 2010). Such indicator may be computed also for the data sample we have used in the presented analysis. We have computed the simplified version of the indicator6 for each given year that determinates threshold under which the households are considered at risk of poverty. Using the indicator and the actual income distribution data we are able to compute the percentage of households which are at risk of poverty from the used sample. The results for period 2004 – 2009 are stated in the following Table 8.

**Table 8 Results for the at-risk-of-poverty indicator computed for the years 2004-2009**

| | At-risk-of-poverty indicator | Proportion of household at risk of poverty |
|---|---|---|
| 2004 | 4176.273 | 25.5% |
| 2005 | 4573.206 | 26.06% |
| 2006 | 5386.9433 | 25.83% |
| 2007 | 6386.9352 | 27.46% |
| 2008 | 7142.3176 | 26.4% |
| 2009 | 7563.78 | 25.1% |

**Source: Authors' own calculation, EU-SILC data.**

The threshold of poverty is growing steadily during the observed period, which is mainly caused by the growth of the median income of the households. This may be interpreted as the growth in the living conditions or as growth in general. If we consider the sample representative enough we may extend the results to the whole Slovak population. Given that we may see that the proportion of poor has grown till the year 2007 when it reached its climax and fall afterwards reaching smaller fraction in 2009 compared to the year 2004.

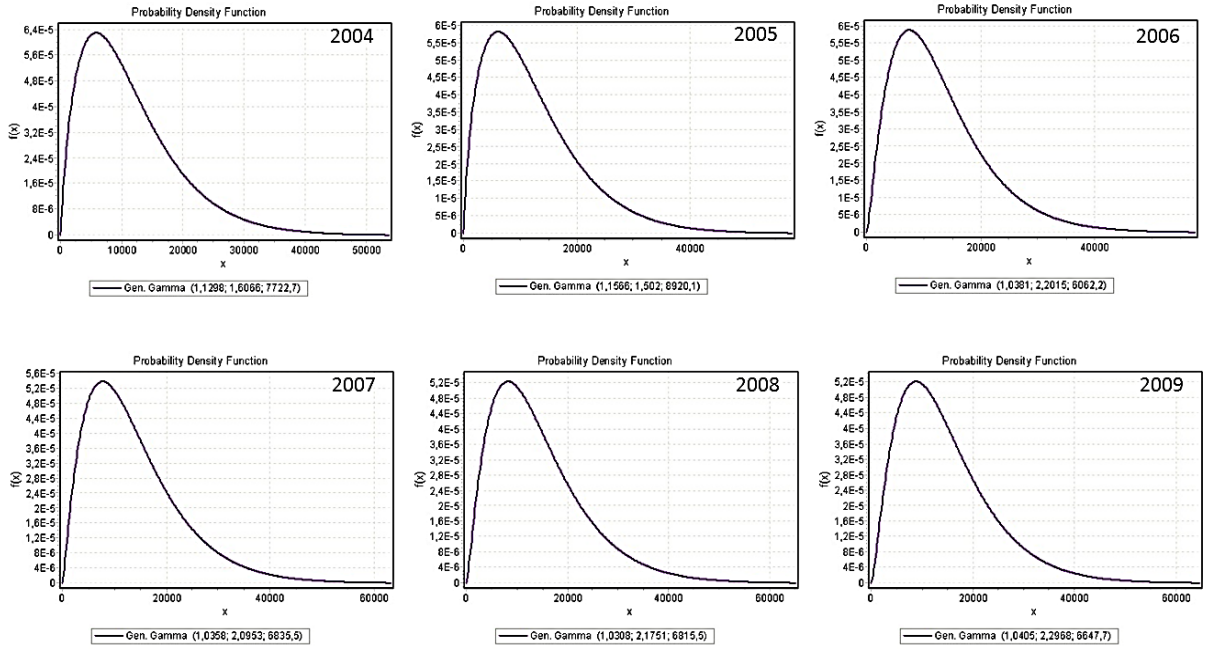
## *4. Results*

The above described data for Slovakia were subsequently used for determining the candidate distribution families and then for the estimation of the best fitting density functions. The Generalized Gamma distribution and the Generalized Pareto distribution families were identified as the most appropriate ones. The density functions of the Generalized Gamma distribution for each year are depicted on Figure .

As the last step of the identification procedure we used several goodness of fit tests, the statistical characteristics, which were already presented in the analysis of data stated in the previous part of this paper and expert knowledge about the problem. The results of the Kolmogorov – Smirnov test, Anderson – Darling test and Chi – Square test for the selected distributions are depicted in the following Table .

[6] We used the total gross household income data adjusted by inflation but abstracted from the equalization for household size.

**Figure 2 Results for the Generalised Gamma distribution for the examined year 2004 -2009**




**Source: Authors' own calculations, EU-SILC data.**

As the last step of the identification procedure we used several goodness of fit tests, the statistical characteristics, which were already presented in the analysis of data stated in the previous part of this paper and expert knowledge about the problem. The results of the Kolmogorov – Smirnov test, Anderson – Darling test and Chi – Square test for the selected distributions are depicted in the following Table .

**Table 2 The goodness of fit tests for the Generalized Gamma distribution estimate for examined years 2004-2009**

| | Kolmogorov Smirnov | Anderson Darling | Chi-Squared |
|---|---|---|---|
| 2004 | 0.04037 | 23.599 | 362.71 |
| 2005 | 0.04767 | 34.605 | 440.0 |
| 2006 | 0.03613 | 22.777 | 148.44 |
| 2007 | 0.03839 | 11.703 | 171.11 |
| 2008 | 0.03041 | 13.028 | 105.76 |
| 2009 | 0.02825 | 9.8042 | 131.13 |

**Source: Authors' own calculations, EU-SILC data.**

The resulting statistical characteristics, which were obtained for the Generalized Gamma distribution are listed in Table  and described below. The mean value for the estimated Generalized Gamma distribution has growing tendency over time. The highest mean of the gross household income was in the year 2009 with value 14,671 €. On the contrary the lowest mean is obtained for the year 2004 at the value 11 414 €. The most frequently occurring value in the Generalized Gamma distribution had, similarly to the mean value, growing tendency. The most frequent total gross household income in the year 2004 was 5,785 €. In the following year the mode has risen to the value 6,042 €. In the years 2008 and 2009 the modes have reached values 8,167 € and 8,780 € respectively. Between the final and original year of our analysis we observed overall growth of the mode by 2,995 €.

**Table 3 Gamma distribution characteristics for the analysed years 2004-2009**

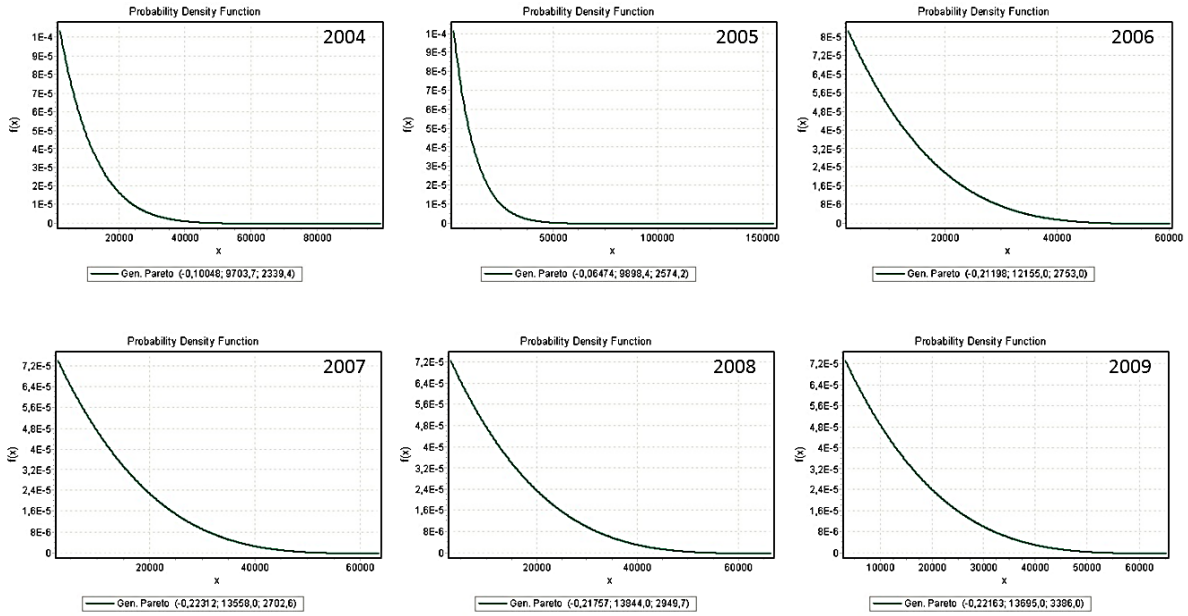
| | Mean | Median | Mode | Max | Min | Variance | Std. Dev. | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2004 | 11,414 | 9,664 | 5,785 | Inf. | 0 | 63,709,000 | 7,982 | 1.31 | 2.47 |
| 2005 | 12,236 | 10,330 | 6,043 | Inf. | 0 | 74,838,000 | 8,651 | 1.31 | 2.43 |
| 2006 | 12,869 | 11,129 | 7,448 | Inf. | 0 | 69,826,000 | 8,356 | 1.27 | 2.40 |
| 2007 | 13,858 | 11,882 | 7,691 | Inf. | 0 | 85,448,000 | 9,244 | 1.31 | 2.54 |
| 2008 | 14,395 | 12,394 | 8,167 | Inf. | 0 | 89,670,000 | 9,469 | 1.30 | 2.50 |
| 2009 | 14,671 | 12,777 | 8,780 | Inf. | 0 | 86,576,000 | 9,305 | 1.24 | 2.29 |

**Source: Authors' own calculations, EU-SILC data.**

We also analyzed the estimate of Generalized Gamma distribution for the total gross household income through the measure of skewness. In each examined year the coefficient of skewness shows positive values. Based on the value of coefficient, which is at its highest in the year 2004 with the value 1.31 and at its lowest in the year 2009, we can state that the Generalized Gamma distribution exhibits for each observed year right hand skewness. The same is showed by the comparison of mean and mode values. Where in 2009 the mean is higher by 5,891 € than the mode. The kurtosis for the estimated Generalized Gamma distribution for the total gross household income exhibits positive values for each observed year. Such finding indicates that the distribution has steeper pattern. So far all of the data for total gross household income indicated kurtosis higher than for normal distribution, which also indicates steeper pattern. However the kurtosis falls from the year 2004 to the year 2009 and therefore the concentration of observed data along the center of distribution slowly loosens up and simultaneously the variability of the data rises. The difference between the kurtosis in year 2004 and 2009 is between 0.181. Besides the already described characteristics, we have also analyzed the estimated Generalized Gamma distribution by its variance, which reached value 63,709,000 in the year 2004 and grew to the value 89,670,000 in the year 2008. In the following year variance dropped to the value 86,576,000. The standard deviation, which express the mean difference among the values and the mean is, based on the Generalized Gamma distribution for the years 2004 to 2009, varying in the range from 7 982 € to 9 569 €. When we compare the statistical characteristics of the original data with the results from the estimated data, we can see many similarities. On the other hand the most remarkable differences can be seen in case of the skewness of original data to the estimated data. The estimate shows a rather moderate skewness in few years compared to the real data, where the skewness is much higher.

**Figure 3 Results for the Generalised Pareto distribution for the examined year 2004 -2009**




**Source: Authors' own calculations, EU-SILC data.**

Second theoretical distribution, which was used for the description of total gross household income data for Slovak republic was the Generalized Pareto distribution. We have estimated the

density functions for the Generalized Pareto distribution, which are depicted on the following Figure .

The results for the goodness of fit tests are stated in the following Table .

**Table 4 The goodness of fit tests of the Generalized Pareto distribution estimated for the analysed years 2004-2009**

| | Kolmogorov Smirnov | Anderson Darling | Chi-Squared[7] |
|---|---|---|---|
| 2004 | 0.03227 | 577.57 | N/A |
| 2005 | 0.02742 | 566.67 | N/A |
| 2006 | 0.03172 | 450.52 | N/A |
| 2007 | 0.0258 | 340.1 | N/A |
| 2008 | 0.02865 | 563.28 | N/A |
| 2009 | 0.02686 | 489.43 | N/A |

**Source: Authors' own calculations, EU-SILC data.**

Similarly to the Generalized Gamma distribution we have focused on the descriptive characteristics. Therefore the characteristics for the estimated Generalized Pareto distribution are listed in the Table . The mean value according to the Generalized Pareto distribution estimate for particular years had similarly to the Generalized Gamma distribution growing tendency. The mean of total gross household income was in 2004 on the level 11,157 €. The mentioned value grew to the value 14,596 € in the year 2009, which is higher by 3,439 € compared to the former year. The mean values for Generalized Pareto distribution were only slightly different than the means for Generalized Gamma distribution.

**Table 5 Pareto distribution estimation characteristics for the analysed years 2004-2009**

| | Mean | Median | Mode | Max | Min | Variance | Std. Dev. | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|
| 2004 | 11,157 | 8,837 | 2,339 | 98,916 | 2,339 | 64,743,000 | 9,046 | 1.51 | 2.77 |
| 2005 | 11,871 | 9,284 | 2,574 | 155,460 | 2,574 | 76,517,000 | 8,747 | 1.66 | 3.63 |
| 2006 | 12,782 | 10,588 | 2,753 | 60,092 | 2,753 | 70,631,000 | 8,404 | 1.15 | 1.07 |
| 2007 | 13,788 | 11,410 | 2,703 | 63,470 | 2,703 | 84,963,000 | 9,218 | 1.12 | 0.95 |
| 2008 | 14,320 | 11,857 | 2,950 | 66,579 | 2,950 | 90,078,000 | 9,491 | 1.13 | 1.01 |
| 2009 | 14,596 | 12,185 | 3,386 | 65,176 | 3,386 | 87,070,000 | 9,331 | 1.12 | 0.97 |

**Source: Authors' own calculations, EU-SILC data.**

The mode for total gross household income according to the Generalized Pareto distribution also had growing tendency. The most frequent gross income in the year 2004 was 2,339 €, which grew till it reached 3,386 € in 2009, which is higher almost by 1,047 €. When we compare the modes of Generalized Pareto distribution with the modes of Generalized Gamma distribution we notice that values for Generalized Pareto distribution are significantly lower. For instance in the year 2008 the mode for Generalized Gamma distribution reached the value 7,690 € and for Generalized Pareto distribution only 2,950 €, which is lower by 4 740 €. Similarly as it was in the case of the Generalized Gamma distribution, the statistical characteristics of the original data are quite close to the characteristics of the estimated data. The only significant exception can be experienced in the case of skewness.

## 5. Conclusion

Drawing from the computed goodness of fit tests we may see that it is not possible to compute the Chi – Square test for the Generalized Pareto distribution. Therefore we will proceed with the assessment based on two remaining tests. The criterion for the Kolmogorov – Smirnov test

[7] The Chi-Square test was not available as an automated result.

and the Anderson – Darling test is to obtain the smallest value possible. Based on broader look we may state that the Generalized Pareto distribution provides better fit than Generalized Gamma distribution according to the Kolmogorov – Smirnov test. On the other hand the values for Anderson – Darling test are significantly lower for Generalized Gamma distribution in general than they are for Generalized Pareto distribution. Based on this information alone we may suggest that Generalized Gamma is more suitable for modeling the income distribution than Generalized Pareto might be. The different results for different statistical tests are the reason, why it is not recommended to rely on their results alone. Thus we further should take into consideration our and expert knowledge of the problem and the statistical characteristics, based on the moments of distribution, to evaluate which one of the theoretical distributions is the most suitable for description of actual income distribution among the Slovak households. In order to draw a rigorous conclusion, not based on superficial glance of the distribution characteristics we will compute an error term for each characteristic as a difference between the value of the characteristic for real income distribution and the value of same characteristic for the fitted density function over the analyzed time period 2004 – 2009. Subsequently we are able to compute the Sum of Squared Errors (SSE) measure that will quantify the error of each theoretical distribution in comparison to the real income distribution. Mentioned statistic SSE is stated in the following Table .

**Table 6 The comparison of the SSE for the Gen. Pareto distribution estimate and Gen. Gamma distribution estimate**

| | Mean | Median | Mode | Max | Min | Variance | Std. Dev. | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|
| Gen. Pareto | 219913 | 523941 | 6,22E+07 | N/A | 861741 | 1,78E+15 | 5248536 | 31 | 5825,34 |
| Gen. Gamma | 400 | 1376760 | 1,58E+08 | 1,55E+10 | 40141742 | 1,61E+15 | 3248452 | 27,81 | 5735,34 |

**Source: Authors' own calculation.**

As we may see it is not possible to compute the SSE measure for the characteristic of maximum for Generalized Gamma distribution since it's convergence to zero lasts to infinity. Similarly the SSE for mode and minimum characteristic for the Generalized Pareto distribution are not relevant since they are the same, which is caused by the properties of the Pareto distribution. Therefore we will discard the mentioned characteristics from the evaluation of the distributions since they would priori favor one against the other. Nevertheless it is important to note that when it comes to maximum, the Generalized Pareto distribution is more suitable since it has finite domain. On the other hand the mode and minimum favors the Generalized Gamma distribution, since it is almost impossible to describe these characteristics correctly by Generalized Pareto distribution.

Considering the characteristics of mode, maximum and minimum irrelevant, we may start with evaluation by the characteristics of central tendency. When it comes to mean the Generalized Pareto distribution seems to be ultimately precise, having SSE at value of only 400. On the other hand the Generalized Gamma has the SSE lower for the median than the Generalized Pareto has, although with not so staggering difference as it was for the mean. Skipping the discarded characteristics the variance and std. deviation is in favor of the Generalized Pareto distribution, again not as decisively as it was for the mean. Finally the measures of skewness and kurtosis again put forth the Generalized Pareto distribution, although keeping in mind that we are working with the sums of squared units, the difference is rather slight.

Based on the evaluation we would find the Generalized Pareto distribution slightly more suitable for describing the income distribution as a stochastic process. Not only because it performs better according to Kolmogorov – Smirnov test, but it has been shown that the properties of the distribution are closer to that of actual income distribution, as they would be in case of Generalized Gamma distribution. Additionally, as it is stated earlier in the section 1, the Pareto distribution was specially developed for the sole purpose of describing the income distribution process and therefore

it satisfies the Pareto law property (Kakwani, 1980). Of course time has shown that the distribution isn't valid for the whole domain of the actual income distribution, which is also visible on the results for the characteristics of income distribution (Table ). We can see that the minimum for each examined year is the same as the mode, which means that the distribution cuts off the observed income lower than the mode. Consequently the distribution underestimates the mode, in comparison to the mode of Generalized Gamma distribution. Despite these drawbacks, which should be kept in mind, the Generalized Pareto distribution performs rather well and for the income greater than the mode provides better fit then the Generalized Gamma distribution.

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# Impact of Ageing on Consumption and Labor Demand (Empirical Evidence from the Slovak Republic) [1]

*Tomáš DOMONKOS[2], Ivan LICHNER[3]*

**Abstract:** Ageing is one of the phenomena European society currently has to face and will be came an even more emerging issue in the near future. Our paper aims to analyze the impact of ageing on consumption and on labor demand by the year 2025 in Slovakia. First the consumption behavior is estimated and then this consumption is used as an input into an Input-output model which determines the changes in labor demand. The results shown that ageing should not be ignored and should rather be treated as an important issue which can be considered as an economic chance and source of future growth.

**Keywords:** Elderly, Silver Economy, Impact of Ageing on Consumption, Labor Demand.

**JEL classification:** C67, D57, D12, J14, J40.

## 1. *Introduction*

The current demographic projections tend to show ageing of population in the majority of EU member states. Ageing is in general considered as a negative phenomenon e.g. for the public finances mainly through increasing the pressure on the pension system and increasing healthcare costs. On the other hand, we can also expect positive effects. The positive effects will be mainly driven by the changes in the consumption structure of the population due to different consumption behavior of the elderly and younger cohorts. In other words, ageing is usually discussed as a problem of our society, but on the other hand if we cannot change this pattern we should rather adapt to the changes and gain social and economic benefits from them on national and also on European level. The paper presented on this place aims to analyze the impact of ageing on consumption and on labor demand by the year 2025 in Slovakia. The results from our analysis may uncover the impact of silver economy on the future economic opportunities, economic growth and labor market issues.

Process of population ageing was considered in Finland to be some years ahead than in other industrialized European countries[4].This is one of the reasons why authors in their work Honkatukia et al. (2009) considered ageing of the population as one of the foremost fiscal challenges. Regional effects of ageing were evaluated by application of regional, dynamic CGE[5] model. Results of the analysis pointed out the fact that population growth is one of the most important determinants of public expenditures. Policy measures that should help ease the pressure on municipal deficits imply increase in income tax rates.

Study of Pedersen et al., (1999) tries to find answers to the following questions in Denmark: "Is there a permanent economic burden due to the demographic development or is the problem temporary in the sense that long run fiscal pressures on the working population is reduced to the present level without imposing significant changes to the Danish welfare system?"[6]. To analyse the

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[4] Honkatukia et al., 2009
[5] Computable General Equilibrium
[6] Pedersen et al., 1999

impacts of demographic development authors use DREAM[7] model. Result of the analysis shown that demographic ageing leads to two types of economic problems: on the supply side there will be a decrease in labor supply which would reduce production capacities and on the other hand there will be problem in public financing due to growth in public expenditures (in case of ceteris paribus conditions). According to results not even funded pension system will be sufficient to avoid temporarily increased burden of financing changes in public expenditures in transition period up to 2035. On the long run this pension system has significantly positive effects on characteristics of economic performance.

Researchers discussed impact of ageing on Norway labor supply in the paper of Aaberge et al. (2004). In this work individual labor supply behavior is integrated in the large-scale CGE model by application of a detailed micro-econometric model of labor supply. Results shown that in case of no changes in labor supply resulting from shifts in wage rates, non-labor income and taxation, fiscal sustainability will require doubling the payroll tax rate in the period of years 1995 - 2050.

Different approach of analyzing silver demand affected by changes of consumption structure, is presented by Schaffnit-Chatterjee (2007). This study defines the main determining factors of consumption structure as follow:

- demographic factor which is the number of households divided according to selected age groups,
- societal factors which are mainly changes in consumer preferences driven by specific changes of the society,
- economic factors which are composed of the income structure according to age and changes of relative prices.

Schaffnit-Chatterjee (2007) also discuss the idea of dynamic and static ageing. Static ageing assumes constant consumption behavior for each age group in the future. Dynamic ageing assumes certain shift of the consumption behavior between age groups caused mainly by ageing. In other words, the consumption behavior of a 35 years old today will be typical for e.g. a 40 years old in the future. In this work demographic development is mainly represented by the number of households and the age structure of the population, society are social changes and changes in consumer preferences and economic development is about economic growth and relative prices. Simplified assumption is presented by Radvansky et. al. (2011) where the silver consumption is affected only by the average personal income during the lifecycle. Societal and economic development affects the overall demand in general, so the difference of demand between older and younger consumers is based simply on different consumption structure.

## 2. *Data and Methodology*

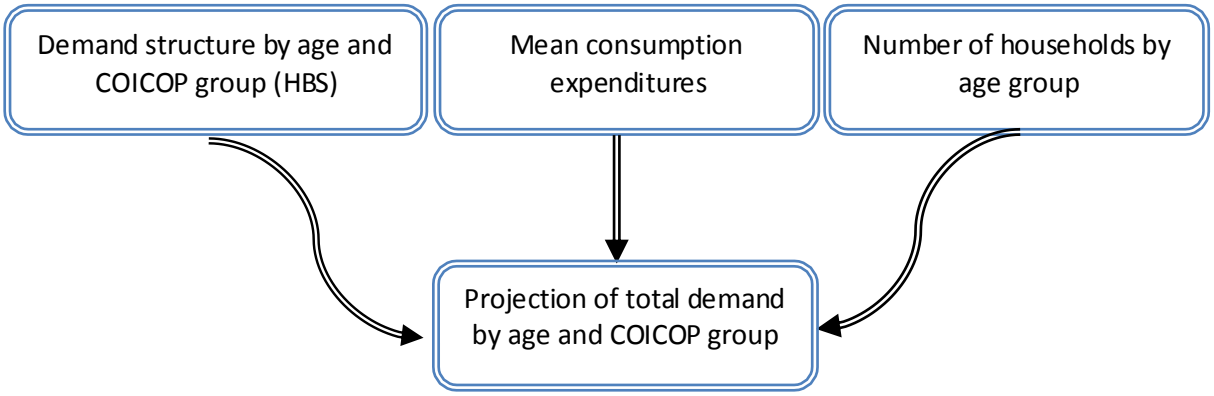
The methodology used in this paper is composed of various subsequent modeling approaches. First the future consumption behavior was analyzed and forecasted. We defined three different scenarios based on the concept of static and dynamic ageing discussed in Schaffnit-Chatterjee (2007). The first scenario is a static one based on the ceteris paribus assumption that the consumption behavior in the analyzed age groups remains the same in the future i.e. the structure of consumption of a 50 years old in 2025 will be exactly the same as the structure of consumption of a 50 years old today. The second scenario assumes that the consumption structure will change and will not remain the same i.e. the structure of consumption of a 50 years old in 2025 tend to show signs of consumption of a 45 years old person's consumption from today. Finally, in the third scenario along the dynamic change applied in the second scenario we also consider that the shifts in the consumption behavior could be different in different consumption groups and age cohorts. When estimating the number of households we assumed linear relationship between the number of

[7] Danish Rational Economic Agents Model

households by age of reference persons and number of inhabitants of the particular age groups. As exogenous input in this estimation we used data from EUROPOP2010 – Convergence scenario[8] aggregated to selected age groups.

Subsequently, by using the estimated number of households we were able to estimate the future households' consumption patterns by product type and age of reference person. We employed data from HBS[9]: mean consumption expenditure and structure of consumption expenditure (COICOP level) by age of reference person. In other words, by connection of the HBS data with the households' number forecast we estimated the future demand based on 4 age groups and 12 COICOP groups. As the main aim of our research was estimation of the impact of ageing population on the labor market we aggregated the achieved results in two groups: younger (less than 59 years of age) and elderly consumers (older or equal than 60 years of age).

**Graph 1: Estimation of the demand**




**Source: authors**

As it was mentioned above, the future households' demand estimations are based on the COICOP classification as we were using Input-output methodology for determination of impact of consumption changes on labor demand we had to solve the issue of determining the relationship between COICOP consumption groups of Household Budget Survey (HBS) and structure of households' final consumption used in Input-output tables (IOTs) that are based on CPA methodology. For this purpose we linked COICOP classification used in HBS with CPA classification used in IOTs by application of transformation table. This transformation table is based on the assumption that changes in demand for different goods and services will cause similar relative changes in demand for products by CPA groups. The used transformation table is as follows:

**Table 1: Transformation table of COICOP and CPA**

| *Product group* | *COICOP* | *CPA* |
|---|---|---|
| Food and beverages | Food and non-alcoholic beverages (CP01) | Products of agriculture, hunting and related services (01) |
| | | Products of forestry, logging and related services (02) |
| | Alcoholic beverages (CP021) | Fish and other fishing products; services incidental of fishing (05) |
| | | Food products and beverages (15) |
| Tobacco | Tobacco (CP022) | Tobacco products (16) |

[8] Source: http://epp.eurostat.ec.europa.eu
[9] Household Budget Survey avilable from Eurostat web site

| | | |
|---|---|---|
| Clothing | Clothing and footwear (CP03) | Textiles (17) |
| | | Wearing apparel; furs (18) |
| | | Leather and leather products (19) |
| Housing and utilities | Housing, water, electricity, gas and other fuels (CP04) | Electrical energy, gas, steam and hot water (40) |
| | | Collected and purified water, distribution services of water (41) |
| | | Real estate services (70) |
| | | Sewage and refuse disposal services, sanitation and similar services (90) |
| Furnishing | Furnishings, household equipment and routine maintenance of the house (CP05) | Furniture; other manufact. goods n.e.c. (36) |
| | | Construction work (45) |
| Health | Health (CP06) | Health and social work services (85) |
| Transport | Transport (CP07) | Motor vehicles, trailers and semi-trailers (34) |
| | | Trade, maintenance and repair services of motor vehicles and motorcycles; retail sale of automotive fuel (50) |
| | | Land transport; transport via pipeline services (60) |
| | | Water transport services (61) |
| | | Air transport services (62) |
| | | Supporting and auxiliary transport services; travel agency services (63) |
| Communications | Communications (CP08) | Post and telecommunication services (64) |
| Recreation and culture | Recreation and culture (CP09) | Other business services (74) |
| | | Recreational, cultural and sporting services (92) |
| | | Other services (93) |
| Education | Education (CP10) | Education services (80) |
| Restaurants and hotels | Restaurants and hotels (CP11) | Hotel and restaurant services (55) |
| Miscellaneous | Miscellaneous goods and services (CP12) | other CPA groups |

***Source: authors***

The main task of the input-output approach was identifying the pure effects of ageing on the labor demand. It is important to mention that assumptions used were not taking into consideration other factors (such as production technology, labor productivity growth, inflation, wage raises etc.) that will affect future economic development to reveal pure effects of ageing. Thus results presented in this study should be considered as an approximation of possible future trends resulting from ageing. The static input output model was modified and extended in the value added array by an employment row as discussed in Goga (2009). This transformation allows determining the impact of changes in the consumption on the structure of employment. The part introducing labor market was structured according to sectors. The labor demand by sector can be determined as: $w^t = A^t x$, where $w^t$ represents vector of labor demand (employment) required to produce $x$ amount of products or services in sectors and $A^t$ is the matrix of direct labor coefficients. By using the above mentioned

relationship and the Leontief's basic open static input-output model $x = (I - A)^{-1}y$ the labor demand according to certain production will be as follows:

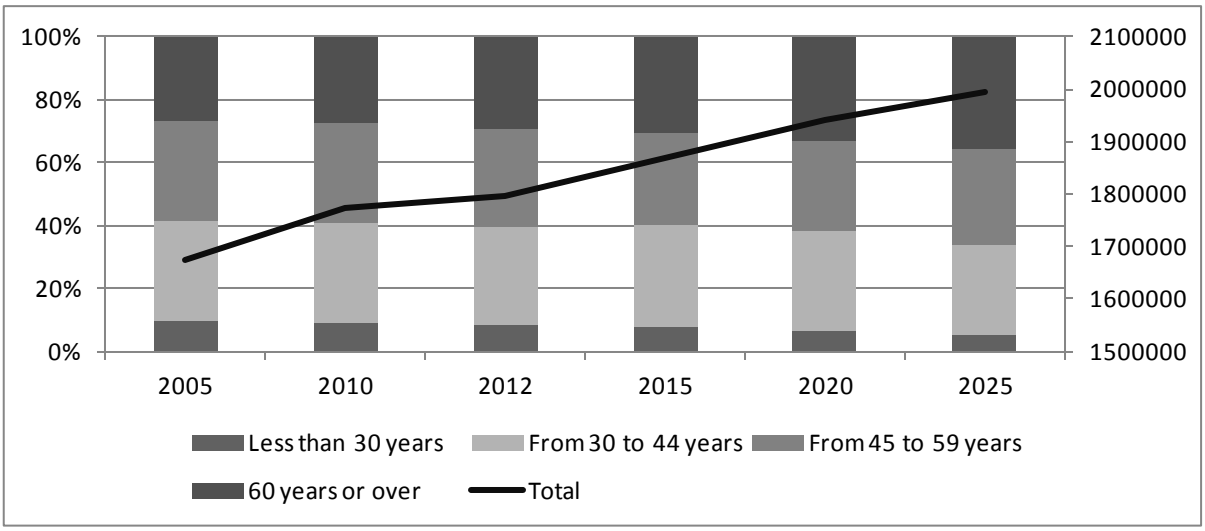
$$w^t = A^t(I - A)^{-1}y \qquad (1)$$

where y represents the vector of final consumption. The final consumption in the Input-Output tables is usually composed of four components which are as follows: consumption of households, investments, government expenditures and export. Using the formula above, when any component of the final consumption is changed, the changes in the labor demand can be determined.

## 3. *Results*

According to EUROPOP2010 estimations the impact of ageing will be in Slovakia limited up to 2020 and the main influence should be expected after this year. The expected share of households with elderly reference person (over 60) will slowly increase over time and will likely achieve almost 35% of all households in Slovakia (see Graph 2) by 2020. The households' share of 30-44 would decrease over time due to gradual ageing and shifting to the age group 45-59.

**Graph 2: Total number of household for Slovakia by 2025**

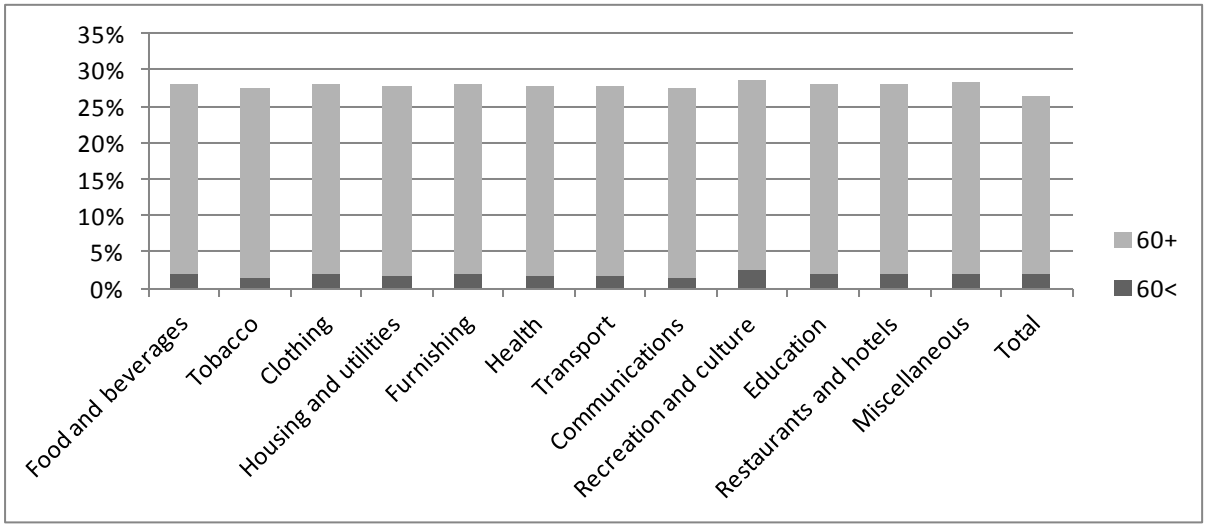



***Source: authors, EUROPOP2010***

The total population will increase over time and also the number of persons aged 45-59 and 60 and over will increase over the analyzed time period. On the other hand number of households in age group 30-45 will increase only by 2020 and then will rather decrease. Alarmingly, the number of persons in the less than 30 group will steadily decrease throughout the analyzed time period. This makes the decrease of its share more dramatic compared to the other two groups under 60. This forecast may show that the future labor demand can face shortages regarding the labor supply and the demand may be satisfied by labor migration or by postponing retirement age.

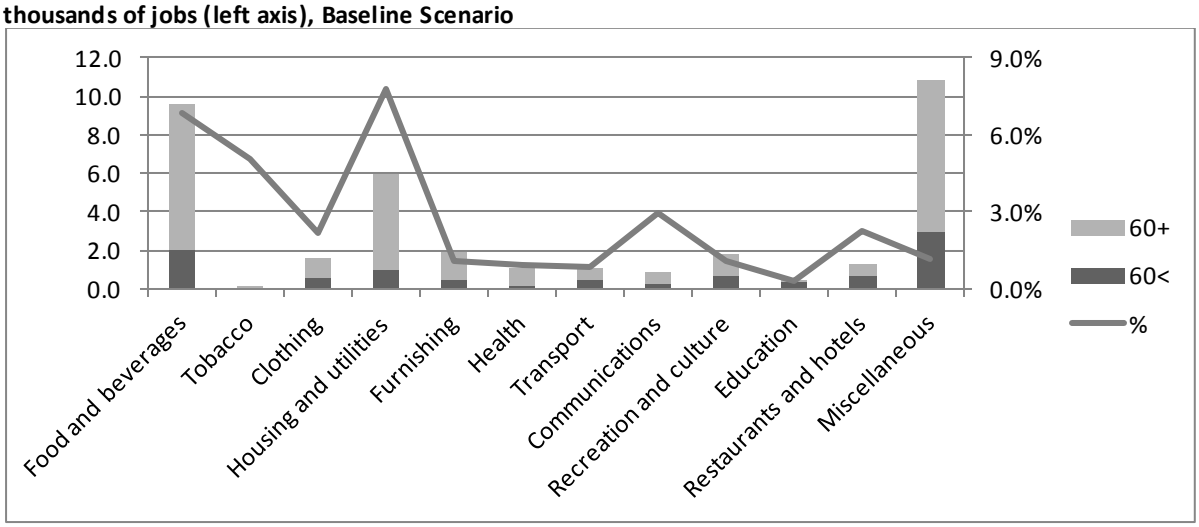
The overall consumption according to the Baseline static scenario tends to be likely increasing in each consumption group. The increase of demand is in relative terms quite similar for all product/service categories. The expected increase in demand varies between 27.5% and 28.6%. As it can be seen on the Graph 3, that majority of additional consumption is created by demand of elderly caused by their increasing share on the total population.

**Graph 3: Ageing related changes in consumption 2010 - 2025, Baseline Scenario, %**




**Source: authors**

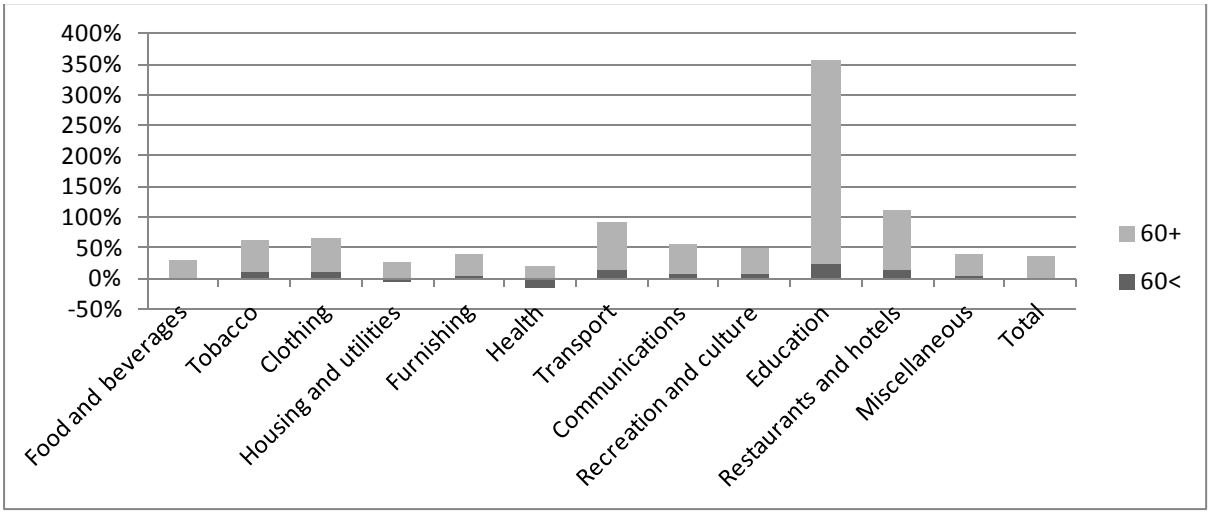
**Graph 4: Expansion labor demand 2010-2025 in percentage terms on the total employment (right axis), thousands of jobs (left axis), Baseline Scenario**




***Source: authors***

Taking a closer look on expansion labor demand generated by changed private households' consumption structure on the figure above (see Graph 4), it is clearly visible, that ageing and shifting demand of elderly would generate expansion labor demand mainly in the following sectors: food and beverages and housing and utilities. Surprisingly, health care is not among sectors with high growth rates. This is caused by the fact, that majority of health care expenditures in Slovakia is financed by health insurance companies and government. The expected increase of jobs in sectors producing food and beverages will be almost 10,000 jobs and in housing and utilities approximately 6,000 new job opportunities. Overall the national labor demand is likely to increase by almost 40,000 jobs. In case of Slovakia, along with the increased demand of silver group also the demand of younger age groups will increase and generate further employment opportunities. This fact is generated by shifts of young age groups entering labor market to cohorts with higher income and expenditures.

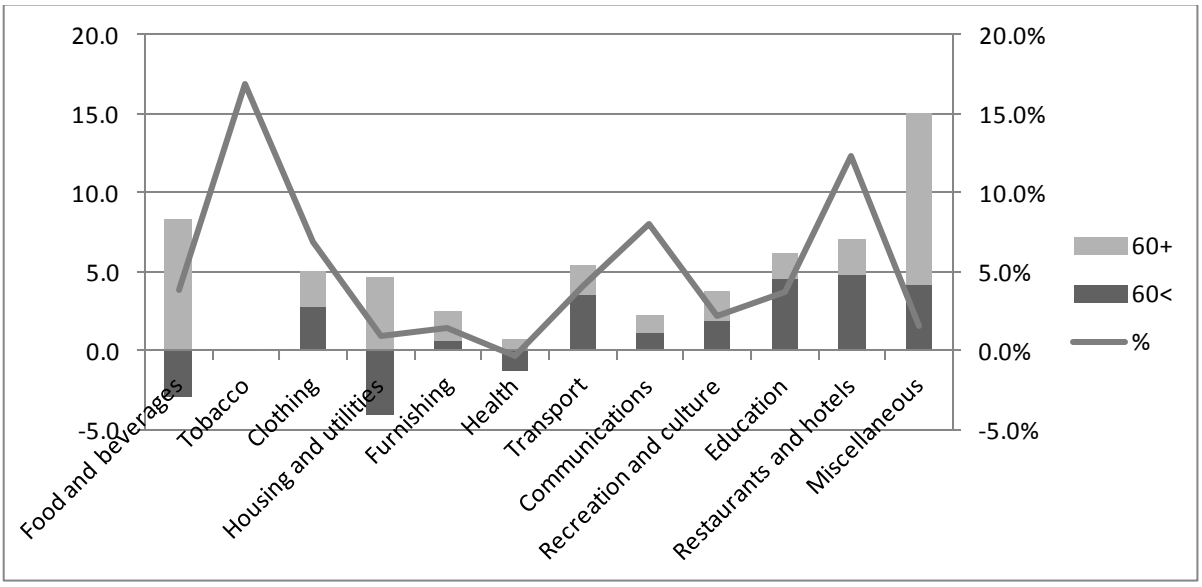
**Graph 5: Ageing related changes in consumption 2010 - 2025, Scenario 2, %**




***Source: authors***

The second scenario based on the assumption of gradual change of consumption behavior over the life cycle shows faster increase of future consumption compared to the baseline scenario. As it was in case of the Baseline scenario, the future increase of demand is mostly affected by the consumption of elderly. This is caused by the increased share of elderly on the total population simultaneously with decreasing share of younger age groups on the total population. Under this scenario the silver demand in Slovakia will not target mostly goods and services for everyday living. Surprisingly, the demand is concentrated mostly on transportation, education and restaurants and hotels. This is caused mostly by decreasing propensity to saving as it is more typical for younger people and relatively small share of these product/service categories in the initial year. Due to healthcare expenditures in Slovakia are financed by health insurance companies and government the future private consumption increase is relatively insignificant.

**Graph 6: Expansion labor demand 2010-2025 in percentage terms on the total employment (right axis), thousands of jobs (left axis), Scenario 2**

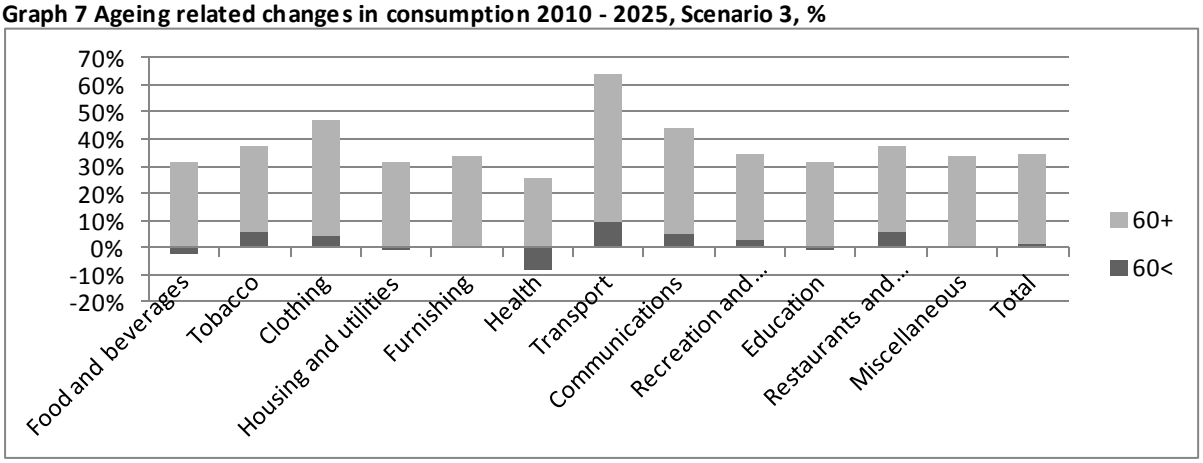



***Source: authors***

The expansion labor demand is remarkable mostly in sectors of food and beverages, transportation, clothing, education and hotels and restaurants. The increased labor demand in the sector of food and beverages, transportation, education and hotels and restaurants respectively is more than 5,000 new jobs. The lower increase in case of food and beverages and housing and utilities compared to the Baseline scenario is caused by different assumption of the behavior of

younger people of whom will spend less on these products, thus their impact will generate job losses in the future. In the same time the elderly consumption will partially mimic the consumption behavior of the 45-59 age groups.

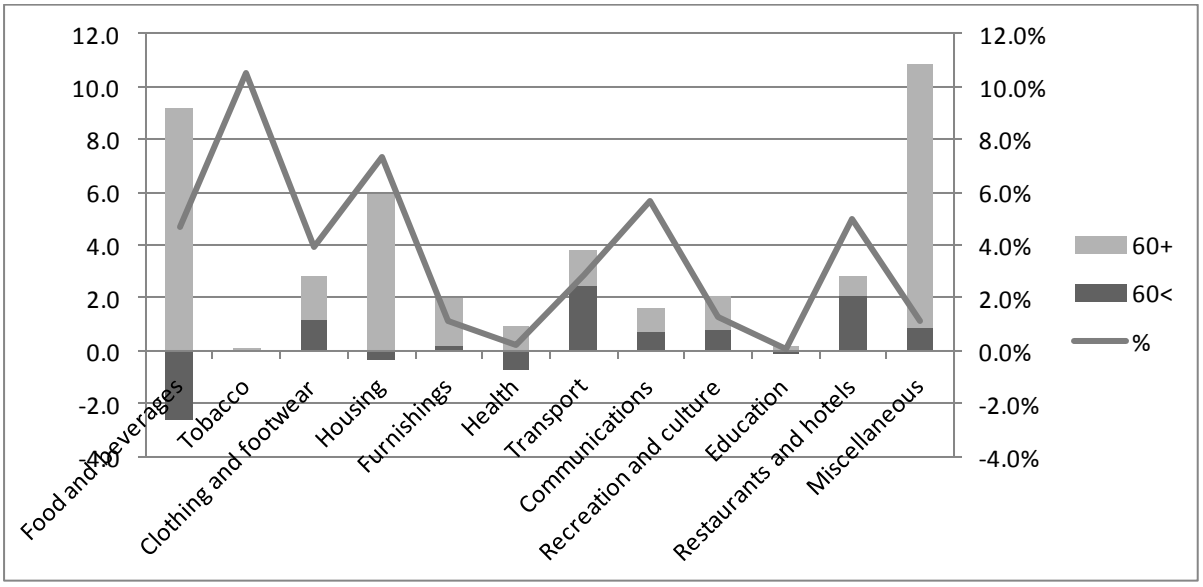
**Graph 7 Ageing related changes in consumption 2010 - 2025, Scenario 3, %**




***Source: authors***

The last scenario is based on the assumption, that the private consumption behavior depends not only on age but it is also determined by the nature of the consumption group and products and services the group is composed of. Increasing demand is remarkable in the sectors of transportation, communication, clothing and restaurants and hotels (see Graph 8). Under this scenario, we can expect an overall increase of future private consumption. Similarly, this demand is mostly generated by the elderly as well as in the previous two scenarios. The younger groups demand will decrease in sectors of food and beverages and in healthcare. The two previous scenarios are rather on the two frontiers of the future development we may expect. The third scenario is between these two frontiers what is visible when the results of the tree scenarios are compared.

**Graph 8: Expansion labor demand 2010-2025 in percentage terms on the total employment (right axis), thousands of jobs (left axis), Scenario 3**




***Source: authors***

From the point of view of the expansion labor demand, the third scenario indicates increase in cases of food and beverages (almost 9,000 new jobs), housing (almost 6,000 new jobs), transportation (almost 4,000 new jobs) and clothing and footwear (almost 3,000 new jobs). The decreasing demand of younger age groups will cause job losses in sectors of food and beverages (more than 2,000), health (almost 700) and housing (almost 400). When comparing the three scenarios, we can conclude that in case we don't consider any shift of consumption behavior across

the age groups the highest increase in consumption and expansion labor demand is expected for so called everyday living goods and services. The more intensive shifts we consider the increase in consumption and expansion labor demand is moving rather towards transportation, communication and restaurants and hotels. We also have to bear in mind that based on cultural and social behavior, the silver demand in Slovakia is currently targeting mostly goods and services for everyday living. This is mostly caused by decreasing ability of traveling and by relatively high propensity to savings, i.e. preferring saving instead of consumption. So in future projections, this fact should be also included as an input when conclusions are developed.

## 4. *Conclusions*

The analysis presented in this paper investigated the impact of ageing on the future private consumption and on expansion labor demand. We considered three different scenarios differentiated according to future consumption behavior. The first two are on the expected frontiers of the future development and the third one is between these frontiers.

In the first static scenario we assumed that the structure of consumption and thus the behavior of consumers do not change over time. The results of this scenario shown that pure impact of ageing will result mostly in increased consumption of each consumption group but from the point of view of expansion labor demand the most remarkable increase may be expected in the sectors of food and beverages and housing. Regarding the second projection that is based on the assumption of shifting consumption behavior over time i.e. the consumption of older groups is changing and in the future older people will behave more like their current younger counterparts. The results show increased consumption in sectors of transportation and restaurants and hotels. Expansion labor demand may be expected in sectors of food and beverages, transportation, education and restaurants and hotels. The last considered scenario is based on the assumption that the consumption behavior is changing over time but in different consumption groups the shifts are not equal as it was assumed in the second scenario. High increase of consumption should be expected in sector of transport and moderate in the rest of the sectors. Regarding expansion labor demand the most remarkable increase may be expected in sectors of food and beverages and housing and moderate in transport and restaurants and hotels.

There is no doubt that ageing is one of the challenges European society has to face in the near future. In general it is considered as a negative event but on the other hand the society has to adapt to new circumstances. This adaptation may be costly but may create many future business opportunities because the specific consumption of the elderly should be satisfied. In case of Slovakia we consider our findings very important because Slovak production has to satisfy the domestic demand and in the same time as a small and open economy it may also focus on other markets in EU or in third countries and grasp the opportunity to gain additional economic growth.

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# Demand Side Cost-Sharing and Prescription Drugs Utilization: Evidence from a Quasi-Natural Experiment

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***Abstract***: In this paper we investigate the effects of introduction of lump sum copayments on the utilization of prescription drugs by elderly patients. We make use of an unique dataset and analyze the policy change that implemented patient cost-sharing in the Czech Republic starting in 2008. After the introduction of copayments the number of prescriptions filled decreased by 29%. At the same time, however, total expenditures on prescription drugs dropped only in the first quarter of the post-introduction period and then returned to previous levels. This was partially due to behavioral responses of patients and physicians: strategic shift of prescription purchases to the time right before the introduction of reform, prescription of more packages on one prescription and an upward shift in the price composition of prescribed drugs. Moreover, patients in general decided to forego those types of drugs that did not cause immediate worsening of health status.

***Keywords:*** health insurance, moral hazard, cost sharing, prescription drugs

***JEL classification:*** I11, I19

## *1. Introduction*

The rapid increase in health care utilization and the corresponding rise in health expenditures over the last decades concern policymakers in most developed countries (OECD 2009). In the European context, rising health expenditures have often led to adoption of additional cost-containment strategies, mostly implemented within the framework of reforms to existing systems of universal health coverage. While some of these measures have been oriented to regulation of providers, those that target the demand (patient) side are most publicly debated. By introducing higher rates of patient out-of-pocket payments policy makers aim to alter the attitudes of people towards their own health, to motivate them to take greater personal responsibility in health care utilization.

The ultimate success and efficiency of cost-sharing measures, however, crucially depends on two main factors. First, universally applied cost-containment measures disproportionately affect vulnerable groups within a population (e.g. youth, elderly, chronically ill), but it is difficult to design adjustment mechanisms for their protection. Second, cost-sharing measures often trigger ex-ante unanticipated behavioral responses. Patients tend to bypass the regulation, and thus develop new behavioral patterns which in turn might have negative consequences for different segments of the medical system. Policy makers should be aware of both pitfalls, understand their implications, and take these into consideration in the process of reform design.

In this paper we investigate the effects of the introduction of lump-sum copayments on the utilization of health care, specifically prescription drugs. We make use of the quasi-experiment of the recent nation-wide policy change that implemented patient cost-sharing in the Czech Republic starting in 2008[3]. Only one year after introduction of copayments, regional elections led to political changes that resulted in at least partial reversal of the reform, as regional governments started to reimburse copayments at health care providers owned by regional governments (for details on policy

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[3] Motivation for the reform as well as details of its implementation are described in MHCR( 2008).

change see Zděnek (2011)). Interestingly, different regions decided to implement different forms of reimbursement, ranging from on-the-spot reimbursement to ex-post payment by bank transfer. In addition, the timing of reimbursement differed. We employ this rich exogenous variation in our analysis. The design of the policy change enables us to not only identify and quantify changes in patient behavior after introduction of the copayment, but also to evaluate how persistent they are over time. Our paper focuses on elderly patients, aged 64 and older. This is often the most vulnerable subgroup of population due to worsened health status, higher prevalence of chronic illnesses and financial constraints due to limited working opportunities and relatively low state pensions.[4]

Our results show that after the introduction of copayments the number of prescriptions filled decreased by 29%. At the same time, however, we find that the total price of purchased prescription drugs dropped only in the first quarter of the post-introduction period and then returned to previous levels with a growing trend. We explore determinants of this seeming inconsistency and identify three important behavioral responses to the cost-sharing. First, we find evidence of strategic timing behavior, estimating that people stocked-up on their medications in advance by almost 50% of the monthly pre-reform level of prescriptions. Second, since the copayment was paid on a per prescription basis, the average number of packages per prescription increased by 14%. Finally, the price composition of purchased drugs changed as physicians started to prescribe more expensive drugs. We show that while the segment of cheapest prescription drugs (less than 30 CZK per package) plummeted by 60% (23% in total price), the segment of high-cost drugs (more than 300 CZK per package) grew by more than 6%.We also analyze the effects of policy reversal. We found no level response to the start of reimbursement, however, we found an increase in the linear trend. This implies that while a reaction to the introduction of copayments was an immediate drop in consumption, people reacted to their reimbursement by a gradual adjustment. The magnitude of this effect is lower compared to the introduction of reform also because only a small subset of pharmacies owned by regional governments was reimbursing the copayments.

To analyze the effect further, we looked into the separate reactions of different age groups. The reaction of different age groups to the reform, however, has been strikingly similar. The only difference can be traced in their further development - while younger cohorts were gradually increasing utilization, older patients remained at the post-reform levels. Patients decided to forego those types of drugs that did not cause immediate worsening of health status (e.g. drugs for high cholesterol or diuretics, and life style maintenance drugs like immunostimulants, products against joint / muscle pain or analgesics). While this decision can be considered a rational outcome of individual cost-benefit analysis, long-term health effects (mainly due to decreased demand in the category of chronic treatment drugs) are yet to be determined. In general, our study confirms that even patients from the highly sensitive subpopulation are willing to change their behavior in response to external stimuli, and that these changes have predictable patterns.

## 2. Review of related literature

The seminal base for the evaluation of the effects of the patient cost-sharing on both medical care utilization and health outcomes are the results of the RAND Health Insurance Experiment (summarized in Manning et al. (1987) and Newhouse (1993)). In the late 1970's the US government funded a large scale social experiment where participating families were randomly assigned to plans with different levels of copayments and deductibles. The main findings that are important for our study are that (1) cost-sharing matters and (2) the price sensitivity of drug utilization to prescription drug copayments is fairly strong.

[4] According to the OECD (2011) the ratio of average pension to average net wage is 64% (for men). This is an average percentage among OECD countries, with Greece and Hungary having the highest and Ireland and Mexico the lowest pensions relative to their respective average net wage.

With expansion of health maintenance organizations (HMO's) in the US and adoption of similar cost-containment measures in the health care systems of other countries, the literature evaluating these measures has expanded. Recently, much attention has been given to prescription drugs.[5] Goldman et al. (2004) and Landsman et al. (2005) both look at the outcomes of natural experiments in the prescription drug coverage and confirm a significant elasticity with respect to price. They find that the price elasticity differs with different type of drugs - from low elasticity of utilization of drugs treating chronic conditions (- 8% for antidepressants and - 10% for antihypersensitives) to higher elasticity of utilization of treatments for acute diseases (-45% for anti-inflammatory drugs and -44% for antihistamines). Both of these studies, however, were done on samples of non-elderly patients.

Rice and Matsuoka (2004) review studies that focus on the elderly. Most of these studies used cross-sectional data to identify the effect of cost-sharing either directly on health outcomes (Kennedy and Erb 2002; Pilote et al. 2002) or on the degree of "appropriateness" of medical services utilization (Tamblyn et al. 2001). The research designs of existing studies, cross section or simple before and after comparison, did not allow the researchers to control for underlying trends in drug utilization. As the one exception, Johnson et al. (1997) use the quasi-experimental design of comparing the health status indicators of HMO enrollees who experienced an increase in drug copayments with enrollees of different HMO who did not. They do not find any significant effect. Most recently, Chandra, Gruber, and McKnight (2010) used a natural experiment of changes in elderly patients' cost-sharing with both variation over time and across plans. They not only estimated the elasticities of prescription drug demand, but also provide the first sound evidence on the existence of offset effects (specifically higher hospitalization rates), mainly for the sickest population with chronic diseases.

The first academic study that quantified the effects of the health care 2008 reform in the Czech Republic was conducted by Zápal (2010). He exploits variation created by the legislative waiver that in April 2009 abolished copayments for children aged 0-18 years to measure the effect on health care utilization. He uses data on drug sales from a pharmacy as a proxy for the number of doctor's visits, finding no effect of the reform. He also points out a strong strategic timing effect, with the suggestive evidence of postponing of physician visits after the start of waiver. However, his dataset consists of data from only one Prague pharmacy and the length of the dataset is very limited. The same natural experiment has been utilized by Votapkova and Zilova (2012), who used data from EU-SILC survey and looked at the change in the number of doctor visits in the year after copayments for children were abolished.

One year after introduction of the copayments in 2008, the Ministry of Health of the Czech Republic prepared a non-technical evaluation document summarized at the March 2009 press release (MHCR 2009). They conclude that regulatory copayments brought yearly savings of 10 billion CZK which were further used to finance the high-cost-treatment of severely ill patients. They also report a 30% drop in the number of (filled) prescribed items and a 21% drop in the number of purchased drug packages.

## 3. Institutional Background

Prior to the reform, the Czech public health insurance system provided complete coverage. The level of cost-sharing by patient was very low (around 10%) and consisted solely of the supplementary payments for prescription drugs (i.e. no copayments)[6]. Expenditures on prescription

[5] Mainly in the context of information used for design of Medicare Prescription Drug Coverage (part D) within the US system of insurance for elderly - Medicare.

[6] Within the Czech health insurance system, part of the price for a prescription drug is paid by an insurance company (reimbursement), and part by a patient (supplementary payments). The ratio varies with the price of the drug, with more expensive drugs being more generously reimbursed.

drugs and medical aids together accounted for approximately 60 billion CZK paid from the public health insurance system per annum.[7] The estimated value of unused and expired drugs was between 4 and 10 billion CZK annually, i.e. 6 - 16 % of the total expenditures on health care (MHCR 2008). Moreover, the Czech Republic had the highest number of physician visits per person in the EU, at 13 visits per year (MHCR 2008). According to anecdotal evidence some of the physician visits were undertaken solely to get a prescription. Ministry of Health claimed that the system of drug prescription and reimbursement was inefficient and that without a reform its financing would be unsustainable in the long term.

On August 21, 2007, the Czech Parliament approved reform of the health care system as part of its comprehensive reform of public finance. The main goal was to establish appropriate incentives on both demand and supply sides of the health care market, thereby controlling costs and enhancing the efficiency of the system as a whole. To achieve this goal, on January 1, 2008, the Ministry of Health of the Czech Republic introduced mandatory cost sharing in the form of lumpsum copayments for several types of health care services including physician office visits (30 CZK), each prescription for drugs (30 CZK), emergency room visits (90 CZK) and each day of hospitalization / institutional care (60 CZK). The patient was obliged to pay 30 CZK for each drug prescribed, regardless of the number of packages purchased. For the prescription drugs fully paid by the patient (e.g. contraception) the copayment was naturally not applicable.

The main function of the copayments was intended to be regulatory and behavioral. In the case of prescription copayment, the declared intention of policymaker was to lower the total number of prescriptions, with particular focus on low-priced drugs that were also available for the over-the-counter purchase.[8] The additional resources in the system, coming either from savings or from the copayments themselves, were supposed to be used to improve treatment of high-severity illnesses and to finance high cost life-saving medications.

It is important to note that several other changes were made in the system of reimbursement of drugs from the universal health insurance. Value added tax (VAT) on drugs increased from 5% to 9%, effective from January 1, 2008. The reimbursement amounts from the insurance companies have not changed, however, and there was a change in the regulation of profit margins of pharmacies on the prescribed drugs. These steps have prevented the VAT increase being directly reflected in the final price of the drug, i.e., VAT increase was mostly absorbed in the profit margins of pharmacies.

The introduction of patient cost-sharing became one of the main topics of the 2008 election for regional councils, which took place in 13 out of 14 regions of the country (excluding Prague). Newly established regional governments pledged to mitigate the effects of health reform on citizens by reimbursing the copayments for treatment in regional government-owned health centers/hospitals from their own regional budgets.[9] Stredocesky kraj started to reimburse copayments on January 1, 2009, followed by the other 12 regions from February 2, 2009. The capital city of Prague (the largest region) has never started to reimburse copayments. Some regions only reimbursed selected types of copayments - for example Zlinsky kraj reimbursed ambulance copayments, but did not reimburse ER copayments, or copayments for prescription drugs. This has resulted in great variation in the ratio of reimbursed copayments among the regions (for details on the reimbursement policies of individual regions see Table 1).

[7] The exchange rate was 24.942 CZK/EUR in 2008 and 26.445 CZK/EUR in 2009.

[8] Contrary to common practice in the US, some drugs can be both prescribed and sold over the counter in the Czech Republic.

[9] Different regions decided to implement different types of reimbursement, for example in Stredocesky kraj the patient had to agree (verbally) with the reimbursement of copayment by the region, in Jihocesky kraj the patient had to sign an agreement that he obtained a gift from the regional government, while in Plzensky kraj the patient had to pay the copayment himself and then claim a reimbursement by post.

**Table 1: Overview of regional reimbursement policies**

| Region | Start of reimbursement | Reimbursement of drug copayments | Type of agreement | % of reimbursed copayments | Number of reimbursing pharmacies |
|---|---|---|---|---|---|
| Praha | never | NO | NA | NA | NA |
| Stredocesky | 1.1 2009 | Yes | oral | 95 % | 5 |
| Jihocesky | 1.2 2009 | Yes | written | 70 % | 7 |
| Plzensky | 1.2 2009 | Yes | ex-post | 25 % | 3 |
| Karlovarsky | 1.2 2009 | Yes | oral/written | 63 % | 1 |
| Ustecky | 1.2 2009 | Yes | written | 40 % | 4 |
| Liberecky | 1.2 2009 | Yes | written | 51 % | 2 |
| Kralovehradecky | 1.2 2009 | Yes | oral/written | 65 % | 3 |
| Pardubicky | 1.2 2009 | Yes | written | 46 % | 5 |
| Vysocina | 1.2 2009 | Yes | written | 60 % | 5 |
| Jihomoravsky | 1.2 2009 | Yes | written | 65 % | 4 |
| Olomoucky | 1.2 2009 | Yes | written | 65 % | 3 |
| Zlinsky | 1.2 2009 | NO | written | 25 % | 4 |
| Moravskoslezsky | 1.2 2009 | Yes | written | 45 % | 8 |

With respect to copayments on prescription drugs, 12 regions (excluding Zlinsky kraj and Prague) have decided to reimburse copayments in pharmacies affiliated with the hospitals and medical centers owned by regional governments (in total 53 pharmacies out of approximately 2400 in the country). Several private pharmacies, including the biggest private chain of pharmacies (with an estimated 120 affiliated pharmacies), have reacted by introducing compensation of copayments in various forms, such as deductions from the price of purchase or gift certificates. They heavily advertised this measure, arguing that if they had not taken it, they would be pushed out of the market. The magnitude of the reimbursement, however, generally corresponded to the reimbursement policy of each particular region.

The institutional set-up of the reform and their reversal created sufficient variation to identify the causal effect of copayments on the utilization of prescription drugs. In particular, it allows us to shed light on the behavioral responses of patients (and physicians) to the introduction of copayments, and the effect of these responses on the efficiency of the new policies.

## *4. Data and Methodology*

We use unique individual level panel data obtained from the major Czech public health insurance company, which currently covers approximately 64% of the population of the Czech Republic. The data spans the period 2006-2009, i.e. two years before the introduction of copayments, one year of their existence and one year after they began to be reimbursed in the regional government-owned medical facilities.

Our sample consists of a balanced panel[10] of 332,724 enrollees older than 64 years, which represents 5% of all enrollees of the health insurance company and 29% of its enrollees older than 64 years of age. The insurance company that provided us with the data is for historical reasons serving more than 77% of the whole elderly population in the Czech Republic. The sample was randomly selected from all elderly enrollees. This allows us to claim that our results give a representative picture of the drugs utilization patterns among the elderly in all regions of the Czech Republic.

Our data provide information about all prescribed drugs, materials and medical aids that enrollees utilized throughout the period of coverage, including both drugs provided at hospitals and physician offices, and drugs purchased by prescription at pharmacies. For our analysis in this paper

[10] Our dataset consist only of enrollees who were continuously insured at given health insurance company during the entire 4 years. In our analysis we thus do not consider people who changed insurers in the given time period, or have deceased. Even though this might bias results, we argue this would be a downward bias and thus our results provide a lower bound for the estimates.

we focus on prescription drugs collected at pharmacies, because only these were affected by the introduction of copayments, and we disregard the drugs provided in hospitals and during other inpatient admissions. [11] Information in our dataset includes identification of general type of drug (the first three digits of ATC nomenclature[12]), number of packages, date of purchase, identification of the physician who prescribed the drug, identification of the pharmacy and the final price of the drug.

We construct four utilization measures: (1) number of prescriptions filled at pharmacies, (2) total price of purchased prescription drugs[13], (3) total number of packages of prescription drugs purchased, and (4) average number of packages per prescription. We then compute the total of each utilization measure for each cohort in each region, year and month, separately for males and females, which yields 46,977 observations in our final dataset.

To quantify the magnitude of the causal effect of the introduction of copayments, we estimate the speci_cation of the form:

$$\begin{aligned} \text{util}_{crmy} = \; & \alpha + \beta_1 \text{reform}_{my} + \beta_2 \text{reversal}_{rmy} + \gamma_1 \text{trend}_{my} + \gamma_2 \text{trend\_after}_{my} \\ & + \gamma_3 \text{trend\_reverse}_{my} + \delta_1 \text{M(-3)}_{my} + \delta_2 \text{M(-2)}_{my} + \delta_3 \text{M(-1)}_{my} + \delta_4 \text{M(1)}_{my} \\ & + \delta_5 \text{M(2)}_{my} + \delta_6 \text{M(3)}_{my} + \rho \text{male}_{rmy} + \omega_1 \text{cohort} \quad + \omega_1 \text{cohort}^2 + \theta_r \; + \varphi_m \\ & + \varepsilon_{crmy} \end{aligned} \tag{1}$$

where $\text{util}_{\text{crmy}}$ is selected utilization measure (in logs) for cohort c in region r, month m and year y, and $\text{reform}_{\text{my}}$ is a dummy variable indicating time after introduction of copayments (i.e. Jan08 - Dec09). Variable $\text{reversal}_{\text{rmy}}$ is zero for the period before the start of reimbursement, while afterwards it takes on the values of the share of copayments that were actually reimbursed in the given region (Jan/Feb09 - Dec09, reimbursement shares available in Table 1. Therefore, we interpret $\beta_1$ as the level percentage change in selected utilization measure after the introduction of copayments, and $\beta_2$ as additional percentage change after copayments started to be reimbursed by regional governments. We control for linear trend in utilisation corresponding e.g. to ageing and increasing health care needs of our cohorts, as well as for possible changes in trends both after introduction and reversal of the policy.

We also account for the possible strategic timing of drug purchases (stockpilling of drugs just before the launch of reform) by introducing the dummy variables $\text{M}(-3)_{\text{my}}$ - $\text{M}(3)_{\text{my}}$ indicating separately three months before and after copayment introduction.[14] We thus capture a persistent (robust) change in the utilization patterns, rather than one-time shift in the timing of prescription collection. We also estimate an alternative specification without these controls, to demonstrate the importance of this phenomenon and its effects on the evaluation of the reform.

[11] One could thus argue that part of the estimated effect was offset by an increase in the drugs provided in physician offices and hospitals. Nevetheless, this form of provision accounts for only around 9% of all drugs, the rest being prescriptions. Moreover, while the raw number of prescriptions dropped by 29% between 2007 and 2008, the amount of drugs provided by physicians grew by only 4%, which is less than the growth in the previous year (7%).

[12] The Anatomical Therapeutic Chemical (ATC) Classification System is used for the classification of drugs. It is controlled by the WHO Collaborating Centre for Drug Statistics Methodology (WHOCC).

[13] Regarding the total expenditure on purchased drugs, it is important to distinguish expenditures on the price of drugs and expenditures on copayments. In our analysis, we decided to omit the latter, as they are a simple multiplication of the number of prescriptions times 30, and their inclusion would distort information on the change in price composition of the purchased drugs.

[14] The three months period was chosen based on the visual inspection of data.

Other control variables included are a quadratic polynomial of cohort (age as of 2006), region and month fixed effects $\omega_c$ , $\theta_r$ and $\varphi_m$ and a gender dummy. We cluster by regions, to allow both for autocorrelation and heteroskedasticity in residuals.[15]

We first estimate both standard and alternative specification without stockpilling dummies on the full sample. Then we use the standard specification to separately estimate effects for six price categories (based on price per one package): drugs priced 0 - 30 CZK (the most affected group of drugs, as the copayment is higher than their price), 30 - 60 CZK, 60 - 100 CZK, 100 - 300 CZK, 300 - 1300 CZK and more than 1300 CZK[16]. By tracking changes in the price composition of drugs, we can detect whether the prescription behavior of physicians has changed (e.g. they might prescribe fewer low-cost drugs and more high-cost drugs).[17]

Next, we estimate the regression separately for different age groups of patients, to describe how the patterns of utilization change with rising age. We divided patients into 5 age groups: younger than 70 years, 70-74 years, 75-79 years, 80-84 years and 85+. Finally, we want to assess whether the copayments affected consumption of different drug categories differently, in particular whether there was a different reaction with respect to acute treatment vs. chronic treatment drugs. Therefore, we estimate the regression separately for each of 82 available ATC groups (2nd level).[18]

# 5. Results

## 5.1. Estimation on aggregate data

A basic description of the sample as well as of trends in the utilisation of prescription drugs in the analyzed period can be found in the Figure 1 and Table 2. Table 2 provides additional information about the age, gender and regional composition of the sample and summary statistics of both important utilisation measures: the number of prescriptions as well price of drugs purchased. Observed trends are in line with general intuition. There has been an increasing share of women in older cohorts, consistent with higher life-expectancy of women and thus higher probability of remaining in a balanced sample. The share of cohort categories on the total sample population remains constant over the years, indicating a fairly similar response of utilisation to reform. We observe substantial variation in utilisation across regions, Prague being the outlier with the lowest number of prescriptions yet the highest price of drugs purchased per person. Nevertheless, on all levels of categorisation we can observe a drop in the number of prescriptions as well as number of packages after introduction of copayments.

**Table 2: Summary statistics of the sample of patients purchasing prescriptions drugs over 2006-2009, by age category and NUTS.**

| Age group | % share on total | female (%) | Prescriptions (per person) 2006 | 2007 | 2008 | 2009 | Price of purchased drugs (per person) 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| <70 | 40 | 57 | 24.6 | 26.3 | 19.1 | 21.1 | 7,140 | 7,840 | 7,990 | 9,330 |
| 70-74 | 23 | 61 | 30.3 | 32.4 | 23.0 | 25.1 | 7,980 | 8,810 | 8,820 | 10,240 |
| 75-79 | 20 | 65 | 34.1 | 36.0 | 25.2 | 27.0 | 7,930 | 8,720 | 8,560 | 9,860 |
| 80-84 | 12 | 71 | 36.1 | 37.5 | 26.2 | 27.4 | 7,330 | 8,950 | 7,790 | 8,620 |
| 85+ | 5 | 75 | 36.3 | 37.0 | 25.5 | 26.0 | 6,310 | 6,550 | 6,240 | 6,830 |

[15] We considered using GLS to account for autocorrelation and heteroskedasticity, however, estimated standard-errors were similar to the OLS estimation with clustering. Bertrand, Duflo and Mullainathan (2004) explain the problems stemming from autocorrelation and heteroskedasticity in difference-in-difference estimates.

[16] Drugs with price higher than 1300 CZK are the top percentile in the price distribution of drugs in the year 2006. In this category, therefore, we capture the trends in prescription of high-cost drugs.

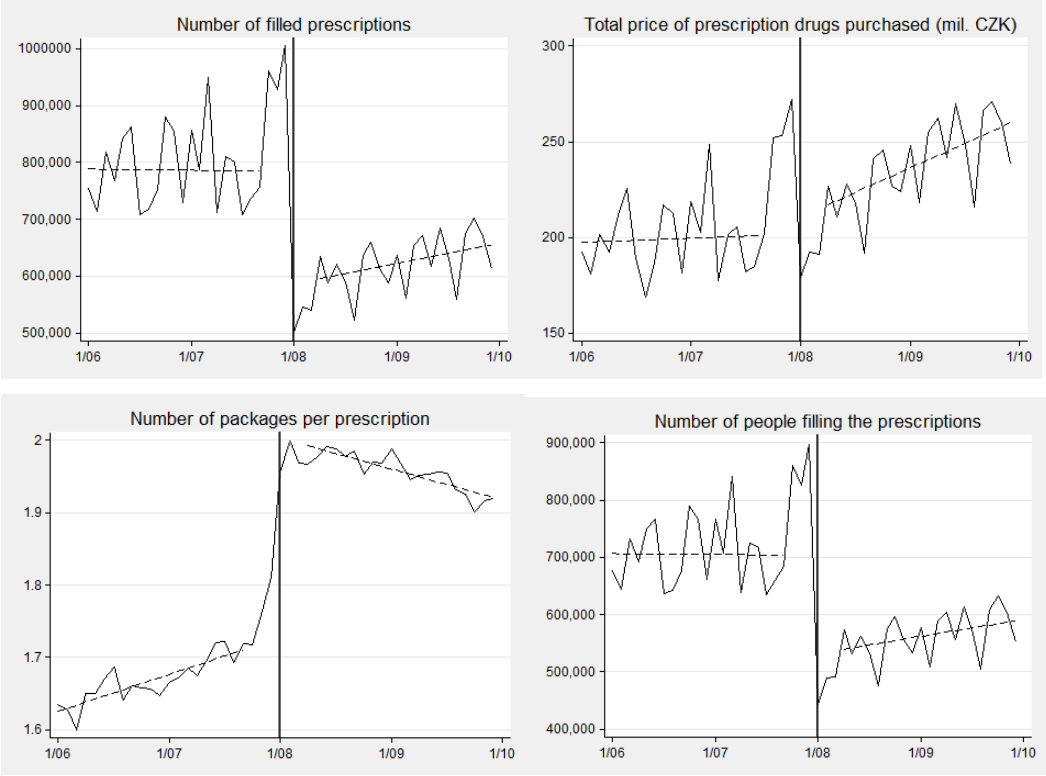
[17] In the system in which more expensive drugs are usually fully reimbursed, physicians may opt for more expensive drugs, effectively lowering the total amount of payments that patient has to make (supplementary payment for drug plus lump sum copayment).

[18] We have excluded groups with fewer than 50 prescriptions, effectively omitting 12 categories.

| Region | pharmacies | patients | Prescriptions (per person) | | | | Price of purchased drugs (per person) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2006 | 2007 | 2008 | 2009 | 2006 | 2007 | 2008 | 2009 |
| Praha | 472 | 64,755 | 23.2 | 24.2 | 18.0 | 19.3 | 7,230 | 7,750 | 8,030 | 9,170 |
| Stredocesky | 269 | 50,015 | 24.1 | 25.1 | 18.3 | 19.7 | 5,330 | 5,800 | 5,840 | 6,800 |
| Jihocesky | 191 | 31,224 | 26.3 | 28.1 | 20.4 | 21.9 | 6,090 | 6,710 | 6,840 | 7,850 |
| Plzensky | 132 | 23,069 | 26.1 | 27.5 | 20.0 | 21.3 | 7,020 | 7,610 | 7,670 | 8,710 |
| Karlovarsky | 102 | 12,401 | 27.3 | 28.7 | 21.0 | 22.7 | 6,540 | 7,110 | 7,160 | 8,470 |
| Ustecky | 204 | 32,676 | 25.9 | 27.1 | 20.1 | 21.7 | 6,150 | 6,630 | 6,900 | 7,920 |
| Liberecky | 118 | 20,431 | 25.6 | 26.8 | 18.8 | 20.3 | 5,870 | 6,310 | 6,380 | 7,310 |
| Kralovehradecky | 149 | 25,915 | 26.5 | 27.9 | 20.4 | 21.9 | 6,860 | 7,250 | 7,520 | 8,560 |
| Pardubicky | 154 | 25,616 | 26.0 | 27.6 | 20.3 | 22.1 | 6,390 | 7,110 | 7,180 | 8,420 |
| Vysocina | 122 | 22,806 | 25.8 | 27.3 | 20.0 | 21.4 | 6,030 | 6,660 | 6,180 | 7,920 |
| Jihomoravsky | 361 | 46,834 | 28.7 | 30.1 | 21.3 | 22.7 | 7,400 | 8,150 | 8,330 | 9,300 |
| Olomoucky | 157 | 24,957 | 27.4 | 28.8 | 20.5 | 22.0 | 6,900 | 7,450 | 7,510 | 8,530 |
| Zlinsky | 160 | 26,228 | 28.1 | 29.8 | 21.1 | 22.6 | 6,490 | 7,160 | 7,280 | 8,290 |
| Moravskoslezsky | 302 | 34,918 | 28.8 | 30.5 | 21.7 | 23.7 | 7,030 | 7,760 | 7,840 | 9,200 |

Figure 1 depicts the evolution of different utilisation measures over time, and illustrates the direction and magnitude of change after the implementation of copayments. We observe a peak in the total number of filled prescription items one quarter before introduction, while immediately after these numbers dropped and remained at the lower levels for the next two years. On the other hand, the total price of purchased prescription drugs decreased only temporarily, and resumed growing at increasing rates afterwards. There is a discontinuous jump in the average number of packages per prescription, indicating that prescription of additional packages was a common behavioral response to the reform. Finally, we find that fewer visits to pharmacies have been made by people to fill prescriptions.[19]

**Figure 1: Overview of aggregate utilisation measures, including linear fit before and after reform (1.1.2008)**




[19] While there is an evident effect of the introduction of copayments, the question of how individual copayments interacted to cause this effect remains. An analysis of this issue can be provided on demand from authors.

These observations were confirmed by the results of our estimation, summarized in Table 3. In panel A we show a robust 29 % level decrease in the **number of prescriptions** filled in the post-introduction period.[20] After the start of reimbursement we observe an increasing trend in the number of prescriptions filled, corresponding to a gradual return of patients to their pre-reform utilisation patterns.

We would like to stress, however, the extent of the **stockpiling effect** and its implications for policy evaluation. Patients were well-informed about the timing of reform and were able to use the opportunity to save money by asking their physicians to prescribe more drugs before its onset. According to our estimates, during the three months before introduction of reform people stocked up (cumulatively) almost 50% of the pre-reform monthly level of prescriptions, which almost perfectly corresponds to the relative drop in the first quarter after introduction. Comparing the results of two specifications in the Table 3 panel A, we see that without accounting for the strategic timing we would overestimate the overall effect by 12.5%, i.e., by more than a third of its actual value.

**Table 3: Effect of introduction and consequent reimbursement of copayments on the utilisation of prescription drugs**

| Region | A. of prescriptions | | B. Price of drugs | | C. # of packages | | D. Packages/prescription | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (1) | (2) | (1) | (2) | (1) | (2) |
| Reform | -0.411*** | -0.285*** | -0.144*** | 0.014 | -0.268*** | -0.125*** | 0.143*** | 0.160*** |
| | (0.017) | (0.021) | (0.018) | (0.023) | (0.016) | (0.020) | (0.005) | (0.006) |
| Reversal | 0.030 | -0.008 | 0.070** | 0.019 | 0.039 | -0.005 | 0.009 | 0.003 |
| | (0.028) | (0.031) | (0.027) | (0.030) | (0.029) | (0.029) | (0.010) | (0.010) |
| Trend | 0.003*** | 0.000 | 0.005*** | 0.001* | 0.006*** | 0.002*** | 0.003*** | 0.002*** |
| | (0.001) | (0.000) | (0.001) | (0.001) | (0.001) | (0.000) | (0.000) | (0.000) |
| Trend_after | 0.002 | 0.000 | 0.007*** | 0.005** | -0.002 | -0.003** | -0.004*** | -0.004*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.001) | (0.001) | (0.001) |
| Trend_reverse | -0.002 | 0.007** | -0.007** | 0.003 | -0.003 | 0.006** | -0.002** | -0.001 |
| | (0.002) | (0.003) | (0.003) | (0.003) | (0.003) | (0.002) | (0.001) | (0.001) |
| M(-3) | | 0.090*** | | 0.130*** | | 0.100*** | | 0.010** |
| | | (0.006) | | (0.016) | | (0.009) | | (0.005) |
| M(-2) | | 0.100*** | | 0.158*** | | 0.133*** | | 0.033*** |
| | | (0.018) | | (0.018) | | (0.018) | | (0.004) |
| M(-1) | | 0.267*** | | 0.330*** | | 0.325*** | | 0.058*** |
| | | (0.014) | | (0.017) | | (0.014) | | (0.003) |
| M(1) | | -0.201*** | | -0.228*** | | -0.233*** | | -0.032*** |
| | | (0.023) | | (0.030) | | (0.023) | | (0.006) |
| M(2) | | -0.017 | | -0.042* | | -0.018 | | -0.001 |
| | | (0.017) | | (0.022) | | (0.017) | | (0.004) |
| M(3) | | -0.200*** | | -0.229*** | | -0.200*** | | 0.000 |
| | | (0.013) | | (0.019) | | (0.014) | | (0.005) |
| R2 | 0.941 | 0.942 | 0.937 | 0.938 | 0.938 | 0.939 | 0.350 | 0.353 |
| N | 46, 977 | 46, 977 | 46, 977 | 46, 977 | 46, 977 | 46, 977 | 46, 977 | 46, 977 |

**Note:** Each panel shows results of regressions of different dependent variables (in logs) under two specifications: (1) baseline regression controlling for level and trend effect of introduction of copayments and reversal; (2) regression with controlling for the timing effect 3 months before and 3 months after introduction of copayments. All regressions control for region, month and fixed effects, gender, as well as cohort effects (quadratic specification) ; SE are clustered on the level of regions. ***,** and * denote significance at 1%, 5% and 10% level; standard deviations are in the brackets

[20] We performed a robust check on our results using the subsample of prescriptions purchased by citizens with residence in different regions, to account for cross-region travelling after the introduction of reimbursement. Nevertheless, results for this subsample were similar to the aggregate results and we have not estimated significant change in the proportion of out-of-region clients after the reform, or its reversal. For detailed results, please contact authors.

While quantity of prescriptions conveys information about patients' visits to physician and its change vis-a-vis the reform, the **number of packages** is more indicative of their actual drug utilization. In Table 3 panel C we report a post-introduction drop in the number of packages purchased by 13% accompanied by significant decrease in growth (-0.3% a month). Response to reimbursement can again be traced to the increase in the growth rate. We detect an even higher stockpiling effect than by prescriptions, cumulatively at 55% of pre-reform values.

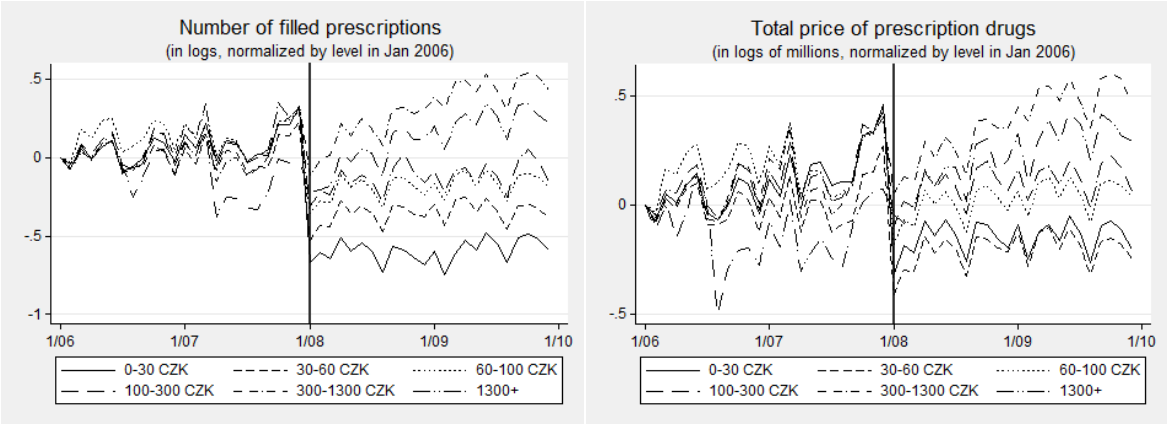
Stockpiling behavior motivated us to look at the evolution of the **number of packages per prescription**. We inferred that as the number of prescribed packages is not effectively limited, the rational response would be to increase it to the maximum extent possible given the expiration date. Indeed, we find a significant increase in the number of packages per prescription estimated at 16% (Table 3, panel D). After the start of reimbursement we observe a trend reversal (-0.2% per month), which leads us to infer that this behavioral response is fairly persistent over time. Estimates of the stockpiling effect confirm our assumption that patients have both stocked up on prescriptions before the reform, and have also obtained prescriptions for more packages.

Finally, we look at the **total price** of prescribed drugs. Estimates endorse visual observation from the Figure 1, where after accounting for the stockpilling effect and consequent offset in utilisation neither reform nor reversal had significant level effect on the total price of prescribed drugs. Comparing columns (1) and (2) in panel B of Table 3 we see that accounting for stockpiling changed the sign of the estimated effect from a decrease (which was communicated by Ministry in media) to an actual increase. On the other hand, we see that after introduction of copayments the trend became significantly steeper (+0.5% per month).

## 5.2. Price composition of purchased drugs

Growing expenditures on a decreasing number of drug packages (and even lower number of prescriptions) present an interesting paradox, which leads to speculation that the price composition of the drugs prescribed changed. Therefore, we have categorized drugs with respect to their unit price (per package) and estimated the effect of copayments on each group separately. Figure 2 depicts the evolution of the number of prescriptions as well as total price of these drugs over time separately for each price group. To simplify comparison, we present variables in the logs, normalized by the log level in January 2006, i.e., as percentage differences from the initial value. Results of estimation are summarized in Table 4a and 4b, panels A-D.

**Figure 2: Evolution of total number and price of filled prescriptions, by price per package**




The copayments should primarily affect the prescription of cheaper drugs. Those drugs with a price lower than the copayment of 30 CZK should be particularly sensitive, and, therefore, the patient is better off by directly purchasing the drug over-the counter. Although some lower priced drugs that are available only by prescription (e.g. antidepressants) exist, if they are fully paid by the patient the

copayment does not apply. Indeed, our data confirm that the number of packages as well as total price of this group of drugs has decreased discontinuously since the introduction of copayments. In Table 4, panel A we show that the number of prescriptions dropped by 61%. The start of reimbursement then seems to reverse the decreasing utilisation trend.[21]

**Table 4a: Effect of introduction and consequent reimbursement of copayments on the utilisation of prescription drugs**

| | A. Total Prescriptions (log) | | | | | |
|---|---|---|---|---|---|---|
| | **<30 CZK** | **30-60 CZK** | **60-100 CZK** | **100-200 CZK** | **300-1300 CZK** | **>1300 CZK** |
| Reform | -0.608*** | -0.296*** | -0.261*** | -0.186*** | 0.063** | 0.183*** |
| | (0.030) | (0.024) | (0.021) | (0.015) | (0.027) | (0.016) |
| Reversal | -0.064 | -0.012 | 0.007 | -0.015 | 0.086* | 0.045 |
| | (0.046) | (0.031) | (0.028) | (0.029) | (0.042) | (0.026) |
| Trend | 0.003*** | -0.001 | -0.002*** | 0.001** | 0.003** | -0.015*** |
| | (0.001) | (0.001) | (0.000) | (0.001) | (0.001) | (0.001) |
| Trend_after | -0.009** | -0.001 | 0.000 | -0.002 | 0.011*** | 0.026*** |
| | (0.003) | (0.002) | (0.002) | (0.001) | (0.001) | (0.002) |
| Trend_reverse | 0.019*** | 0.005 | 0.007*** | 0.007** | -0.002 | 0.000 |
| | (0.004) | (0.003) | (0.002) | (0.002) | (0.003) | (0.002) |
| R2 | 0.921 | 0.927 | 0.933 | 0.939 | 0.928 | 0.733 |
| N | 45,430 | 45,540 | 44,145 | 45,626 | 41,924 | 33,169 |
| | **B. Total Price of Purchased Drugs (log)** | | | | | |
| | **<30 CZK** | **<30 CZK** | **<30 CZK** | **<30 CZK** | **<30 CZK** | **<30 CZK** |
| Reform | -0.228*** | -0.119*** | -0.115*** | 0.001 | 0.057* | 0.228*** |
| | (0.024) | (0.023) | (0.020) | (0.017) | (0.031) | (0.024) |
| Reversal | -0.060 | -0.024 | 0.025 | 0.012 | 0.099** | 0.006 |
| | (0.040) | (0.025) | (0.025) | (0.029) | (0.043) | (0.031) |
| Trend | 0.006*** | -0.002** | 0.000 | 0.002*** | 0.007*** | -0.002 |
| | (0.001) | (0.001) | (0.000) | (0.001) | (0.001) | (0.001) |
| Trend_after | -0.012*** | 0.000 | -0.002 | -0.004*** | 0.005*** | 0.016*** |
| | (0.002) | (0.002) | (0.002) | (0.001) | (0.001) | (0.002) |
| Trend_reverse | 0.010*** | 0.004 | 0.007*** | 0.006** | -0.001 | 0.000 |
| | (0.003) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) |
| R2 | 0.904 | 0.919 | 0.925 | 0.936 | 0.917 | 0.686 |
| N | 45,430 | 45,540 | 44,145 | 45,626 | 41,924 | 33,169 |

Contrary to aggregate results, in this group the total price has persistently dropped by almost 23%. It is smaller than a drop in the number of filled prescriptions, which can be explained by 24% increase in the number of packages per prescription. We thus can conclude that for the category of drugs with a unit price lower than 30 CZK, the reform had the intended effect of decreasing both utilization and expenditures on drugs from the perspective of public insurance. Nevertheless, we cannot infer anything about the amount of drugs purchased over the counter and related expenditures. Moreover, even though drugs under 30 CZK represent around 20% of all packages sold, they constitute only 2-3% of the total price of prescription drugs purchased.

Within the category of cheaper drugs (under 300 CZK), we originally singled out drugs with unit price 30-60 CZK as in this category the price of drug corresponds to the copayment for prescription plus copayment for the physician visit. Yet, the results are very similar to categories 60-100 CZK and 100-300, thus we will comment on them together. We found a persistent drop in both the number of prescriptions filled (30, 26% and 19%, respectively) and a smaller drop in the total price (12, 12, and 0%). This is, however, a much weaker response than in the category of the cheapest drugs. Reimbursement that began in 2009 primarily affected long-term trends, indicating

[21] One could argue, however, that a deeper drop was expected, as prescription of this group of drugs is irrational. We therefore performed a robust check of this estimation using as dependent variable the total price for the prescription (because the prescription could be still rational if more than one package was prescribed). Results confirmed our intuition, with an estimated 88% drop.

that patients return to their pre-reform utilisation. In summary, in the broader category of drugs cheaper than 300 CZK, we confirm a discontinuous drop in utilization, consistent with the intentions of the reform. This broader category represents more than 90% of total purchased packages, however, only 50% of total price.[22] Yet, the results are striking, because as numerous pharmacists have commented by in media, the reform did not effectively changed the total purchase price for the patient, as the 30 CZK copayment was absorbed by the lower supplementary payment of the patient.

**Table 4 (cont): Effect of introduction and consequent reimbursement of copayments on the utilisation of prescription drugs**

| | C. Total Number of Packages (log) | | | | | |
|---|---|---|---|---|---|---|
| | **<30 CZK** | **30-60 CZK** | **60-100 CZK** | **100-200 CZK** | **300-1300 CZK** | **>1300 CZK** |
| Reform | -0.364*** | -0.121*** | -0.113*** | -0.016 | 0.060** | 0.177*** |
| | (0.026) | (0.024) | (0.020) | (0.016) | (0.027) | (0.021) |
| Reversal | -0.061 | -0.021 | 0.016 | 0.008 | 0.120*** | 0.027 |
| | (0.046) | (0.027) | (0.025) | (0.029) | (0.033) | (0.029) |
| Trend | 0.007*** | -0.001* | 0.000 | 0.005*** | -0.001 | -0.003** |
| | (0.001) | (0.001) | (0.000) | (0.001) | (0.001) | (0.001) |
| Trend_after | -0.012*** | -0.002 | -0.003 | -0.007*** | 0.012*** | 0.015*** |
| | (0.003) | (0.002) | (0.002) | (0.001) | (0.001) | (0.002) |
| Trend_reverse | 0.013*** | 0.004 | 0.007*** | 0.006** | -0.000 | 0.001 |
| | (0.004) | (0.003) | (0.002) | (0.002) | (0.003) | (0.003) |
| R2 | 0.911 | 0.919 | 0.925 | 0.937 | 0.920 | 0.714 |
| N | 45,430 | 45,540 | 44,145 | 45,626 | 41,924 | 33,169 |
| | **B. Number of Packages per Prescription (log)** | | | | | |
| | **<30 CZK** | **<30 CZK** | **<30 CZK** | **<30 CZK** | **<30 CZK** | **<30 CZK** |
| Reform | 0.244*** | 0.175*** | 0.148*** | 0.170*** | -0.004 | -0.006 |
| | (0.010) | (0.005) | (0.008) | (0.005) | (0.008) | (0.015) |
| Reversal | 0.003 | -0.010 | 0.009 | 0.023* | 0.034 | -0.018 |
| | (0.014) | (0.011) | (0.013) | (0.012) | (0.019) | (0.032) |
| Trend | 0.004*** | -0.000 | 0.002*** | 0.004*** | -0.004*** | 0.012*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) |
| Trend_after | -0.003** | -0.001 | -0.003*** | -0.005*** | 0.001 | -0.011*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) |
| Trend_reverse | -0.006*** | -0.001 | 0.001 | -0.001 | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) |
| R2 | 0.474 | 0.211 | 0.245 | 0.469 | 0.155 | 0.141 |
| N | 45,430 | 45,540 | 44,145 | 45,626 | 41,924 | 33,169 |

**Note:** Each panel shows coeficients for different dependent variable for different price ranges. All regressions control for region, month and fixed effects, gender, as well as cohort effects (quadratic specification) ; SE are clustered on the level of regions. ***,** and * denote significance at 1%, 5% and 10% level, standard deviations are in the brackets

On the other hand, drugs with unit price higher than 300 CZK represent 50-60% of total price of prescription drugs, and the total number of packages in this group did not show any permanent decrease after the reform. Quite the opposite, for the drugs priced 300-1300 CZK, we estimate a 6% increase in the number of prescriptions in the period after reform accompanied by a significant increase in the trend. This translates into evolution of expenditures by 6% increase in total price after the start of reform and an additional 10% after reversal (again with increasing trend). We do not find evidence of a bundling effect in this category.

The increasing trend is even more pronounced in the category of drugs which represented the top 1% of expenditures in 2006, i.e. more expensive than 1300 CZK. Here we find an 18% increase in number of prescriptions accompanied by almost 1.5 percentage points / month increase in linear trend. The number of packages and total price of drugs follow very similar patterns. Again, a bundling effect is not present.

[22] After reform the ratios changed to a little above 80% and 40%, respectively

## *5.3.* Changes in the utilization of prescription drugs by age category

Our analysis of utilisation by age categories is motivated by the different health needs of individual age subgroups. Indeed, we see that patients older than 85 years file almost 50% more prescriptions per person than patients younger than 70 years. Interestingly, however, total price of their drugs only amounts to 90% of the bill of younger patients. Consequently, we ask whether these differences also imply different willingness and ability to cut down on utilisation.

In general, the magnitude of discontinuous jump in utilisation measures after the introduction of copayments is very similar for all age groups and thus correspond to overall values - 29% decrease in number of prescriptions and approx. 14% decrease in number of packages (with 14-18% increase in packages per prescription), with no significant change in the total price of purchased drugs.[23] The largest difference can be noted for the category of people older than 85 years - as they do not have a long-term trend of increasing utilisation (approx 0.3% per month) and after reimbursement they do not tend to converge to the pre-reform levels, but rather stay at lower post-reform levels.

We were interested in identifying the main driver of the differences between age-categories. First, we compared the price composition of the average "drug consumption basket" of different categories. However, we did not find significant differences. Therefore, we looked further into the utilisation of drugs from different treatment categories.

## 5.4. Effect of the reform on the utilization of selected drug categories

In the classification of drugs, we follow the Anatomical Therapeutic Chemical (ATC) classification system which has 14 main groups (1st level) with different pharmacological and therapeutic subgroups (2nd level). While in the dataset we observe 94 categories, for estimation we omitted 12 as having too few observations. For the illustration of general pattern, we have chosen categories that had one of the ten greatest shares in total utilisation of at least one age group in at least one year. In Table 6 we report the share of the given category on the total number of prescriptions for all age groups, and their estimated change after the reform.

**Table 6: Drug categories with greatest utilization drop (# packages) after introduction of copayments**

| ATC | Description | % share on total consumption | | | | | Estimated change in # of prescriptions | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | <70 | 70-74 | 75-79 | 80-84 | 85+ | <70 | 70-74 | 75-79 | 80-84 | 85+ |
| A02 | Drugs for acid related disorders | 2.6 | 2.5 | 2.7 | 2.9 | 3.2 | -0.135 | -0.152 | -0.145 | -0.087 | -0.040§ |
| A10 | Drugs used in diabetes | 4.7 | 4.1 | 4.1 | 1.3 | 1.7 | -0.117 | -0.129 | -0.147 | -0.091‡ | -0.040§ |
| B01 | Antithrombonic agents | 5.1 | 5.8 | 6.1 | 6.3 | 6.3 | -0.312 | -0.282 | -0.272 | -0.247 | -0.172 |
| C01 | Cardiac therapy | 2.8 | 4.1 | 5.3 | 6.6 | 8.0 | -0.110 | -0.088 | -0.066 | -0.038§ | -0.082‡ |
| C03 | Diuretics | 5.4 | 5.7 | 6.3 | 6.8 | 7.5 | -0.123 | -0.112 | -0.135 | -0.102 | -0.087† |
| C04 | Peripheral vasodilators | 2.0 | 2.6 | 3.1 | 3.8 | 4.6 | -0.177 | -0.129 | -0.126 | -0.053§ | -0.068§ |
| C05 | Vasoprotectives | 3.6 | 4.0 | 4.3 | 4.6 | 4.8 | -0.207 | -0.216 | -0.197 | -0.224 | -0.082 |
| C07 | Beta blocking agents | 7.3 | 6.8 | 6.3 | 5.7 | 4.8 | -0.129 | -0.110 | -0.126 | -0.092 | -0.012§ |
| C08 | Calcium channel blockers | 5.3 | 5.2 | 4.9 | 4.7 | 4.3 | -0.091 | -0.083 | -0.075 | -0.040 | -0.005 |
| C09 | Agents acting in Renin-angiotensin system | 11.0 | 10.3 | 9.8 | 9.3 | 8.5 | -0.033 | -0.029 | -0.041 | -0.020 | 0.020 |
| C10 | Lipid modifying agents | 6.2 | 5.4 | 4.4 | 3.1 | 1.8 | -0.088 | -0.104 | -0.091 | -0.079† | -0.103§ |
| M01 | Anti-inflamatory and anti-rheumatic products | 5.5 | 5.3 | 5.2 | 5.1 | 4.9 | -0.265 | -0.233 | -0.257 | -0.239 | -0.129 |
| N05 | Psycholeptics | 2.7 | 2.7 | 2.8 | 3.2 | 3.8 | -0.674 | -0.782 | -0.808 | -0.778 | -0.467 |
| N06 | Psychoanaleptics | 2.7 | 3.0 | 3.3 | 3.7 | 3.9 | -0.063 | -0.027 | -0.079 | -0.040 | 0.016 |
| R03 | Drugs for obstr. aerial disease | 2.6 | 2.6 | 2.4 | 2.1 | 1.9 | 0.077† | -0.078 | -0.091 | -0.067‡ | 0.051‡ |

**Note:** Categories were chosen by the drop estimated for the age category of people younger than 70. Dependent variable is number of packages, all regressions control for county and month fixed effects and adjust for stock pilling; SE are clustered on the level of regions. Estimates are all significant at 1% level, if not stated otherwise († - at 5%, ‡ - at 10%, § - not stat. significant)

[23] Results are available upon request from authors.

The biggest share of all utilised prescription drugs in most age categories was for drugs for the cardiovascular system (group C). in terms of age structure, while for patients under 80 years after reform utilisation of these drugs dropped (ranging from -21% for lipid modifiers to -41% for vasoprotectives), for older patients the magnitude of the drop has been about half of those numbers. We explain this by differences in the need of utilisation. These are maintenance drugs for treatment of chronic health conditions.

Our results indicate that at younger age, where severe symptoms are unlikely to be observed, patients may choose to forego their medication. This becomes less and less sustainable at older ages, when symptoms are more likely to manifest. By way of contrast, a good example of a chronic treatment drug where cutting down on utilisation is not an option are drugs used for to treat diabetes (A10). Indeed, in this category (see Table 6) we see only a modest drop in utilisation in any age category.

On the other hand, in Table 7 we report the top 10 drug categories with the greatest utilisation drops after reform.[24] In line with common intuition, these are mostly so called "life-style maintenance" drugs, where the decision to utilize the drugs lies primarily at the discretion of patients. Indeed, after introduction of copayments all age groups decided to forego use of psycholeptics, vaccines, immunostimulants, medicines treating cough and cold, products against joint and muscular pain, and dermatological preparates.

**Table 7: Drug categories with greatest utilization drop (# packages) after introduction of copayments**

| ATC | Description | <70 | 70-74 | 75-79 | 80-84 | 85+ |
|---|---|---|---|---|---|---|
| J07 | Vaccines | -0.816 | -0.837 | -0.810 | -0.636 | -0.311§ |
| N05 | Psycholeptics | -0.674 | -0.782 | -0.808 | -0.778 | -0.467 |
| M02 | Topical products for joint/muscular pain | -0.635 | -0.573 | -0.532 | -0.434 | -0.224 |
| R05 | Cough and cold preparations | -0.569 | -0.565 | -0.533 | -0.413 | -0.127§ |
| D08 | Disinfectants | -0.444 | -0.374 | -0.337 | -0.440 | 0.007§ |
| L03 | Immunostimulants | -0.418 | -0.279 | -0.297 | -0.082§ | 0.172§ |
| N02 | Analgetics | -0.383 | -0.343 | -0.311 | -0.321 | -0.201† |
| D01 | Antifungals | -0.369 | -0.265 | -0.282 | -0.183 | 0.056‡ |
| B01 | Antithrombotic agents | -0.312 | -0.282 | -0.272 | -0.247 | -0.172 |
| H03 | Thyroid therapy | -0.309 | -0.277 | -0.314 | -0.261 | -0.084† |
| M01 | Anti-inflammatory and antirheumatic products | -0.265 | -0.223 | -0.257 | -0.239 | -0.129 |
| D06 | Antibiotics (dermatological) | -0.252 | -0.222 | -0.247 | -0.151 | -0.022§ |
| D07 | Corticosteroids | -0.225 | -0.123 | -0.184 | -0.117† | 0.020§ |
| C05 | Vasoprotectives | -0.207 | -0.216 | -0.197 | -0.224 | -0.082 |

**Note:** Categories were chosen by the drop estimated for the age category of people younger than 70. Dependent variable is number of packages, all regressions control for county and month fixed effects and adjust for stock pilling; SE are clustered on the level of regions. Estimates are all significant at 1% level, if not stated otherwise († - at 5%, ‡ - at 10%, § - not stat. significant).

## 6. *Effect of the reform on the utilization of selected drug categories*

In this paper we analyze the natural experiment of introducing small lump-sum copayments for health services in the Czech Republic. Our findings have several generalizable implications for any policy makers considering similar measures. First, we find that people approach reforms with reasonable foresight and adjust their behavior to mitigate the impact of reforms. In our example, patients not only prepare in advance by "stocking-up" on prescriptions few months before the introduction of reforms, but also exploit the weakness of the reform design where the fee is paid per prescription, not per package. This implies that policy makers should: 1) carefully construct the incentive structure of reform in the process of its design (e.g. limit number of packages per

[24] These categories were selected based on the drop estimated for the age category of people younger than 70 years.

prescription), and, 2) in the evaluation stage, be aware of strategic timing issues that can bias initial estimates of the effects.

We have also looked at whether the reform disproportionately affected the most vulnerable subgroups of the population, where we proxy vulnerability by age category. In younger cohorts patients were willing to cut down on their utilisation and lowered their demand for so called "life-maintenance" as well as chronic treatment drugs. On the other hand, in older cohorts the post-reform drop was more limited; indicating that these age-groups cannot forego treatment without severe health implications. One could therefore argue, that the reform did not have an immediate negative effect on the health of elderly, as they have carefully considered which drugs they can and cannot afford to forego. There are, however, also possible negative implications. First, the elderly face a higher financial burden of copayments, which in their case represent a non-negligible share of monthly expenditures (approx 4.5% based on Household Budget Survey statistics). Second, long term health outcomes may be negatively affected by under-utilisation of chronic treatment drugs, consideration that can be confirmed only after passage of time.

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# Dynamic model for the analysis of productive environments in a pseudo crisis phase: The case of demographic ageing

*Ricardo Tomás FERREYRA*[1], *Alberto José FIGUERAS*[2]

***Abstract*:** In this paper, the hypothesis of an increasing elderly productive population is assumed in order to preserve the dynamical equilibrium between costs and production in the context of ageing on labour markets that takes place in demographic systems. The empirical Von Thünen equation based on the distance to the market, which had historically been useful in the past to evaluate the ground and to select the economical activity, is adopted here as a starting point for the transformation that allows obtaining a new dynamic point of view for the global estimation and preliminary analysis of demographic ageing impacts in productive environments.

***Keywords:*** Ageing, Dynamical balance, stock, rent, mobility.

***JEL classification:*** C00, I00, J00, R00.

## *1. Introduction*

This work deals with the development of a dynamical model for the productivity analysis of a human system when the ageing and the population growth rate are increasing. This effort was thought profitable because the demographic ageing is of interest in the study of economical systems. Few months ago, the purpose of this work was to develop a theoretical connection with the historical Von Thünen (1826) model for the spatial distribution of economical activities (Beckmann, M. , 1972, Dickinson, H.O., 1969 and Peet, R. J., 1969) and the dynamic balance that takes place in every economical systems over time. Then, while developing the model a lot of interesting analogies with other fields of the knowledge were found. Now, the purpose of this paper is to provide a tool for the preliminary dynamical analysis of the ageing crisis. What is more, the underlined idea is to provide a developable tool that should quantitatively predict the evolution of the ageing systems from the real measurements of its intrinsic parameters. Although at the moment parameters are estimated, the idea of a balance, which is built from them, is clear and it should have persists. That is also to say that the Von Thünen balance should help in this dynamical development. The Von Thünen model was related to the empirical fact that higher transport costs of the products were balanced with the closer localization of the activities.

The balance equation has three terms: 1) the profit of an economical activity (rent), 2) the economical loss in the way to obtain the good (cost, transport, etc.), and 3) the gain (price minus costs multiplied by volume of production). The sum of the three is equal to zero. In this paper, life is considered as an economically productive balanced process developed over time. To this end, the spatial Von Thünen model is viewed as the first step in the way to define the dynamical equilibrium by using analogy as a strategy. The formalization is developed by focusing on the rent, the production cost and the ageing cost because of the demographical ageing of the active isolated system. Then, a new point of view for the analysis of the ageing is generated because another

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analogy is suspected: 1) the fruitful ground on the hearth related to the localization model and, 2) the productive human life associated with the dynamic model. Both items are interpreted as the essential terms to keep the production alive in their respective models. The city center is isolated in the localization model and the same occurs with the system (human, population,..) with no external interactions from the time-dependent model.

In the spatial model every economical activity is associated with a specific localization. Analogously, in the dynamical model every balance can be related to a period of time at a specific stage of people's life or at a level of cumulative production. Thus, to distribute space in the ground is similar to define periods in the life. Furthermore, in the dynamical model the life's cost (the cost that people need for grow old, or ageing cost) is associated with the gain in the agricultural activity. Once the analogy between models is obtained, it is useful to observe that as a person grow up the necessary family care (or state care) decreases. When people are young, it is very common to see that new activities are carried out in clubs, schools, teams and universities. Activities are developed just for educational purposes or for living into a community. But, at these stages, the cost is also supported for the individual. If the state or the neighborhood interacts, then the family partially, or totally, releases its initial charge. This charge may become reversible. In fact, at the midway of the life, the family's cost for supporting a healthy person is almost zero, and usually the healthy individual helps his family with goods.

How people obtain goods depend on the job. In analyzing works, there are a lot of cases. To give few typical examples: the person works in the state with dependent relationship, or the individual works for the world under humanitarian goals, or the employee who works to survive or people whose motivation is to work in order to save money or to live better. In any case, an old but economical healthy person gives to the world more movement or more cumulative energy than the necessary amount of it to survive. On the other hand, for elderly ill people that belong to an economical ill system, the costs or the ageing clearly makes difficult the production of goods and services. Accordingly, at the end of the life there are two possibilities: First, the representative individual has a positive rent. This person naturally decreases his costs as soon as he grows older. Second, the representative elderly man that has lost his or her work abilities or interests because of different reasons. This situation is associated with a collapse and with serious social consequences. This person increases his costs as it happens with the transport costs to land when it is placed far from the city. Sadly, the human case is totally different because of the irreversibility of time: "We cannot travel to the youth" while the opposite effect happens with agricultural activities that can travel near the city center when they have higher production costs far away. Hopefully, "After a life's decision we can belong to the group of elderly people with positive rent". The other case is the ill case which is as predictable as negative. So, the ill case will not be considered in this work. To deal with the ageing economical problem the underlying ideas are the energy balance and the evolution that takes place inside the dynamical system. The dynamical model is obtained throughout the semantic redefinition of the localization variables as if they were demographic variables. The new generated dynamical model is interpreted as a demographic system which can be useful for early and global predictions. The model is developed in five sections: 1) Introduction, 2) The Von Thünen model, 3) The analog dynamical system for productivity, 4) Discussion and 5) Conclusion. Finally, the presented model provides a local-global perspective and a dynamical tool, and can be applied to very different complex systems at different scales such as individuals, countries or the whole world.

## 2. The Von Thünen model

Von Thünen (1826) is considered the father of the economy of localization since his work broke with the contemporary English thought. In fact, his analysis was based on empirical and especial observations about cities, transports and farms localizations, and how they affect costs and salaries. The Von Thünen model was developed from an economical system in which there was no

industry development. So, this fact explains why the historical model was based on the following assumptions:

1) The city was isolated and there is no external influence.
2) The state was isolated and all the ground around must be an isolated landscape
3) The landscape was plane without rivers and without mountains
4) The ground and the weather were the same in all the state
5) The farmers moved they products by wagons or carts and there were no roads
6) The farmers looked for maximizing their profits

Von Thünen presented in 1826 a theory of regional development based on four rings of activity around the isolated cities. In this theoretical context, some things appeared to be clear:

1) Milk derivatives and agriculture had been produced near the city because they are perishable. This is the first ring.
2) Wood products should also be produced near the city because of the weight. That is to say that the weight was directly associated with transport costs. Wood products are heavy, then, they were placed in the second ring.
3) Cereals and grains lasted more than milk. So, they can be placed farther in the third ring.
4) The last and fourth ring should contain animals due to the fact that they can move on they own at some point.
5) Far from these rings there was an uninhabited land. Also, it is assumed that the production inside the rings was consumed by the population of the city.

In this model both the cost of the ground and the use of the ground depend on the distance to the city. It can be interpreted as a balance between the transport cost and the cost of the ground. Farther from the city the cost of the land decreases its value. The model is also a balance between the cost of the transport and the localization of the activity due to the fact that the use of the ground depended on the distance. Activities with higher transport costs were located closer to the city and activities with lower transport cost are located far away. To formalize, the Von Thünen model can be expressed as

$$Q_i(p_i - c_i) = Q_i f_i k_j + LR_{IJ} \quad (1)$$

where

$LR_{IJ}$ = Localization rent of activity i in placement j

$Q_i$ = Production volume

$p_i$ = product price of activity i

$c_i$ = product cost of activity i

$f_i$ = transport cost of the product of activity i from the market (cost per km)

$k_j$ = Distance to the market from location j

To summarize, the rent of activity i in placement j is equal to the gain in terms of physical quantity minus the cost of the transport of the good.

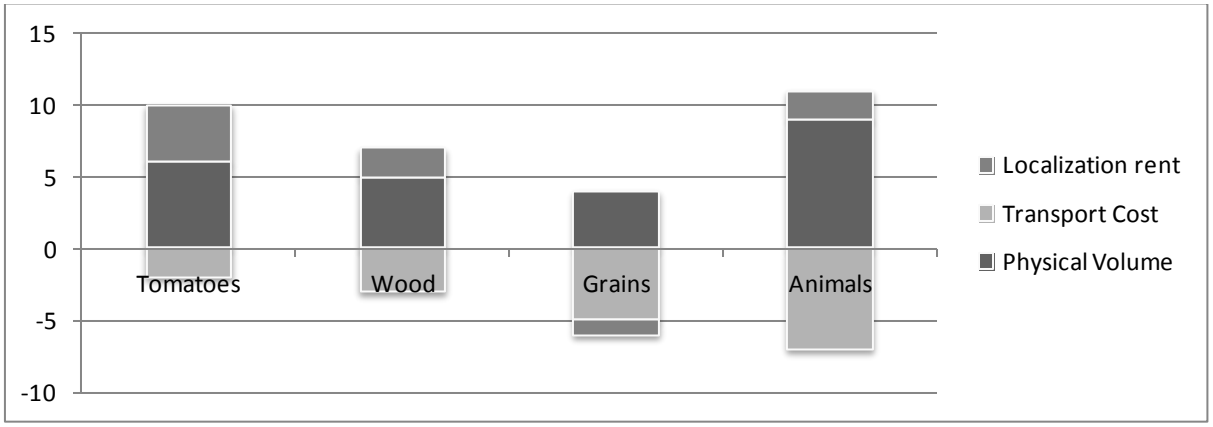
Table 1 shows a hypothetical case in which the rent of localization per unit of production can be viewed easily. The numerical values are adopted only for illustrative purposes, but there are neither real nor economical.

**Table 1 – Example of balance from the product of activities: The flow of goods.**

| Product of Activity | $p_i - c_i$ | $-f_i k_j$ | $\frac{LR_{IJ}}{Q_i}$ |
|---|---|---|---|
| Tomatoes | 6 | -2 | 4 |
| Wood | 5 | -3 | 2 |
| Grains | 4 | -5 | -1 |
| Animals | 9 | -7 | 2 |

***Source: Author***

**Graph 1. Academic example of the activity distributions and their production, cost and localization rent**




**Source: Author**

Graph 1 show that the location rent can be positive or negative. The transport cost is always negative and it is increasing in direct relationship with the distance to the city center. The difference between price and costs depend on the activity. It can be considered the case of no external customers, then $p_i = 0$ . If $p_i = 0$ , then $Q_i(0 - c_i) = Q_i f_i k_j + LR_{IJ}$. So, for internal transactions $Q_i(0 - c_i)$ is balanced with $Q_i f_i k_j + LR_{IJ}$ . This observation is so essential in the following.

## *3. The dynamical system for a productivity model*

The Von Thünen model is now adapted in order to obtain a dynamical model for the productivity analysis of complex systems. The system can be a person, a community, a country or the whole world. It is assumed that cumulative production of goods and experiences over time has the cost of system's ageing. To state a simple analogy, what is happen with a complex economical system over time is what occurs along the life of a person. All features included in this study are internal to the systems. So, the system has to be isolated. Isolation means that no external agent can give neither life nor grants or donations to the studied system. Furthermore, external agents are neither weak nor altruist, but indifferent. However, internal transactions are allowed because of economical, physical and biological reality. The model is now based on the following assumptions:

1) The dynamical system is isolated.
2) The state is isolated and all the world is isolated (ageing over all world populations)
3) The work for young and elderly people is the same type
4) The youth and elderly people have the same tools and information to work
5) The workers continue their labour along the time. There are neither privileged jobs nor healthier works.
6) The workers look for maximizing their profits and they are good people
7) The actual life expectance will not change significantly in the far future.

This is a theory of productivity development for people at different stages in their lives. In principle, it is based on four periods of time according to their ages. The four period of the life are:

1) The children are in the beginning of their life. They are near their parents, who take care of them. Children need their parents to survive. So, they have to live closer to their families. This is the first period.
2) The youth, in general, is near their family because they do not work. Young people need money for educational purposes but also need financial support to survive. Local and global laws protect the youth providing them the possibility to develop a career or profession. They need to stay close to their parents. They spent most of their time at clubs, schools and universities. The youth is placed in the second period.
3) Adults and senior people are independent, free and have legal responsibility. They are in the third period of the life. They have to work to support the youth and frequently to support more elderly people.
4) The last and fourth period contain the oldest people. Sometimes they can work with positive rent, but often an important amount of them are not in the labour market because they are ill or weak and receive social benefits. Frequently, policies "protect" elderly people against work. So, two kinds of elderly people are clearly distinguished.

   * Far from these periods there was unlimited time. However, it is assumed that people's life is consumed by producing goods or services for the population of the city, the community, the country, the world, etc.

As soon as healthy people are far from their original beginning, the cost of the necessary goods to support them decreases sharply. The model is also a balance between the cost of the support and the stage in people's life due to the fact that the use of the goods depended on the people's age. If everything is according to the model, periods of life with higher support costs (and lower productivity) are located closer to their social beginning and periods of life with lower cost are far away. In the past, activities with lower transport cost were located far away. Nowadays, this is the case of healthy elderly people.

Sequentially, the demographic system is formulated. The basal hypothesis is that the migration is banned (no external goods, no external youth, no external grants, etc.). This is the zero term "0" inside the parenthesis in the left member of Eq. (2). So, it is assumed a closed demographic system. The goods to be consumed for the system are only internal. That is to say that the system is going to be self-consumed.

The whole model is analog to a dissipative system. Also, it is analogous to the "dynamic" of a personal stock control problem where external system's donations are not allowed. However, internal transactions or interactions with the neighborhood are necessary to survive. This will be a kind of rent, but rent can be positive or negative with the hidden idea that it has to be as real as real life. To formalize an intermediate step, the preliminary stock model can be expressed as

$$M_i\left(0 - \ddot{X}_\iota\right) = M_i\omega_i^2 X_i + 2 \in \omega_i M_i \dot{X}_\iota \qquad (2)$$

Where, at stage i:

$t_i$ $= time$
$M_i$ $= Volume$
$w_i^2$ $= Price\ per\ unit\ of\ physical\ stock$
$X_i$ $= Physical\ stock\ existence\ per\ unit\ of\ volume$
$M_i w_i^2 X_i$ $= Physical\ stock\ price$
$\dot{X}_\iota$ $= \frac{\Delta X_i}{\Delta t}\ (Variation\ of\ X_i\ \ per\ unity\ of\ t).$
$\in$ $=$ Mobility of the system to improve its profit or its interactions
$2 \in \omega M_i \dot{X}_i$ $=$ Stock price increment $(+ \text{ or } -)$ because of transactions at period i.

$$\ddot{X}_i = \frac{\Delta \dot{X}_i}{\Delta t}\ (Variation\ of\ \dot{X}_i\ \ per\ unity\ of\ t).$$
$$M_i(0 - \ddot{X}_i) = -M_i \frac{\Delta \dot{X}}{\Delta t}\ \ Stock's\ \text{value}$$
$$i = The\ system\ is: 1\ (\text{too young}), 2\ (\text{young}), 3\ (\text{adult})\ \text{or}\ 4\ (\text{elderly}).$$

All parameters in Eq. (2) can be measured from a complex dynamical system. In particular, in this problem the measurements of complex systems parameters are possible. Population volume, costs per unit of production per individual are available in the economical literature at every moment. Mobility can be estimated. See Ferreyra, R.T., 2013, and Ferreyra, R.T., Ferreyra, M. A. 2013.

The dynamic balance is analog to a classical mass-spring damped system. In the discrete case, Eq. (2) is a balance for the stage "I" of the life. Thus, one can write Eq. (2) for the continuous case (An infinite number of stages). So, let us consider the continuous case, then $M_i \to M$, $\omega_i \to \omega$ , and $X_i \to X$. Also, one can assume the initial conditions $X(0) = 0$ and $\dot{X}(0) = \dot{X}_0$ . For simplicity, it is adopted the notation change

$$A\dot{X} - 2 \in \omega \dot{X} = 0 \qquad (3)$$

Where A in Eq. (3) is associated with rent of the activity per unit of variation of the production. The term is also related to interactions, inversions, supplies, actions or movements that are implied by the activity. By simplifying M and by rearranging terms in Eq. (2) and by considering Eq. (3), it is finally obtained

$$(0 - \ddot{X}) = w^2 X + A\dot{X} \qquad (4)$$

Where

$\omega^2 = Production\ price\ per\ unit\ of\ production$
$X = Production$
$w^2 X = Production\ price$
$\dot{X} = \frac{dX}{dt}\ (Variation\ of\ X\ \ per\ unity\ of\ time).$
$A = Rent\ of\ the\ activity\ per\ unit\ of\ \dot{X}$
$A\dot{X} = Rent, (+)\ system's\ earnings\ \ and\ (-)\ system's\ neighborhood\ \ profits$
$\ddot{X} = \frac{d^2X}{dt^2}\ \ (Ageing\ cost)$
$t = t(q)\ time$
$q = cumulative\ production$

Equation (4) is a dynamic balance. All terms have [rent or cost or price (in monetary units)] as the common unity. Since typical or representative economical parameters $X^*$ , $\omega^{*2}$ and $A^*$ can be taken or measured from the system, Eq. (4) is transformed to a dimensionless form. The balance in Eq. (4) ensures that the actual value of the production plus the rent is equal to the total cost which is read as the ageing cost because the independent variable is time and time has direct relationship with cumulative production. The solution of Eq. (4) is given by

$$X = e^{-\left(\frac{A}{2}\right)t}\left\{a\ cosh\left[\left(\sqrt{\left(\frac{A}{2}\right)^2 - \omega^2}\right)t\right] + b\ sinh\left[\left(\sqrt{\left(\frac{A}{2}\right)^2 - \omega^2}\right)t\right]\right\} \qquad (5)$$

Where the parameters $a$ and $b$ are determined from initial conditions in the form

$$\begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} 0 \\ \frac{\dot{X}_0}{\sqrt{\left(\frac{A}{2}\right)^2 - \omega^2}} \end{pmatrix} \qquad (6)$$

By combining Eq. (5) and Eq. (6) it is obtained

$$X = e^{-\left(\frac{A}{2}\right)t}\left\{\left(\frac{\dot{X}_0}{\sqrt{\left(\frac{A}{2}\right)^2-\omega^2}}\right)sinh\left[\left(\sqrt{\left(\frac{A}{2}\right)^2-\omega^2}\right)t\right]\right\} \tag{7}$$

Equation (7) provides the economical production of an entity (preferable a complex system like a human being or like a community) along the cumulative production q which depends on time. According to Eq. (7), the extreme productivity value $\mathrm{X} = \mathrm{X_m}$ occurs whent $= \mathrm{t_m}$

$$t_m = \left(\frac{1}{\sqrt{\left(\frac{A}{2}\right)^2-\omega^2}}\right)tanh^{-1}\left(\frac{\sqrt{\left(\frac{A}{2}\right)^2-\omega^2}}{\frac{A}{2}}\right) \tag{8}$$

By assuming $\mathrm{X} = \mathrm{X_m}$and by considering Eq. (7) and Eq. (8) it follows$\dot{\mathrm{X}}_0$

$$\dot{X}_0\left(\frac{1}{|w|\sqrt{\epsilon^2-1}}\right) = sign(w)\frac{e^{\frac{\epsilon}{\sqrt{\epsilon^2-1}}.tanh^{-1}\left(\frac{\sqrt{\epsilon^2-1}}{\epsilon}\right)}}{sinh\left(tanh^{-1}\left(\frac{\sqrt{\epsilon^2-1}}{\epsilon}\right)\right)} \tag{9}$$

In this model, $\mathrm{w} = |\mathrm{w}|$ and $\mathrm{sign(w)} = 1$. Since $\mathrm{w} = \mathrm{sign(w)}|\mathrm{w}|$ , then $\frac{\dot{\mathrm{X}}_0}{\mathrm{w}}$ depend only on $\epsilon$ which can be measured from the outside of the system. Furthermore, $\dot{\mathrm{X}}_0$ only depends on the intrinsic parameters $\epsilon$ and w of the system. These parameters are alike in similar systems. So, systems or complex systems with similar intrinsic parameters can be viewed as a family. For instance, a representative complex system can be a person, (See Ferreyra, R.T., 2013, and Ferreyra, R.T., Ferreyra, M. A. 2013). More generally, it is also theoretically and practically possible the statistical measurements of the parameters of governments, societies and institutions.

Equation (9) shows that $\dot{\mathrm{X}}_0\left(\frac{1}{\mathrm{w}\sqrt{\epsilon^2-1}}\right)$ depend only on $\epsilon$. Therefore, by using the Eq. (3), Eq. (7) and Eq. (9), the production as a function of the two intrinsic parameters $\epsilon$ and $\omega$ is given by

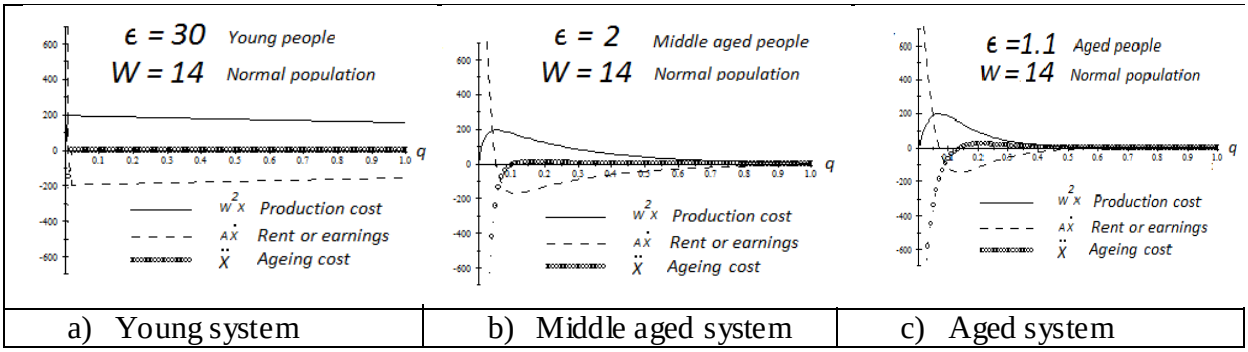
$$X = \left(\frac{e^{\frac{\epsilon}{\sqrt{\epsilon^2-1}}.tanh^{-1}\left(\frac{\sqrt{\epsilon^2-1}}{\epsilon}\right)}}{sinh\left(tanh^{-1}\left(\frac{\sqrt{\epsilon^2-1}}{\epsilon}\right)\right)}\right)e^{-(\epsilon\omega)t}sinh\left[\left(w\sqrt{\epsilon^2-1}\right)t\right] \tag{10}$$

The production depends on time which is a variable. Since $\mathrm{t} = \mathrm{t(q)}$ , then production also depends on cumulative production. In predictions, the estimated production in Eq. (10) does not take into account neither randomness nor catastrophic external events. But, frequently things go on their predictable way. This is mostly true after internal parameters have been measured. So, in this case, Eq. (10) can be a useful tool for the preliminary production estimation in the context of the global analysis. The basal model is an over damped system with inertia and energy storage.

In the casuistic, a typical population is considered first. The derived dynamical model is analog to the mass-spring over damped system. This observation helps for the reasoning when the size of the population will be taken into account. In fact, there is a non damped mass spring system (associated with the over-damped system) such that $\mathrm{W}^2 = \frac{\mathrm{K}}{\mathrm{M}}$ . In such systems, $\mathrm{K}$ is the rigidity and $\mathrm{M}$ is the mass or the inertia. The inertia has direct relationship with the population's size. For instance, large inertia implies that $\mathrm{M} \to \infty$ and $\mathrm{W} \to 0$. For the first example, the population is neither large nor small, so $\mathrm{W} = 14$ is adopted just to see the curves. On the other hand, the ageing is controlled by the mobility parameter $\epsilon$. In the bibliography, see Ferreyra, R.T., 2013, and Ferreyra, R.T., Ferreyra, M. A. 2013, it is showed that the mobility $\epsilon$ is proportional to the standard deviation of the normal distribution associated with the system. Also, in that work, it is showed that this standard deviation is like a measurement of the movement or vitality. In consequence, the ageing should imply positive lower $\epsilon$ values while positive large values are associated with the youth. It is

important to note that negative $\epsilon$ values are not real in healthy systems, but they drive the ill systems to the economical death. Negative $\epsilon$ systems are not compatible with life. Also, it is assumed that the intrinsic parameters do not change over time. For a given population, the costs vary as a function of the mobility as it can be seen in Graph 2. The dynamic balance distributes the rent, the production costs and the ageing in the system.

**Graph 2. Stages identification in the growth process for W=14 (normal system's inertia): a) $\in = 30$ there is no stages, b) $\in = 2$ there are at least four stages, c) $\in = 1.1$ earlier ageing effects in the growth stages. For illustrative purposes it is adopted t=q.**




| a) Young system | b) Middle aged system | c) Aged system |
|---|---|---|

**Source: Author**

There are five representative points $t_0, t_1, t_2, t_3, t_4$ related to the cumulative production. These points define five different stages in the system's life:

0) $t_0$ such that $X(t_0) = 0$. The activities beginning,
1) $t_1$ such that $X(t_1) = A\dot{X}(t_1)$. Condition for the system's youth initiation,
2) $t_2$ such that $A\dot{X}(t_2 = t_m) = 0$. System's first adult period initiation,
3) $t_3$ such that $A\dot{X}(t_3) = \ddot{X}(t_3)$. System's second adult period initiation,
4) $t_4$ such that $\ddot{X}(t_4 = t_r) = 0$. End of the production, retirement or end of the activity.

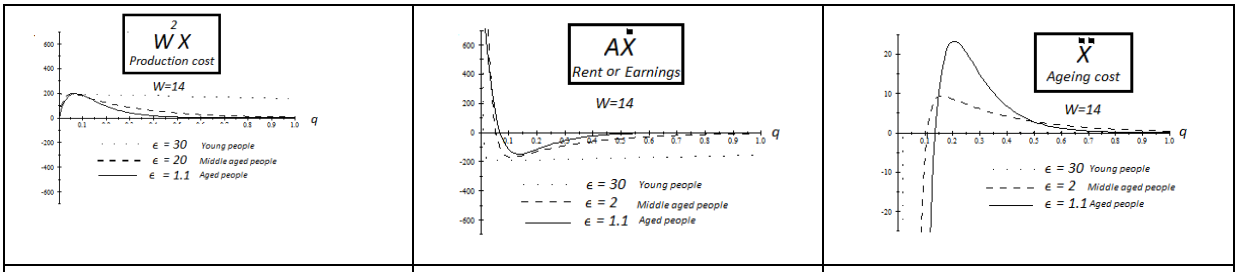
The $t_r$ value is obtained as it is shown in Eq. (11)

$$t_r = \left(\frac{1}{w\sqrt{\epsilon^2-1}}\right) cotanh^{-1}\left[\frac{1+\frac{\sqrt{\epsilon^2-1}}{\epsilon}}{\frac{\sqrt{\epsilon^2-1}}{\epsilon}}\right] \tag{11}$$

If $\in \rightarrow 1^+$, then $t_r \rightarrow \infty$. This implies that the end of activity can be moved to the right or to the left by changing the intrinsic parameters. For example, in practical terms, the time for the end of the activity in a human is the retirement age. If the intrinsic parameters change over time, the retirement age will change.

The production capitalizes the system and its cost is a partial measurement of how much life the system has spent to obtain the product. The rent represents the rest of the life the system has invert in the production process. This rent improves the system's comfort during the ageing process. In other words, life can be thought as internal energy into a box. Afterwards, part of it had used to produce positive work while the rest had warmed the system. The system is isolated but life is not. So, life belongs to the system.

**Graph 3. The effect of mobility $(\in = 30, 2, 1.1)$ in: a) production price, b) rent and c) ageing cost for a normal volume population $(W = 14)$. For illustrative purposes it is adopted t=q.**




| a) Production cost | b) Rent ( (+) or (-) ) | c) Ageing cost |
|---|---|---|

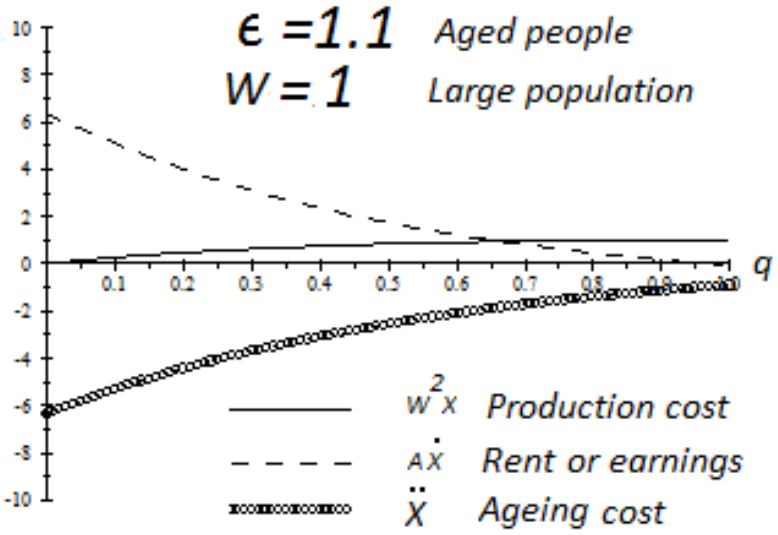
**Source: Author**

Graph 3 shows that as the mobility coefficient decreases, production cost decreases and the amount of rent also decreases. Positive rent is consumed for the system while negative rent is given to the internal neighborhood of the system. As the mobility is increased, the ageing cost decreases. This is reflexive because in the process of people's ageing their mobility decreases.

## *4. Discussion*

The three terms considered (rent, production cost and ageing costs) interact by the control of the dynamical equilibrium. However, variations of each of the three can be compatible or not with a healthier economical system. If not, the system will collapse over time. Ageing cost can be positive or negative (this also can happen with people at a particular stage of the life and as a subset of every population). If the ageing costs for all cumulative productions are positive the process will be as follows: First, a weakness period. Second, the economical death is produced (costs tends to infinite). On the other hand, if ageing costs are negative for all cumulative production, then the aged population will take relevant risks (little by little to work more and more, and to receive less and less). If the retirement age occurs when the production price is comparable with the rent, or associated with null ageing costs, then the retirement age will be higher and higher over time. The retirement age will disappear under these circumstances. See Graph 4.

**Graph 4. Production Cost, Rent and Ageing costs for $W = 1$ and $\in = 1.1$**




**Source: Authors**

Thus, the old people in the population must play a more active role in the production system until near the end of their lives. In consequence, the retirement system will have less sense. Historically, the migration of the youth that belongs to young systems had been a kind of solution.

In fact, reciprocal help between ambitious (or poor) youth and elderly communities has always existed. However, the ageing process is a world process that means that, at the end of the day, this kind of temporal phenomena will disappear. In consequence, new policies of reciprocal collaboration should be developed or new policies to consume goods should be healthily standardized. The hypothesis of isolated system that only interacts with environment makes important the primary goods such as water, air, healthy food, warming, home, etc. So, in any way, primary goods should be quantified in isolated systems. But, to discuss into economical terms: How useful to the world will be the idea of increasing life expectance at the time that the work is increased at elderly stages of the life? Theoretically: Will retirement systems exist in the far future? How? What should change? What kind of goods do people should consume? What kind of things do they should dismiss? How do human biological limits can affect the predictions given by Graph 4? Let us assume an isolated system, ageing of the system, a growing population, growing production over time and no biological limits: Is there a maximum cumulative production? The answer is NO. Since, human life has an empirical limit: What message this model is offering to us? Work to death? [3]

## *5. Conclusion*

A dynamical model for the ageing analysis is proposed. From the model it is possible to theoretically estimate how long the active period of a system will last once measurements of the intrinsic variables of the systems are assumed. The predictability will be much better if the intrinsic variables are measured from reality at the time that the set of original hypothesis remain valid over time. Practical issues are derived from the model. For example:

a) The ageing cost directly depend on the second variation of the production with respect to the cumulative production for a given system,

b) A mobility factor was identified for the rent cost which is related to the vitality of the population,

c) For a given cost per unit of production, the initial values of variation of the production with respect to cumulative production only depends on the intrinsic parameter of mobility of the system. For aged systems the absolute value of $\dot{X}_0$ decreases.

d) For large populations, the ageing cost clearly depends on the variation of the rent,

e) The calculated retirement age varies as a function of the ageing and the population growth rates for the given retirement criteria.

f) The obtained dynamical production model is analogous to a mass-spring over-damped system where the inertial term is related to the ageing process.

In addition, there were two possibilities in the analysis:

1) High positive ageing cost. In this case, for the hypothetical context it can be helpful to preliminary estimate how much time the system is going to have before this irreversible ageing crisis will start. This is due to the fact that simple and handy formulations are provided. But, probably, for this case the most important thing is related to this message: The ground is necessary to support agricultural activities in the same way that goods and

[3] The opinions in this work were developed from hypothetical and unrealistic situations and in the context of theoretical research. In consequence, opinions do not represent believes of neither academic institutions nor political organizations.

services are necessary to support the ageing. That is to say: "if there are no goods, then there is no ageing". This sounds drastic, unreal and ironic. However, the process of dismissing the no necessary goods for life probably will be one way to avoid or to put off or to postpone or to dismiss the ageing crisis associate with ill aged isolated economical systems.

2) Low positive or negative ageing costs. An increase number of elderly people that produce positive rent would attenuate the potential ageing crisis with a trivial economical consequence: retirement systems will have to change their policies due to the fact that they will have less sense. Mobility is very low and inertia is very high. The aged people will decrease their rent along the accumulative production o along the time. Securely, the concept of primary goods should be re-understood because of isolation. (For instance water, air, healthy food, warming, home,..). What is more, the actual life expectance will not change a lot because of actual biological facts at the time that the retirement age is higher and higher, the elderly population will have to be healthy for working more and more years. The previous reasoning is more or less the same as to say that "as it had happened in the past, people should work to death" whenever they belong to isolated economical systems, but ...they will be healthier and older than before. In practical terms, probably, "elderly people from this group will help and save their isolated systems".

By summarizing, the banned migration and ageing in the increasing population of inactive elderly people (negative mobility) implies the weakness and then the death of the economic system. Although this consequence had been historically predictable and also predictable for the formulation, the proposed model helps much more in considering active elderly people (positive mobility) or aged systems as well as their possibilities and vital quantities.

Practical results such us mobility, retirement age, ageing cost estimations as well as the relations and implies for a variety of intrinsic parameters were developed. The final result of this work was the given general dynamical balancing law. In addition, its analogies, its consequences and its potential applications were discussed. Thus, the proposed model can be applied to isolated systems as a tool for the economical ageing analysis.

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# Lifetime earnings and life expectancy[1]

*Radoslav PETER[2], Martin ŠUSTER[3]*

***Abstract***: In this paper we test hypothesis that wealthier individuals live longer. Using a large micro data base of current and former retired participants covering years 2005 – 2011 from the Social Insurance Company our paper aims to study and explore trends and differentials in life expectancy based on lifetime earnings in Slovakia. Tobit and probit models confirm a positive relationship between life earning and life expectancy. Furthermore we estimate remaining life expectancy at age 62 especially of Slovak male pensioners. Despite low level of earnings variance, our findings indicate the difference of 8 years in life expectancy between the lowest and the highest income percentile in this group. Results of our analyses are in line with wide foreign research on this topic. The outcomes of the conditional life expectancy may further provide normative implications for the Slovak merit based pension system and the first pillar settings.

***Keywords:*** Lifetime earnings, life expectancy, mortality tables.

***JEL classification:*** C40, C67, D31, H20, I38

## *1. Introduction*

The systematic differences across the population in mortality risk are usually omitted in the social security systems architecture. Then, the unintended redistribution based on differences in life expectancy related to such factors as income, gender, and race can occur. Over 40-years ago Milton Friedman drew attention to this fact. He concluded that people with higher incomes live longer (Friedman, 1972).

Since the essential work of Kitagawa and Hauser (1973), a large amount of research has focused on the extent, causes, and trends of differential mortality determined by socioeconomic status.

A common finding of the cross-disciplinary research is that life expectancy is higher for higher income persons (Gaudecker, Scholz, 2007; Brown, 2002). Schalick(2000) reports that the gap in mortality risk has been growing. However, welfare measures based on economic variables such as Gross Domestic Product give an incomplete and potentially biased representation of standards of living (Becker, Philipson and Soares, 2005).

In spite of worldwide rich literature on this topic, empirical evidence of this phenomenon in central Europe is quite rare. There are two main reasons for that: Firstly, data needed to responsible work are not available, resp. only short time series are available. Secondly, in the past there were a relatively high level of income and living standard equality in socialist economics.

Our paper aims to study and explore trends and differentials in life expectancy based on lifetime earnings in Slovakia using a micro data of current and former retired participants covering years 2005 – 2011 from the Social Insurance Company. We use the data structure, which has not been used for this kind of research yet. This data allow us to study our topic using three methods. At first, the variable alive/dead predetermines us to use binary choice models, for instance Probit model. Secondly, the short time series and especially unclosed personal records face us with right

[1] For discussion only. Preliminary and incomplete. Please do not cite. Comments welcome

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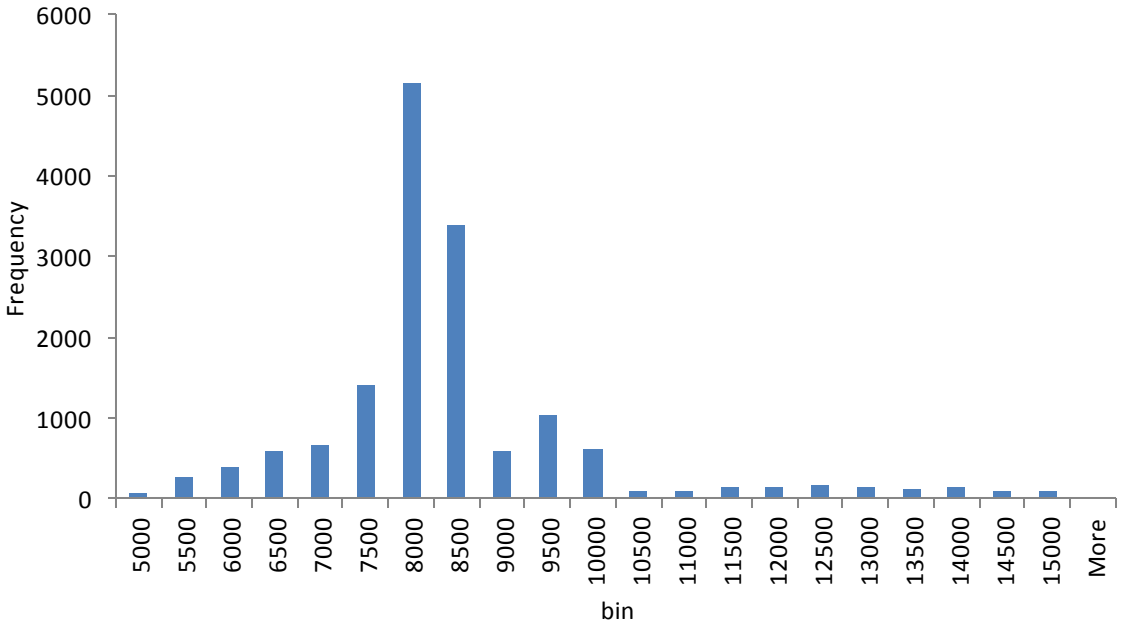
censored data. This means a data point is above a certain value but it is unknown by how much. At the last observation we still don't know how long the person would live. Lastly, cross section data are sufficient enough for mortality tables compilation.

In the second chapter of this paper these data and methodology are described in detail. The third chapter discusses outcomes and results. Last chapter concludes the paper findings.

## 2. Data and methodology

In this paper, we use a very large dataset of administrative records from the Slovak Social Insurance Company. The main variable for our estimations is retirement pension used as a proxy for a lifetime income. Retirement pension is measured in Slovak crowns and Euro. Observations range from 2005 to 2011. To ensure the homogeneity in our dataset, we use only male retirement pensioners. Using female or other type of pensioners, e.g. disabled or early retired, could cause ambiguity in our estimations due to different calculations of pension income. These data are available in digitalized form only since 2005.

**Graph 1: Histogram of retirement pensions in January 2005 for 62y old males in Slovak Crowns**




**Source: Social Insurance Company**

Retirement pension formula changes slightly over time.[4] That is why we strictly work with separate cohorts. The value of retirement pension is given by salary (or income which is subject to social contribution) and social insurance period.

$$y = \mathrm{APWP} * \mathrm{YSI} * \mathrm{CPV} \qquad (1)$$

Salary enters the formula in the form of average personal wage point (APWP). Basically, for each year in which a person is earning the average wage, personal point of 1 is assigned. For lower than average wage, personal point will be lower than 1 and vice versa. Personal wage points are then averaged and multiplied by the number of years of social insurance (YSI) and the current pension value (CPV), which changes every year based on the development of average wages in the economy.

[4] Current pension value changes every year for newly awarded pensions, but do not match valorization of current pensions. Moreover, there were few parametric changes in retirement pension scheme in last years.

The more someone earns and the longer he works, the higher pension should he received. The average retirement pension in January 2005 for male born in 1943 was 8209.2 SKK (272,5 eur).

This simplification does not give us a perfect knowledge about lifetime income because of three main reasons. Firstly, the retirement pension formula disadvantages the higher income groups. Personal wage point says about the income in each single year of social insurance, but in case a personal wage point exceeds the maximum value, it is reduced before imputation to retirement formula. Secondly, our data prevent us to see number of years of social insurance. Our approach also does not consider personal welfare, which could be more robust factor than personal income. Our proxy of lifetime earnings misses out on some things typically included in the income definition such as bequests, capital income or transfers. In addition, income equality was relatively higher in eighties and nineties, which is important for current pensioners.

Bearing the incompleteness in mind, we use retirement pension as a lifetime proxy as no better indicator is available and it is applicable to all retired persons. It enables us to work with relatively large and homogeneous sample.

The data mining and database processing were the most time requiring parts of our work.

In our paper we would like to prove the positive relationship between retirement pension (as the lifetime income proxy) and lifetime expectancy at age 62 in the Slovak Republic. To confirm this hypothesis we implement 3 methods:

a) Tobit model with a censored sample.
b) Lifetime expectation based on Probit model forecast of survivorship for income percentiles.
c) Life expectancy calculation based on mortality tables for income deciles

A) Tobit model with censored sample provides estimation of relation between life expectancy and retirement years survived. In our model the sample tracks pensioners from 2005 to 2011. In general, Tobit model is an extension of probit model. Statistically, it can be expressed as (Gujarati, 2004):

$$Y = \begin{cases} \beta_1 + \beta_2 X + u, & if \quad RHS > 0 \\ 0, & otherwise \end{cases} \tag{2}$$

where Y is dependent variable and X is independent variable. Dependent variable Y says how many years person has lived since 2005. This variable ranges from 0 to 7, where 0 means that person died in 2005 and 7 means that person has not died before 2011 and lives 7 or more years since 2005. This means the data for pensioners who died after 2011 are censored. Independent variable X, in our case, is lifetime earning per person represented by retirement pension in January 2005.

B) The easiest way how to interpret our data is to use a simple binary response model. One type of model from the group of binary models is a Probit. Probit function is the inverse cumulative distribution function and can be generally expressed as

$$P(Y = 1|X) = P(Z \leq \beta_1 + \beta_2 X) = F(\beta_1 + \beta_2 X) \tag{3}$$

where P(Y=1|X) means the probability that an event occurs given the values of explanatory variable X and where Z is the standard normal variable and F is standard normal cumulative distributive function (Gujarati, 2004).

In our model, endogenous variable Y estimates the probability, by which the pensioner will live in the particular year based on his retirement income level. Let's assign 1 for the case, when person lives at certain time and 0 for the case, when person does not live at that particular point of time. Model will then calculate the probability with which person lives at particular moment based on her retirement income.

These probabilities are then used to calculate a proxy for life expectancy ($LEx_i$)5 by cumulative multiplication for each income percentile i as:

$$LE_x^i = \max_x\{\prod_{a=62}^{x} p_a \geq \frac{1}{2}\} \quad (4)$$

where pa denotes survival rate, which means probability a person aged x will live to age x +1.

C) Using a cross section data, a period mortality table (life table) based on the mortality experience of a population during a relatively short period of time can be compiled. In this method we work with the individuals grouped into ten income groups - income deciles denoted d (again based on pension income in January 2005) and cohorts x. The standard Mortalitiy tables methodology based on death rates is used (see e.g. WHO, 2013).

We present the 2005 period mortality table. For this case, the life expectancy at a given age is the average of remaining number of years expected prior to death for a person at that exact age.

$$LE_x^d = \sum_{x=62}^{\infty}(l_x + p_x * l_x)/2l_x \quad (5)$$

where $LE^d_x$ denotes life expectancy at age category *x*, $l_x$ denotes survivorship, hypothetical number of individuals out of 100000 who will live until next year, and $p_x$ denotes survival rate, which means probability a person aged *x* will live to age *x +1* and is calculated by observed survivals.

# 3. Results

## 3.1. Tobit model with censored sample

In this regression we use retirement pension in January 2005 as the independent variable and the number of years survived since then as dependent one. This variable is right censored at level 7. We repeat this for each cohort separately due to changes of retirement pension formula over time.

Results of Tobit analyses are displayed in table below. First column represents date of birth of pensioners and ranges from 1925 to 1943. Values of estimated coefficients suggest positive relation between lifetime earnings and retirement years survived in all cohorts. Standard errors indicate that all estimated coefficients are significant on all attainable significance levels. These results confirm our assumption that people, who have higher retirement income live longer.

**Table 1: Tobit model with censored sample results**

| *born* | *coef* | *st error* | | *born* | *coef* | *st error* |
|---|---|---|---|---|---|---|
| *1925* | *0,000365* | *4,84E-05* | | *1935* | *0,000821* | *6,46E-05* |
| *1926* | *0,000428* | *4,62E-05* | | *1936* | *0,000888* | *6,58E-05* |
| *1927* | *0,000493* | *4,91E-05* | | *1937* | *0,000846* | *6,73E-05* |
| *1928* | *0,000535* | *4,99E-05* | | *1938* | *0,000866* | *0,000071* |
| *1929* | *0,000508* | *5,15E-05* | | *1939* | *0,000888* | *7,15E-05* |
| *1930* | *0,000572* | *5,43E-05* | | *1940* | *0,001084* | *7,58E-05* |
| *1931* | *0,000691* | *5,83E-05* | | *1941* | *0,001109* | *7,47E-05* |
| *1932* | *0,000667* | *5,91E-05* | | *1942* | *0,000883* | *7,26E-05* |
| *1933* | *0,000661* | *6,22E-05* | | ***1943*** | ***0,000687*** | ***0,000054*** |
| *1934* | *0,000793* | *6,35E-05* | | | | |

**Source: Authors calculations**

Rising coefficient of independent variable with the year of birth in line with the rising number of censored data indicates stronger effect. The average effect of an increase in monthly

[5] This is our intuitive proxy for life expectancy, however consulted with experts in demographics.

pension by 1000 SKK (33.2 eur) on the prolongation of life expectancy ranges from 1/3 of year to one year.

## 3.2. Lifetime expectation based on Probit model forecast of survivorship for income percentiles.

Our independent variable is again retirement pension in January 2005. Dependent variable now reaches 0 or 1 along with the observed timeline. Table of results is similar to the previous one, representing the Tobit outcomes. Here we can see that all the tests are statistically significant and they came up with positive coefficients.

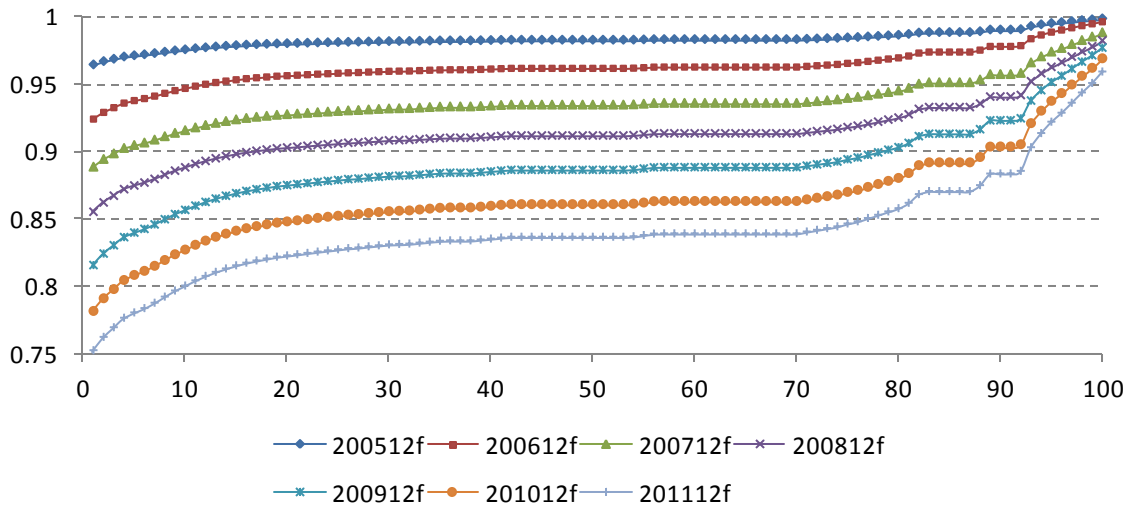
**Table 2: Probit model results for male in 2005**

| *born* | *coef* | *st error* | | *born* | *coef* | *st error* |
|---|---|---|---|---|---|---|
| *1925* | *8,18E-05* | *2,09E-05* | | *1935* | *0,000115* | *2,23E-05* |
| *1926* | *8,05E-05* | *2,00E-05* | | *1936* | *0,000123* | *2,29E-05* |
| *1927* | *8,95E-05* | *2,03E-05* | | *1937* | *0,000141* | *2,30E-05* |
| *1928* | *6,60E-05* | *2,00E-05* | | *1938* | *0,000103* | *2,32E-05* |
| *1929* | *8,80E-05* | *2,04E-05* | | *1939* | *0,000098* | *2,32E-05* |
| *1930* | *0,000109* | *2,13E-05* | | *1940* | *0,000137* | *2,35E-05* |
| *1931* | *0,000101* | *2,24E-05* | | *1941* | *0,000202* | *2,35E-05* |
| *1932* | *0,000129* | *2,32E-05* | | *1942* | *0,000126* | *2,27E-05* |
| *1933* | *0,000117* | *2,31E-05* | | ***1943*** | ***0,000109*** | ***1,90E-05*** |
| *1934* | *0,000117* | *2,26E-05* | | | | |

**Source: Authors calculations**

One of the probit outputs is survivorship forecast probability. The results displayed in the graph below are forecasted survivorships for income percentiles of male born in 1943. This forecast is slightly predetermined by probit function characteristics.[6]

**Graph 2: Probability of survivorship for 62y old male in 2005 according to income percentile**



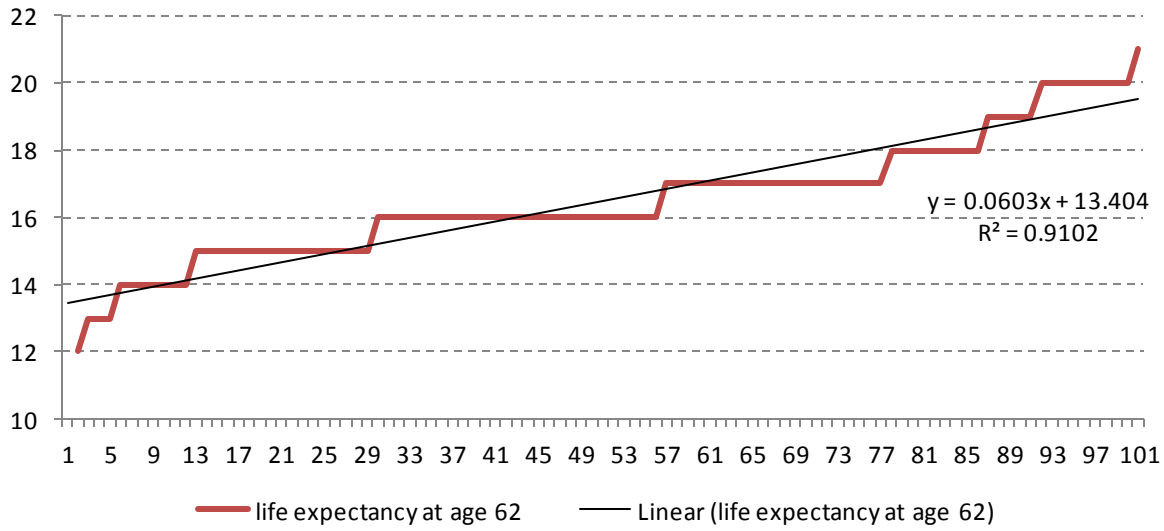

**Source: Authors calculations**

Results of survivorship forecasts for income percentiles were used to calculate lifetime expectancy at age 62 in line with formula (4). The results show that there is a big difference in life expectancy between the lowest and the highest income percentile.

[6] In general Profit function is linear in X a strictly monotonous.

The 1st percentile life expectancy at age 62 reaches 12 years, while for the top percentiles it is over 20 years of life. The graph below displays forecast of life expectancy for males aged 62 in 2005 for each income percentile.

**Graph 3: Life expectancy at age 62 in 2005 according income percentile**




**Source: Authors calculations**

## 3.3. Life expectancy calculation based on mortality tables for income deciles

Mortality tables, which are based on 2005 cross section data for male pensioners cohorts, indicate life expectancy at age 62 in range from 12,2 to 16,6 years. Despite using age groups from 62 to 80, we consider this method very important and suitable in line with proving higher life expectancy across income deciles. Here just pure demographic and no statistical methods are used.

**Table 3: Life expectancy by income decile**

| *age category x / income decile* | *LEd1* | *LEd2* | *LEd3* | *LEd4* | *LEd5* | *LEd6* | *LEd7* | *LEd8* | *LEd9* | *LEd10* |
|---|---|---|---|---|---|---|---|---|---|---|
| ***62*** | ***12,2*** | ***14,4*** | ***15,1*** | ***15,9*** | ***15,9*** | ***16,3*** | ***16,7*** | ***16,6*** | ***16,6*** | ***16,6*** |
| *63* | *11,7* | *13,7* | *14,4* | *15,1* | *15* | *15,5* | *15,9* | *15,9* | *15,9* | *15,8* |
| *64* | *11,2* | *13,1* | *13,7* | *14,4* | *14,2* | *14,7* | *15,1* | *15* | *15,2* | *15,1* |
| *65* | *10,8* | *12,5* | *13* | *13,7* | *13,4* | *13,9* | *14,4* | *14,3* | *14,4* | *14,2* |
| *66* | *10,3* | *11,8* | *12,4* | *12,9* | *12,8* | *13,1* | *13,6* | *13,5* | *13,7* | *13,5* |
| *67* | *9,8* | *11,2* | *11,8* | *12,2* | *12,1* | *12,4* | *12,8* | *12,7* | *12,9* | *12,9* |
| *68* | *9,3* | *10,6* | *11,2* | *11,5* | *11,4* | *11,7* | *12* | *12* | *12,2* | *12,3* |
| *69* | *8,8* | *10,1* | *10,6* | *10,7* | *10,7* | *10,9* | *11,3* | *11,3* | *11,5* | *11,6* |
| *70* | *8,4* | *9,5* | *9,9* | *10,1* | *10* | *10,1* | *10,6* | *10,5* | *10,8* | *10,9* |

**Source: Authors calculations**

Results are in line with wide range of literature studying GDP per capita and life expectancy in various countries. The results indicate that life expectancy rises with rising welfare but only to a certain limit. In our sample, life expectancy does not increase after reaching seventh decile income level. The seventh decile includes pensioners with the average retirement pensions. Life expectancy for males at age 62 for the lowest decile in 2005 is estimated at level 12.2 years. It rises to seventh decile, where it reaches 16.7 years and hold this level for the highest income deciles. A similar pattern is observed also for other cohorts.

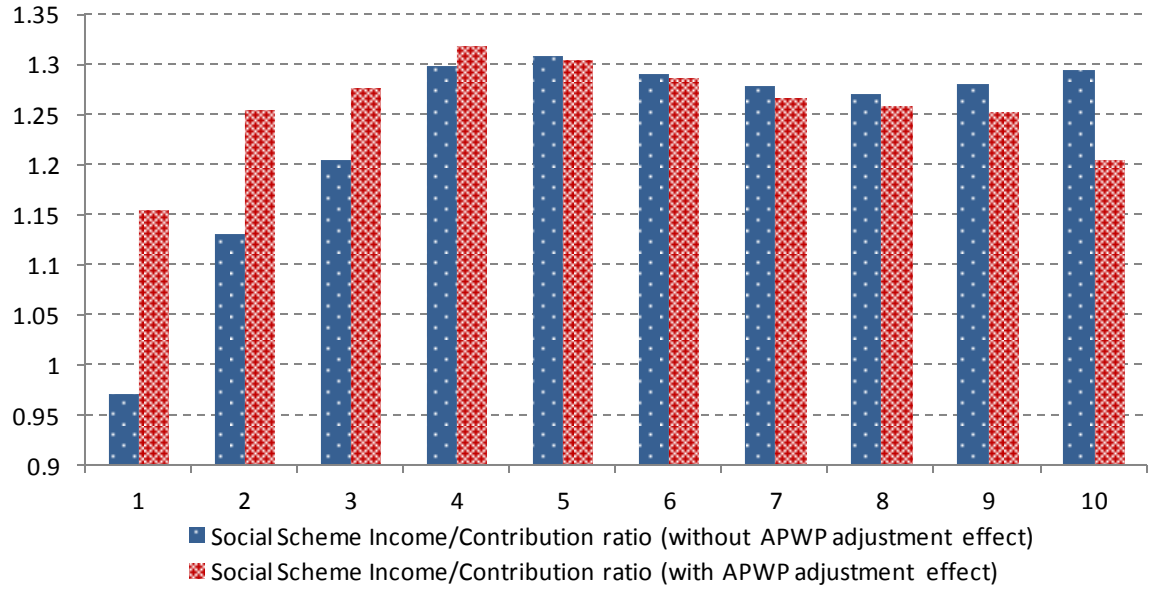
Here we can see the difference in life expectancy calculated for income percentiles using probit forecast probabilities. The increase in life expectancy for highest percentiles is caused by probit model characteristics.

## 3.4. Distributional consequences of Life expectancy differentials

The income-related differences in life expectancy are substantial when evaluating the distributional consequences and solidarity of retirement pension's system scheme. The Graph (3) presents the simple version of retirement pension income/contribution ratio for newly retired males, based on APWP adjustments valid in 2005[7]. If the APWP in 2005 was over 1.25, then 60 percent of the difference between 1.25 and the original APWP was added. And vice versa if the APWP was lower than 0.75, 40 percent of the difference between the value 0.75 and that lower average personal wage point was added.

At the income side of ratio formula we use life expectancies at age 62 calculated above and an average retirement pensions for each income decile. On the other side, the average personal wage point and contribution period in years are used.

**Graph 4: Retirement pension income/contribution ratio**




**Source: Authors calculations**

The ratio is relatively not so favorable for the lowest income decile. The explanation could be found in short retirement period. Moreover, the lowest decile would be disadvantaged by the system setting with no PAWP adjustments. From forth to highest decile, the rude retirement pension formula does not generate distributional consequences. The PAWP adjustments taken in effect in 2005 are essential to strengthen solidarity. It favors three bottom deciles and penalizes especially highest income decile.

[7] The principle of solidarity in the retirement pension calculation was settled by § 63 Act no. 461/2003 Z. z. on Social Insurance and prolonged by latest novel. The average personal wage point reduction coefficients are settled for period 2004 to 2018.

## *4. Conclusion*

In this paper we present the results of a comparative analysis of mortality incidences based on the three different measures in this paper. All three methods confirm our hypotheses about differences in life expectancy based on the lifetime income. Male pensioners with higher retirement pension in Slovakia live longer.

The official life expectancy at age 62 for total male population in 2005 published by Slovak Statistical Office is 15.06 years. Our proxy for life expectancy estimated by second method gives as 16.5 years. We explain the higher value by two main reasons: Firstly, we do not work with the complete male population at age 62, but only with regular retirement pensioners. This mean we do not count disabled or other special pensioners. Our sample pensioners are supposed to be healthier than the total population. Secondly, as mentioned above, this outcome can be slightly affected by Profit function characteristics for higher income percentiles. Using this method we draw the difference in or life expectancy proxy at over 8 years. While its value for lowest income percentiles is 12-13 years, the highest income percentiles reach over 20 years of life expectancy.

Argument of restricted sample can be used to interpret results of mortality tables from the third method. Life expectancy varies from 12.2 for lowest decile to 16.6 for the highest income decile for 62 years old males in 2005. Life expectancy for the whole sample at the level 15.6 (Table 4) is slightly higher, but in line with the official statistics. This gives us conformity about our results.

Our results are in line not only with official mortality tables, but also with foreign research findings. Gaudecker and Scholz (2007) compute life expectancies at age 65 and find six years on the difference in life expectancy between the lowest and the highest socio-economic group in Germany. Dugan (2007) estimates difference in age of death between low and high lifetime income of two to three years for males and females in United States.

The income-related differences in life expectancy are substantial when evaluating the distributional consequences and solidarity of retirement pension's system scheme. According to our simple retirement pension income/contribution ratio, the personal average wage point adjustment taken in effect since 2005 are essential to ensure solidarity in 1.st pillar pension scheme.

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# *Appendix:*

***Table 4: Abbreviate mortality tables for males in 2005***

| age | count | Dx | Px | mx | qx | lx | dx | Lx | Tx | LEx |
|---|---|---|---|---|---|---|---|---|---|---|
| 62 | 15426 | 274 | 15289 | 0,01792 | 0,01776 | 100000 | 1776,175 | 99111,91 | 1555327 | 15,6 |
| 63 | 15264 | 291 | 15119 | 0,01925 | 0,01906 | 98223,83 | 1872,466 | 97287,59 | 1456215 | 14,8 |
| 64 | 15559 | 336 | 15391 | 0,02183 | 0,02159 | 96351,36 | 2080,647 | 95311,04 | 1358927 | 14,1 |
| 65 | 15382 | 358 | 15203 | 0,02355 | 0,02327 | 94270,71 | 2193,952 | 93173,74 | 1263616 | 13,4 |
| 66 | 14140 | 360 | 13960 | 0,02579 | 0,02546 | 92076,76 | 2344,117 | 90904,7 | 1170442 | 12,7 |
| 67 | 13185 | 367 | 13002 | 0,02823 | 0,02783 | 89732,64 | 2497,419 | 88483,93 | 1079538 | 12,0 |
| 68 | 12465 | 390 | 12270 | 0,03178 | 0,03129 | 87235,22 | 2729,155 | 85870,65 | 991053,8 | 11,4 |
| 69 | 12068 | 401 | 11868 | 0,03379 | 0,03322 | 84506,07 | 2807,62 | 83102,26 | 905183,1 | 10,7 |
| 70 | 12126 | 446 | 11903 | 0,03747 | 0,03678 | 81698,45 | 3004,562 | 80196,17 | 822080,9 | 10,1 |

***Source: Authors calculations***

# Projecting economic activity with respect to expected shifts in retirement age (case of Slovakia)[1]

*Peter HORVÁT*[2], *Miroslav ŠTEFÁNIK*[3]

***Abstract***: Submitted paper presents the application of a logit model to project figures on economically active population in Slovakia. The parameters of the logit model are estimated using the European Union Labour Force Survey data. The parameter related to retirement age was calibrated based on an empirical analysis using data from the European Union Survey on Income and Living Conditions. Thanks to this, the projections show the development in three scenarios based on the expected age of retirement (62, 65 and 70). Even if Slovakia would be shifting the retirement age up to 70 years, this would only postpone an unavoidable decline in the labour supply after 2020.

***Keywords:*** economic activity, logit, labour supply

***JEL classification:*** J21, J22, J26

## 1. *Introduction*

Modelling the supply of labour has a long tradition in the economic theory. Most of the approaches focus on the relation of working time and wage. The methodology in this area is therefore rather elaborated. This paper presents an application of a methodology when a logit model is used to predict the economic activity of the population. The parameters of the logit model are, in the first step, estimated on individual data and afterwards, in the second step, used on aggregate demographic projections. Creating predictions in this way allows us to incorporate scenarios related to differences in the shift of retirement age. In three scenarios we expect the retirement age to be remaining at 62 and shifting continuously either to 65 or 70. The projections show, that shifting the retirement age would only postpone, but not eliminate an unavoidable decline in labour supply in Slovakia after 2020.

This paper presents an adjustment of the methodology of an already existing model projecting the structure of labour supply and demand based on a macroeconomic forecast. This model is called VZAM and is described in (Workie Tiruneh, 2012). This work is therefore based also on the work of our colleagues, which were involved in creation of the original VZAM model. Here we are trying to improve the methodology of implementing scenarios referring to shifts in retirement age.

## 2. *Theoretical approach*

The approach we have chosen is based on an established micro-economic model explaining the numbers of hours supplied on the labour market being a function of wage and individual characteristics.

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For the purpose of our predictions we have extracted the reasoning behind this theoretical model and applied it on the supply of labour in terms of economic activity of a population subgroup. Population subgroups are defined by available demographic projections which are structured by gender, age, education and region. Based on 2 genders, 14 age groups, 6 educational groups and 8 regions we get 1344 population subgroups. For these subgroups we are able to produce a relative wage, which is a share of the average wage within the subgroup to the total average wage.

In our model we are operationalizing the rate of economic activity of a subgroup to be a function of relative wage, which we at this point assume to remain constant in time during the reference period. Economic activity is also a function of individual characteristics of the subgroups (gender, age, education and region).

Our model could be therefore formalised as follows:

$$r = w + X + t + u \quad (1)$$

Where

r - rate of economic activity, w – relative wage, X – vector of individual characteristics (dummies for gender, age and educational groups and region), t – time, u- error term.

Based on the ILO distinction of approaches towards projecting labour supply our approach presents a mixture of time extrapolation methods and regression models based on correlations between participation rates and economic, demographic or cultural factors (ILO, 2011).

## 3. Data used and calibration

Projections of economic activity with respect to expected shifts in retirement age were obtained using the model VZAM 1.1[4]. The input data of the model are population projections by age, sex and region until 2033 (Prognóza populácie krajov Slovenska do roku 2030, 2012), complemented by the educational structure based on existing trends in educational attainment patterns of the Slovak population. The second key input was the Labour Force Survey (LFS) micro-data database used to estimate the probability of being economically active at the individual level. EU-SILC longitudinal data set of individual data (2006-2009) were used as the data source for calibrating the behaviour of working population shortly before reaching the retirement age. Both, the LFS as well the EU-SILC individual datasets were provided by the Statistical Office of the Slovak republic to the Institute of Economic Research of Slovak Academy of Sciences (IER SAS).

The EU-SILC longitudinal data were used for calibration mainly because of two reasons. The majority of individuals participating in the survey are presented in the sample for more than two periods and also because this database allows more accurate identification of an individual's age. Table 1 depicts the number of periods of individuals in the sample.

**Table 1: Number of periods of individuals in the sample**

| Number of years | Frequency | Percent | Cum. |
|---|---|---|---|
| **1** | 942 | 3.08 | 3.08 |
| **2** | 8 338 | 27.28 | 30.36 |
| **3** | 10 647 | 34.84 | 65.2 |
| **4** | 10 636 | 34.8 | 100 |
| **Total** | 30 563 | 100 | |

**Source: EU-SILC database and authors calculations**

[4] More information on the methodology of the model can be found in (Workie Tiruneh, 2012)

The main limitation of the dataset is that the survey does not provide the ability to identify economic status of the individual according to the ILO5 definition. The question referring to the self-defined economic status (PL180 - MOST RECENT CHANGE IN THE INDIVIDUAL'S ACTIVITY STATUS) was used as an approximation of the changes in economic status. We have followed the occurrences of leaving into retirement within the working population. The proportion of those who left into retirement among the total working population was 0,853% during the period 2006-2009.

Based on the proportion of population leaving the labour market into retirement, we have fixed the coefficient related to the dummy variable referring to the fact whether an individual is in productive age or not. The value of the calibrated coefficient was obtained by applying the logit[6] function on the particular proportion as follows:

$$\beta = -\ln\left(\frac{1}{\frac{EA_e}{EMPL}-1}\right) \qquad (2)$$

where $\beta = 1.758$ is the value of the calibrated parameter for the variable productive age, $\mathrm{EA_e}$ number of economically active individuals who went into early retirement and $\mathrm{EMPL}$ number of employed individuals.

## 4. The estimation

Projections were done in two steps. The probability of being economically active were estimated on individual data and afterwards applied on the demographic projection in aggregated form.

First step: Micro data estimation

Firstly the coefficients used to project the probability of being economically active, for each of the subgroups, were estimated using individual data. For this purpose we have used the LFS micro data. A logit form of the equation was selected. A dummy variable referring to being economically active was selected as the explaining variable. Practically all the information available from the demographic projections was used to explain the economic activity, namely dummy variables for sex, region, educational and age group, mean wage within subgroup, number of population in the subgroup and a trend variable referring to year of the reference period. These were complemented with a dummy variable referring whether an individual reached the formal retirement age or not. Using this variable allows us to create scenarios of shifts in the formal retirement age. In scenarios expecting a shift in retirement age we simply set the variable being 1 in the future for the age group which we assume to be influenced by the shift. For example the age group 60-64 gets a value of one from the point of time in the future when we assume the retirement age to shift to 65 years[7].

$$\ln(P|EA=0) = \beta_1 sex_{dummy(1)} + \beta_2 region_{dummy(2-8)} + \beta_3 age\_group_{dummy(3-13)} + education\_groupdummy(2-5) + \beta 4 productive\_agedummy + \beta 5 mean\_wage + \beta 6 edu\_p + \beta 7 trend + ut \qquad (3)$$

Subgroups are defined as a projected population by age, sex, region and education. The results of the logistic regression are shown in table 2.

[5] http://laborsta.ilo.org/applv8/data/c1e.html

[6] Applying the logit function was necessary because the model was estimated in a "logit" form.

[7] This variable is not a strict dummy variable, because we had to work with the 5-years age groups (Eurostat's LFS anonymisation strategy). Therefore we have set it as continuous, with values from 0 to 1, as the shift in retirement age is made in year intervals and less than 1 year age shifts. The value of the variable always reflects what is the proportion of each age group after the formal retirement age. The authors would also like to thank Tatiana Bujňákova for creating this variable for the VZAM model based on Slovak legislation and strategic documents.

**Table 2: Estimation results**

| | Coef. | Std. Err. | Z | P>z | 95% Conf. | Interval |
|---|---|---|---|---|---|---|
| **Male** | 0.81 | 0.01 | 126.65 | 0.000 | 0.79 | 0.82 |
| **Age20-24** | 0.62 | 0.01 | 55.01 | 0.000 | 0.60 | 0.64 |
| **Age25-29** | 1.42 | 0.01 | 108.28 | 0.000 | 1.40 | 1.45 |
| **Age30-34** | 1.78 | 0.01 | 122.55 | 0.000 | 1.75 | 1.81 |
| **Age35-39** | 2.23 | 0.02 | 142.43 | 0.000 | 2.20 | 2.26 |
| **Age40-44** | 2.46 | 0.02 | 156.77 | 0.000 | 2.43 | 2.49 |
| **Age45-49** | 2.25 | 0.01 | 153.58 | 0.000 | 2.22 | 2.28 |
| **Age50-54** | 1.56 | 0.01 | 114.49 | 0.000 | 1.54 | 1.59 |
| **Age55-59** | 0.25 | 0.01 | 18.32 | 0.000 | 0.22 | 0.27 |
| **Age60-64** | -1.76 | 0.02 | -106.77 | 0.000 | -1.79 | -1.72 |
| **Age65-69** | -2.75 | 0.02 | -114.53 | 0.000 | -2.80 | -2.71 |
| **Age70-74** | -3.79 | 0.04 | -95.91 | 0.000 | -3.87 | -3.71 |
| **Age75+** | -4.88 | 0.07 | -72.16 | 0.000 | -5.02 | -4.75 |
| **Dumregion2** | -1.44 | 0.01 | -124.77 | 0.000 | -1.47 | -1.42 |
| **Dumregion3** | -1.68 | 0.01 | -141.36 | 0.000 | -1.70 | -1.65 |
| **Dumregion4** | -1.49 | 0.01 | -123.8 | 0.000 | -1.51 | -1.47 |
| **Dumregion5** | -1.55 | 0.01 | -137.58 | 0.000 | -1.57 | -1.52 |
| **Dumregion6** | -1.61 | 0.01 | -140.61 | 0.000 | -1.64 | -1.59 |
| **Dumregion7** | -1.47 | 0.01 | -129.99 | 0.000 | -1.49 | -1.44 |
| **Dumregion8** | -1.57 | 0.01 | -141.56 | 0.000 | -1.59 | -1.55 |
| **Low_sec** | 1.18 | 0.01 | 144.14 | 0.000 | 1.17 | 1.20 |
| **Upper_sec_voc** | 1.50 | 0.01 | 173.11 | 0.000 | 1.49 | 1.52 |
| **Upper_sec_gen** | -0.84 | 0.01 | -72.56 | 0.000 | -0.86 | -0.82 |
| **Tertiary_science** | 1.45 | 0.02 | 82.83 | 0.000 | 1.42 | 1.48 |
| **Prod_age** | 1.76 | . | . | . | . | . |
| **mean_wage** | -0.16 | 0.00 | -53.72 | 0.000 | -0.17 | -0.16 |
| **Subgroup_size** | -1.32e-4 | 0.00 | -219.88 | 0.000 | -1.33e-4 | -1.31e-4 |
| **Trend** | 0.04 | 0.00 | 11.37 | 0.000 | 0.03 | 0.05 |

**Source: Authors calculations and LFS database of the Statistical Office of the Slovak republic**

The table shows a fixed coefficient for being in productive age using the value acquired from EU-SILC. All the variables were significantly contributing to the model. The model was statistically significant in explaining economic activity as Log likelihood values went from -894 555.5 in the first iteration to -459 617.5 in the seventh iteration.

The goodness of fit test indicated the need for additional explanatory variables to increase the explanatory power of the model, but based on the character of our analysis, the list of used explanatory variables was restricted by the demographic data.

The test of multicolinearity showed favourable results for all variables included.

Second step: Application on the demographic projections

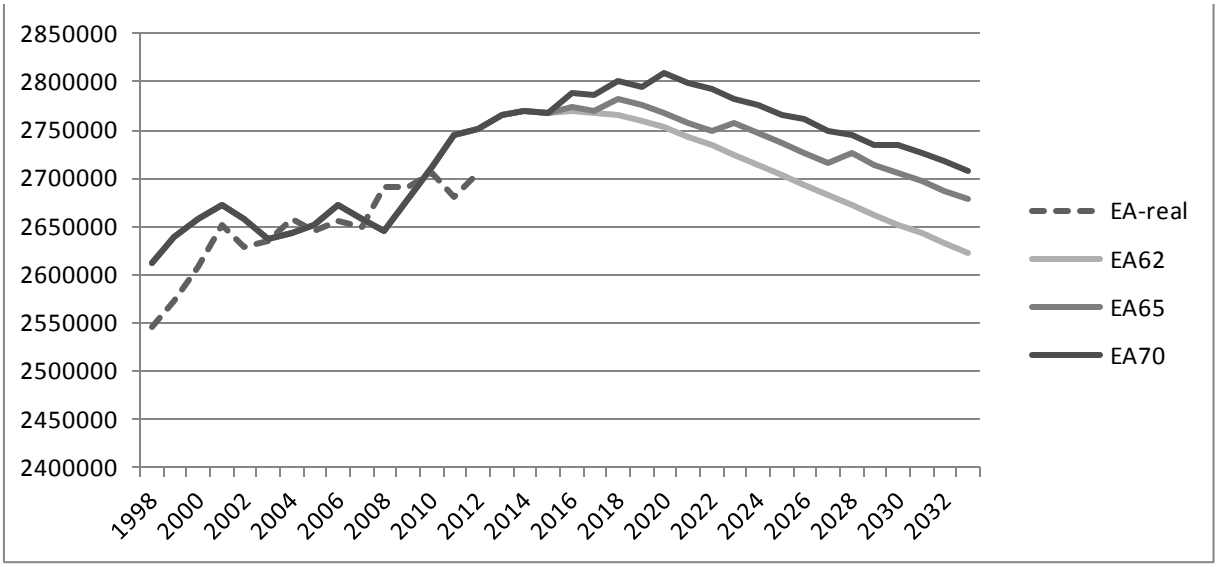
Thanks to the fact that in explaining the economic activity at the individual level we have used only the information available in the demographic projections, we are able to construct the same dummy variables also in the aggregated data set with demographic projections. This allows us

to reconstruct the probability function based on the estimated coefficients. We construct the prediction based on the values predicted by the logit model for each of the subgroups, which we afterwards transform into the form of probabilities. Multiplying the size of the subgroup by the probability of being economically active, based on the characteristics of the subgroup, gives us the predicted number of economically active in the subgroup.

## 5. Results

For all three scenarios the peak of economic activity will occur in 2020 at 2.753-2.809 million economic active population based on the estimation results. Past 2020 a decrease in economically active population is expected. This will lead to a decrease in about 3,5-4,8% (depending on the scenario) at the end of the reference period, when compared to the peak. The overall projected numbers of economically active population together with the real data are shown in the graph below.

**Graph 1: Comparison of the economic activity in three scenarios and real data**

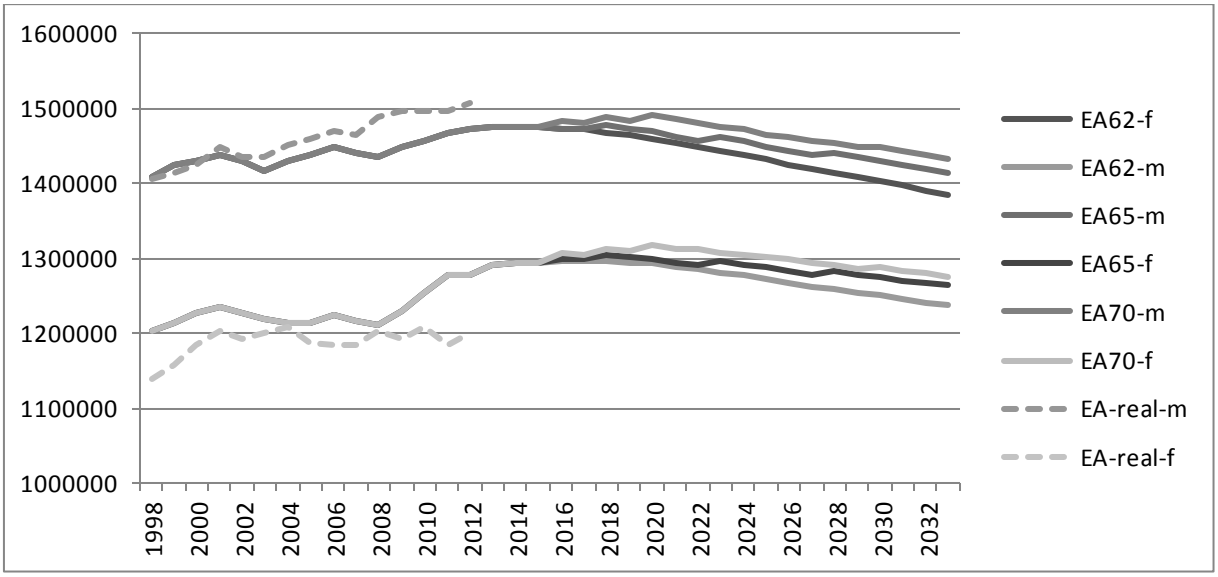



**Source: Authors calculations and LFS database of the Statistical Office of the Slovak republic**

Regarding the approach chosen to create these projections it is also interesting to follow the structure of economically active population. A comparison of projected and actual development of economically active population, by gender, is displayed in the graph 2. It is possible to see, that the model underestimates the number of economically active men and overestimates the number of economically active women. The error is bigger in case of female economically active population. This finding indeed offers some opportunity for improvement of the model. The peak of economically active male population will again occur in 2020, at level about 1.460-1.491 million of active men. The retirement age used to be lower for the female population in the past. Its current growth is the same in comparison to males today, because the retirement age differences between genders have disappeared.

Because of the scenarios applied, the most interesting output of the model are the projections of economically active population in age groups, especially for the age groups 60-64 and 65 +. The shift in retirement age is most visible in the age group 60-64. This age group has increased more than 400% from 1998 to 2012, in the level from 16,600 to more than 65,000 active people. In line with the scenario EA62 this shift in numbers of economically active population 60-64 will not occur because this scenario assumes no change in current retirement age, with the number of active population aged 60-64 culminating at 48,194 in 2020.

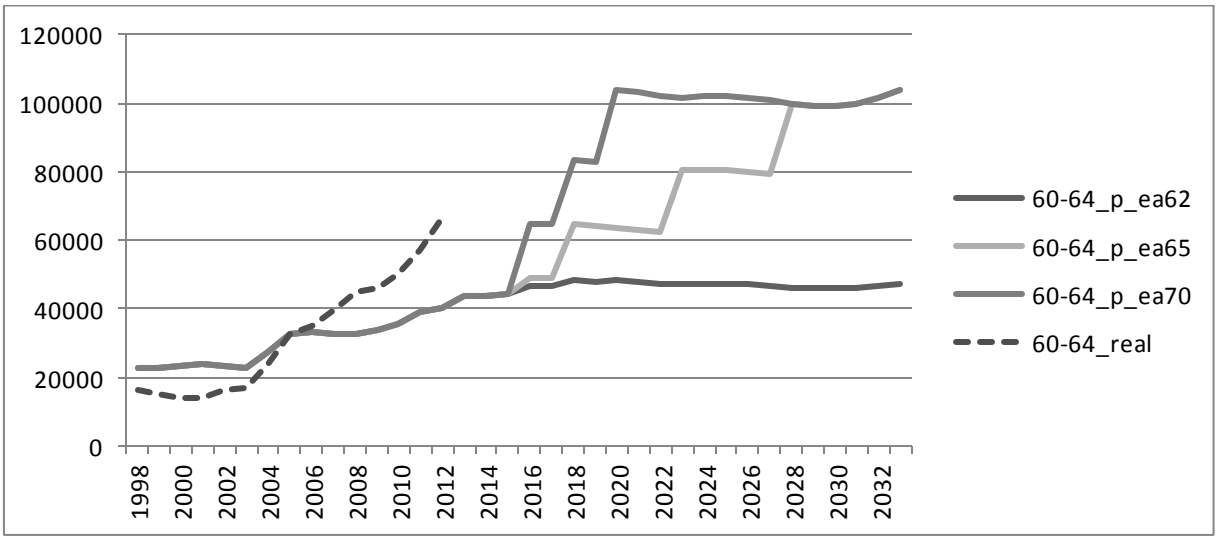
**Graph 2: Comparison of the economic activity in three scenarios and real data by sex**




**Source: Authors calculations and LFS database of the Statistical Office of the Slovak republic**

For the scenarios EA65 and EA70 there should be a rise of the active population to a level of around 99,797 in 2028, caused by the sift in retirement age. The figures of scenario EA65 and EA70 are the same because both scenarios assume the same shift in retirement age of the age group 60-64. All three scenarios remain the same until 2015, based on planned shifts in the retirement age. Scenarios EA65 and EA70 reach the level from 2028 via a different path, because they assume a different pace of increase in the retirement age. The figures are shown in the graph number 3.

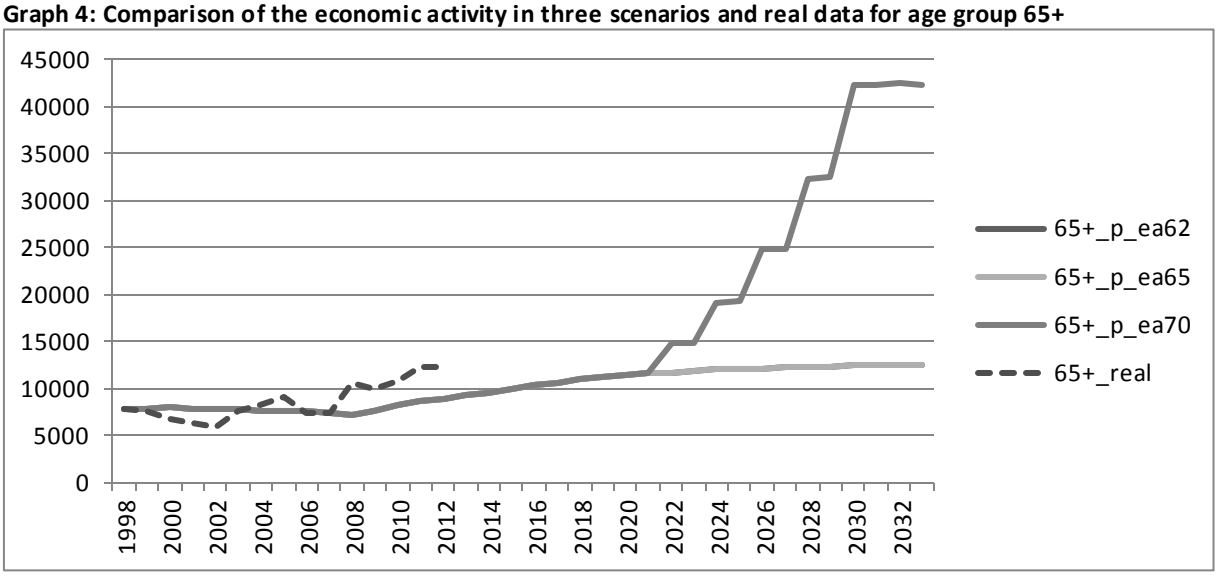
**Graph 3: Comparison of the economic activity in three scenarios and real data for age group 60-64**




**Source: Authors calculations and LFS database of the Statistical Office of the Slovak republic**

In the age group 65+ it is possible to observe an increase in the number of economically active population during 1998-2012. The trend of growth would be the same until 2021 for all three scenarios according to the projection. In case of the scenario EA70 a rapid increase of economically active population is expected in 2021. This is because this scenario expects a rise in retirement age above the age of 65 in 2021. In both other scenarios EA62 and EA65, the age group 65+ remains unaffected and, therefore, at the same level.

**Graph 4: Comparison of the economic activity in three scenarios and real data for age group 65+**

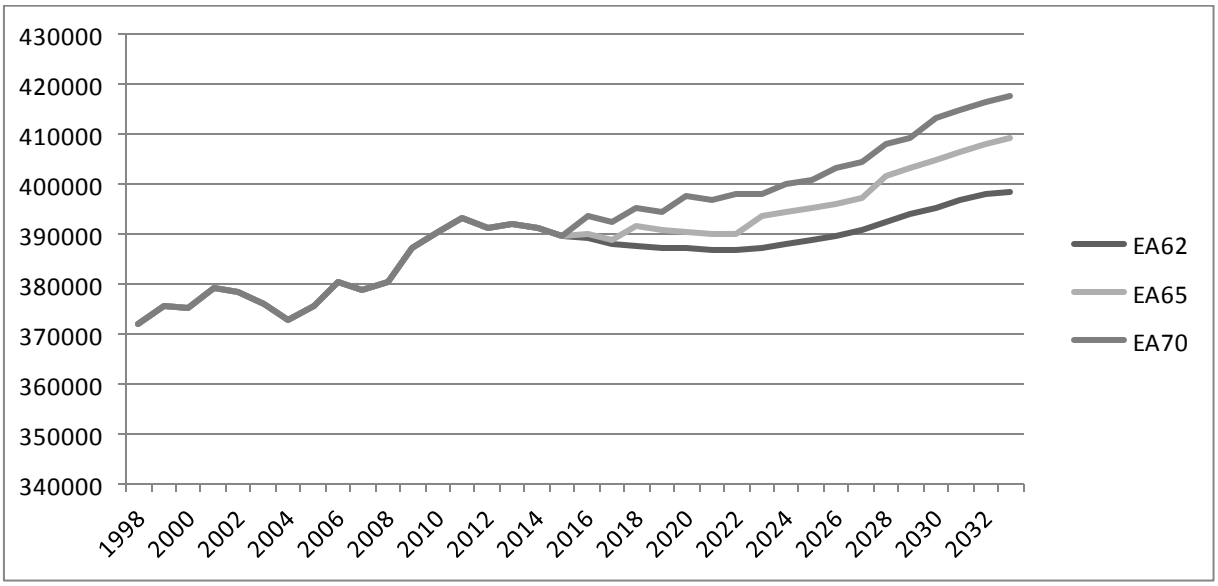



**Source: Authors calculations and LFS database of the Statistical Office of the Slovak republic**

When looking at the regional structure of economically active population a different pattern can be observed in Bratislava, than in all the other Slovak districts. For Bratislava it is possible to observe either a stagnating or increasing trend (based on the scenario). In all other Slovak regions a decline of economically active population is projected.

The moment of difference between growth and stagnation of economic active population in Bratislava region is the change in the retirement age, which can be seen in graph 5. In the scenario EA70 there is an increase of economic active population to almost 420,000 in the horizon of the projection.

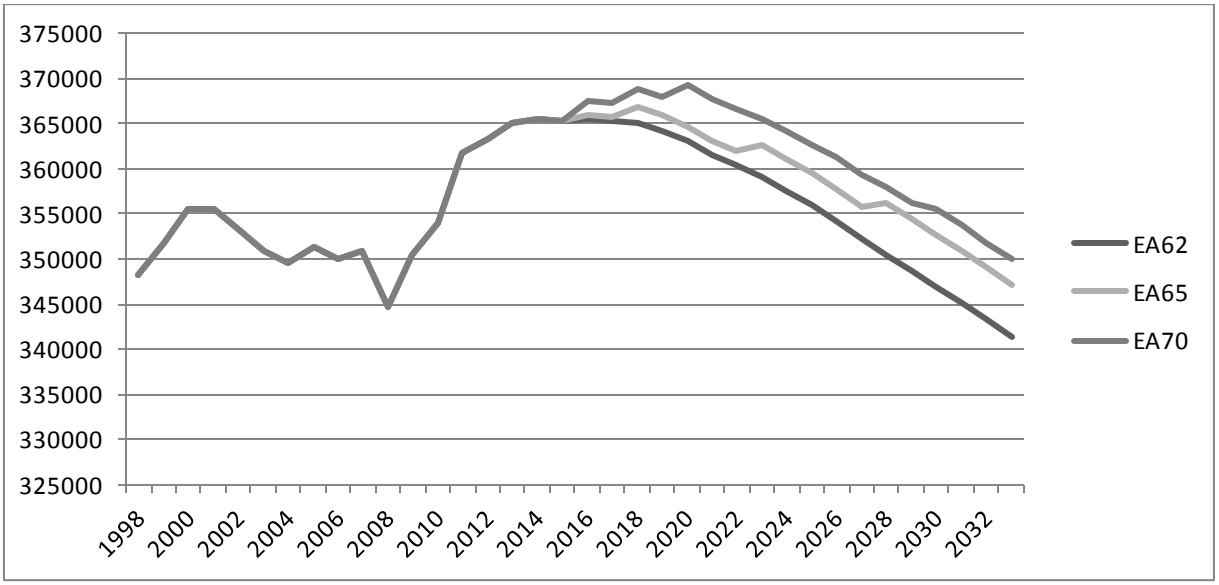
**Graph 6: Comparison of the economic activity in three scenarios for Bratislava region**




**Source: Authors calculations and LFS database of the Statistical Office of the Slovak republic**

Figure 7 shows the decline in economic activity for the region of Košice, where the peak is in 2020. Despite an increasing retirement age, the number of economically active population in the region of Košice will fall to the lowest level of 341,253-349,942 (based on scenario) in 2033.

**Graph 7: Comparison of the economic activity in three scenarios for the region of Košice**




**Source: Authors calculations and LFS database of the Statistical Office of the Slovak republic**

## 6. Discussion

Presented projections of economic activity are trying to employ an elegant methodology using one logit equation to grasp the variations in economic activity of subgroups defined based on gender, age, education and region. This methodology allows a simple implementation of scenarios related to expected shifts in the retirement age. Based on the projections, Slovakia is, after an initial growth, going to face a decline in economically active population. Increase in the retirement age will compensate expected decline to some extent, but only Bratislava region will avoid the decline. In other regions the shift of retirement age will only postpone the decline of economically active population. As a result, significant restrictions for the economy can be expected based on the decline of labour supply.

Even more interesting than the projected figures may be the methodology applied. One equation, logit model was applied, combining individual data with demographic projections. The methodology offers a simple and elegant opportunity to incorporate scenarios related to increase in retirement age. Based on the legislation and current plans of the Slovak government we have constructed scenarios expecting the retirement age to remain 62, or shift continuously towards 65, or a rather dramatic shift up towards 70 years. These were implemented using a dummy variable referring to being in productive age, meaning before reaching the retirement age. This variable, together with other explanatory variables was included into the estimation of the logit model on individual LFS data.

Using a logit equation to project economic activity is also related to several limitations. The biggest is a lower accuracy of the predictions for marginal groups, with the rate of economic activity far from the average; for example for the youngest and oldest age cohorts. Marginal subgroups, in terms of the rate of economic activity, are pressed closer towards the average. This is also the reason for overestimation of the numbers of female economically active population and on the contrary under estimation of the numbers of economically active males.

Despite these limitations which are related to the methodology applied, using a logit model in the way we have done it, to project economic activity, could bring useful results. The best option would be its joint application with expert judgements when projecting the economic activity of the marginal subgroups.

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## *Data used:*

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The European Union Survey on Income and Living Conditions (Slovak individual data set, provided by the Slovak Statistical Office)

# Ageing of labor force in the agricultural sector in the Czech Republic

*Marta GRYČOVÁ*[1]

***Abstract*:** More than 50% of the total labour force in the agricultural sector is over the age 45 in the Czech Republic. The social and economic problems of this sector are deepening. This paper tries to describe the ageing population problem on the Czech agrarian labour market and stress the consequences of the ageing of the employed in the agricultural sector. The aim of the paper is to analyse possible consequences on the gross agricultural product from the agricultural sector and its labour productivity using the available data from the Czech statistical office databases and Eurostat. The results of linear regressions estimated by OLS method uncover a positive relationship between the number of young farmers and the gross agricultural product and labour productivity, and a high correlation between the number of young farmers and the amount of subsidies devoted to them.

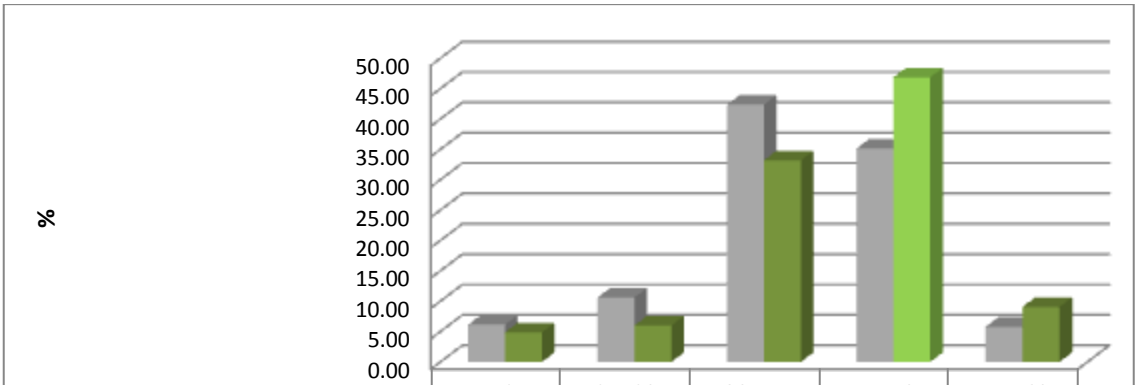
***Keywords:*** ageing of labour force, gross agricultural product, subsidies to young farmers, labour productivity.

***JEL classification:*** J43, Q18

## 1. Introduction

Only 3.05% of total labour force works in the agricultural sector in 2012 in the Czech Republic. Comparing to the value of 3.6% in 2003 this percentage has been decreasing for a long time. More than 50% of the total labour force in the agricultural sector is over the age 45 in the Czech Republic. In this introductionary section the state and the development of age structure in the Czech agriculture are described.

**Graph 1. The age structure of labor force in the total economy and in the agricultural sector, 2012**




| | 15 - 24 | 25 - 29 | 30 - 44 | 45 - 59 | over 60 |
|---|---|---|---|---|---|
| Age range in the total economy (CZ) | 6.14 | 10.60 | 42.36 | 35.11 | 5.79 |
| Age range in the agricultural sector (CZ) | 4.87 | 6.00 | 33.18 | 46.87 | 9.08 |

**Source: data Czech Statistical Office, own calculation**

According to the Czech Statistical Office database 4.9 % of employees in agricultural sector (CZ-NACE A) are in the age range of 15-24, 6 % in the range of 25 – 29, 33.2 % in the range of 30-44 and over 46.9 % in the range of 45-59 and over 9 % in the range of over 60 years (see Graph 1).

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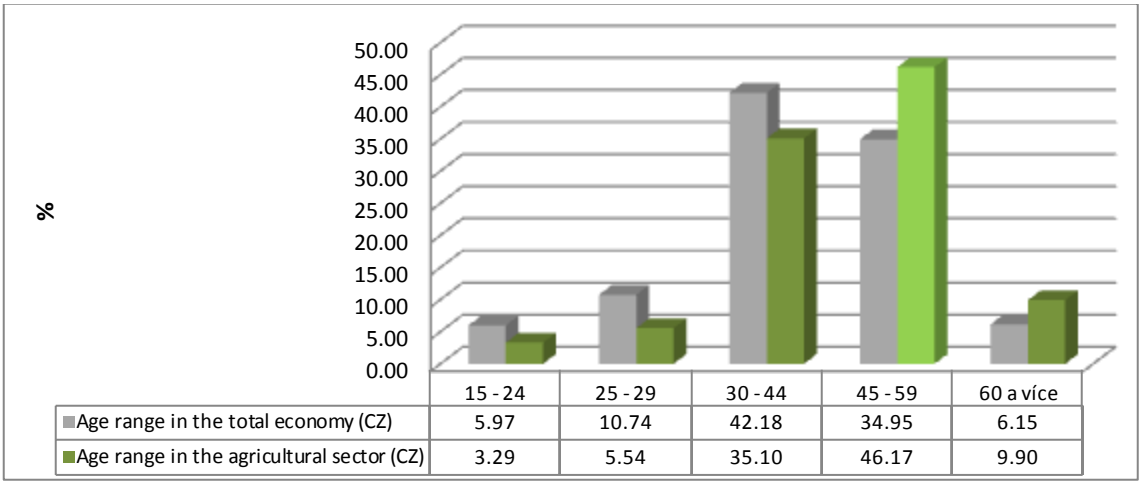
This ageing problem is getting better a little in the age range of 30-44 in the 1st quarter 2013 (see Graph 2). However, for the rest of age ranges the situation gets worse (less young labour force and more older labour force).

**Graph 2. The age structure of labor force in the total economy and in the agricultural sector, 1st quarter 2013**

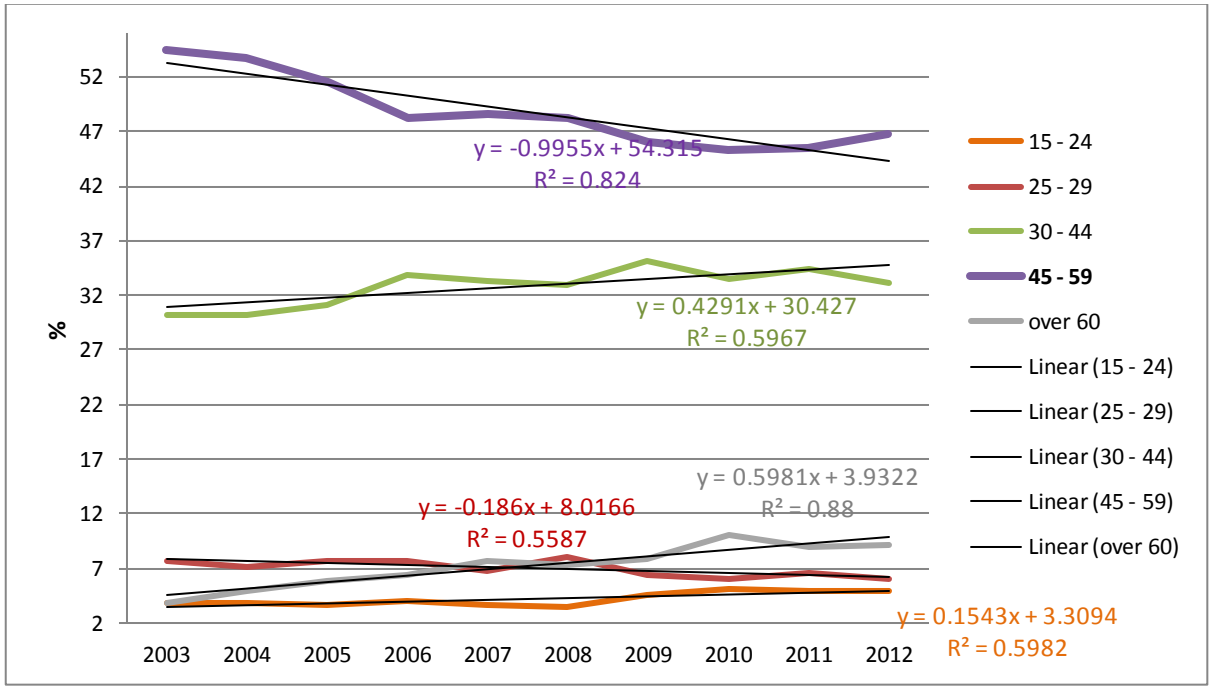



| | 15 - 24 | 25 - 29 | 30 - 44 | 45 - 59 | 60 a více |
|---|---|---|---|---|---|
| Age range in the total economy (CZ) | 5.97 | 10.74 | 42.18 | 34.95 | 6.15 |
| Age range in the agricultural sector (CZ) | 3.29 | 5.54 | 35.10 | 46.17 | 9.90 |

**Source: data Czech Statistical Office, own calculation**

The Graph 3 illustrates changes of the age structure in the agricultural during the period of 2003 to 2012. During this period the number of labour force in the age range of 15-24, 30-44 and mainly in the rage of over 60 years increased. Apart from those increases that are not very high mainly in the range of 15-24, the number of labour force in the age range of 25-29 a little and much more in the age range of 45-59 decreased. So it seems that the subsidies to the young farmers since 2007 might be effective, even though a quite big increase can be detected last year in the crucial age range of 45-59 and a little decrease in the range of 30-44 and 25-29 slightly. There can be seen also nearly constant development in the age range of 15-24 from the year 2010.

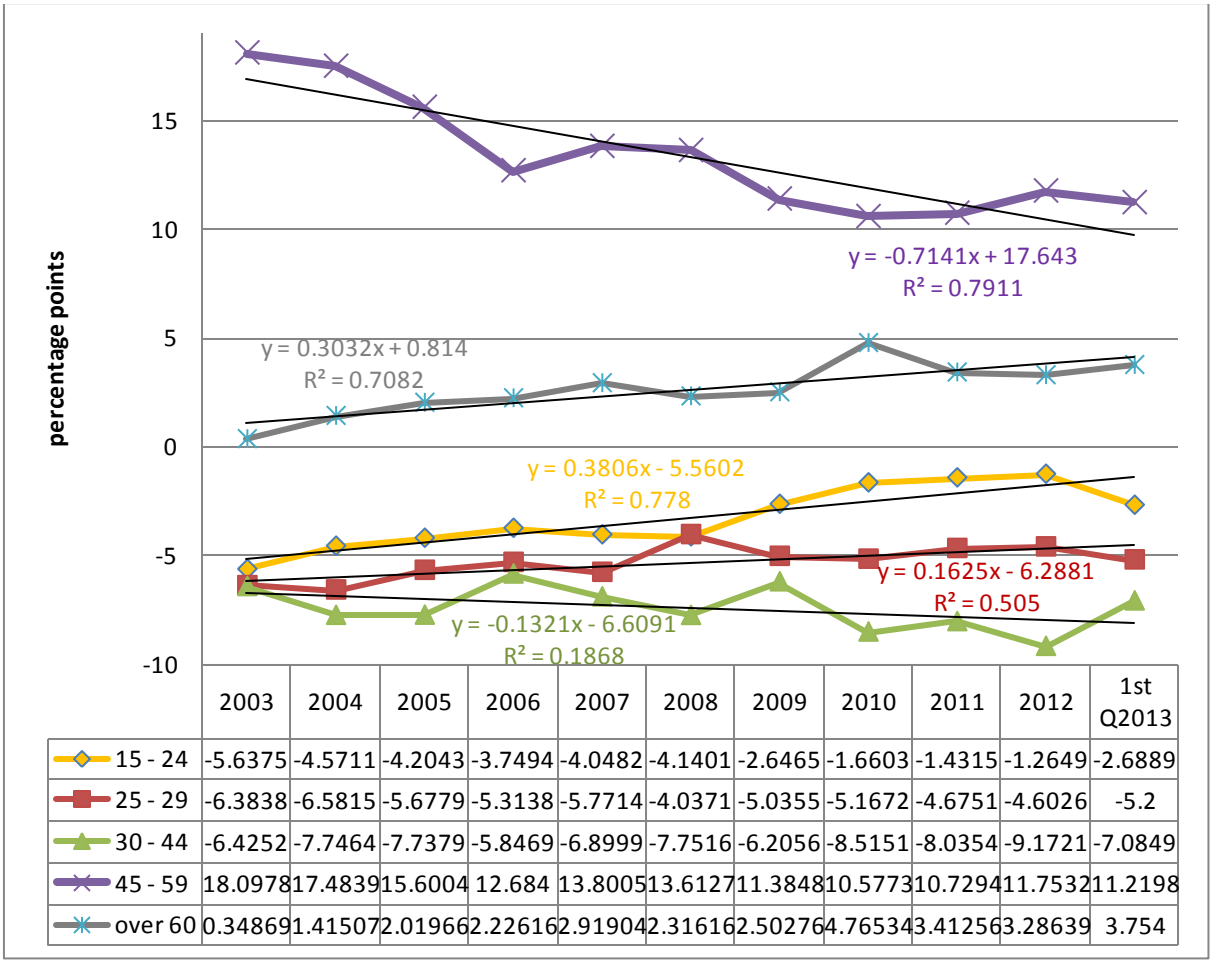
**Graph 3. The age structure of labor force in the agricultural sector, 2003-2012**




**Source: data Czech Statistical Office, own elaboration**

This age structure typical for the Czech agriculture deviates from the values for the total economy (total labour force) in the same direction for a very long time. For example, the age structure of the labour force in the agricultural sector differs from the one of the total national economy in the age range of 15-24 years by about -1.3 percentage points, in the range of 25-29 by -4.6 percentage points, in the range of 30-44 by -9.2 percentage points, in the range of **45-59** by over **+11.75** percentage points and in the range of over 60 by +3.3 percentage points in 2012.

**Graph 4. The difference between the age structure in the total national economy and in the agricultural sector in percentage points, 2003-2012**




| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 1st Q2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 - 24 | -5.6375 | -4.5711 | -4.2043 | -3.7494 | -4.0482 | -4.1401 | -2.6465 | -1.6603 | -1.4315 | -1.2649 | -2.6889 |
| 25 - 29 | -6.3838 | -6.5815 | -5.6779 | -5.3138 | -5.7714 | -4.0371 | -5.0355 | -5.1672 | -4.6751 | -4.6026 | -5.2 |
| 30 - 44 | -6.4252 | -7.7464 | -7.7379 | -5.8469 | -6.8999 | -7.7516 | -6.2056 | -8.5151 | -8.0354 | -9.1721 | -7.0849 |
| 45 - 59 | 18.0978 | 17.4839 | 15.6004 | 12.684 | 13.8005 | 13.6127 | 11.3848 | 10.5773 | 10.7294 | 11.7532 | 11.2198 |
| over 60 | 0.34869 | 1.41507 | 2.01966 | 2.22616 | 2.91904 | 2.31616 | 2.50276 | 4.76534 | 3.41256 | 3.28639 | 3.754 |

**Source: data Czech Statistical Office, own calculation**

The Graph 4 demonstrates this deviation during the period of 2003 to the 1st quarter 2013. The deviation of the age structure of the labour force in the agricultural sector and that in the total national economy increased for the age range of over 60 years, 15-24 and 25-29 a little, and decreased for the age range of 15-59 and for the age range of 30-44 a little during this period.

This statistical description of the ageing problem in the Czech agricultural sector gives the illustration of the nature of the problem, even though getting better a little maybe thanks to the subsidies from the EU programs as the program Young Farmer Scheme (YFS). For evaluation of this program in Greece that was positive see Aggelopoulos and Arabatzis (2010). This phenomenon of ageing of the agricultural labour force, especially its accelerating nature, comprises of many important consequences for many social and economic variables, but mainly for the rural development and labour productivity of the sector. For the consequences to labour productivity see Malmberg et. al. (2005), but the productivity of older force is underestimated according to them. The argument behind the negative effect of ageing of the labour force on the labour productivity is that most investments in training take place at young age and so the productivity increases, and on the

other hand the depreciation of the human capital takes place when old (and thus decreasing the labour productivity) and the maintaining of their abilities is very costly. For more detail and empirical analysis see see Verhaegen en Salthouse (1997), Gelderblom and de Koning (2002) or Skirrbekk (2003).

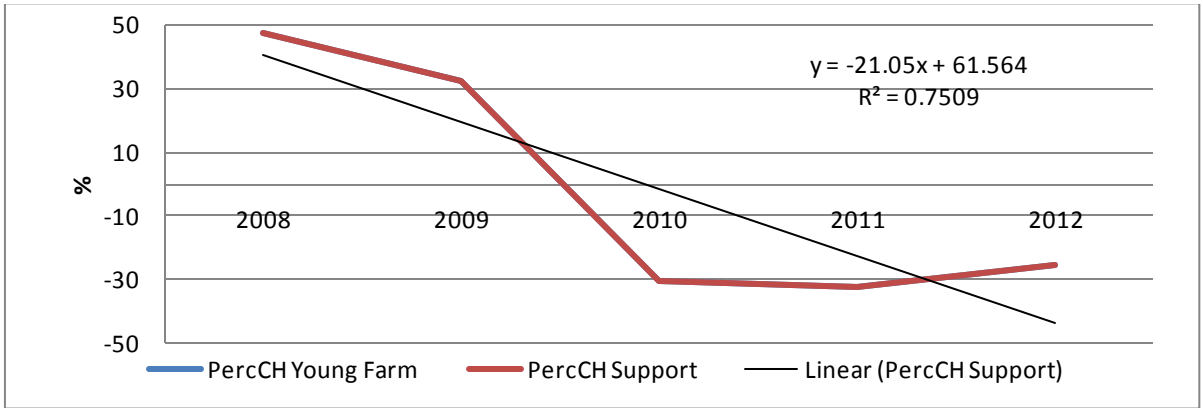
This paper tries to identify the main consequence of this situation on the agrarian labour market on the labour productivity, resp. it makes out a regression between the number of the number of young farmers defined under the program Young Farmer Scheme, i.e. farmers under the age of 40 starting farming in agriculture and as a proxy the number of employees in the age range of 15-39 with the labour productivity and gross agricultural product.

## 2. Used methodology

The annual data of the number of new farmers defined by the Young Farmer Scheme (YFS) as a farmer under the age of 40 years starting farming and the value of subsidies related to the program YFS were from the website of The State Agricultural Intervention Fund (SAIF) for the period of 2007-2012. The annual and quarterly data of employment of the age range of 15-39 in the agricultural sector in the Czech Republic, gross agricultural product and labor productivity (calculated as the ratio of gross value added over total employment both in the agricultural sector) were extracted from the Eurostat and Czech Statistical Office databases and national accounts.

However, the data downloaded from SAIF are logically absolutely correlated (0.99) and so the changes in the growth of those variables are absolutely the same (see Graph 5). Thus the proxy variable of the number of the employment of the age range from 15-39 in the agricultural sector (Eurostat database) is used instead.

**Graph 5. The percentage change of the number of new young farmers and amount of subsidies to them under the definition of YFS, 2008-2012.**




***Source: The State Agricultural Intervention Fund (SAIF)***

This paper uses simple statistical quantitative method, i.e. Pearson correlation coefficient, to analyse the variables' time series in the form of:

$$r = \frac{\sum_{i=1}^{n}(X_i-\bar{X})(Y_i-\bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i-\bar{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i-\bar{Y})^2}} \quad (1)$$

For more detail about Pearson correlation coefficient see Rodgers and Nicewander (1988).

**Regression models.** The first linear regression model relates the number of new farmers defined by the YFS as a starting farmer under the age of 40 years with the value of investment subsidies related to the program Young Farmer Scheme (YFS). However, these variables are highly correlated. Therefore these results were not reliable and should not be taken into account. Rather the variable of total employment in the age range of 15-39 from Eurostat is used in the following equation of the linear regression model:

$$EMP(15-39)_t = \beta_0 + \beta_{1t} SUB(YFS)_t + u_t \quad (2)$$

where EMP(15-39) as the endogenous variable the employment in the age range of 15-39 in the agricultural sector and SUB(YFS) is the amount of subsidies under the program YFS.

In the second model exogenous variable is the employment in the age range of 15-39 in the agricultural sector and endogenous variable is the real gross agricultural product (as an outlying parallel to the Okun law that relates unemployment rate to the real growth rate, i.e. Change in the unemployment rate = a + b*(Real output growth), see Knotek, 2007, p. 75, for further modeling of the relationship of the employment and GDP see Fizari et al., 2011, or Sanchez and Liborio, 2012):

$$GAVreal_t = \beta_0 + \beta_{1t} EMP(15-39)_t + u_t \quad (3)$$

where GAVreal is the real gross agricultural product (in the sense of purchasing power parity and secondly in the sense of prices of the year 2005). And the last model is changed only by the new endogenous variable of the labor productivity.

$$GAVperEmpl_t = \beta_0 + \beta_{1t} EMP(15-39)_t + u_t \quad (4)$$

and

$$GAVperthousHours_t = \beta_0 + \beta_{1t} EMP(15-39)_t + u_t \quad (5)$$

where the GAVperEmpl is the average agricultural gross value added per employee in mil. CZK (calculated as a ratio of gross value added in agricultural sector over the number of total employment) and GAVperthousHours is similarly the ratio of gross value added in agricultural sector over the number of total thousands hours worked in the agricultural sector in mil. CZK.

These models were estimated using the ordinary least square method (see e.g. Gujarati, 2003).

The main hypotheses about the probable results of these regressions are: 1.small positive effect of subsidies on the employment in the age range of 15-39), 2. positive relationship between the employment in the age range of 15-39 in the agricultural sector and the real gross agricultural product and 3. positive relationship between the employment in the age range of 15-39 in the agricultural sector and labor productivity in both versions.

## 3. Results and discussion

The correlation coefficient for the number of employees in agricultural sector in the age range of 15-39 and the amount of subsidies to the young farmers is as expected positive and equal to 0.2787, but seems too small (even smaller for the 1st differences, i.e. 0.0848).

The correlation coefficient for the number of employees in agricultural sector in the age range of 15-39 and agricultural output in purchasing power parity (Eurostat) is equal to -0.4794 (the period of 1998-2012) that is contrary to our hypotheses but not completely against the theory, because the labor productivity might increase during the period thanks to the capital investment and thus not needing so many employees. However, this is not the case of Czech highly undercapitalized agricultural sector. This indicate when observing the raw data that as the agricultural output increases the number of employees in the age range of 15-39 in agricultural sector decreases rapidly. Neverthless, in case of 1st differences the correlation coefficient is equal to 0.5568 that is in accordance with the hypotheses.

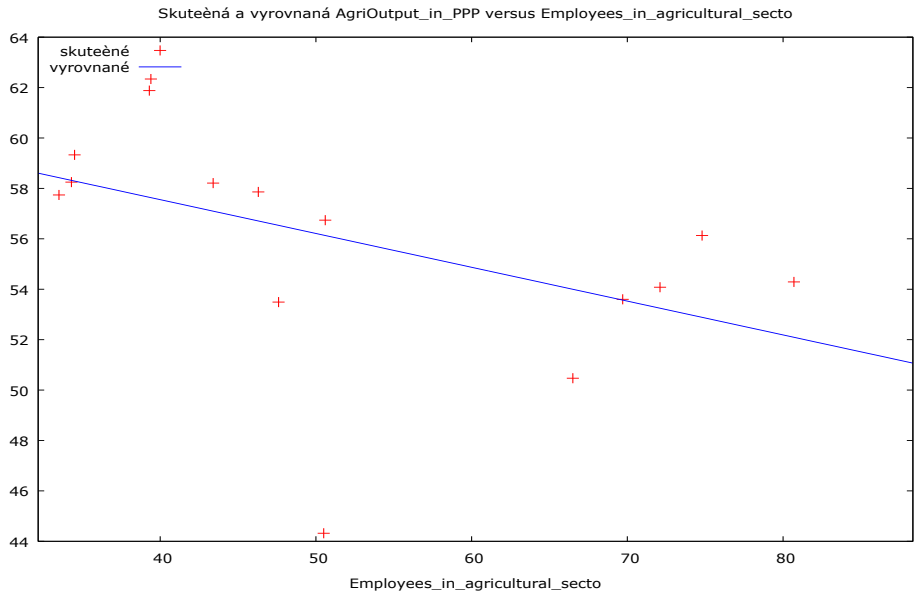
The correlation coefficient for the number of employees in agricultural sector in the age range of 15-39 and agricultural real gross value added in prices of the year 2005 in mil. CZK (GAVreal) is a small and positive of 0.0774 that approves our hypotheses (as well as in the case of 1st differences, i.e. 0.0515).

In case of the labor productivity the correlation coefficient for the number of employees in agricultural sector in the age range of 15-39 and the labor productivity in the sense of GAVperEmpl is

again negative and equal to -0.83976 and with the labor productivity GAVperthousHours is also negative, i.e. -0.84148. In the case of 1st differences it is positive and equal to 0.0002 and negative of -0.0073 respectively.

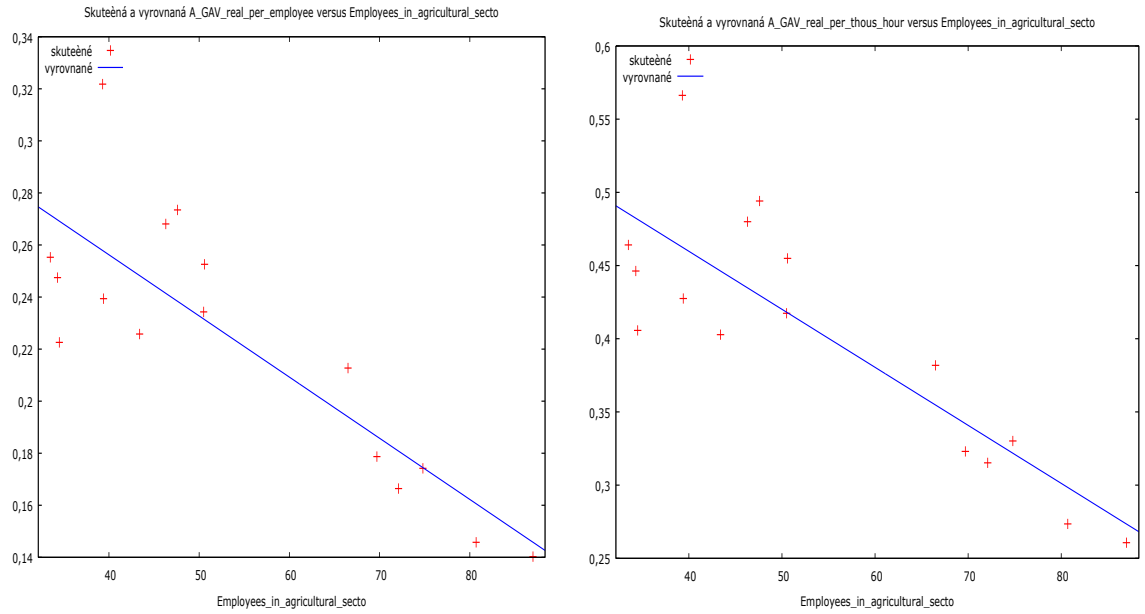
The regression lines for the mentioned combination of variables, but only those statistical significant, are illustrated in the Graphs 7 and 8. However, both illustrate the rather negative relationship contrary to the hypotheses of this paper.

**Graph 6. The regression line between the real agricultural output and employment in agricultural sector in the age range of 15-39, 1997-2012.**




**Source: data Eurostat, Gretl output**

**Graph 7. The regression line between the labor productivity and employment in agricultural sector in the age range of 15-39, 1997-2012.**




**Source: data Eurostat and Czech Statistical Office, Gretl output**

The results of the regressions are summarized in Table 1.

**Table 1. Results of the simple regression models**

| **Equation (2)** | **R^2=0.077** | ***R^2=0.007*** | | | | |
|---|---|---|---|---|---|---|
| Variable | Coefficient *β* | *Coefficient β (case of 1st differences)* | t-value | *t-value (case of 1st differences)* | p-value | *p-value (case of 1st differences)* |
| Constant | 34.4479 | *-1,74947* | 6,4163 | *-1,1472* | 0,00303*** | *0,33449* |
| SUB (YFS) | 1,07103e-08 | *2,19575e-09* | 0,5804 | *0,1475* | 0,59277 | *0,89212* |
| **Equation (2) with lagged variables** | | | **R^2=0,989** | | | |
| Constant | -1,31747e+09 | | -11,1673 | | 0,00792*** | |
| EMP(15-39)_1 | 3,71683e+07 | | 12,7527 | | 0,00609*** | |
| SUB (YFS)_1 | 0,860252 | | 9,4165 | | 0,01109** | |
| **Equation (3)** | **R^2=0.2298** | **R^2=0.006** | | | | |
| | Coefficient *β* (case of PPP) | Coefficient β (case of prices 2005) | t-value (case of PPP) | t-value (case of prices 2005) | p-value (case of PPP) | p-value (case of prices 2005) |
| Constant | 62,9205 | 57757,3 | 16,9434 | 9,2933 | <0,00001*** | <0,00001*** |
| EMP(15-39) | -0,134165 | 31,6282 | -1,9695 | 0,2905 | 0,07059* | 0,77567 |
| **Equation (3) –case of PPP – 1st differences** | | | **R^2=0.2298** | | | |
| | Coefficient *β* (case of PPP) | | t-value (case of PPP) | | p-value (case of PPP) | |
| Constant | 2,15212 | | 1,6360 | | 0,12778 | |
| EMP(15-39) | 0,543067 | | 2,3221 | | 0,03862** | |
| **Equation (4)** | **R^2=0.7052** | **R^2=0.7081** | | | | |
| | Coefficient *β* (case of GAVperEmpl) | Coefficient β (case of GAVperthousHours) | t-value (case of GAVperEmpl) | t-value (case of GAVperthousHours) | p-value (case of GAVperEmpl) | p-value (case of GAVperthous Hours) |
| Constant | 0,350228 | 0,618276 | 15,1087 | 15,9239 | <0,00001*** | <0,00001*** |
| EMP(15-39) | -0,00234983 | -0,00396349 | -5,7870 | -5,8276 | 0,00005**** | 0,00004**** |

**Source: Data Czech Statistical Office, Eurostat, The SAIF, Gretl outputs**

## *4. Discussion of regression results*

When concentrating on the sign of the coefficients at the exogenous variables the one for the equation (2) is positive in accordance to the hypotheses, but this result is not statistically significant therefore their cannot be taken into account. Statistical significance has been proved for the results of the Equation (2) with both lagged variables, Equation (3) – the case of PPP and Equation (3) – the case of PPP – 1st differences that are in accordance to the hypotheses (positive relationship between the subsidies to young famers and employment in the agricultural sector in the age range of 15-39, and the positive relationship of real gross agricultural output and the employment in the agricultural sector in the age range of 15-39). However, the negative relationship between labor productivity and employment in the agricultural sector in the age range of 15-39 was found statistically significant contrary to the hypotheses of this paper. Also the coefficients of determinants of equation (4) were quite high in contrast to those of equations (2) and (3).

The linear regression models used in this paper are very simple models and thus it is hard to compare them to the studies of other authors. However, at least the results that approved the hypotheses of the paper can be said similar to those of compared to those of other authors (e.g. Aggelopoulos and Arabatzis, 2010) and those results contrary to the hypotheses – those concerning the labor productivity can be compared to the results of Malmberg et. al. (2005). However, furthermore developed and complicated model has to be estimated.

## *5. Conclusion*

The paper tries to contribute to the field of ageing labor force in the agricultural sector analysis and to answer the question of whether and to what extent the changes in the number of young farmers do have any and what kind of effect on labor productivity in agriculture and on gross agricultural output.

The positive impact of subsidies to young famers on the employment in the agricultural sector in the age range of 15-39 positive and also the positive relationship of real gross agricultural output and the employment in the agricultural sector in the age range of 15-39 was found. However, the negative relationship between labor productivity and employment in the agricultural sector in the age range of 15-39 was found statistically significant contrary to the hypotheses of this paper.

The econometric models in this paper are very simplified and the results distorted by the omitted important variables and factors. More thorough and much more complicated model of agricultural labor market modified for agricultural policy analysis including all important variables (mainly for the for the actors of gross agricultural output and labor productivity as wages, capital and many other) like in Erjavej et al. (2000) need to be estimated.

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# Household Savings Forecast and its Implementation to Modelling of Slovak Economy[1]

*Kristína PETRÍKOVÁ*[2]

***Abstract:*** In the paper household savings situation, its forecast and implementation to macro-economic model is analysed. Term of Silver economy will be introduced. As a part of Silver economy, savings of households with older reference person are main object, as their rising demand can bring new consumption paths during coming years. Main idea of Silver economy is that older population should not only be seen as a burden for society and country budgets, but that it can drive economic growth during following years as well. It has been proved that those aged 50 and above hold significant purchasing power. Furthermore, they possess vast amount of savings, which according to latest research they are also willing to spend during later years. Based on this savings situation is projected for next years, which will mainly be affected by changing demographic trends. Afterwards CGE model is used to make estimations on the impacts of higher consumption of older citizens on economy.

***Keywords:*** Ageing, savings, investment, consumption, model

***JEL classification:*** J11.

## 1. Introduction

Nearly all European countries face more or less rapid ageing process of population nowadays. Overall, life expectancy will be rising by 3 months every year until 2060.[3] This demographic trend is often viewed as a burden for national economies, imposing higher public expenditures in particular sectors. This issue, however, can also present an opportunity for economy which lies in using the demand of growing number of older citizens as a potential for future growth. Concept of focusing on economic potential of ageing population by the means of satisfying their demand for specified goods and services is called Silver economy.[4] As higher share of citizens will be of older age, they will gain higher purchasing power, even though their income situation varies across different states of Europe.

Slovakia will not be an exception and its population will grow older as well with increasing share of people aged 60 and over. Main purpose of this artide will be to take a closer look on the financial situation of older citizens, and how it will develop over following few years. We will look on households income and expenditure situation, from which propensity to save will be derived. Based on this, projections for next years will be made on how savings will develop in various age groups. Taking these findings into consideration, we will afterwards use static CGE model to simulate potential changes in economy for a given scenario. Given the fact that static CGE model will be used, scenario projected will gather short-run results for the economy.

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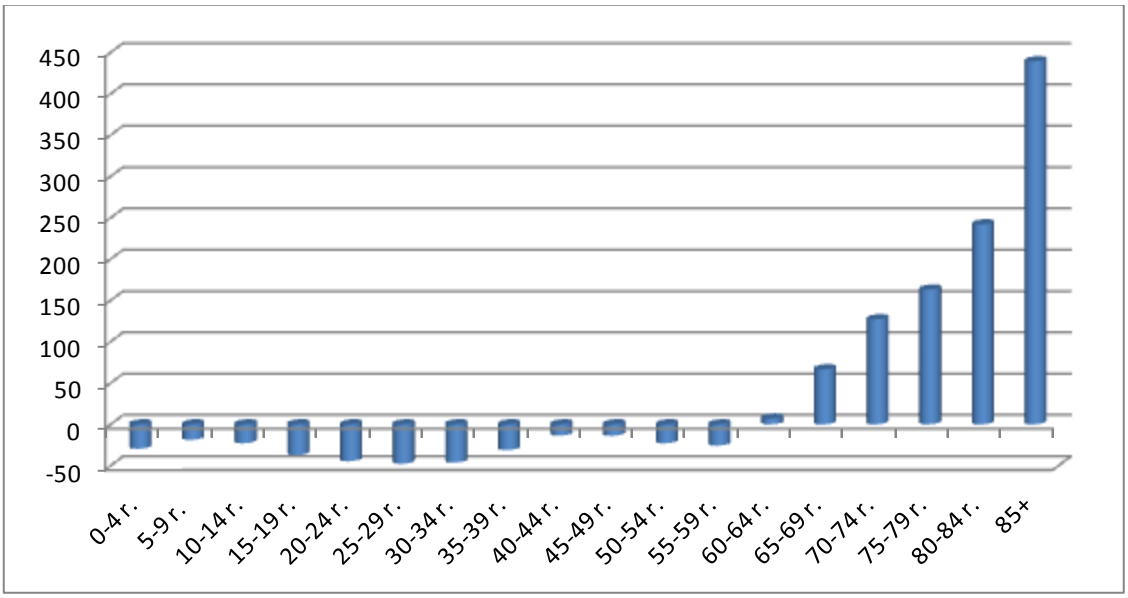
[3] European Union, 2012
[4] KOHLBACHER, F. - HERSTATT, C., 2010, p. xvi

## 2. Ageing and financial situation

Projections made up to year 2060 showed that life expectancy will grow up to 84,6 years for men and to 89,1 for women in European union. Currently, Slovakia is country with 7th lowest life expectancy within member states, having average life expectancy of 75,3 in 2010, with projected increase up to 84,8 years.5 According to predictions, people aged 65 and over will represent more than 30% of population of Slovakia by 2050, which means twofold increase compared with year 2010.6 However, share of population cohorts younger than 60 will decrease constantly over predicted period. These changes are illustrated in Graph 1, where increases/decreases within various age cohorts are depicted in percentage points between years 2010-2060. Clearly rising trend can be observed for all age cohorts of 65 years and over.

**Graph 1: Changes in different age groups for Slovakia in percentage points between 2010-2060**




***Source: Eurostat, author's calculations***

Based on these expectations, it is desirable to analyse financial situation of Slovaks broken down into different age groups. For purpose of the article we have taken into account 6 age groups:

- 16–34 years
- 35–44 years
- 45–54 years
- 55–64 years
- 65–74 years
- 75 years and over.

As there are no exact micro-data available for individuals, households are taken as a basic unit, divided into groups based on age of reference person. Data provided by National Bank of Slovakia, from Household Finance and Consumption Survey was used for quantitative analysis together with data obtained from Household Budget Survey.

In Table 1 distribution of current savings within various age groups as well as figure for average current savings per household in given age group for the year 2010 can be seen. Total amount of current savings was calculated as sum of all financial assets held by households. As can be seen from the table, amount of savings was increasing with age up until the cohort of 45-54 years, while households having older reference person had decreasing tendency with increasing age. Those

[5] European Union, 2012
[6] DOVÁĽOVÁ, G., 2011, p. 6

with reference person aged 45-54 years held highest average amount of current savings, which is in accordance with the premises of life cycle model of savings and consumption. This states that an individual's goal is to maximize utility over lifetime, and thus the amount of wealth should be increasing over the independent or working period of ones' life up until individual starts to spend this accumulated wealth in order to fund consumption during retirement years.[7] It also has to be noted that in older age groups household can often consist of only one person, thus lowering total amount of savings. Another shortcoming of given figures for older age groups is the fact that seniors often do not stay in independent household during their final years, but are living with their younger relatives where the age of reference person can be up to generation lower than the one of senior.

**Table 1: Distribution of current savings between different age groups, average savings per household in 2010**

| Age group | Percentage of savings owned by age group | Average current savings per household (EUR) |
|---|---|---|
| 16-34 | 15,13% | 3 866,61 |
| 35-44 | 25,36% | 7 244,95 |
| 45-54 | 28,64% | 7 880,79 |
| 55-64 | 20,23% | 7 061,69 |
| 65-74 | 9,43% | 3 504,08 |
| 75+ | 1,21% | 2 160,68 |

**Source: Household Finance and Consumption Survey, author's calculations**

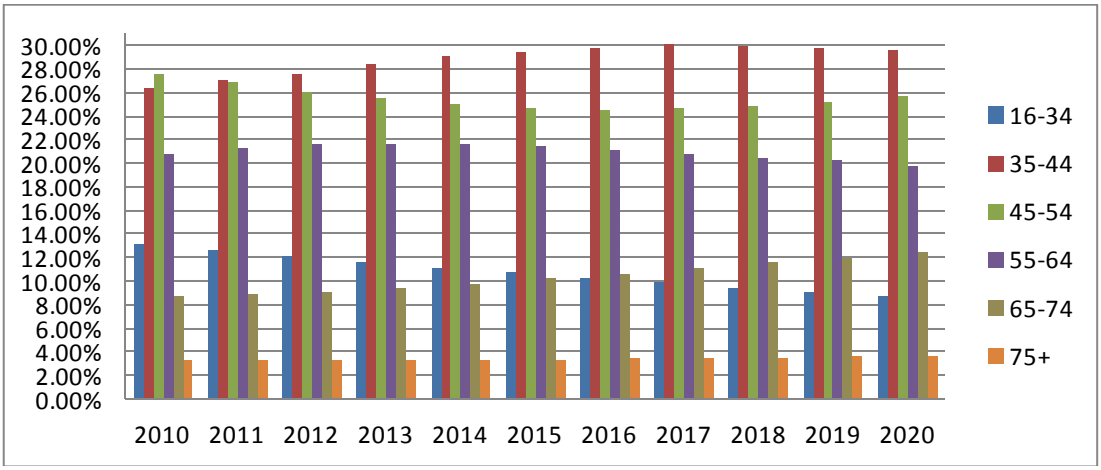
In Figure 1 below forecast on how savings situation in various age groups will develop between years 2010-2020 is depicted. For each year the percentage share on total amount of savings for given age group is illustrated. Forecast was made based on demographic projections of development of population of Slovakia up to year 2020 together with actual consumer behaviour of Slovaks represented by propensity to save and their actual income situation. In the youngest age cohort significant decrease can be observed, number of those aged 35-44 is likely to rise at first half of decade with peak of almost 30% share on total savings, which will later gain reverse trend. Savings of those aged 45-54 will take inverse trend from their younger counterparts, with decreasing trend in first years and starting to increase after the year 2017. Younger generation of seniors, those aged 55-64, seems to have declining trend during final years of forecast, with a share of something below 20% of total savings in 2020. Savings in age group of 64-74 have clearly increasing trend, with starting value around 9% in 2010 reaching up to almost 13% in 2020. Similar, although not as intense trend can be observed in the oldest age group, with slight increases over selected period. This forecast is made only to year 2020, however, expected demographic changes signal even more intensive shift to higher representation of older age cohorts in population during years after.

From given forecast it can be seen that in accordance with demographic development and seniors' income and saving propensity situation they will gain more financial resources with coming years. With higher financial assets accumulated comes the question whether seniors will be also willing to spend these funds, or whether consumption behaviour in overall will follow trend from the past decades, when most of seniors did not want to spend their assets, mainly because of prospect of leaving it to following generations. This pattern, however, seems to be inverting on the European level, with increasing numbers of seniors who are willing to spend their assets during later years of their retirement.[8] Looking on the problem from the perspective of Slovakia, possibility of change in seniors' consumption patterns such as increase in expenditure on goods and services will be analysed by means of economic modelling.

[7] LINDBERGH, J. – NAHUM, R.A. – SANDGREN, S., 2008

[8] GASSMAN O. [2009], p. 78

**Figure 1: Development of household savings for different age groups between 2010-2020, in percentage points out of total for given year**

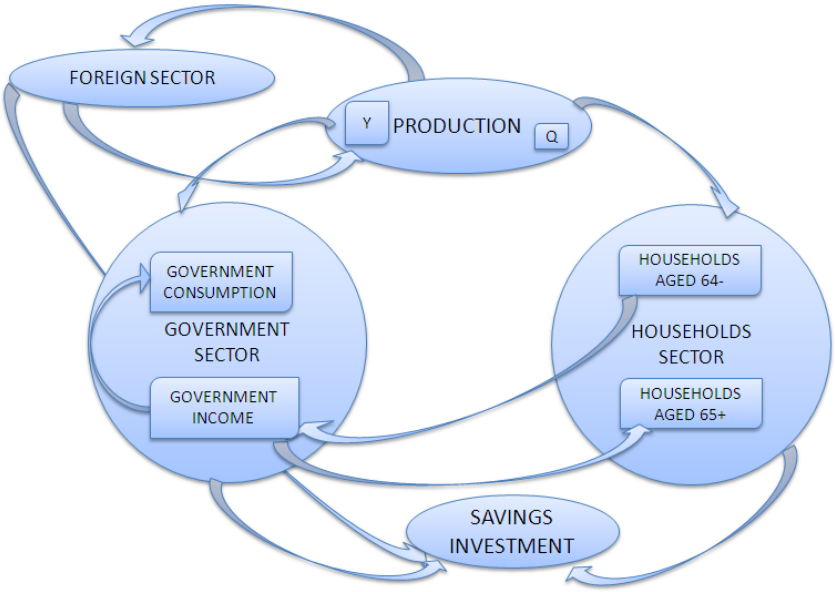



**Source: Household Budget Survey, ŠTEFÁNIK, M., et al. 2013, ŠPROCHA, B. 2010, author's calculations**

## 3. Modelling economy using CGE model

After having estimated future development of savings situation of various age groups for Slovakia, the idea of Silver economy can be presented in a broader, macro-economic view. Since older households are main focus of concept of Silver economy, estimations in the modelling part will be made on how changes in their consumption behaviour can influence economy as a whole. For this purpose static CGE[9] model will be used. CGE models are macro-economic models based on micro-economic assumptions main of which is Walras law of non-existence of unsatisfied demand and its contemporary formulation by Arrow and Debrew. Principle of this theory is that economy is in state of general equilibrium if and only if all partial markets are in equilibrium and hence all excess demands as well as excess supplies are equal to zero given the budget constraints. Since estimated model has static form, it will reflect only transition of economy from one state of equilibrium to another during one time period.

**Figure 2: SAM matrix illustration**




**Source: Author's illustration**

[9] Computable General Equilibrium

Data entry for CGE model is SAM[10] matrix. It is divided into production sectors, institutional sectors and foreign sector. To project Silver economy into SAM matrix, few major changes in its organisation were made. As one of ideas of Silver economy states that economy should be able to satisfy increased demand of seniors for particular goods and services, the production sector was divided into two subsections, one being production in general (Y) except for health care sector, which was taken as the second subsection (Q). Health care section can be viewed as area which will be demanded more by seniors in future. Furthermore, households sector was divided into two subsections as well, with breaking point being the age of reference person of 65 years. Thus we get two subsections for production and two subsections for households, together with government sector and foreign sector.

Illustration of relations between production and consumption sectors can be viewed in Figure 2. There are four main sectors: production sector, consisting of two subsections, foreign sector where both types of goods are imported and exported, government and households sector where both types of goods are consumed. Particular relations between government income and expenditures and two types of households are depicted as well.

Model is specified via system of equations, with starting values being original values of SAM matrix. For production, two input factors are used: capital and labour. Production sector is modelled via Cobb-Douglas production function with constant returns to scale. Consumption is modelled via Cobb-Douglas utility function, foreign sector is described in Armington concept, export is modelled via CET[11] function and import via CES[12] function. To close the model question of macro-economic closure that would reflect reality most appropriately arises. Two traditional closures are Keynesian and neo-classical, while many other options for choosing closure have been published. In neo-classical closure it is assumed that total labour supply together with total capital supply are not altered during simulations which means that production resources are fully utilized. This also implies non-existence of unemployment, when labour force can only move within sectors, but it cannot be increased, or decreased in total. In case of Keynesian closure the existence of unemployment is not omitted, whereas total amount of capital together with investment are fixed on its benchmark level for given period.[13]

As model presented has static form, only scenario that will gain immediate short-run results can be applied. When choosing appropriate closure for the model, it needs to be taken into account that this closure is used to assess short-run or immediate effects on the model. In a short-run amount of capital invested in production units cannot be altered. Thus capital is fixed for this period of time and it can only be moved from one production sector to another, maintaining same value of its total supply.[14]

To obtain a well-defined system of equations, further assumptions are made. It will be taken that those households aged 65 and over will not receive any income from labour, thus they will be pure receivers of pensions provided by government sector and capital income earned from their ownership of capital assets. It is also assumed that households aged 64 and below will not receive any financial assets from government, but that they will pay contributions and taxes from their income to government. In static CGE models savings and investment usually maintain an identity relation, which means that total savings equals total investment. From the point of view of consumers, government and households, savings present share of their total income which was not immediately consumed but has been allocated for future use. Thus amount of savings affects

[10] Social Accounting Matrix
[11] Constant elasticity of transformation
[12] Constant elasticity of substitution
[13] PÁNIKOVÁ, L. 2007, p. 12
[14] THAIPRASERT, N. – DAGNEY, F. – HICKS, M. 2012, p. 452-453

demand for goods and services of these sectors. Investment, on the other hand, influences production sectors, as it enables producers to obtain resources for producing goods.[15]

Given the prospect of rising share of older people in population and the idea of Silver economy which says that seniors may be a driving force of future growth, this hypothesis was implemented to the CGE model. In order to do so, original propensity to save of households aged 65 and over was lowered in the model by 5%. This illustrates the situation when the change in seniors' consumption behaviour has occurred so that these age cohorts would be willing to spend higher amount of money on purchasing goods and services in order to increase their standard of living.

Impact of higher demand of older households is analysed below. Main results are showed in Table 1. As can be seen, increase in consumption has resulted in decrease in savings of senior households. Change in GDP is slightly negative. This situation can be interpreted via expenditure approach of calculating GDP, as the increase in consumption is reflected in decrease in investments, which is negated between each other. As this was short-run alteration, production sector was not able to adjust to higher demand of older households which is mainly due to the fact of fixed capital supply on the market.

**Table 2: Main changes in economy for the short-run scenario**

| | Percentage change | | Absolute change (mill. EUR) | |
|---|---|---|---|---|
| | Sector Y | Sector Q | Sector Y | Sector Q |
| Production | -0,08% | 0,00% | -102,84 | 0,03 |
| Labour demand | -0,19% | 0,00% | -34,06 | 0,00 |
| Capital demand | 0,00% | 0,00% | -0,01 | 0,01 |
| Government consumption | -0,18% | -0,18% | -17,75 | -3,27 |
| Import | -0,08% | 0,04% | -47,73 | 0,01 |
| Export | -0,08% | 0,00% | -46,16 | 0,00 |
| Investment | -1,79% | -1,79% | -330,91 | -0,18 |
| | Percentage change | | Absolute change | |
| | Households aged 64- | Households aged 65+ | Households aged 64- | Households aged 65+ |
| Households' consumption | -0,06% | 6,89% | -19,74 | 312,67 |
| | -0,06% | 6,89% | -0,17 | 3,65 |
| Households' savings | -0,06% | -18,04% | -7,68 | -317,94 |
| | Percentage change | | Absolute change | |
| GDP | -0,08% | | -54,14 | |

**Source: Author's calculations**

## *4. Discussion*

It was already mentioned that it is frequently stated for static CGE models for total investment to be equal to total savings in economy. As can be seen from results listed above, senior households augmented their spending via using savings, which decreased by more than 18% within one period. It is also observable, that total amount of savings used is approximately the same as decrease in investment in production sectors. Thus these changes can be understood also as a signal that with higher consumption of seniors driven by using their savings comes decrease in investment,

[15] BURFISHER, M. E. 2011, p. 31

which in turn has negative impact on production sector and can result in deceleration of economic growth.

As current demographic development signalizes, there will be high rise in numbers of seniors during coming decades. Even without them changing their consumption patterns at some point, this phenomenon will still mean certain shift in income and savings situation speaking from aggregate point of view. This hypothesis has been studied before. It has been assessed that even in open economies, such as the one of Slovakia, investment and savings bear close correlation although this relation has been decreasing over time.[16] It has also been observed that countries which have higher share of seniors in population tend to spend more, thus having lower overall propensity to save compared to those with higher shares of younger population.[17]

## 5. Conclusion

Due to the demographic transition, there will be considerable increase in numbers of older people in population. In the article both savings forecast for Slovak households and results of short-run scenario for CGE model were presented. Having examined the results of modelling, issues concerning possible short-run impacts of increased spending of senior households on Slovak economy were mentioned in discussion part.

As only short-run results of CGE model were presented in the paper, one of the goals of future research will be to introduce dynamic CGE model of Silver economy. This would enable to model also long-run scenarios, which would considerably enrich research results, giving prospect on how economy will react in longer term to maintain general equilibrium.

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# The effect of child support policy on fertility, marital turnover decisions in the Czech Republic[1]

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**Abstract:** In this paper, we analyse the interaction between fertility and marriage, and the effect of government policy on these decisions. In particular, we would like to examine the effect of maternity allowance policy in the Czech Republic. We built a simple life-cycle model, which is able to capture reaction of women to various levels of maternity allowance. We further examine Czech data in order to estimate effect of the maternity allowance on birth, marriage and divorce rates.

**Keywords:** Family Economics; Fertility decisions; Child allowance

**JEL classifications:** D11, D12, J12, J13, J18

## *1. Introduction*

What motivates the parents to have more children? What deters the young couple to have children at all? Fertility decision is one of the most important decisions made in the life cycle of a person. In the developed countries, the decisions of fertility, i.e., how many children to have in a family, are closely interconnected with marriage related decisions. In this paper, we analyse the interaction between fertility and marriage, and the effect of government policy on these decisions. In particular, we would like to examine the effect of maternity allowance policy in the Czech Republic. We built a simple life-cycle model, which is able to capture reaction of women to various levels of maternity allowance. Special attention is paid to the marriage and birth giving decisions, allowing for both to be endogenous and thus mutually interconnected. Later, we examine Czech data in order to estimate effect of the maternity allowance on birth, marriage and divorce rates. These results are then used to calibrate theoretical model in order to get projections of the women behaviour response to various levels of the maternity allowance in the Czech Republic. Understanding of child support policies is very important, especially in the countries, where fertility rate is lower than replacement rate, and where various child support policies are implemented in order to avoid the negative consequence of the low fertility rate, e.g. pension deficit problem caused by generation gap.

Understanding the reaction of women to these policies would help to tune them to become more efficient. The Czech Republic is not the exception. After its transition period, the fertility rate decreased to the one of the lowest rates in Europe during 1990's.[5] Czech government implemented various child support policies to encourage women to give more births. Consequently, the fertility

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[5] See Sobotka (2002), for further discussion on the relationship between transition and demography in the Czech Republic. Regarding the other explanation of decline in fertility rate than increase in opportunity cost of women, Philipov and Kohler (2001) argue that what has changed is the timing of having child and find empirical evidence in CEE countries, including the Czech Republic.

rate has risen from 1.1 to 1.5 per fertile women.[6] Based on this evidence, some researchers argue the various policy instruments to encourage women to give births were quite effective, especially after 2000 (Kocourkova, 2009). However if we go little further and take a closer look at the composition of births across the marital status, we find that fertility has risen mainly due to single mothers. Below (Table1) is the statistics on live births in Czech Republic: The number of births increased from 2000 to 2009 and the increase in the number of babies born out of wedlock accounts for the most of total increase in birth. In 2000, approximately 20 % of the births are from unmarried couples, whereas in 2009 this proportion almost doubled to 38 %. It seems that the child support policies affected the pattern of marriage: they induced single mothers to have more children. Further, during this period there is a decrease in the marriage rate.[7] One of the reasons might be that because of the increase in child support, (potential) single mothers do not have the need to get married in order to have children and thus it decreases marriages of couples who would get married if the child support payment was smaller. Another specific feature is high divorce rate (crude divorce rate, 2.8, in 2009 is one of the highest in Europe).[8] Given the interaction between fertility and the marital status, the government policy intended to increase the fertility rate should be evaluated considering its impact on the marriage pattern of women.

Table 1: Number of live birth decomposition by marital status of mother, Czech Republic

| Year | Total | Single | Married | Divorced | Widowed |
|---|---|---|---|---|---|
| 1991 | 129,354 | 9,226 | 116,651 | 3,120 | 357 |
| 2000 | 90,910 | 15,064 | 71,118 | 4,465 | 263 |
| 2009 | 118,348 | 38,060 | 72,394 | 7,610 | 284 |

Source: Marriages in selected territory (DEMCU003) by CZSO public database.

## 2. Literature Review

The idea to model family and fertility decisions applying framework in economics is not new. Since the seminal work of Becker (1973) on economics of family, an increasing amount of research has contributed to the topics of family creation. Applying economic concept of rational agents in the environment of family, economists are trying to explain and predict the impact of various policies.

Boca (2002), using the panel data set constructed from the Survey on Household Income and Wealth of the Bank of Italy, finds that the child care policy and the part-time job policy increased the probability of having a child and working in Italy. Similarly, Fialova and Mysikova (2009) estimate the effect of social benefit policy in the Czech Republic on the labour participation of women, using cross sectional data constructed from EU-SILC 2005 data set. The marital status and fertility decision of women are treated as exogenous in their analysis. Greenwood, Guner, and Knowles (2003) and Aiyagari, Greenwood, and Guner (2000) constructed a life-cycle model, where agents face multiple decisions of marriage, fertility, divorce, and labour participation in an overlapping generation framework. The latter one stresses the importance of incorporating fertility decision as an endogenous variable in the model whose purpose is to evaluate the fertility policies. If the fertility decision is exogenous to the model, then the women react to the child support policy only by changing their marital status and the overall analysis is biased.

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[6] Czech Statistical Office, Population development charts, 1950-2009.

[7] In this regard, some people might suspect that this fraction changed due to change in marriage rate. However from 2000 to 2009, the crude marriage rate (number of marriage per 1000 inhabitants) changed from 5.4 to 4.6, (15 % change), which does not seem to explain fully this large magnitude change in marital status of mothers.

[8] The number is taken from the publicly available data provided by Eurostat (http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/).

Some empirical studies confirm the interaction of the marriage pattern and the fertility rate. For example, Upchurch, Lillard, and Panis (2002) find that the marital status and the marital history of women have an effect on the fertility of women. A previous marriage experience would discourage out-of-wedlock births and the women with an out-of-wedlock birth experience tend to go through moremarriage/divorce turn-overs than others. Lillard and Waite (1993) empirically confirm that the expection of a short duration of marriage deters women from having a child. On the other hand, Cherlin (1977) finds that children glue parents in the wedlock and thus enhance marital stability. To sum up, the literature shows the interaction between marriage and fertility. Even though Greenwood, Guner, and Knowles (2003) create a complex framework of family creation and fertility decision, they do not capture the effect of remarriage. However as pointed by Chiappori, Iyigun, and Weiss (2008) remarriage plays important role in marital decisions and have significant impact on marital patterns. Burdett, Imai, and Wright (2004) explain how on-the-job search imposes externalities on the partners and might result in excessive turnovers.

Looking at education, Chiappori, Iyigun, and Weiss (2009) explain how returns to education might affect schooling investments of women. This is very important when the long-run effect over decades is analysed. Increased returns to education change women own investment in education which affects their marriage market position and the marriage market equilibrium. Similar aspect is studied by Greenwood, Guner, and Knowles (2003) who investigate interconnection between child support and investment in education of children. Authors stress the long run effect of child support policies as they change the children's position in the marriage market through the changes in their education. This effect is transmitted through generations and changes long-run population composition.

## 3. Overview of maternity leave and maternity allowance policies

Length of maternity leave did not change since 1989 in the case of single birth by married women. Leave starts 8 to 6 weeks prior the estimated date of birth and last 28 weeks. In the case of multiple births it is prolonged by 9 weeks. Major change occurred on 1st Jan. 07, since when single women are no more eligible for prolonged maternity leave. Table 2 summarizes changes of maternity leave.

Table 2: Development of maternity leave

| Valid from | Maternity leave in weeks | Eligibility |
|---|---|---|
| 1st Jan. 89 | 28 (37 when 2+ kids or single) | Only women |
| 1st Jan. 01 | 28 (37 when 2+ kids or single) | Both women and men |
| 1st Jan. 07 | 28 (37 when 2+ kids) | Both women and men |

Source: "Rodicovsk a dovolena a rodicovsky prispevek", Ivana Vyvazilova (2009, 2010).

Maternity allowance is calculated as proportion from “denni vymerovaci zaklad" (DVZ). DVZ is function of daily gross wage that is based on two thresholds until Jan. 1st 09 and three thresholds afterwards. In all instances DVZ consists of 100 % of all gross wage that is below first threshold, 60 % of part of gross wage that is between the first and second threshold and 30 % of part of gross wage that is between the second and the third threshold if third threshold exists. Most significant change happened in Jan 1st 2009, when the first and second thresholds were elevated by more than 40 % and third threshold was added. For example, woman whose daily gross wage was 2000 CZK got 478.86 CZK per calendar day before and 887.46 CZK after the change in Jan 1st 09.

The brief description of changes in methodology of calculation daily maternity allowance is presented in Table 3. Allowance paid per month is calculated as a number of calendar days in the given month times the daily maternity allowance.

Table 3: Dvelopment of maternity allowance in value

| Valid from | % of DVZ | Allowance schedule conditional on income |
|---|---|---|
| 1st Oct. 99 | 69 | 100 % up to 360 CZK and 60 % for everything above 360 CZK up to 540 CZK |
| 1st Jan. 00 | 69 | 100 % up to 400 CZK and 60 % for everything above 400 CZK up to 590 CZK |
| 1st Jan. 01 | 69 | 100 % up to 430 CZK and 60 % for everything above 430 CZK up to 630 CZK |
| 1st Jan. 02 | 69 | 100 % up to 480 CZK and 60 % for everything above 480 CZK up to 690 CZK |
| 1st Jan. 06 | 69 | 100 % up to 510 CZK and 60 % for everything above 510 CZK up to 730 CZK |
| 1st Jan. 07 | 69 | 100 % up to 550 CZK and 60 % for everything above 550 CZK up to 790 CZK |
| 1st Jan. 09 | 70 | 100 % up to 786 CZK, 60 % up to 1178 CZK and 30 % up to 2356 CZK |
| 1st Jan. 10 | 70 | 100 % up to 791 CZK, 60 % up to 1186 CZK and 30 % up to 2371 CZK |
| 1st Jan. 11 | 70 | 100 % up to 825 CZK, 60 % up to 1237 CZK and 30 % up to 2474 CZK |
| 1st Jan. 12 | 70 | 100 % up to 838 CZK, 60 % up to 1257 CZK and 30 % up to 2514 CZK |

Source: Zakon c. 61/1999 Sb., 420/2002 Sb., 421/2003 Sb., 187/2006 Sb. Narizeni vlady c. 247/1999 Sb., 413/2000 Sb., 347/2001 Sb. CSSZ (http://www.cssz.cz/cz/nemocenske-pojisteni/davky/vypocet-davek-nemocenskeho-pojisteni.htm) Sdeleni Ministerstva Prace a Socialnich vec, c. 396/2008 Sb., 354/2009 Sb.,

## 4. Model: Benchmark

The model presented in this section is very simple and it disregards many life time aspects that drive women's decision process in the real life. Nevertheless, even this simplified version is already able to describe basics of the interplay of marriage-birth decision and produce quite good predictions about marriage-birth patterns observed in the Czech Republic.

Model focuses purely on the women and disregards men. We assume pool of ex-ante identical women. Each woman lives *J +2* periods: *J* periods as an adult person and 2 periods as a kid. In order to follow women during her life span we denote the stage of adulthood *by t = 1, 2, … J.* Women are fertile during whole adulthood and their decision of having child is independent on how many kids she has already had as well as it is independent on her marriage history and current marriage status. At each period, woman can give birth at most to one child and this decision is sole made by the women without any fertility shocks which would restrain her fertility effort. Kids are living with mother until they enter adulthood. Exceptions are kids that are born in period J. These live with mother only one period. Mothers must cover childcare expanses of $e^c$ each period that child lives with her. In this model we follow only one generation. Development of population does not play crucial role. Therefore we do not care about what happen to kids after they enter adulthood or what happen to them when their mother pass away before kids turn to be adult. Neither do we care about the gender of the kids. Model is simplified in such a way, that kids are considered purely as consumption goods. Adult woman can make marriage decision in every period. Single woman can get married or stay single. Married woman can get divorced or continue to be married. Thus no woman can be divorced at period t = 1.

At the beginning of each period, women observe two exogenous shocks drawn from uniform distribution: marriage benefit shock $\varepsilon_t^m \sim U[-l_m, l_m]$ and child benefit shock $\varepsilon_t^c \sim U[-l_c, l_c]$. These shocks are mutually independent and their values are observed before any decision – marriage and birth – are made. Woman must cover childcare costs for one child, however she does not receive any child benefit shock. Married couple shares childcare costs by fifty-fifty rule. Thus married woman pays only half of all childcare costs.

Every period of adulthood, woman experiences utility

$$u(m_t, b_t | S_t) = -e^c (b_{t-1} + b_t)(2 - m_t)/2 + \varepsilon_t^m m_t + \varepsilon_t^c b_t, \quad (1)$$

where $S_t = \{b_{t-1}, \varepsilon_t^m, \varepsilon_t^c\}$ is the set of her state variables in period t. Her marriage decision in time t is captured by $m_t$, where $m_t = 0$ if she stays single in period t and 1 otherwise. Similarly, her birth decision is expressed by the number children she has in period : $b_t$. Term $(2 - m_t)/2$ is result of fifty-fifty sharing rule that is applied to childcare costs. We denote $(m_t, b_t) = m_t$,

$b_t \in [0,1] \times [0,1]$ marriage and birth choice of woman at time t.

Every period, before woman makes any decision, she perfectly observes shocks $\varepsilon_t^m$ and $\varepsilon_t^c$ . Her goal is to choose such $b_t$ and $m_t$ that maximize her further life time expected utility.

$$V_t\ (S_t\ ) = \max_{m_t\ ,b_t}\ \{u(m_t, b_t, S_t\ ) + E\ [V_{t+1}\ \ (S_{t+1}\ )]\} \quad (2)$$

Last period utility level is given by birth choice in J − 1 period last period shocks:

$$V_J\ (S_J\ ) = \max_{m_J\ ,b_J} u(m_J, b_J, S_J)\ . \quad (3)$$

We solve woman decision making (1-3) by backward induction. Woman, in the last period after observing marriage and child shocks, selects $\mathrm{mJ}$ and $\mathrm{bJ}$ such that she solves the problem (3). Resulting $\mathrm{m_J}$ and $\mathrm{b_J}$ are functions of $\mathrm{b_{J-1}}, \varepsilon_{\mathrm{J}}^{\mathrm{m}}$ and $\varepsilon_{\mathrm{J}}^{\mathrm{c}}$.

We have to identify such marginal values of $\varepsilon_{\mathrm{J}}^{\mathrm{m}}$ and $\varepsilon_{\mathrm{J}}^{\mathrm{c}}$.which makes woman indifferent between being single and married and similarly between having a child and not having a child.

Woman prefers $\mathrm{A_J}\ (1,1)$ to $\mathrm{A_J}\ (0,1)$ if

$$u(1,1|S_J\ ) - u(0,1|S_J\ ) = e^c\ (b_{J\ \_\ 1} + 1)/2 + \varepsilon_J^m > 0,$$

Or

$$\varepsilon_J^m > -ec\ (bJ - 1 + 1)/2, \quad (4)$$

Similarly woman prefers $\mathrm{A_J}\ (1,0)$ to $\mathrm{A_J}\ (0,0)$ if

$$\varepsilon_{\mathrm{J}}^{\mathrm{m}} > -ec\ (bJ - 1)/2, \quad (5)$$

prefers $\mathrm{A_J}\ (1,1)$ to $\mathrm{A_J}\ (1,0)$ if $\varepsilon_{\mathrm{J}}^{\mathrm{c}} > -ec\ /2,$ (6)

prefers $\mathrm{A_J}\ (0,1)$ to $\mathrm{A_J}\ (0,0)$ if $\varepsilon_{\mathrm{J}}^{\mathrm{c}} > -\ ec\ ,$ (7)

prefers AJ (1, 1) to AJ (0, 0) if εm and εc are such that

$$0 < -ec + (ec * bJ - 1)/2 + 2\,\varepsilon_{\mathrm{J}}^{\mathrm{m}} + 2\,\varepsilon_{\mathrm{J}}^{\mathrm{c}}. \quad (8)$$

From (4-8) we can make following inference:

Women who experienced $\varepsilon_{\mathrm{J}}^{\mathrm{m}}$ and $\varepsilon_{\mathrm{J}}^{\mathrm{c}}$ such that

$$\varepsilon_{\mathrm{J}}^{\mathrm{m}} > -\frac{\mathrm{ec} * \mathrm{bJ} - 1}{2},\ \varepsilon_{\mathrm{J}}^{\mathrm{c}} < ec\ /2 \quad (9)$$

get married and do not give birth at period J.

Women who experienced $\varepsilon_J^m$ and $\varepsilon_J^c$ such that

$$\varepsilon_J^m > -e^c * (b_{J\ \_\ 1} + 1)/2,\ \varepsilon_J^c > \frac{e^c}{2},$$
$$0 < -\mathrm{ec} + (\mathrm{ec} * \mathrm{bJ} - 1)/2 + 2\varepsilon_{\mathrm{J}}^{\mathrm{m}} + 2\varepsilon_{\mathrm{J}}^{\mathrm{c}}, \quad (10)$$

get married and give birth at period J.

Women who experienced $\varepsilon_J^m$ and $\varepsilon_J^c$ such that

$$\varepsilon_J^m < -(ec * b_{J\ \_\ 1})/2\ ,\varepsilon_J^c < e^c,$$
$$0 > -e^c + e^c * b_{J\ \_\ 1}/2 + 2\varepsilon_J^m + 2\varepsilon_{J,}^c \quad (11)$$

stay single and do not give birth at period J .

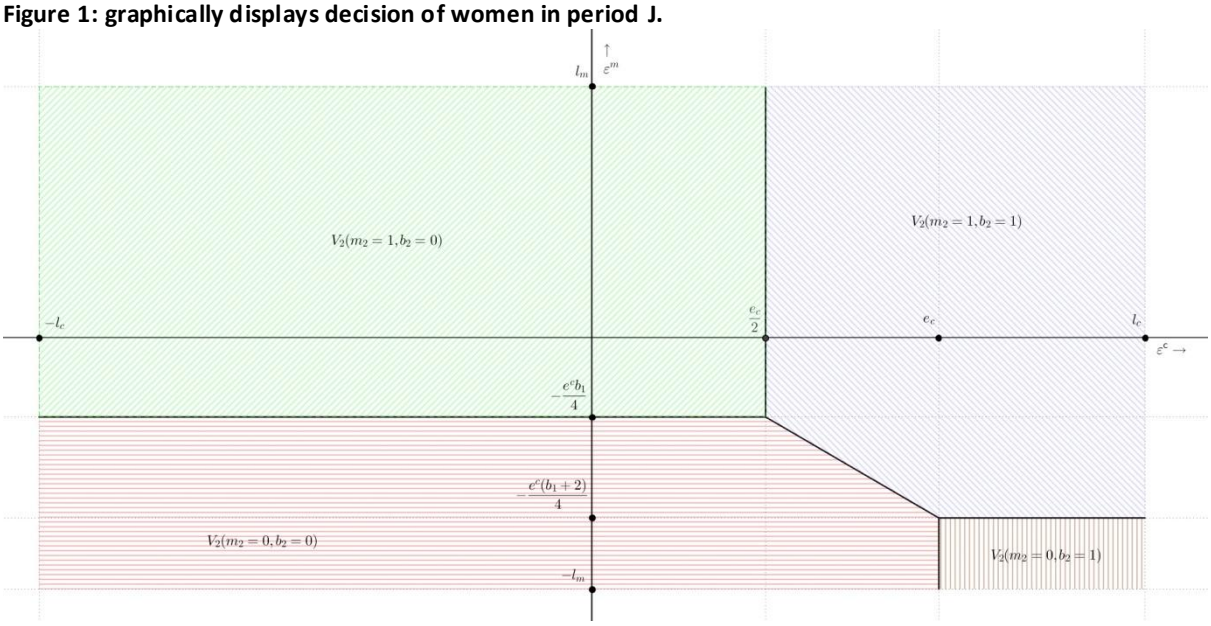
Women who experienced $\varepsilon_{\mathrm{J}}^{\mathrm{m}}$ and $\varepsilon_{\mathrm{J}}^{\mathrm{c}}$ such that

$$\varepsilon_{\mathrm{J}}^{\mathrm{m}} < -ec * \frac{\mathrm{bJ} - 1 + 1}{2}, \varepsilon_{\mathrm{J}}^{\mathrm{c}} > \mathrm{e^c}, \quad (12)$$

stay single and do not give birth at period J .

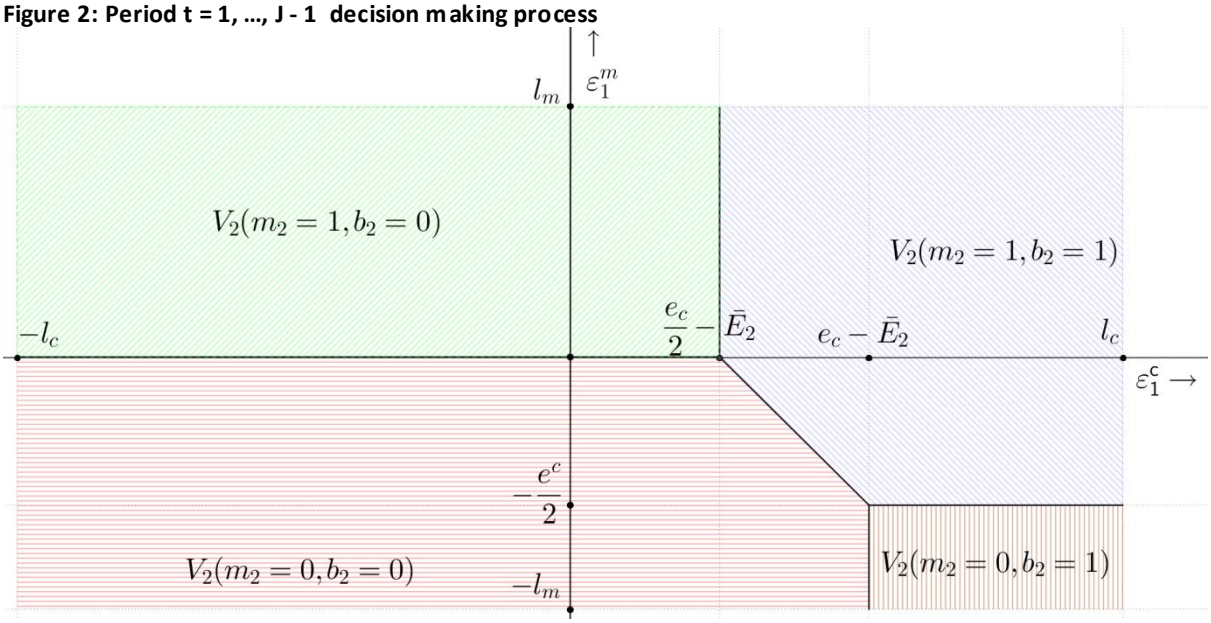
Figure 1 graphically displays decision of women in period J.

**Figure 1: graphically displays decision of women in period J.**




Analogously, by comparing $u(m_t, b_t \,|S_t)$ for all $(m_t, b_t) \in \{0,1\} \times \{0,1\}$ we can describe decision making process of women in all periods $j = 1,\ldots,J-1$. Figure 2 graphically displays decision of women in period t.

**Figure 2: Period t = 1, ..., J - 1 decision making process**




## 4.1. Predictions

Now, we have a closer look at the model prediction of women's response to changes in costs of child care. In this simplified version we do not have explicitly incorporated maternity allowance, however it raising maternity allowance is equivalent to decreasing child care costs. Therefore, when we will be talking about increasing child care costs (moving along dimension of $ec$) we basically have in our minds decrease in maternity allowance. We focus on the unconditional distribution of women over all four stages $(m_t, b_t) \in \{0,1\} \times \{0,1\}$. Unconditional distribution is defined by probabilities $P(m_t, b_{t,}\, b_{t-1,})$ and these probabilities are computed by following recursive schema:

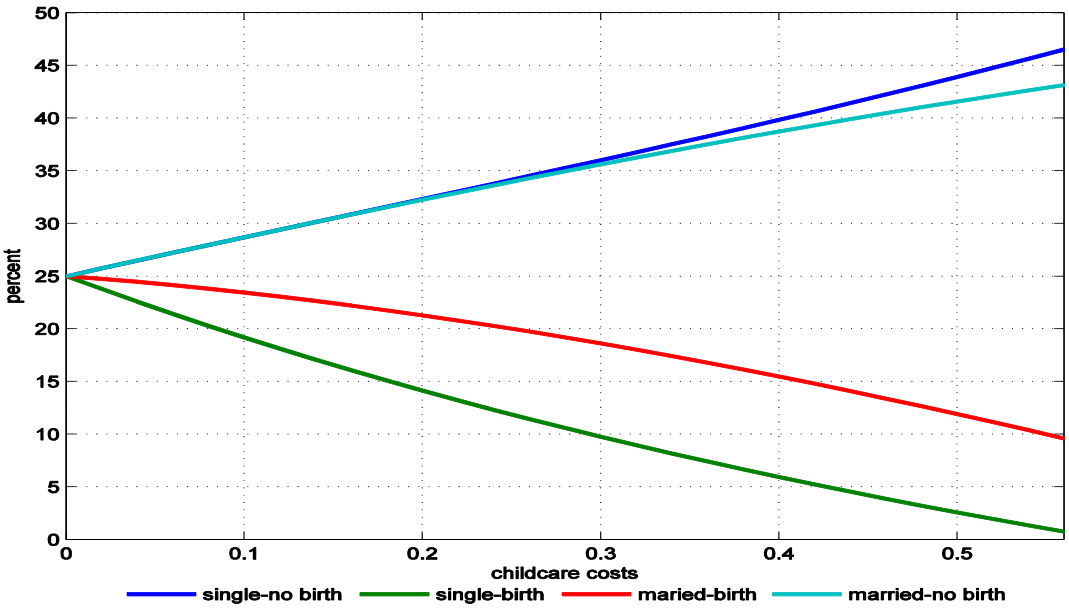
$$P(m_t, b_t, b_{t-1,}) = P(m_t, b_t \,|b_{t-1}) * P(b_{t-1}), \forall\, t = 1,\ldots,J,$$

$$P(b_{t-1}) = \sum_{m_t, b_t \in \{0,1\}^2} P(m_t, b_t, b_{t-1,}),\ \forall\, t = 1,\ldots,J,$$

$$P(b_0 = 1) = 0,$$
$$P(b_0 = 0) = 1.$$

Because of the biological constraint women is unlikely to give birth earlier than in one year following previous birth. However, usually this term is even longer. If we assume that women is fertile between age of 15 and 45, we get 30 year time window. If we additionally consider 2 years as reasonable minimum difference between two subsequent births, we can split 30 years of women's fertility in 15 periods.[9] Moreover, we set $l_c = 1$ and $l_m = 1$. Figure 3 depicts the response of women to change in child care costs. Particularly, we can see the distribution of women over the set of choices in the eighth period $(m_8, b_8) \in \{0,1\} \times \{0,1\}$.

**Figure3: Distribution of women over the marriage and birth choices in the 8th period**




# 5. *Empirical Analysis*

## 5.1. Data description

To count the number of birth, marriage, and divorce, we use certificates data, provided by Czech Statistical Office (CSO). The certificate data records the date incidence of birth, marriage or divorce, education level of parents or spouses as well as the place of their residence. To merge with the economic data such as income level, we collapse the observations into groups, where each group is characterized by the age category (every 5years, i.e., 15-19, 20-24, ..., 40-49), calendar year (2002-2010) and place of residence at14 district level. To focus our analysis on the fertility behaviour of women, we drop the observations whose age are younger than 15 or older than 49. So at the end we have 882 observations (14(regions)*7(age indicators)*9(calendar years)).[10]

To construct the 'rate' (birth, marriage, divorce), we further divide the number of incidence by the population size of the each cell. To compute the population size of the cell, we use the demographic data obtained from each regional office.

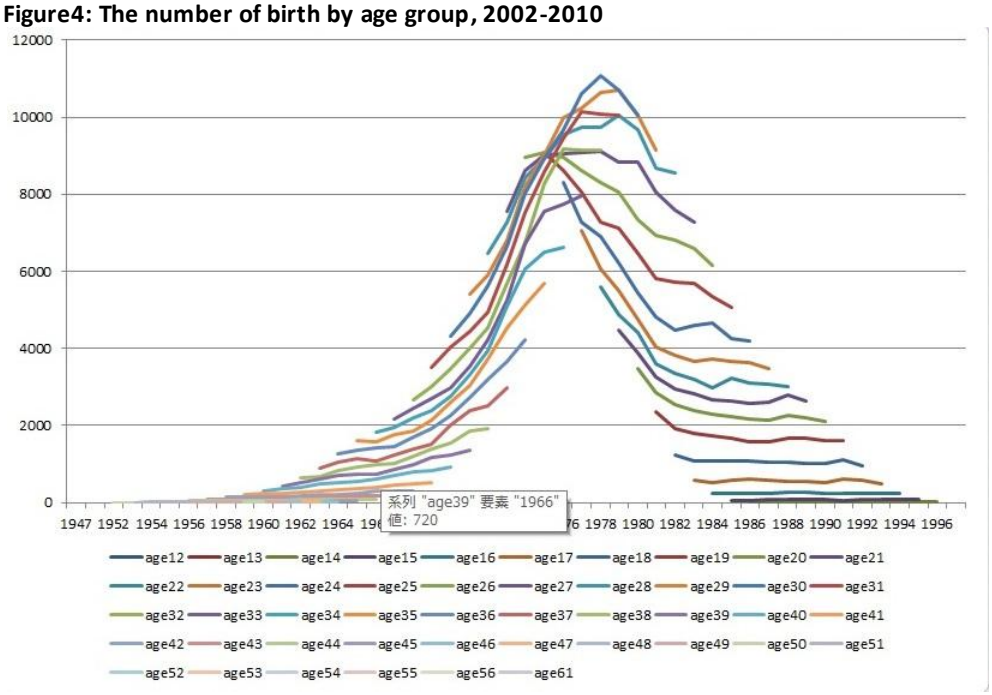
[9] This is very crude simplification and it needs additional revisions which will be elaborated in the later version of the model.

[10] Note that to be consistent with population data, we need to drop the educational information of the individuals. We plan to add those information, once we construct the complete population data with the educational information.

We merge the compiled rates described above with the economic status in- formation of each cell, which is derived from the Czech Structure of Earnings Survey set, which is known as Information System on Average Earnings (ISAE), or Trexima. This data set contains the information on hourly wage (2000-2010) and hours worked quarterly (2002-2010), which enables us to calculate the expected the maternity benefit, if one gives a birth.[11] The sample contains in- formation of the employee of all the companies with more than 250 employees and stratified random sample of companies with less than 250 and more than 10 employees. The data covers more than one thirds of the Czech enterprise employment and cover all industries, except of the public budgetary sector of health, education and public administration. (Jurajda 2001) To be more precise on the information of the income which is subject to the maternity benefit, we focus our analysis on the time period 2002-2010 when we could get the information on working hours. Furthermore, to control for the income effect separately from the effect of the maternity benefit, we construct the variable which measures the relative wage: the wage of the cell divided by the average wage of the fertile women of the year.

Maternity benefit is given as a fixed ratio of 'daily assessment base', which is kinked function of the daily earnings defined by the monthly wage divided by calendar days: There are the intervals of earnings which face the different percentage ratio. For example, in 2010 up to 791czk, daily wage is counted 100% as daily assessment base. From 792czk to 1186czk, 60% is counted, from 1186 to 2371czk, 30% is counted and more than 2371czk of daily earnings is excluded from the daily assessment base. The monthly benefit is, then, the fixed ratio (69% until 2007 and 70% from 2008) of the daily assessment base multiplied by calendar days.[12]

**Figure4: The number of birth by age group, 2002-2010**




**Source: Czech Statistical Office**

In Figure 4 we plot the number of the birth of the cohorts. Each line expresses the number of the birth of the group with particular age and on the left of each line, the number of births in 2002

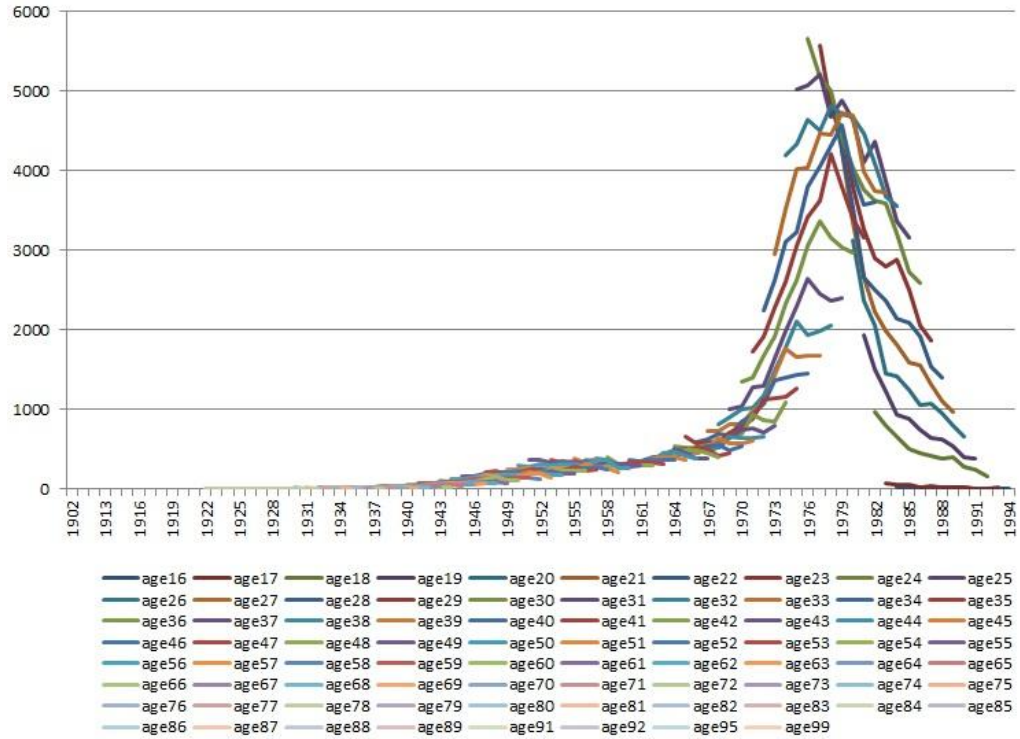
[11] Trexima records the wage of employee directly taken from the personnel database of the companies, which corresponds to social security quarterly wage records. Thus we believe that to compute the maternity benefit, this is the most precise wage information we could get in the Czech Republic.

12 As a result, the maximum ceiling of the benefit of this system is set to 28,890 monthly.

and on the right the number of birth in 2010 is plotted. For example, the number of birth of the group age 30 increases up to 2008 but decreases afterwards. With this figure, we can see the trend of the birth incidence of each age group during 2002-2010. Interestingly, the later birth (the birth after the age 30) has an increasing trend, but the earlier birth (the birth earlier than the age 30) has a decreasing trend.

Similarly, we plot the incidence of marriage and divorce in Figure 5 and 6.

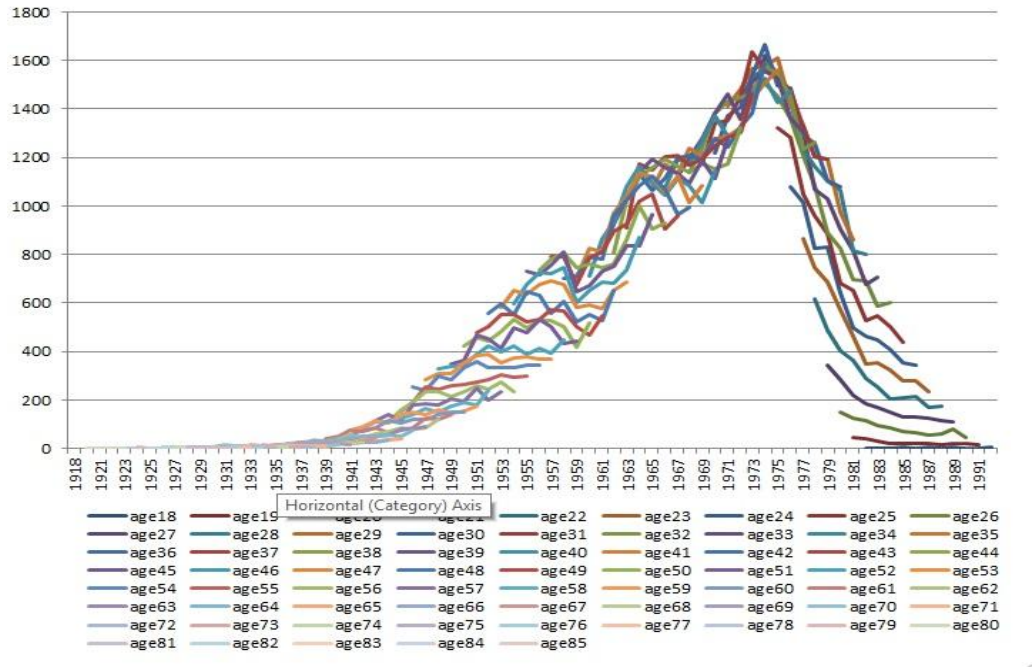
**Figure5: The number of marriage by age group, 2002-2010**




**Source: Czech Statistical Office**

Generally we can see the decreasing in number of marriage in almost all age groups. In their early 20's, the number of marriage are largely decreasing. We suspect that the main reason is of huge decrease is mainly caused by two factors: overall decreasing trend in marriage and the delayed marriage. Furthermore, the peak comes around late 20's. In the case of divorces, it reaches its peak a little after that of marriage: the early 30's. Similar to the case of marriages, in their early 20's, the number of divorces is decreasing. It is quite natural if we consider the decrease in marriages. However on the contrary to decreasing trend of marriage, the divorces have an increasing trend for almost all age group after 20's. This suggests that the divorce rate defined by the number of divorce divided by the stock of marriage might have increasing trend in the Czech Republic.

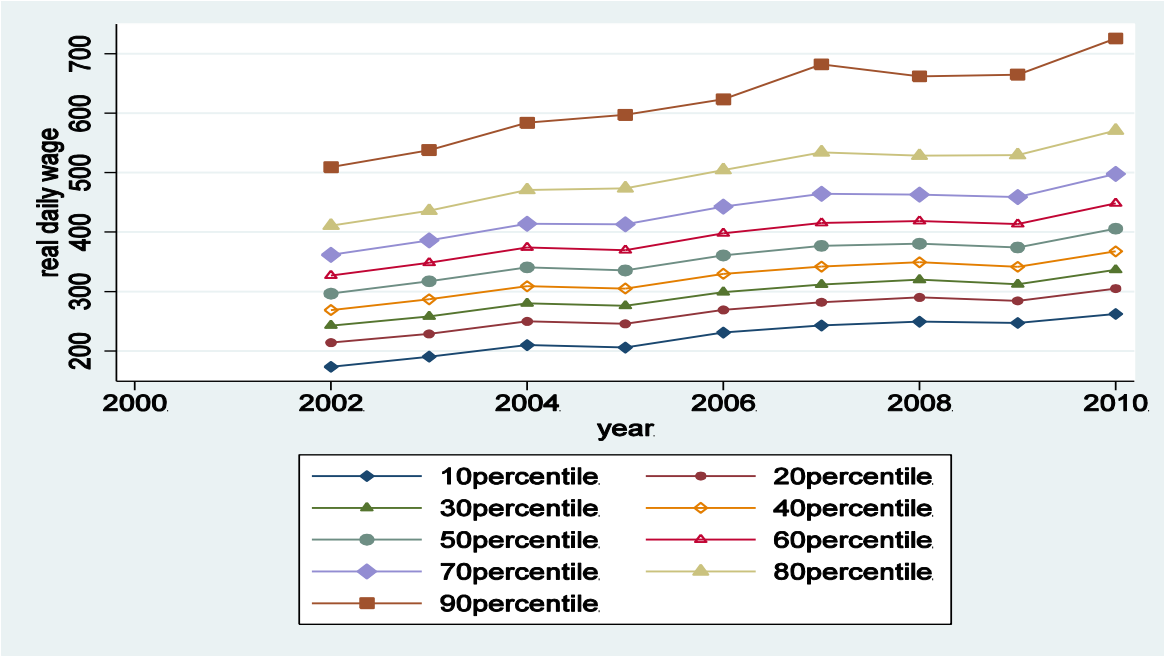
**Figure 6: The number of divorce by age group, 2002-2010**




**Source: Czech Statistical Office**

The real wage trend of the percentile groups of the fertile women are plotted in Figure 7.

**Figure 7: The wage trend by percentile, 2002-2010**




**Source: Trexima database.**

Reflecting the expansion of Czech economy after its transition, the real wage of fertile women are steadily growing during the period studied. This increasing trend is more prominent in the higher wage groups.

## 5.2. Empirical Method

We plan to estimate the effect of child support policy on the fertility and marital turnover. Thee individual observation is a group of individuals characterized by region of residence (14 regions), age(categorized into 7, every 5 years for fertile women in their age 15-49), calendar time of divorce (2002-2009). To get the income information of the each group, we merged certificates data with Trexima data. Using the income information, we further calculated the amount of maternity allowance, which is variable concern. Regarding the sign of the variables concerned, we have following hypothesis:

(1a) maternity allowance increases the birth rate because the cost of having child effectively gets cheaper (1b) maternity allowance decreases the birth rate because of the increase in uncertainty on the marriage status, coming from the higher frequency of marital turnover

(2a) maternity allowance increases marriage rate because of the increase of marital turnover (2b) maternity allowance decreases marriage rate because women can afford to be single to grow a child

(3a) maternity allowance increases divorce rate because women can afford to get divorced and have kids.

Specifically the following specification is tested.

$$\Pr(R_{i,j,t}) = f(\text{benefitratio}_{i,j,t} + X_{i,j,t} + Y_j + Z_t), \quad (13)$$

where i, j, t denote the cell, residential place, and the calendar time of divorce. $\Pr(R_{i,j,t})$ is the number of births, marriages or divorces in the cell i divided by the population size of the fertile women in the cell.

$\text{benefitratio}_{i,j,t}$ is the amount of maternity benefit in czk per day value divided by their daily wage. $X_{i,j,t}$ capture individual characteristic, such as age category or relative wage to the average wage(wageratio). $Y_j$ and $Z_t$ is the regional and time dummies respectively. Each egression is tested using weighted least squares, where the weight is the population size of the cell. Below is the expected sign of the coefficient of $\text{benefitratio}_{i,j,t}$ with respect to the hypothesis above.

Expected sign of benefitratio

| | | | |
|---|---|---|---|
| 1a | (+) | 1b | (-) |
| 2a | (+) | 2b | (-) |
| 3a | (+) | | |

## 5.3. Empirical Results

The results from the regression analysis are presented in Table 4 to 6. For the age category dummies, the reference group is age 15-24 years old. In the first column the result when we control for age category dummies, time dummies and year dummies is presented. In the second column we present the results when we control for the interaction term of age and year dummies. We do so because as reported in the Data section, there seems different time trend across the different age groups.

In terms of births, the positive coefficient of benefitratio suggests that the maternity allowance has a positive effect on the fertility, which means that our results support hypothesis (1a). Regarding the effect of the income level on the fertility, we find the positive coefficient of wageratio. This finding might seem counterintuitive: as the wage of woman goes up, her opportunity cost increases, and thus, she is reluctant to have a baby. However, many studies fail to show the significant negative effect of wage on the fertility. In this regard, our finding is quite consistent with existing literature. In the column 3 to 5, we present the results when the regressions are run on the different income group: low income group consists of the cells with income lower than 20

percentiles, middle income consists upper than 20 percentiles and lower than 80 percentiles and high income group higher than 80 percentile. wageratio has positive sign although for the high income group, however benefitratio has positive and significant sign only for the middle income group. This suggests that the maternity allowance has the significant effect on the middle class income group. Indeed, for the low income class the sign of the maternity allowance is strongly negative: for the low income class, the maternity allowance has a negative effect. This might be caused by the fact that for the low income family their income level is under the substantial level, and thus, even though the benefit ratio is high, they cannot afford the children. This tendency becomes stronger when their income level is lower, i.e., the benefit ratio is higher.

In Table 5 the results from the regression where the dependent variable is the marriage rate is presented. The maternity allowance has a positive effect on marriage rate with full sample (Column 1 and 2). This effect is prominent in middle income class: our finding is consistent with hypothesis (2a) for middle and weakly for high income class, but for low income it supports (2b).

At last, the regression of the divorce rate is presented in Table 6. With all the samples our finding supports that hypothesis (3): the women get divorce more often because they can afford to have children being single. However the regressions with the different wage group do not support this: the maternity allowance has a negative effect on divorce.

This might be caused by the uncontrolled correlations among the dependent variables. One way of addressing this problem is try the different specification incorporating the issue of correlations of disturbances of the regressions such as Seemingly Unrelated Regression. Or alternatively, the specification allows us to solve the structural form. For example, the birth rate might have a negative effect on divorces because existence of child deters the divorces. One way of solving this issue is including lagged variables of the other dependent variables in the regression: for example, include lagged birth rate in the regression of divorce rate.

**Table 4: The effect of the maternity allowance on births**

| VARIABLES | (1) OLS | (2) OLS-ageXyear dummies | (3) OLS-low income | (4) OLS-middle income | (5) OLS-high income |
|---|---|---|---|---|---|
| benefitratio | 0.256*** | 0.343*** | -5.548*** | 0.0639 | -0.0927 |
| | (0.0722) | (0.0695) | (0.661) | (0.191) | (0.160) |
| wageratio | 0.105*** | 0.115*** | | | |
| | (0.00923) | (0.00914) | | | |
| age (26-35) | 0.0382*** | | 0.00149 | 0.0398*** | 0.0375*** |
| | (0.00210) | | (0.0125) | (0.00332) | (0.0112) |
| age (36-45) | 0.0728*** | | | 0.0731*** | 0.0690*** |
| | (0.00147) | | | (0.00164) | (0.00233) |
| Constant | -0.246*** | -0.268*** | 4.104*** | -0.0384 | 0.0627 |
| | (0.0571) | (0.0548) | (0.487) | (0.139) | (0.135) |
| Observations | 770 | 770 | 134 | 459 | 177 |
| R-squared | 0.833 | 0.850 | 0.622 | 0.836 | 0.894 |

**Note:** * significant at 10%; ** significant at 5%; *** significant at 1%.Marginal effects and standard errors (in parentheses) are reported. All regressions include the year dummies and regional dummies. The reference group for age category dummies. are the women whose age are 16-25

**Table 5: The effect of the maternity allowance on marriages**

| VARIABLES | (1) OLS | (2) OLS-ageXyear dummies | (3) OLS-low income | (4) OLS-middle income | (5) OLS-high income |
|---|---|---|---|---|---|
| benefitratio | 0.302*** | 0.412*** | -3.516*** | 0.265*** | 0.231*** |
| | (0.0365) | (0.0396) | (0.539) | (0.0780) | (0.0373) |
| wageratio | 0.0412*** | 0.0503*** | | | |
| | (0.00364) | (0.00379) | | | |
| age (26-35) | 0.0167*** | | | 0.0115*** | |
| | (0.00156) | | | (0.00238) | |
| age (36-45) | 0.0210*** | | 0.0319*** | 0.0169*** | 0.0277*** |
| | (0.000877) | | (0.0112) | (0.00119) | (0.00136) |
| Constant | -0.247*** | -0.318*** | 2.601*** | -0.178*** | -0.156*** |
| | (0.0287) | (0.0313) | (0.398) | (0.0562) | (0.0268) |
| Observations | 882 | 882 | 158 | 564 | 160 |
| R-squared | 0.518 | 0.560 | 0.421 | 0.506 | 0.803 |

**Note:** * significant at 10%; ** significant at 5%; *** significant at 1%.Marginal effects and standard errors (in parentheses) are reported. All regressions include the year dummies and regional dummies. The reference group for age category dummies. are the women whose age are 16-25

**Table 6: The effect of the maternity allowance on divorces**

| VARIABLES | (1) OLS | (2) OLS-ageXyear dummies | (3) OLS-low income | (4) OLS-middle income | (5) OLS-high income |
|---|---|---|---|---|---|
| benefitratio | 0.0138 | 0.0313** | -0.215*** | -0.0602 | -0.0374 |
| | (0.0127) | (0.0133) | (0.0530) | (0.0458) | (0.0277) |
| wageratio | 0.00809*** | 0.0105*** | 0.00966*** | -0.0205*** | 0.00742 |
| | (0.00175) | (0.00176) | (0.00136) | (0.00563) | (0.00579) |
| agecat2 | -0.00895*** | | | | |
| | (0.000405) | | | | |
| agecat3 | 0.000627*** | | | 0.00594*** | 0.00417*** |
| | (0.000242) | | | (0.000374) | (0.00118) |
| Constant | -0.00187 | -0.0143 | 0.150*** | 0.0553 | 0.0279 |
| | (0.0100) | (0.0105) | (0.0395) | (0.0358) | (0.0235) |
| Observations | 755 | 755 | 113 | 463 | 179 |
| R-squared | 0.773 | 0.797 | 0.853 | 0.732 | 0.659 |

**Note:** * significant at 10%; ** significant at 5%; *** significant at 1%.Marginal effects and standard errors (in parentheses) are reported. All regressions include the year dummies and regional dummies. The reference group for age category dummies. are the women whose age are 16-25

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# Unemployment and Public Finances - Development in the Slovak Republic and its comparison with the Czech Republic[1]

*Vlasta FEJEŠOVÁ*[2]

***Abstract:*** Public finances and the government deficit are nowadays frequently consulted issues. Under search are ways to reduce the public expenditures while eliminating the associated negative effects. In this paper, we try to establish a link between the volume of public spending directed towards the labour market support and a development of the macroeconomic indicator "rate of unemployment". Using regression analysis and a simple econometric model, we outline the sensitivity in the response of the change in the level of unemployment to the level of public spending and vice versa, i.e. the change in the level of public spending to the possible change in the unemployment rate.

***Keywords:*** unemployment, labour market policy, general government budget, regression analysis, econometric model.

***JEL classification:*** H60, J68

## 1. Introduction

In addition to the analysis of a social budget, Scholz, Cichon and Hagemejer devote in their publication "Social Budgeting" also to the connections between social protection systems, public finances, labour market and a macroeconomic development. They note that links between the national economy, its structure, development and social protection systems are versatile. The social protection system is not only a redistribution mechanism; the structure and development of its revenues and expenditures have many direct and indirect effects on the present status and potential future economic development. Within this paper, using regression analysis and basic econometric modelling we try to establish a link between the development of the macroeconomic indicator "rate of unemployment" and the level of public spending directed towards the labour market support, via both active and passive labour market policy. We outline the sensitivity in response of the change in the level of unemployment to the level of public spending and vice versa, i.e. the change in the level of public spending to the possible change in the rate of unemployment.

## 2. Used methodology

Using elementary econometrics, we analyse the linear dependence of the above variables. Examination of the linear relationship includes 34 observations. These quarterly data for the period 1995Q3 to 2003Q4 were taken from the official database of the Statistical Office of the Slovak Republic. For the calculation of individual estimates we used the software package EViews 5. Model parameters were estimated using the ordinary least squares method. As already mentioned we examine the linear relationship and thus assume a simple linear model which can generally be written as:

[1] The paper has originated within work on the project IGA VŠE F1/30/2010 "Impact of Tax and Expenditure Instruments on the Microeconomic and Macroeconomic Efficiency"

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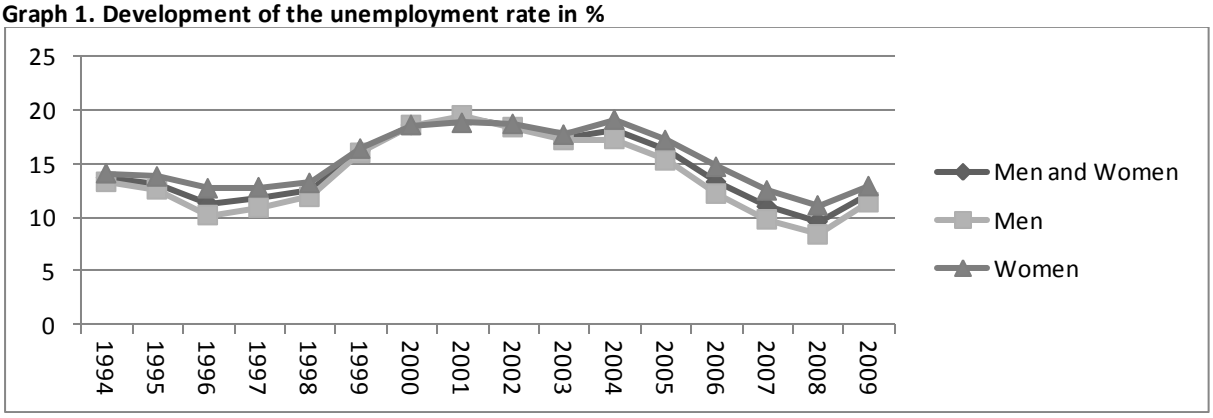
$$y = \beta_0 + \beta_1 x + \varepsilon \quad (1)$$

where: y – dependent variable, x – independent variable, β0 – constant providing information on the straight line's position, β1 – regression coefficient related to the change in the descriptive variable, ε – random components.

# 3. Unemployment and its development in the Slovak Republic

Development of the rate of unemployment in the Slovak Republic has undergone a dynamic development during the period of social and economic changes after 1989, when from a relatively negligible value of about 1% the unemployment rate began to rise sharply. During the monitored period it has temporarily declined from around 13.7% in 1994 to 11.3% and then rose again. Its steep rise in 1999 has culminated in 2001 when it has peaked at 19.2%. The decline in unemployment occurred only after 2005 and in 2008, when due to rapid growth in the economy the unemployment rate fell to 9.6%. In 2009, due to the financial and economic crisis and the related events, such as mass redundancies and the return of unemployed people from abroad, there came once again to a sharp increase in the rate of unemployment.

**Graph 1. Development of the unemployment rate in %**




**Source: Statistical Office of the Slovak Republic**

## 3.1. Selected parameters of the employment policy and public expenditures

### *3.1.1. Financing of the passive labour market policy*

Within the passive labour market policy we will pursue unemployment benefits paid under the legal arrangement, provision of which is upon fulfilment of relevant conditions mandatory. Overview of key changes in financing of the passive labour market policy is shown in Table 1.

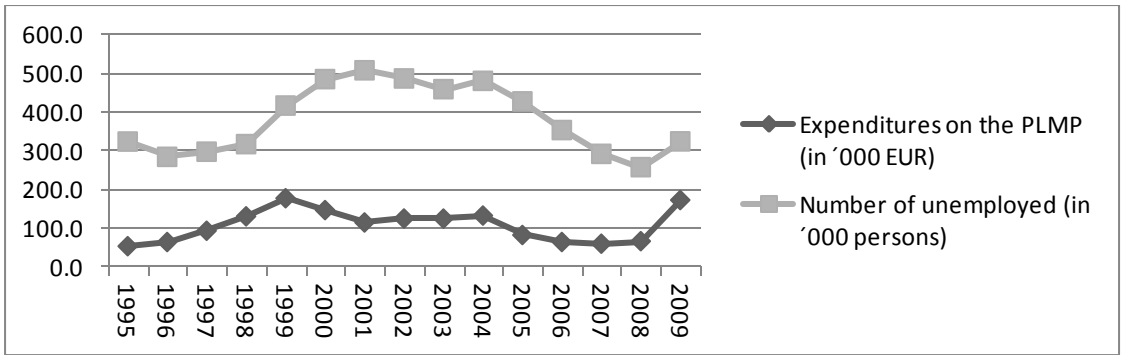
**Table 1 - Overview of parametric changes in unemployment benefits**

| | 1995 | 1999 | 2000 | 2004 |
|---|---|---|---|---|
| Benefit rate (%) | *4.0* | *4.0* | *3.75* | *2.0* |
| Benefit level in % of the assessment base | *60 - 50* | *50 - 45* | *50 - 45* | *50.0* |
| Max. benefit level | 1.5-times MW | 1.5-times SM | 1.5-times SM | *x* |
| Duration of drawing in months | 3 - more | 3 - more | 3 - more | 6 |
| Terms of the benefit's provision | min.12 months in the past 3 years | min. 24 months | min. 24 months | min. 3 years in the past 4 years |
| Duration of the employment / duration of the benefit's drawing in months | up to 15 years - 6 months<br>from 15 to 20 years - 9 months<br>over 25 years - 12 months | up to 15 years - 6 months<br>over 15 years - 9 months | up to 15 years - 6 months<br>over 15 years - 9 months | 6 months |

***Note:*** *MW – minimum wage, SM – subsistence minimum*

Setting of the conditions has followed in particular the prevention of an increase in the proportion of the long-term unemployed to their total number. Drawing of benefits for 12 months has caused changes in work habits that adversely affected the development of the rate of unemployment. Shortening of the time over which the benefit is drawn creates a scope for the labour force mobility within the dynamically changing labour market. It is obviously necessary to note that these changes should also follow the prerequisite of cost-effectiveness in public spending and positively impact the general government budget's balance.

**Graph 2. Development of expenditures on the PLMP – unemployment benefits with respect to the number of unemployed**

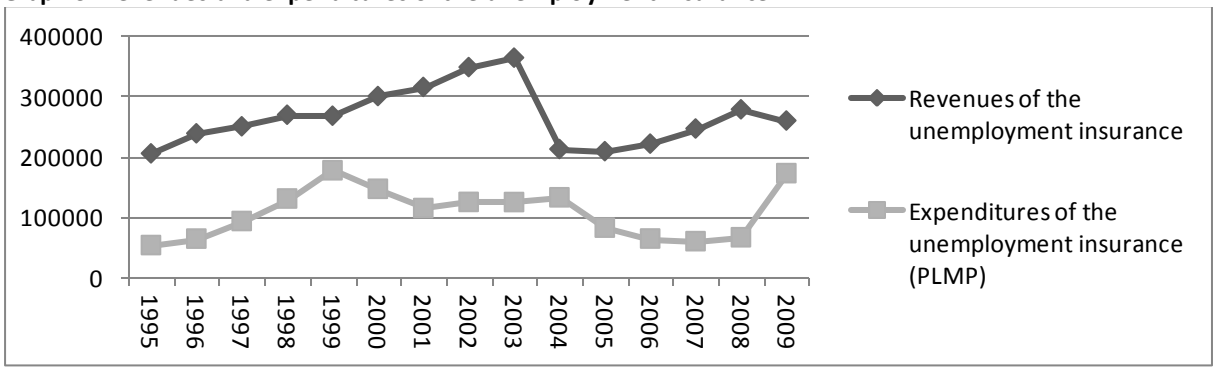



**Source: Statistical Office of the Slovak Republic**

Impact of parametric changes of the unemployment insurance in 1999 and 2004 on the level of public spending is obvious. Their sharp increase in 2009 has been caused by the rise in unemployment as a result of the financial and economic crisis. Financing of the passive labour market policy also includes revenues of the general government budget legally determined by the relevant rate from the defined assessment base.

By reducing the rate of the contribution towards the unemployment insurance over the monitored period has been ensured adequacy in the generation and use of resources, including the already mentioned support of the business environment in the form of reductions in the rates for employers.

**Graph 3. Revenues and expenditures of the unemployment insurance**



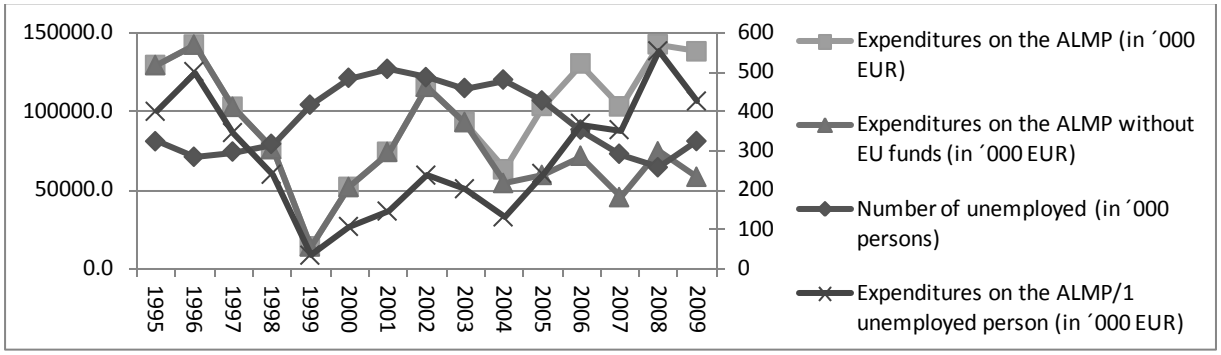

**Source: Statistical Office of the Slovak republic, author**

## 3.2. Financing of the active labour market policy

Active labour market policy is financed through instruments whose number has increased as a result of key amendments to the Act on Employment. The change in the structure of the active labour market policy instruments has reflected the needs resulting from their practical use and since 2004 also conditions for financing of these instruments from resources of the EU structural funds. The amount of expenditures directed towards the active labour market policy, however, is not determined only by the criterion of the extent of its instruments. Following the increase in the

number of instruments via amendment of the law adopted in 1996, the volume of expenditures has until 1999 decreased. In the following period the expenditures have increased until 2002, despite the fact that the range of instruments was partially broadened. The law has tightened conditions for granting contributions for the job creation in the interest of preventing speculative spending on the active labour market policy.

**Graph 4.Development of expenditures on the ALMP and development of the number of unemployed persons**




**Source: Statistical Office of the Slovak republic, author**

In pursuit of the indicator "expenditure of the active labour market policy per one employed job seeker" as indicated by Chart 4, we may note that the pace of change in the amount of expenditures on an employee generally corresponds with the change in total expenditures on the active labour market policy. An extreme increase in expenditures per one employee in 2008 – even in the situation of a decrease in the number of unemployed – may be attributed to projects which in that year showed high start-up costs and have not created an adequate number of jobs.

**Table 2 - Expenditures on the active labour market policy per one unemployed person**

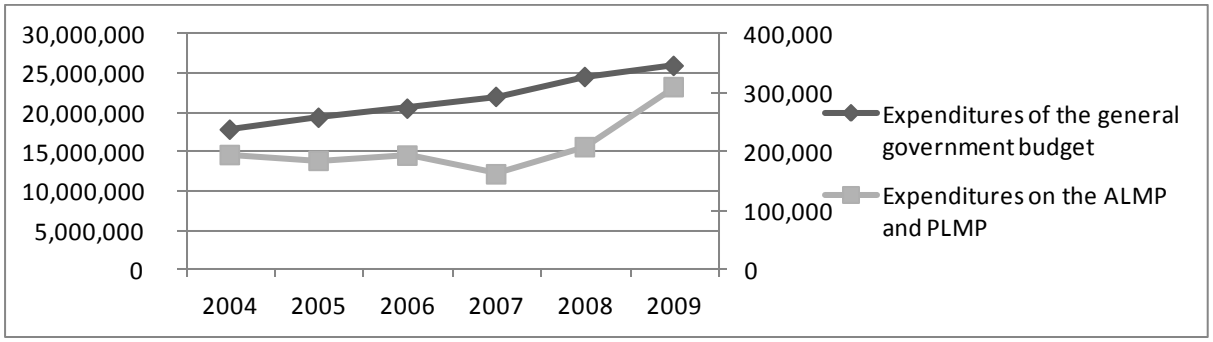
| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|
| Number of unemployed (in '000 persons) | 459.2 | 480.7 | 427.5 | 353.4 | 291.9 | 257.5 | 324.2 |
| Expenditures on the ALMP/1 unemployed (in EUR) | 202.9 | 131.2 | 241.9 | 369.1 | 353.2 | 553.8 | 426.1 |

**Source: Statistical Office of the Slovak republic, author**

## 3.3. General government budget and employment policy

The general government budget is in accordance with the Act on Budgetary Rules composed by the state budget and budgets of government entities. Over the monitored period, financing of the employment policy has been subjected to several institutional changes. Currently is the active labour market policy financed directly from the state budget, including the EU structural funds, while the passive labour market policy is financed from the Basic unemployment insurance fund administered by the Social insurance agency. When comparing the development of expenditures on the labour market policy and total general government expenditures, we do not see any direct link. Decrease in expenditures on the labour market in 2007 is influenced by low unemployment but also by the reduction in expenditures on the active labour market policy. The increase in 2009 relates to the financial and economic crisis, particularly by the rise in the number of unemployed as a result of massive layoffs as well as due to the return of persons previously working abroad. At the same time, the state has increased its intervention on the labour market by taking actions supporting its development. From the chart we may deduce that fluctuations in expenditures on the labour market policy are absorbed within the generally steady development of total expenditures of the general government budget. The year 2009, however, must be considered separately, whereas the growth in total expenditures of the general government budget has been caused by expenditures for eliminating consequences of the crisis, including also other domains than the labour market policy.

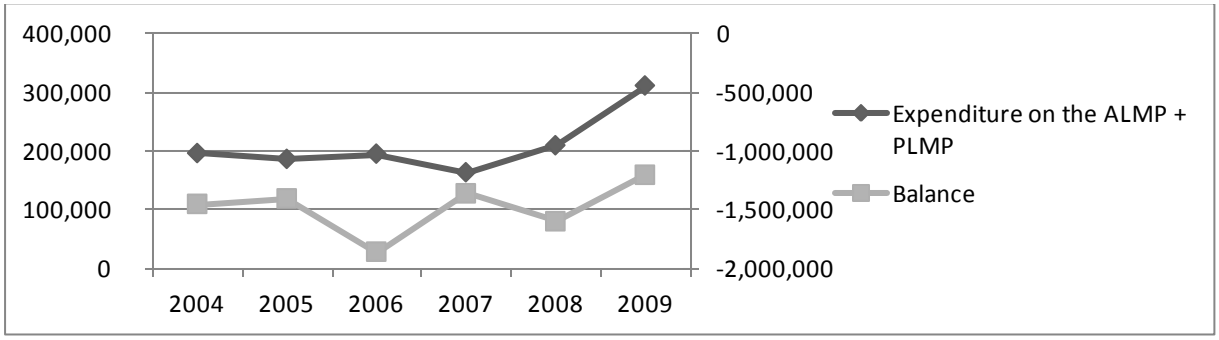
**Graph 5. Development of expenditures on the labour market policy and expenditures of the general government budget**




**Source: Ministry of Finance of the Slovak Republic, Central Office of Labour, Social Affairs and Family, author**

In the following chart we take a look at the development of expenditures on the labour market policy and the general government budget's balance. During the monitored period it appears that in periods of increased expenditures on the labour market policy there increases the general government budget's deficit and the other way round, with the exception of 2009 when increased expenditures on the support of the labour market also correspond with the reduction in the general government budget's deficit.

**Graph 6. Development of expenditures on the labour market policy and the balance of the consolidated general government budget**




**Source: Ministry of Finance of the Slovak Republic, Central Office of Labour, Social Affairs and Family, author**

While assessing the above mentioned facts, however, into account needs to be taken also the weight of the expenditures on the employment policy within the general government budget. From Table 3 it can bee seen that the level of expenditures on the labour market policy reached its maximum level 1.19% of the overall general government budget and 0.49% GDP at current prices.

**Table 3 - Share of expenditures on the labour market policy on total expenditures of the general government budget (RVS) and the GDP**

| | *2004* | *2005* | *2006* | *2007* | *2008* | *2009* |
|---|---|---|---|---|---|---|
| *Share on RVS expenditures (%)* | *1.09* | *0.96* | *0.95* | *0.74* | *0.85* | *1.19* |
| *Share on GDP at current prices (%)* | *0.43* | *0.38* | *0.35* | *0.26* | *0.31* | *0.49* |

**Source: Ministry of Finance of the Slovak Republic, Statistical Office of the Slovak Republic**

## 3.4. Relationship between the development of unemployment and public expenditures

In this chapter we focus on the relationship between the development of the rate of unemployment and the development of public expenditures allocated towards the labour market support within both active and passive labour market policies in conditions of the Slovak Republic. We try to pay attention to the relationship between the state expenditures towards the labour

market policy and the development of unemployment. This relationship will be followed at two levels:

1. is it possible that the level of the unemployment rate influences the level of expenditures of the general government budget, and vice versa,
2. is it possible that the amount of expenditures directed towards the labour market policy influences the development of unemployment?

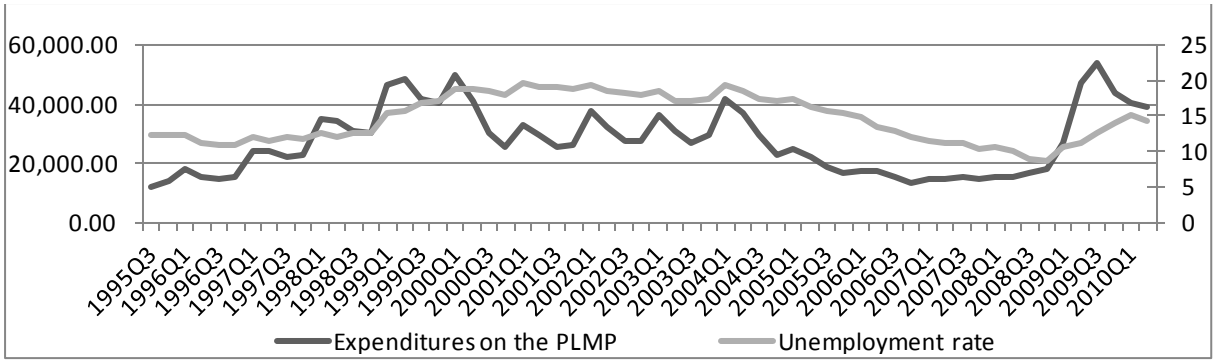
The given assumption will be followed individually for both passive and active labour market policies.

### *3.4.1. Expenditures on the passive labour market policy*

The following chart shows the development of expenditures of the general government budget in the years 1995 through 2009 (in EUR '000). The rate of unemployment on the right axis is expressed as a percentage.

From the graphic representation and visual comparison of the both indicators we may conclude that the development of expenditures on unemployment benefits and thus the development of expenditures on the passive labour market policy corresponds with the development of the rate of unemployment. We may see that until 2000, gradual increases in the unemployment rate correspond also with the simultaneous increase in public expenditures. "Stabilization" of the rate of unemployment in the years 2000 through 2004 at the level of 18 to 19% brings along the corresponding development of the unemployment benefits, albeit at a lower level. The sharp increase in expenditures in 2009 was caused by the already mentioned increase in the unemployment due to the crisis.

**Graph 7. Development of expenditures on the PLMP – unemployment benefits depending on the development in the unemployment rate**




**Source: Statistical Office of the Slovak Republic, author**

Let us now approach the analysis of the development of expenditures on the labour market policy depending on the development of the unemployment rate in terms of the Slovakia's economy.

Resulting values of the parameters are β0 = 8509.644 and β1 = 2111.837 and their subsequent insertion in (1) provides the estimated model in the following form:

PLMP = 8509.644 + 2111.837 UNEMP, where

PLMP – expenditures on the passive labour market policy,

UNEMP – unemployment rate.

The model shows that if the unemployment rate rises by 1%, expenditures on the passive labour market policy increase by EUR 2,111,837. The coefficient of determination (R-squared) takes the value of 0.272641 meaning that the model explains 27.3% of the variability of the dependent variable, in our case expenditures on the passive labour market policy, and the remaining approximately 72.7% is attributed to random components. Estimated parameter β1 and the model as a whole is statistically significant. For the given estimate it is necessary to point at the low value of

the Durbin-Watson statistics in the output, equal to 0.465417, that signals the presence of autocorrelation in the given model. The presence of autocorrelation violates the basic statistical feature of the method of the ordinary least squares on non-autocorrelation of random components. Autocorrelation of the model can be removed using various techniques, such as the so-called AR(1) – an autoregressive process of the first order. By integrating the AR(1) (i.e. the dependence, where the present-time random component depends on the random element of the previous quarter of the year) into the model in order to remove autocorrelation, we obtain a new estimate.

After the removal of autocorrelation from the model (B), the examined statistics (R-squared, t-statistics, F-statistics, Durbin-Watson statistics) improve significantly and therefore this linear relationship may be considered decisive and realistic. The model explains 74.2% of the variability of the dependent variable, in our case expenditures on the passive labour market policy and the remaining approximately 25.8% is attributed to random components.

Interpretation:

$\beta 0$ = - 69,502.50 represents the amount of expenditures on the passive labour market policy provided there does not exist any unemployment. This, however, lacks any logical meaning and the constant $\beta 0$ thus provides us only the information on the straight line's position;

$\beta 1$ = 6,755.735 means that an increase in the rate of unemployment by 1% corresponds with an increase in expenditures on the passive labour market policy by EUR 6,755,735.

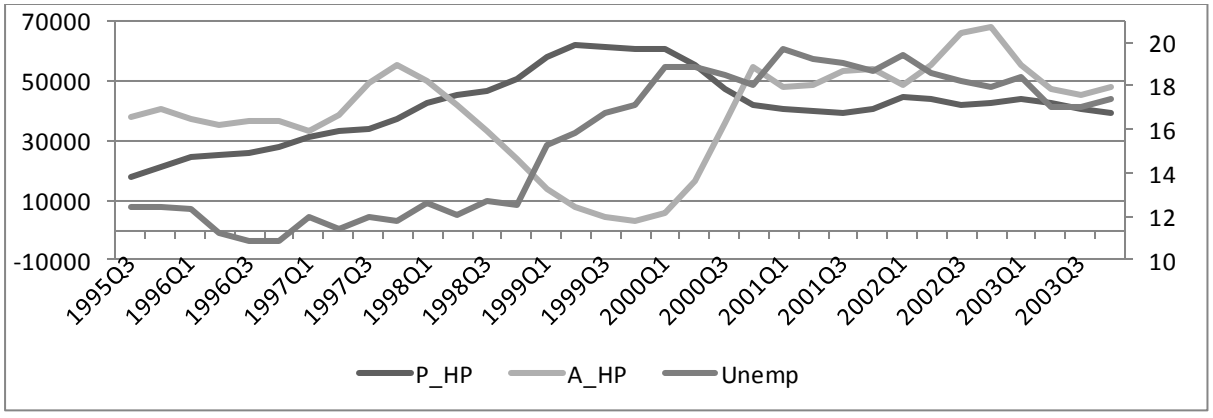
After removal of autocorrelation using the first order autoregression it thus may be concluded that if the unemployment rate rises by 1%, expenditures on the passive labour market policy increase by EUR 6,755,735.

### *3.4.2. Expenditures on the active labour market policy*

#### *Expenditures on the active labour market policy and the rate of unemployment*

For expenditures on the active labour market policy, we might expect the opposite relationship with respect to the unemployment rate when compared to expenditures on the passive labour market policy. Their aim is to activate the labour market in anticipation of a subsequent reduction in the rate of unemployment. Let us look whether the level of expenditures directed towards the labour market policy may affect the development of the unemployment rate. The development of expenditures of the general government budget on the active labour market policy in the years 1995 through 2003 and the mutual course of the three parameters are shown in the following chart. The rate of unemployment on the right axis is shown as a percentage.

**Graph 8. Development of expenditures on the PLMP, ALMP and unemployment rates**




**Source: Statistical Office of the Slovak Republic, author**

In pursuing the graphic representation of the development of monitored indicators, we may observe that the assumed event may be in the data from 2003 obvious (since 2004, the Statistical

Office of the Slovak Republic does not publish data on expenditures on the active policy financed from the state budget, for the purpose of the study are available only annual data). The curve corresponding to the increase in public spending follows the reduction of unemployment and this finding may hold also the other way round. Let us, however, look at the statistical dependence of those phenomena.

Is the rate of unemployment determined by the amount of expenditures on the active labour market policy, or is it the change in the unemployment rate that affects the amount of expenditures on the active labour market policy? We have repeatedly used the software package EViews 5. From analysis of the linear relationship of expenditures on the active labour market policy and the rate of unemployment we have found that the examined statistics (R-squared, t-statistics, F-statistics, Durbin-Watson statistics) return unsatisfactory values. From the obtained results it may be concluded that the model parameter β1 and the model as a whole is statistically insignificant. The value of the coefficient of determination is too low and therefore the chosen independent variables (expenditures on the active labour market policy and the unemployment rate) practically do not explain at all the variability of the dependent variable, namely the rate of unemployment and expenditures on the active labour market policy. Based on these results we may therefore assume that the rate of unemployment is almost entirely independent upon expenditures on the active labour market policy, or that expenditures on the active labour market policy almost entirely fail to be determined by the rate of unemployment.

Therefore, provided the total amount of expenditures on the active labour market policy does not affect the level of the unemployment rate and the other way round, the unemployment rate does not depend on the development of total expenditures on the active labour market policy, we will try to follow the dependency of expenditures on the active labour market policy and the number of unemployed.

### *Expenditures on the active labour market policy and the number of unemployed*

Let us return to the finding related to the graphic representation from the first chapter that the pace of the increase in expenditures on the active labour market policy corresponds with the reduction in the number of unemployed. The relationship between these quantities may be once again assumed in two levels:

a) increase in expenditures on the active labour market policy results in placement of unemployed persons on the labour market and subsequently in the reduction of the number of unemployed, or

b) increase in the number of unemployed requires increased expenditures supporting their re-integration on the labour market.

**Is the number of unemployed determined by the amount of expenditures on the active labour market policy?**

Once again we make use of the software package EViews 5. (Note: We use the database of annual data over the whole monitored period since the data for the active labour market policy are since 2004 available only on an annual basis). The coefficient of determination (R-squared) takes the value of 0.340249 which means that the model explains 34.0% of the variability of the dependent variable, in our case the number of unemployed, and the rest of approximately 66.0% is attributed to random components. Estimated parameter β1 and the model as a whole is statistically significant. For the given estimate it is necessary to point at the low value of the Durbin-Watson statistics in the output standing at 0.564677, which signals the presence of autocorrelation in the given model. By integrating the AR(1) into the model to remove autocorrelation, we obtain a new estimate. After the removal of autocorrelation from the model the studied statistics (R-squared, t-statistics, F-statistics, Durbin-Watson statistics) significantly improve and therefore this linear relationship may be considered decisive and realistic. The coefficient of determination (R-squared) takes the value of 0.735072 meaning that the model explains 73.5% of the variability of the dependent variable, in our

case the number of unemployed, and the remaining approximately 26.5% is attributed to random components. The model shows that if expenditures on the active labour market policy increase by EUR 1,000 the number of unemployed decreases by 0.64 persons.

***Is the volume of expenditures on the active labour market policy affected by the change in the number of unemployed?***

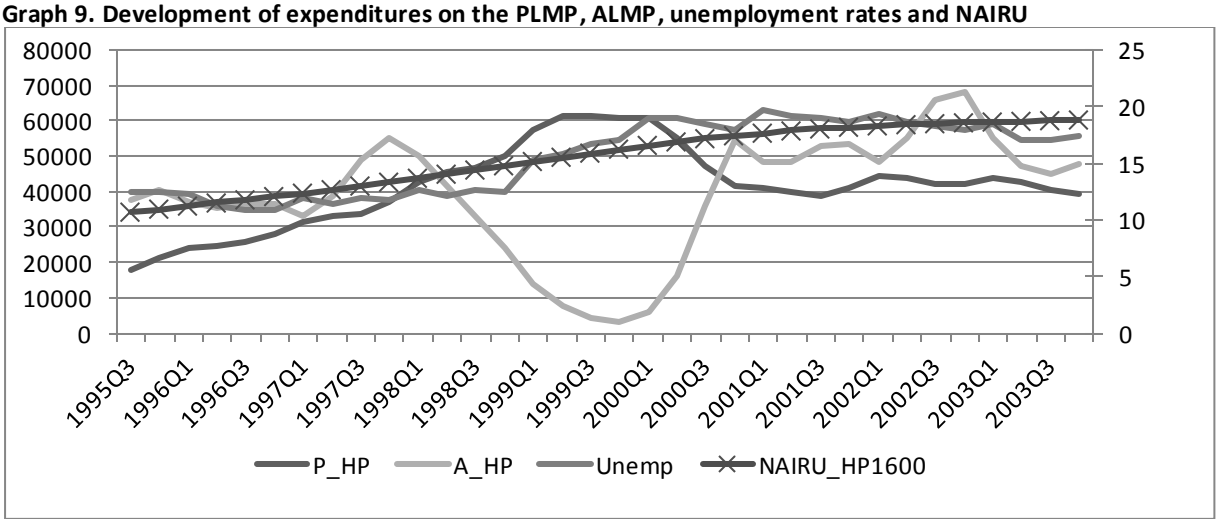
Let us also try to look at the opposite relationship in the observed variables. The coefficient of determination (R-squared) takes the value of 0.340249, which means that the model explains 34.0% of the variability of the dependent variable, in our case expenditures on the passive labour market policy, and the remaining approximately 66.0% is attributed to random components. Estimated parameter β1 and the model as a whole is therefore statistically significant. The value of the Durbin-Watson statistics in the output stands at 1.050443, which signals the presence of autocorrelation in the given model. For the 15 observations, the values should be within the range from 1.077 to 1.361. By integrating the AR(1) into the model to remove autocorrelation, we obtain a new estimate. Outputs of both versions of the model (before and after the removal of autocorrelation) are not significantly different and indicate that if the number of unemployed drops by 1,000 persons, the costs decrease by EUR 249,492.

## 3.5. Development of the rate of unemployment, public expenditures, NAIRU

In this study we paid attention to the development of the unemployment rate and expenditures on the active and passive employment policy and their interdependences. For information let us note how the observed indicators developed in relation to the equilibrium rate of unemployment that does not accelerate inflation – NAIRU.

Professional texts state that NAIRU is an unobservable variable; therefore it is necessary to estimate its trajectory using some suitable method. In our text, NAIRU is estimated by applying the Hodrick-Prescott filter with the smoothing parameter λ=1600 (the value Hodrick-Prescott suggested for quarterly data) to the time series of the unemployment rate.

**Graph 9. Development of expenditures on the PLMP, ALMP, unemployment rates and NAIRU**




**Source: Statistical Office of the Slovak Republic, author**

Within the monitored period, the NAIRU estimate reaches its lowest level in the third quarter of 1995 – 10.7% and its highest level in the fourth quarter of 2003 – 18.8%. When comparing the actual and equilibrium rate of unemployment, we see that the unemployment rate is getting below the NAIRU in the second quarter of 1996 where it remains until the fourth quarter of 1998 when the unemployment rate reaches its lowest level below the equilibrium rate, by 2.3%. Below the equilibrium level has the unemployment rate dropped also during the period from the third quarter

of 2002 until the end of the monitored period, over which it has reached its lowest level in the second and third quarter of 2003, by 1.7%. The real unemployment rate has reached its highest level in the first quarter of 2000 when it oscillated 2.3% over the level of the equilibrium unemployment.

Gylánik and Hucek in their study published by the National Bank of Slovakia "Estimate of NAIRU for the Slovak Economy" note towards the development of the actual and equilibrium unemployment in the Slovak economy over the monitored period that there may be distinguished two main periods. From 1997 until mid 2001 – when the unemployment reached its maximum (19.7%) – prevailed the growth trend in the rate of unemployment due to the ongoing economic transformation that required structural changes in the economy resulting in rationalisation of the workforce, elimination of numerous businesses and reduction in the demand for labour, respectively. Since the second half of 2001 started gradually surface positive effects of the inflow of foreign direct investments in the form of privatisation of state enterprises, and later the so-called "green field" investments promoted by economic reforms. Based on NAIRU estimates was noted an overheating of the economy in the period from 1995 to 1998, when unemployment ranged bellow the equilibrium unemployment level. In 1999, the government adopted restrictive measures leading to a sharp slowdown in the economic activity and a gradual increase in the unemployment rate above the NAIRU level.

## 3.6. Discussion

With respect to attained outcomes, we may formulate the following conclusions:

In this paper, we pursued two versions of relationships within monitoring of the unemployment and public finances, namely:

a) rate of unemployment and public expenditures (within both passive and active labour market policy)
b) number of unemployed and public expenditures (within the active labour market policy) – as a result of outputs of the relationship under the point 1. For monitoring of the dependency in indicators we have employed the method of ordinary least squares.

**Towards the point a):**

In pursuing the dependency of the development of indicators "rate of unemployment" and "volume of expenditures from the general government budget", we have looked for answers to the following questions related to passive and active labour market policies:

***Passive labour market policy***

1. Is it possible that the level of the rate of unemployment influences the volume of expenditures from the general government budget?

In the passive labour market policy we have concluded that this linear dependency may be considered decisive and realistic. The model explains 74.2% of the variability of the dependent variable following the incorporation of an autoregressive process of the first order. We arrived at the conclusion that if the unemployment rate increases, expenditures on the passive labour market policy also increase.

Following the confirmation of the dependency related to the first question, we did not proceed to monitoring of the dependency of indicators related to the second question.

***Active labour market policy***

1. Is it possible that the level of the unemployment rate influences the level of expenditures of the general government budget?

2. Is it possible that the amount of expenditures directed towards the labour market policy influences the development of unemployment?

Within the active labour market policy we have concluded that the rate of unemployment is almost entirely independent upon expenditures on the active labour market policy, or that

expenditures on the active labour market policy almost entirely fail to be determined by the rate of unemployment.

The model for both types of relationships explains 0.63% of the variability of the dependent variable, which led us to the noted conclusion.

**Towards the point b):**

Since within the active labour market policy we were not able to establish the dependence between expenditures and the rate of unemployment, for the further monitoring of the relationship of expenditures we choose the indicator "number of unemployed". Once again, we have chosen two questions, namely:

1. Is the number of unemployed determined by the amount of expenditures on the active labour market policy? Thus, does an increase in expenditures on the active labour market policy result in a placement of unemployed persons on the labour market and, subsequently, in the reduction of the number of unemployed persons?

We concluded that this linear relationship may be considered decisive and realistic. The model explains 73.5% of the variability of the dependent variable upon incorporation of an autoregressive process of the first order. We may note that if expenditures on the active labour market policy increase, the number of unemployment persons decrease.

2. Is the volume of expenditures on the active labour market policy affected by the change in the number of unemployed? Does an increase in the number of unemployed persons require an increase in expenditures supporting their reintegration into the labour market?

We concluded that this linear dependency may be considered partially possible. The model explains 34.0% of the variability of the dependent variable and 46.0% of the variability of the dependent variable upon incorporation of an autoregressive process of the first order. A high percentage is thus attributed to the impact of random components.

In our conclusions we may incline towards the justification of the fact that the unemployment rate (as well as the number of unemployed) does not register a strong, respectively – depending on the chosen variable – almost no dependence on the volume of expenditures directed towards the active labour market policy. This finding may be explained by the following facts:

- change in the number of unemployed is caused not only due to the active labour market measures, but also by the already mentioned departures from the labour force resources (long-term unemployment, voluntary unemployment, etc.);
- low weight of the volume of expenditures on the active labour market policy on the total expenditures of the general government budget as well as on the level of GDP;
- non-transparent use of resources which distorts impact of expenditures on the reduction of the number of unemployed;
- a particular problem for a more detailed monitoring of the effectiveness of the funds spent on the active labour market policy represents the fact that there is not available a full-featured statistics; available statistics does not provide information on how many unemployed are being placed on the labour market due to the effectiveness of various instruments of the active labour market policy. Available are thus (as noted by Lubyová in 1997) only total reductions in the unemployed persons that include also employments of persons outside the programs of the active labour market policy, as well as departures from the labour force resources.

## 4. *Relationship between the development of unemployment and public expenditures under the conditions of the Czech Republic*

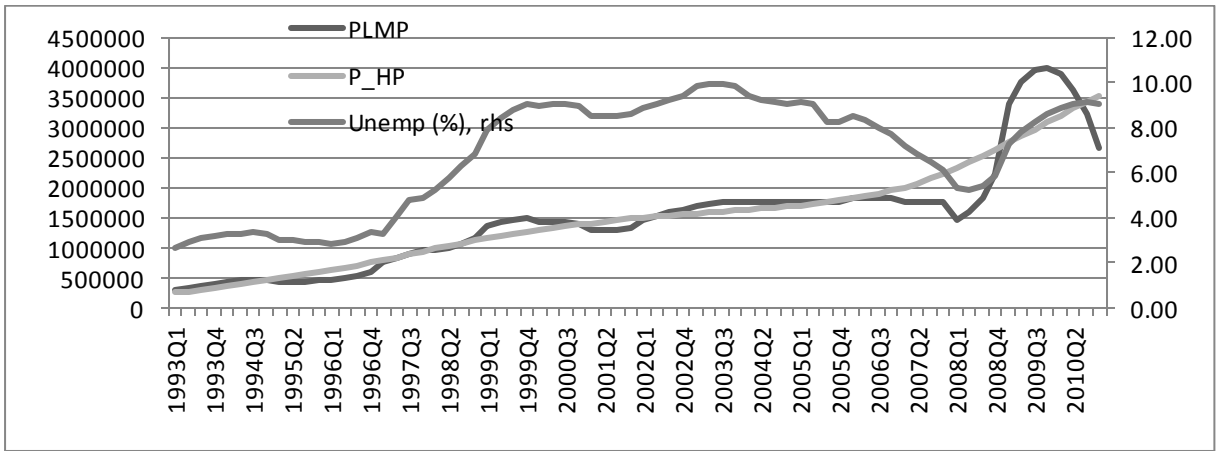
We will try to make a similar analysis of the relationship between the development of the unemployment rate and the development of public expenditures towards the labour market support

in terms of both active and passive labour market policies also for the conditions for the Czech Republic.

## 4.1. Expenditures on the passive labour market policy

Development of the state budget expenditures on the passive labour market policy is shown in the following chart. The rate of unemployment on the right axis is expressed as a percentage. Given the availability of the data on expenditures on the passive labour market policy on the annual basis, for the purposes of determining the values of the chart – on the quarterly basis – we made use of a specific feature of the software package EViews 6 that modifies the data frequency.

**Graph 10. Development of expenditures on the PLMP – unemployment benefits depending on the development of the unemployment rate in the Czech Republic**




**Source: Czech Statistical Office, Ministry of Labour and Social Affairs of the Czech Republic, own processing**

From the graphic representation and visual comparison of the both indicators we may conclude that also for the conditions of the Czech Republic the development of expenditures on the passive labour market policy corresponds with the development of unemployment. We may see that until 1999, increasing unemployment rate corresponds with increases in public expenditures. Again we may see a sharp increase in the expenditures in 2009 due to the already mentioned increase in the unemployment caused by the crisis. The higher rate of the decline in expenditures compared to the decline in unemployment may be influenced by the length of time for which unemployment benefits are drawn.

Analysis of the relationship of the development of expenditures on the labour market policy and the development of the rate of unemployment includes 72 observations. These are quarterly data covering the period 1993Q1 through 2010Q4.

The resulting values of model parameters are $\beta 0 = -112357.0$ and $\beta 1 = 236716.4$. The model shows that if the unemployment rate rises by 1%, expenditures on the passive labour market policy increase by CZK 236,716 thousand. The coefficient of determination (R-squared) takes the value of 0.426530 meaning that the model explains 42.65% of the variability of the dependent variable, in our case expenditures on the passive labour market policy, and the remaining approximately 57.35% is attributed to random components. Estimated parameter $\beta 1$ and the model as a whole is statistically significant. For the given estimate it is necessary to point at the low value of the Durbin-Watson statistics in output equal to 0.049086 which signals the presence of autocorrelation in the given model.

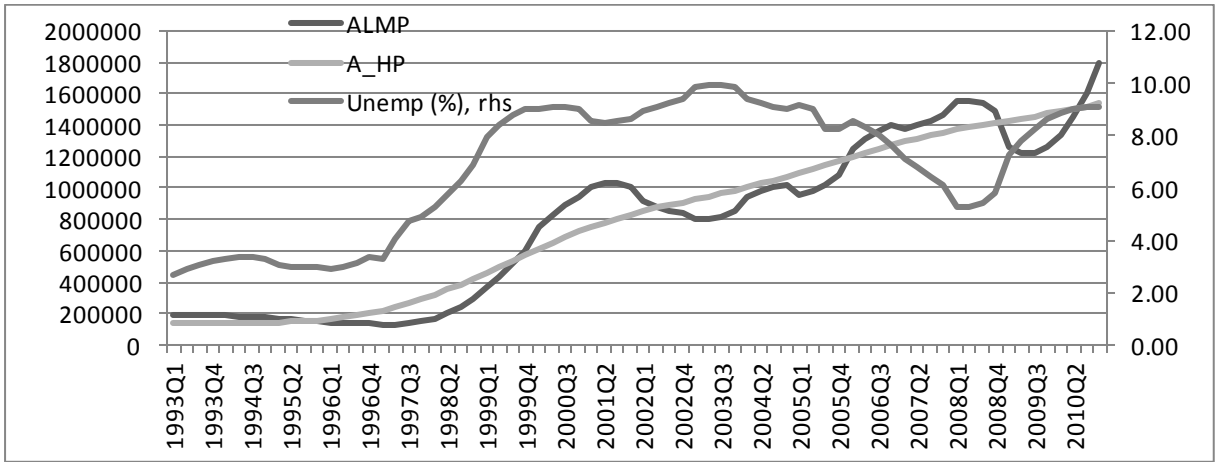
Upon attempt to remove autocorrelation from the model (2), the studied statistics (R-squared, Durbin-Watson statistics) improved, however autocorrelation was not fully eliminated, probably due the conversion of data to quarterly figures (use of the annual database has removed the autocorrelation issue). Based on this fact we may consider this linear relationship decisive and

realistic. The model explains 97.3% of the variability of the dependent variable, in our case expenditures on the passive labour market policy, and the remaining 2.7% is attributed to random components. Based on the results of the model we may conclude that if the unemployment rate rises by 1%, expenditures on the passive labour market policy increase by CZK 343,055.7 thousand. When using annual data of the amount of expenditures, the model explains 79.38%, respectively expenditures increase by CZK 1,020,592 thousand.

## 4.2. Expenditures on the active labour market policy

Let us recall that with respect to expenditures on the active labour market policy, we should expect the opposite relationship to the unemployment rate when compared to expenditures on the passive labour market policy. Their aim is to activate the labour market in anticipation of a subsequent reduction in unemployment. Let us repeat the question: Is the unemployment rate determined by the amount of expenditures on the active labour market policy, or is it the change in the unemployment rate that affects the amount of expenditures on the active labour market policy?

**Graph 11. Development of expenditures on the ALMP and the unemployment rate in the Czech Republic**




**Source: Czech Statistical Office, Ministry of Labour and Social Affairs of the Czech Republic, own processing**

In looking for the possible dependency of the development of expenditures on the active labour market policy on the development of the rate of unemployment, the resulting values for the model parameters are β0 = -108171.4 and β1= 130464.1. The model shows that if the unemployment rate rises by 1%, expenditures on the active labour market policy increase by CZK 130,464.1 thousand. The coefficient of determination (R-squared) takes the value of 0.407738 which means that the model explains 40.77% of variability of the dependent variable, in our case expenditures on the active labour market policy, and the remaining approximately 59.23% is attributed to random components. Estimated parameter β1 and the model as a whole is statistically significant. The low value of the Durbin-Watson statistics in output equal to 0.050356 signals the presence of autocorrelation in the given model.

Upon attempt to remove autocorrelation from the model, the examined statistics improved and the resulting values of the model parameters took values of β0 = -2978846 and β1 = -66109.54. The model shows an indirect relationship which may suggest that if the unemployment rate rises by 1%, expenditures on the active labour market policy fall by CZK 66,109 thousand. The model explains 98.83% of the variability of the dependent variable and the remaining approximately 1.17% is attributed to random components.

When using annual data of the amount of expenditures, the model explains 41.62%. Based on the results of the model we may conclude that if the unemployment rate rises by 1%, expenditures on the active labour market policy increase by CZK 5,275,565.6 thousand. Based on the calculated values we again attempt to remove autocorrelation. Following the adjustment, the model

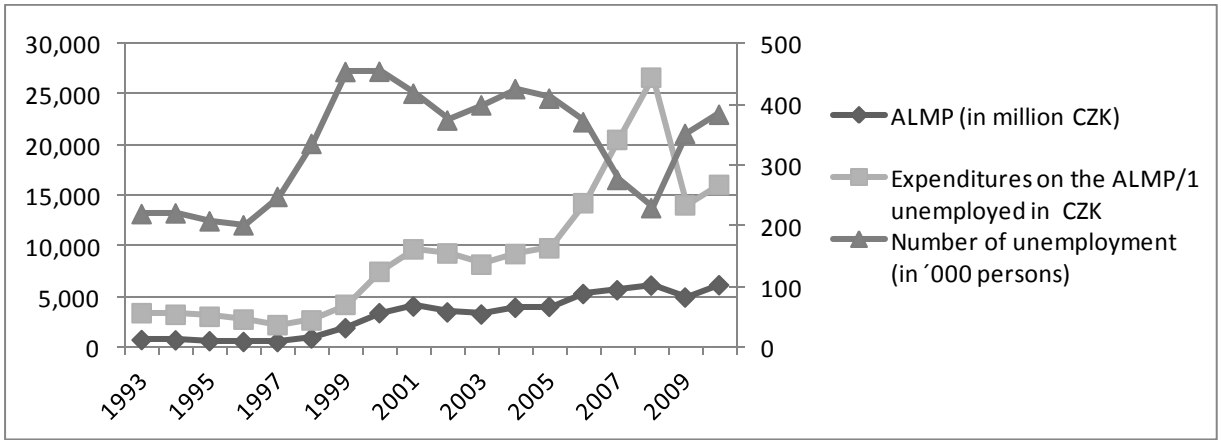
explains 88.9% and we obtain the resulting values for the model parameters β0 = -15321588 and β1 = -139504.9. The model again shows an indirect relationship from which we may assume that if the unemployment rises by 1%, expenditures on the active labour market policy decrease by CZK 139,504.9 thousand.

How may these results be interpreted in the practice? Should it hold true, that an increase in the rate of unemployment should call for an increase in the expenditures supporting reintegration of unemployed into the labour market? Based on the test results we will attempt to express the view that the development of expenditures on the active labour market policy does not follow the development of the unemployment and lag slightly behind. This trend may be traced from Chart 12.

For the second question, whether the development of unemployment depends on the development of expenditures on the active labour market policy, represent the resulting values of the model parameters β0 = 4.389139 and β1 = 3.13 E-06. The coefficient of determination (R-squared) takes the value of 0.407738, meaning that the model explains 40.77% of the variability of the dependent variable. The model implies dependency from which we may assume that if expenditures on the active labour market policy increase by CZK 1,000, the unemployment rate increases by a negligible value. The low value of the Durbin-Watson statistics in the output equals to 0.055187, signalling the presence of autocorrelation in the given model.

Upon attempt to remove autocorrelation from the model the examined statistics improved and the resulting model parameters took values of β0 = -43.29768 and β1 = -2.27 E-06. The model implies an indirect relationship from which we may assume that if expenditures on the active labour market policy increase by CZK 1,000, the unemployment rate falls to negligible values. The model explains 98.83% of the variability of the dependent variable and the remaining approximately 1.17% is attributed to random components.

**Graph 12. Development of expenditures on the ALMP and development of the number of unemployed persons in the Czech Republic**




**Source: Czech Statistical Office, Ministry of Labour and Social Affairs of the Czech Republic, own processing**

When using annual data of the amount of expenditures and upon attempt to remove autocorrelation, the model explains 79.11%. The resulting values of model parameters amount to β0 = 11.37115 and β1 = -3.04 E-07. From the model results we may assume that if expenditures on the active labour market policy increase by CZK 1,000, the unemployment rate falls to negligible values.

Based on the outcomes we may conclude that the unemployment rate almost entirely fails to be determined by expenditures on the active labour market policy.

On the basis of calculated outputs we attempt to address the question of what can cause the different relationship between the development of expenditures on the active labour market policy and the development in the unemployment rate, respectively, the number of unemployed persons within the examined countries.

In pursuit of the indicator of the volume of expenditures on the active labour market policy per one job seeker in accordance with Chart 12, we may note that the pace of change in the amount of expenditures per employee generally corresponds with total expenditures on the active labour market policy. The extreme growth in expenditures per employee even under the situation of a decrease in the number of unemployed in 2009 is likely due to the adoption of fiscal measures to address impacts of the crisis. Since the graphic representation of the development in monitored indicators does not suggest any significant differences in the pace of the development of expenditures on the active labour market policy, we take a look also at the overall volume of expenditures on the labour market policy with respect to the overall budgetary expenditures and their share on the GDP at current prices.

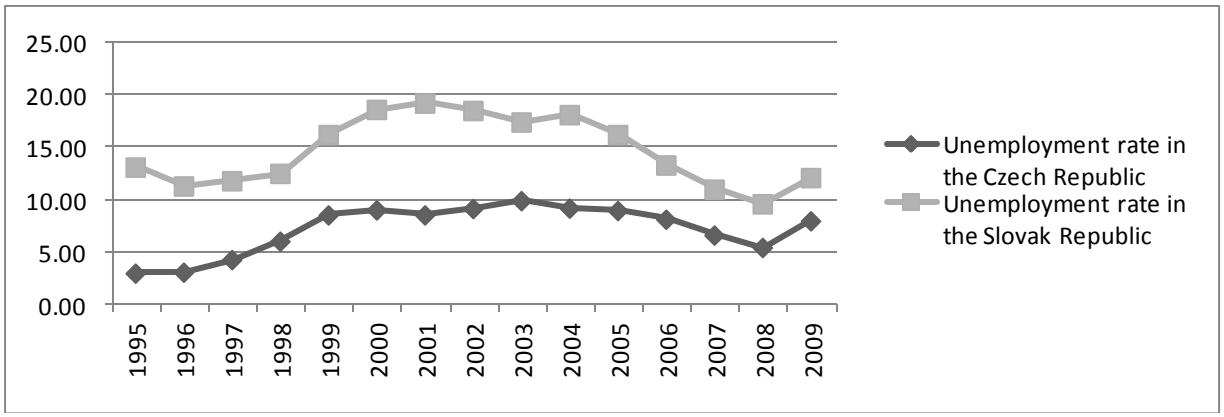
**Table 4 - Share of expenditures on the labour market policy on total expenditures of consolidated public budgets (KVR) and GDP in the Czech Republic**

| | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Share on KVR expenditures (%) | 1.02 | 1.05 | 1.03 | 1.42 | 1.42 |
| Share on GDP at current prices (%) | 0.42 | 0.41 | 0.41 | 0.62 | 0.60 |

**Source: Ministry of Finance of the Czech Republic, Czech Statistical Office, own processing**

In comparison with Table 3, from Table 4 we may conclude that wile during the monitored period the level of expenditures on the labour market policy in the Slovak Republic reached the maximum of 1.19% of the total government budget and 0.49% of the GDP at current prices, in the Czech Republic their share on consolidated public budgets has reached 1.42 % and 0.62% of the GDP at current prices. This means that the weight of expenditures on the labour market policy is in the Czech Republic significantly higher and in a situation, when the Slovak Republic's GDP at current prices stands at about 50% of the GDP at current prices of the Czech Republic only since 2006 and the value of the rate of unemployment is in the Czech Republic typically half as high (see Chart 13).

**Graph 13. Development of the unemployment rate in the Czech Republic and Slovak Republic**




**Source: Statistical Office of the Slovak Republic, Czech Statistical Office, own processing**

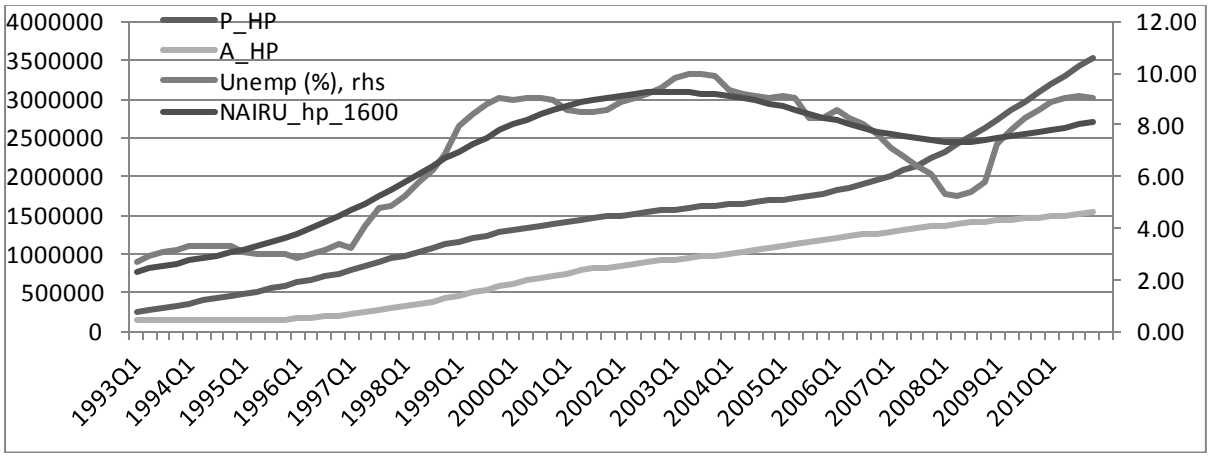
## 4.3. Development of the unemployment rate, public expenditures, NAIRU in the Czech Republic

In order to preserve the balance in information, we show how the monitored variables developed in the Czech Republic with respect to the equilibrium rate of unemployment. We re-estimate NAIRU by applying the Hodrick-Prescott filter with the smoothing parameter $\lambda = 1600$ (Hodrick-Prescott suggested value for the quarterly data) to the time series of the rate of unemployment.

During the monitored period reaches estimated NAIRU its lowest level in the third quarter of 1993 – 2.33% and its highest level in the fourth quarter of 2002 and the first quarter of 2003 – 9.27%. When comparing the actual and equilibrium rates of unemployment, we see that the unemployment

rate is getting below NAIRU in the first quarter of 1995 where it remains until the third quarter of 1998. Below its equilibrium level the unemployment rate gets also in the period from the second and third quarter of 2002, third and fourth quarter of 2005 and during the period from the fourth quarter of 2006 to the first quarter of 2009. The actual unemployment rate has reached its highest level in the third quarter of 2003 when it oscillated 0.72% over the equilibrium level of unemployment.

**Graph 14. Development of expenditures on the PLMP, ALMP, rates of unemployment and NAIRU**




**Source: Czech Statistical Office, Ministry of Labour and Social Affairs of the Czech Republic, own processing**

## *5. Conclusion*

In the chapter 4 we have summarised conclusions from comparison of the development of the rate of unemployment and the development of expenditures on the labour market policy in the Slovak Republic. To verify the findings stated in conclusions, we have double-checked – using the same method – also the dependence of the monitored indicators under the conditions of the Czech Republic. Our assumption that the rate of unemployment (or the number of unemployed persons) in the Slovak Republic does not register a strong, respectively – depending on the chosen variable – almost no dependence on the volume of expenditures used on the active labour market policy due to the low weight of the volume of expenditures on the active labour market policy (and the labour market as such) on the total expenditures of the general government budget and260 the volume of GDP, appears to be possible. In the Czech Republic, where the weight of expenditures on the labour market policy and the level of unemployment is generally half as high, has been the dependence of the monitored indicators confirmed, albeit with almost negligible values.

The conclusions we have reached using comparative analysis may be regarded as assumptions. The issue of the labour market and its financing is a complex system within which there operate many factors affecting the efficiency both in the material and financial terms. Formulation of definitive conclusions thus requires the analysis of many factors that determine the system of the labour market.

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# How to reduce pension system deficits of PAYG pension system in Slovakia?[1]

*Ivan LICHNER*[2]

***Abstract***: As many population forecasts predicted in the upcoming decades demographic transition in Slovakia will lead to inevitable population ageing. This is already approved by the actual development in many west-European countries. Increasing share of older population groups will affect the number of pensioners depending on the pension systems – both private and publicly financed. Focus of this paper will be given to pressures on PAYG[3] pillar of Slovak pension system that is governed by public social insurance company stemming from increased number of pensioners. Thus we will not be modeling effects on the second pillar of Slovak pension system. Aim of this paper is to discuss possible ways of mitigating the increased claims from persons in pension age.

***Keywords:*** PAYG, pension system, social contributions, old-age dependency, economic activity

***JEL classification:*** H68, H83

## 1. Introduction

Demographic changes motivated researchers in different countries to analyse impacts of ageing on the future economic development. Many of them are concentrating on the effects of ageing on the pension systems and public finances. Ageing of population is attributed to the post-war baby-boomer generations in developed countries and very similar process of baby-booming that was experienced by many former post-communist countries in 1970's and early 1980's, which indicates that ageing will be more apparent in these counties with some time lag. Thus also the works on the issue are more often dealing with this phenomenon in developed countries.

In the work of Broer (1999) analysis of effects of ageing on economic growth and distribution of welfare in next century for Netherlands is conducted by using applied general equilibrium model. In this paper overlapping generations model of Auerbach-Kotlikoff (1987) nature modified for small open economy is applied. Two possible reforms of social system are considered: reduction in PAYG benefits and its combination with reduction of indirect tax rates to partially offset for the loss of income of current old generations. The results show that main redistribution impact of ageing will not occur between the current young generations and future generations, but between current young and current middle-aged and old generations (the loss in life time wealth will be 4% for former and 30% for the latter). This is due to the fact that current old generations will evade future inevitable tax and social contributions increment. Author in this paper indicates PAYG social security system as one of the main distortions on economic growth and argues that 10% reduction in PAYG social security system should lead to an aggregate discounted increase of 6% of GDP (between years 2000-2200) and positive redistribution of wealth towards future generations.

The demographic ageing is an issue also in Japan thus there also have been research conducted with respect to it. One of the works dealing with ageing is paper by Ihori et al. (2011)

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[3] Pay as you go

which focuses on analysis of Health Insurance Reform in Japan in 2006 that was partially motivated by aging of population and its impact on sustainability of health insurance program. Medical expenditures for 65+ generations represented more than half of Japan's total medical expenditure in 2006 (Ihori et al., 2011). Authors employ multi-period overlapping generations model developed by Auerbach and Kotlikoff (1983) within general equilibrium framework. Results of this study indicates that analysed reform of Health Insurance does not significantly reduce future medical expenditures and that also preventive care does not largely effect macro-economy even though they decreases future medical expenditures.

Recent work of Lisenkova et al. (2012) has focused on impact of ageing on the labour market in Scotland and with contribution of Merétte applied the OLG-CGE framework to conduct the analysis. More specifically it describes the impact of decline in labour force supply and its ageing on relevant economic indicators. Model framework also enables to introduce age-specific productivity and labour force participation which makes the results of simulations more realistic. Results showed that ageing would result in accumulation of capital as older generations are relatively asset „richer" in comparison to younger generations and this will generate modest increase in output. One of the key findings of his paper is that under current tax rates and per person public spending, public debt would increase from 2,5% of GDP in 2006 to 19% of GDP in 2106. If increase in pension spending is financed by increase in pension contribution rate (increase from 6.8% to 14.7%) the deficit in 2106 would reduce to 14% of GDP which in fact is still not very optimistic and also other measures will need to be implemented.

In Slovakia several authors have examined the impact of ageing on the pension system as very vivid public discussion of changes in the pension system parameters took place over the past decade. Research conducted by EMPA (2007) has analyzed the impact of changes in pension legislation on the economic development and PAYG system deficits. In the work Kvetan and Radvanský (2008) authors analyzed the impact of introduction of two pillar compulsory system on the deficits of PAYG system. Results suggested that under most of the scenarios analyzed two pillar system will lead to lower deficits. Sivák et al. (2011) conducted simulation of future sustainability of PAYG system in and their results indicate that parametric changes in the pension system will not be sufficient to divert the negative impacts of demographic transition in Slovakia. In the study Rievajová et al. (2012) following measures with impact on the pension system sustainability were discussed: increase in contribution rates, changes in retirement age, higher efficiency of contributions collection, decrease contributions to second pillar, valorization mechanism changes. We will try to quantify the impact of selected measures on the PAYG system deficits and identify future changes that should lead to system sustainability.

## 2. Pension system and its determinants

Pension system in Slovakia consists of three main pillars that help to diversify the future risks of not providing adequate pensions in the future. Although second and third pillar are currently voluntary and thus not all of the citizens are involved in them. In the compulsory first PAYG pillar all of the employees and their employers are contributing defined share of the employee gross wage. Eligibility to pension from this pillar is conditional to minimal period of pension contribution (15 years) and achievement of retirement age. Purpose of the old age pension is defined by law[4] as attempt to provide old age income to insured person. Pension ($Pens$) from the first PAYG pillar of Slovak pension system is calculated by following formula:

$$Pens = APWP \times PIP \times CPV \quad (1)$$

where $APWP$ is average personal wage point, $PIP$ represents period of pension insurance and $CPV$ is current pension value at the moment of pension eligibility. From this year to 2016 old age

[4] Slovak National Council Act 461/2004 Coll on social insurance

pensions are yearly increased by same fixed sum and Swiss formula5 with changing weights towards pensioners' households inflation6 is used for calculation of the sum.

Second pillar of Slovak pension system is based on the contributions of insured person to their personal pension accounts. Participation in this pillar is currently voluntary for labour market entrants and they should decide whether they enter up to 35 years of age. Until 2013 all labour market entrants were included in the second pillar and had 2 years for decision to leave this part of the pension system. Financial sources accumulated on the pension accounts are used for investments of insurance companies to different financial assets (bonds, stock index and stocks) in compliance with legislation regulating their activities. Eligibility for the pension from the second pillar is attached with two conditions: retirement age (same as in first pillar) and period of insurance (min. 10 years).

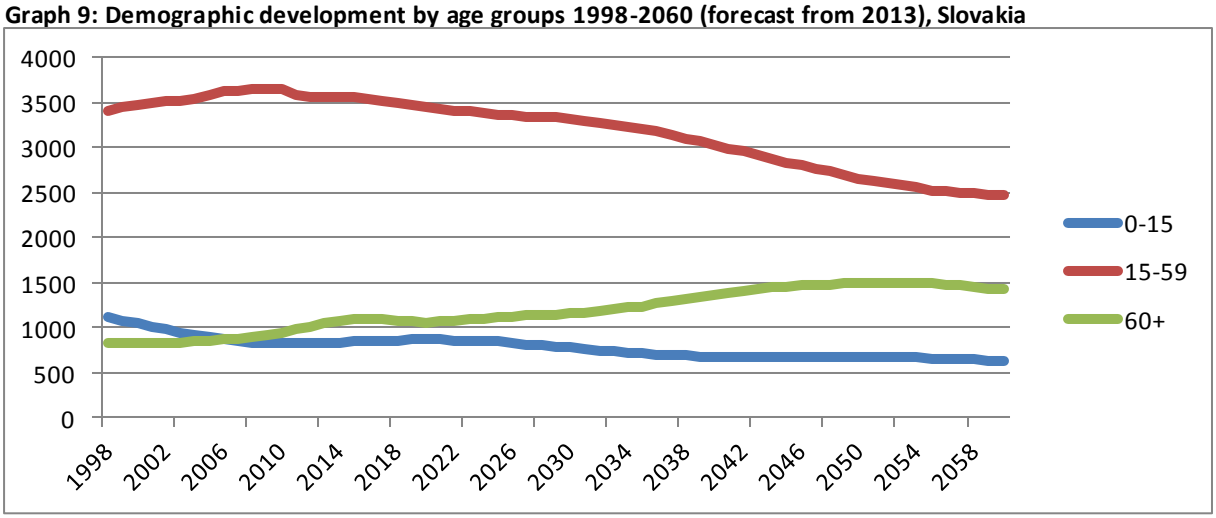
So called third pillar of the Slovak pension system is voluntary and financial source of participants are managed by private insurance companies. Their activities are regulated by the legislation and monitored by national bank. Aim of the third pillar is to provide additional pension income in old age.

In the following part of this paper we will focus mainly on the PAYG first pillar of Slovak pension system and partially also on the second pillar as contributions (employers' and employees') are divided between those two pillars. As main determinants of future sustainability and development of PAYG in Slovakia were identified demographic development, economic activity, wages, inflation, financial markets development and parametric setup of the pension system.

***Demography***

According to Bleha et al. (2013) demographic development in Slovakia will lead to increase of 65+ population by approximately 1 mill. in period 2012-2060. In our analysis we will use the EUROPOP2010 Convergence scenario that shows some significant changes in the demographic structure of population in Slovakia, but is more optimistic on the ageing and thus result should be taken with care. First and most crucial trend is gradual decline in the number of citizens aged 15-59 that represents major part of working population. On the other hand number of people in the pre-retirement and pension age will increase from current level around 1 mill. to approximately 1.5 mill around year 2040 from which it will remain at this high level. These two trends will have significant consequences on the pension system sustainability in the future. Thus it was inevitable to alter the only PAYG system that was in Slovakia to more diversified pension system.

**Graph 9: Demographic development by age groups 1998-2060 (forecast from 2013), Slovakia**




**Source: Slovak Statistical Office (SSO), Eurostat**

[5] Swiss formula: index = 0.5 w + 0.5 i, where w – nominal wages index, i - CPI

[6] From year 2017 pensions indexation will be based solely on "pensioners' households inflation"

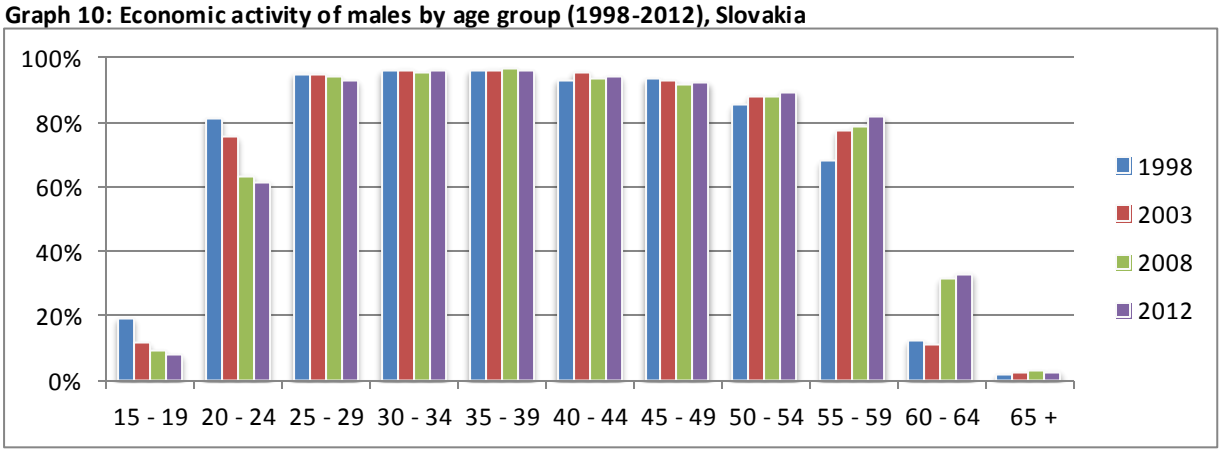
***Economic activity***

Important effect on the contributions to pension system has economic activity of population in working age. In the following paragraphs we will take a closer look on development of economic activity by age and sex. Due to future decline in the number of people in the working age we can expect also decline in the number of active people. Lower number of active people will lead to increased pressures on the companies in attracting the potential employees.

***Males***

Over the past 15 years levels of economic activity changed significantly mainly in the groups of younger population and people in pre-retirement age. Economic activity of men aged 15-24 deceased significantly due to higher motivation to achieve better education and thus those age cohorts were less active on the labour market. Economic activity of men aged 60-64 almost tripled during the same period as result of increased retirement age. Also in the age group 55-59 activity grown from above 60% to more than 80% in high correlation with parametric changes in pension system. Economic activity of men 65 and above remained marginal.

**Graph 10: Economic activity of males by age group (1998-2012), Slovakia**

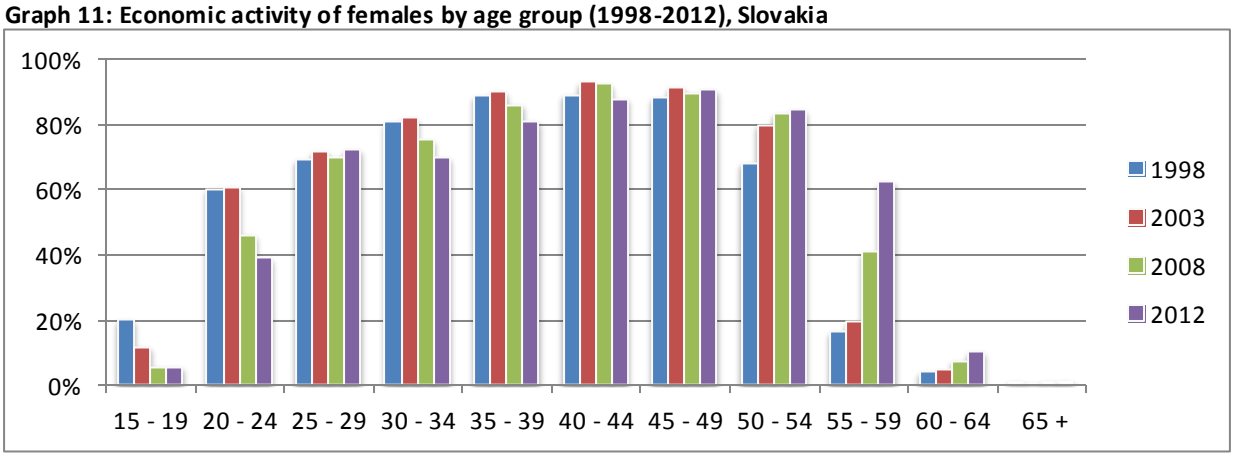



**Source: SSO**

***Females***

Similar trends that were present in males population are observable in the females population. Younger women tend to attain higher education and impact of this trend was even more remarkable for the age groups 15-19 and 20-24 in which drop by 73% respectively 35% occurred. Different situation was on the other end of working age spectrum where economic activity of women aged 55-59 soared by almost 300% from only above 16% in 1998 to more than 62% in 2012. Participation of women above 60 on labour market remained relatively low as result of lower level of retirement for this group. Over next decade retirement age for men and women is set to level on the 62 years of age.

**Graph 11: Economic activity of females by age group (1998-2012), Slovakia**

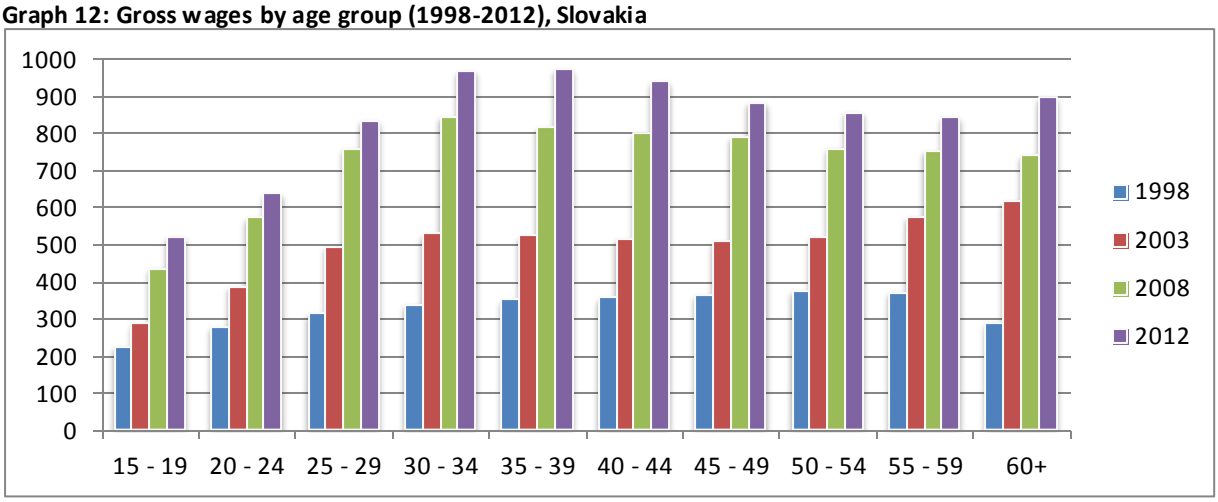



**Source: SSO**

***Wages***

As one of the crucial determinants of pension system sustainability was in Sivák et al. (2011) identified wage levels of pension system contributors. Over the past 15 years wages of employees in all age cohorts increased. Level of wages of labour market entrants is on the lower bound of the wage rates spectrum. This is determined by the fact that those employees lack inevitable work experience. Peak of the wages in 2008 and 2012 is observable in the age group of employees aged 30-39. Persons in this group have gained valuable work experience and their health and personal status are positively influencing their income. Older workers 50-59 were the top earners in years 1998 and 2003 since then most of them retired and they positions were taken by younger cohorts. Wages in last three age cohorts are still on relatively high level as result of that if these cohorts are participating on labour market they are seeking value for their experience.

**Graph 12: Gross wages by age group (1998-2012), Slovakia**

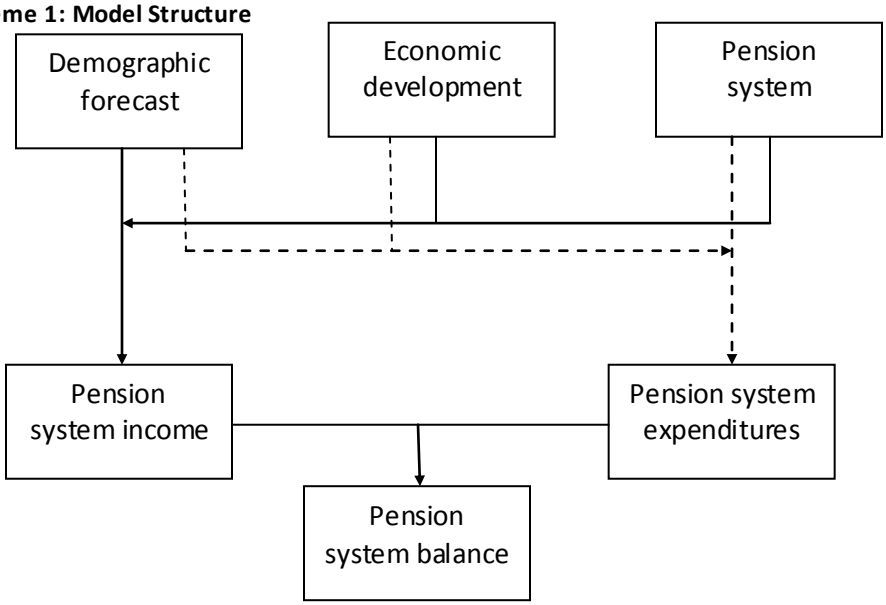



***Source: SSO***

# 3. Methodology

Methodology used for approximation of future development of PAYG system in Slovakia is based on the principles described in Kvetan and Radvanský (2008). Applied model is using actuarial principles to calculate current deficit/surplus[7].

**Scheme 1: Model Structure**




***Source: Authors***

[7] Kvetan and Radvanský (2008)

Model consists of three main blocks: demographic, economic and pension system block. First demographic block provides model with estimation of future population development by 5-year age cohorts to year 2060. In the economic block two main determinants – wages and inflation - of the PAYG system performance are exogenously set. In the pension system block main parametric characteristics are defined. In the following Scheme main influences in the model are depicted.

Demographic development is estimated by 5-years age groups on the basis of EUROPOP2010 Convergence scenario. Our estimations are produced for each year up to 2060. We decided to focus mainly on the parametric changes of the pension system and thus left other available variants of demographic projects out of our interest. In this block of model in line with expected demographic development number of active persons by 5-year age groups was estimated, based on the assumptions that will be discussed bellow. In the next step number of employed by 5-year age group was calculated. For the number of employed we introduced two scenarios: in the first, static one, unemployment rate remained at its current level, in alternative scenario we expected that up to 2020 unemployment rate will decrease to 10% and since then will be slowly converging to level of 5% in 2060. Number of pensioners is also determined within this block of the model as constant share on the number of inactive people aged 60+.

Variables representing economic development and having crucial impact on future PAYG balance – wages and inflation - were in the analysis set on the basis of expert judgment. As starting point we used estimations of future economic development presented in the Kvetan and Radvanský (2008). We've adjusted expected values slightly downwards for wages to 3% growth rate p.a. over the period of outlook in most plausible scenario as result of economic crisis. For inflation measured by CPI we assumed that most likely development is to be around 2% p.a. In alternative scenarios in which we were testing the sensitivity of PAYG system on wages and prices development we assumed following combinations of wage and prices development: (2.5%;1%) and (5%;2%) respectively.

Pension system block was designed to primarily provide response of PAYG pillar income and expenditures on the parametric changes of Slovak pension system. There are several parametric changes that should be applied when adjusting the pension systems: contribution rates, replacement rate (or pensions' indexation) and retirement age. In pension system block scenarios for first two (three) parametric changes were defined. We reflected changes in retirement age in the activity rates by age groups as discussed bellow.

To calculate income of PAYG pillar of pension system ($I$) we used following formula:

$$I^{5y} = w^{5y}.\mathrm{empl}^{5y}.\mathrm{ecr} \quad (2)$$

$$I = \sum_{5y} I^{5y} \quad (3)$$

where $\mathrm{I}^{5y}$ represents income from contributions of 5-years age group of employees, ecr is effective pensions contribution rate, $\mathrm{empl}^{5y}$ represents number of employed people within a 5-years age group and $\mathrm{w}^{5y}$ stands for average nominal wage paid to given 5-years age group.

On the expenditure side of the pension system amount necessary to be paid to pensioners from PAYG pillar of pension system is determined. To estimate the total future expenditures ($E$) following formula was used:

$$E = ap \times PENS\_POP \quad (4)$$

where $ap$ is average pension and $PENS\_POP$ number of pensioners receiving the pension from the PAYG pillar of pension system. Current balance of PAYG system is then calculated simply as difference between estimated income and expenditures of the system:

$$B = I - E \quad (5)$$

We analyzed three different possible scenarios with respect to the contribution rate to analyze impact of this parametric change. In the first scenario we expected that effective contribution rate would remain at its level before the change in the PAYG system in year 2012 – contribution to first pillar 9% of the wage base. Next scenario simulates the effects of increased

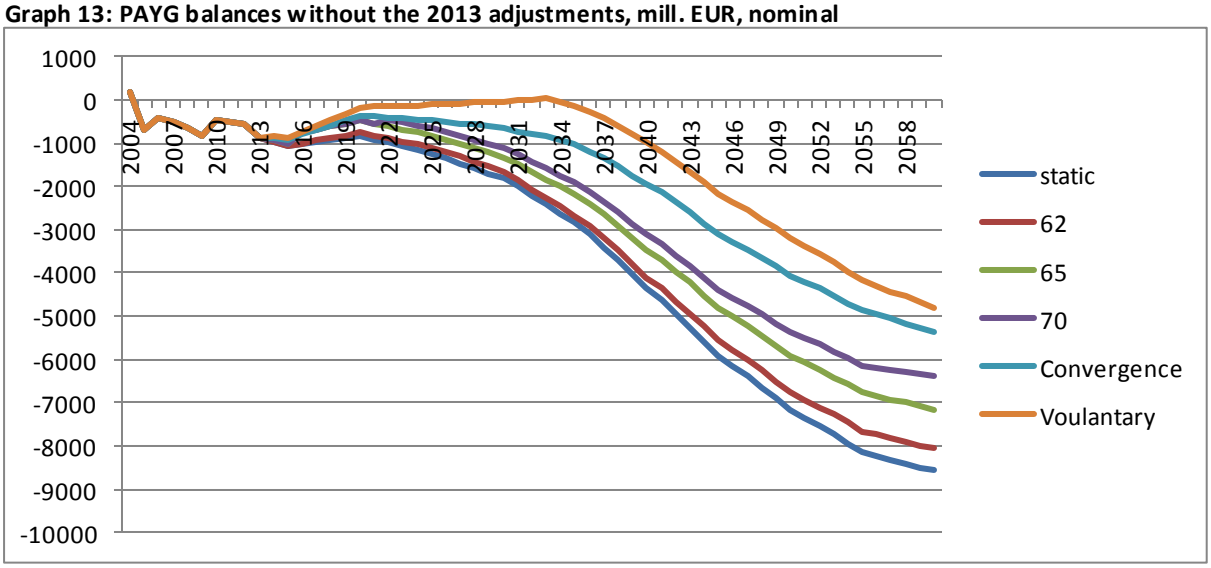
contributions to PAYG – 14% of wage base. And extreme scenario expects the abolition of second pillar of pension system and assumes 18% contribution rate to PAYG pillar. For the changes in the average pension we assumed that current setup will remain unchanged for the whole period of forecast.

We reflected the changes in the retirement age in the different development of the activity rates by 5-years age groups. With respect to the expected development of the activity rates we defined six alternative scenarios. First, static scenario, expects that activity rates of each 5-year group from year 2012 will remain unchanged over the forecasted period. Based on the results of Štefánik and Horvát (2012) next three scenarios were defined. In those scenarios authors calculated activity rates up to year 2033 expecting that retirement age will remain for males and females at 62 years of age after 2011 (Scenario 62), will increase to 65 years (Scenario 65) and increase to 70 years (Scenario 70)[8]. After year 2033 we expected static development and activity rates from year 2033 were used in those scenarios. Two additional scenarios were defined to examine impact of different behavior on the PAYG pillar of pension system. In so called convergence scenario we assumed that activity rate of 5-years group – 60-64 years of age – will be converging to levels of activity of 55-59 in year 2033. Last scenario expects extreme behavior of working age population for males and females. In this scenario to year 2033 activity rates of age groups 25-64 are converging to maximal activity rate of given sex achieved in the past. Thus from year 2033 activity rate of males 25-64 would be 97.1% and 92.8% for females respectively. For younger cohorts we used activity rates of Scenario 65 as we assumed that education will remain important factor influencing activity in the future. In th rest of the paper we will refer to this scenario as Voluntary.

## 4. Results

During the year 2012 intensive discussion on the parametric changes increasing sustainability of PAYG pillar of pension system took place in Slovakia. Current setup of the pension system in 2012 was about to produce high deficits of PAYG system. Thus increased contributions into first pillar of pension system were introduced at the expense of second pillar.

**Graph 13: PAYG balances without the 2013 adjustments, mill. EUR, nominal**




**Source: Authors**

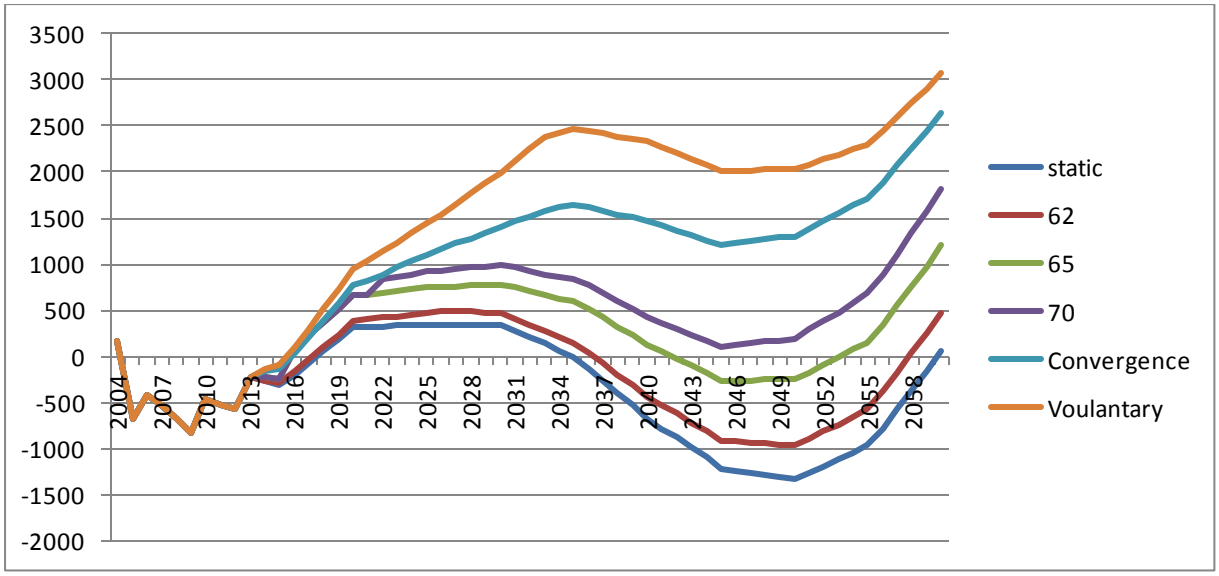
Changes in indexation of pensions that is turning from Swiss formula to its interconnection with so called pensioners' households inflation. Connection between retirement age and life

[8] Štefánik and Horváth (2012)

expectancy will be effective from year 2017. And several additional measures increasing solidarity of the PAYG pillar of pension system, such as: minimal pension, different calculation of average personal wage point etc. Balances of PAYG under different scenarios about the activity rates of population without the adjustments are depicted on the Graph 5. Development of wage and inflation is assumed to be at most plausible values of 3% and 2% respectively. Meanwhile unemployment rate staying at its current level of approximately 13.5%.

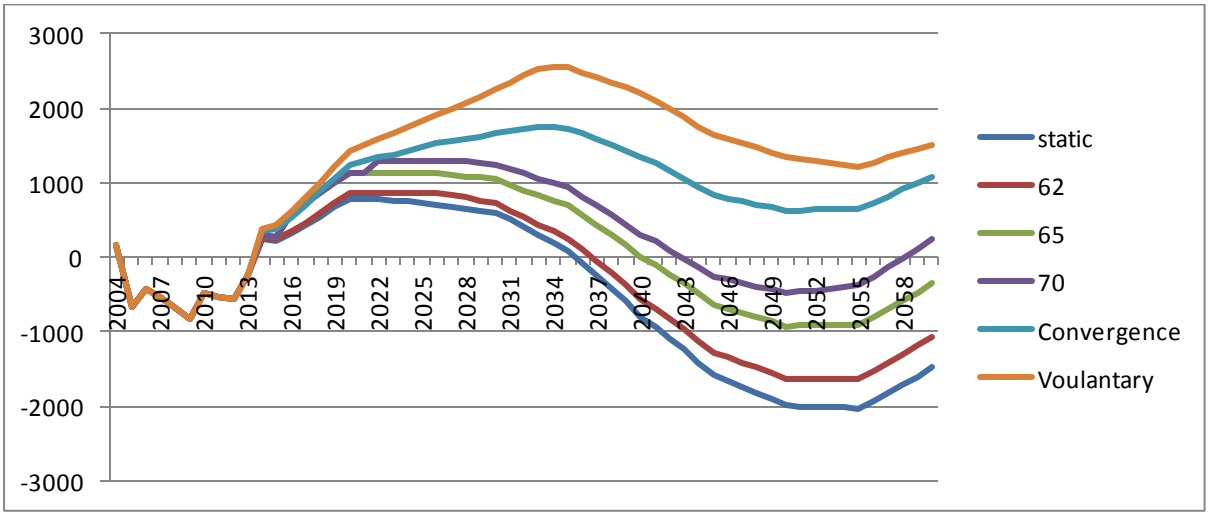
As a result of simulations revealed main deficits should be expected after years 2030-35 depending on scenario. We can see that not even economic activity at levels of voluntary inactivity would change the balances of PAYG system in to surplus. Changes in the PAYG system in the last year would reduce deficits and around year 2019 even though would lead to surpluses for static and 62 scenario that would allow the system to increase the pensions paid. In rest of the scenarios already around year 2015 PAYG system would generate positive balance.

**Graph 14: PAYG balances after the 2013 adjustments, mill. EUR, nominal**




**Source: Authors**

**Graph 15: PAYG balances cancelation of second pillar, mill. EUR, nominal**



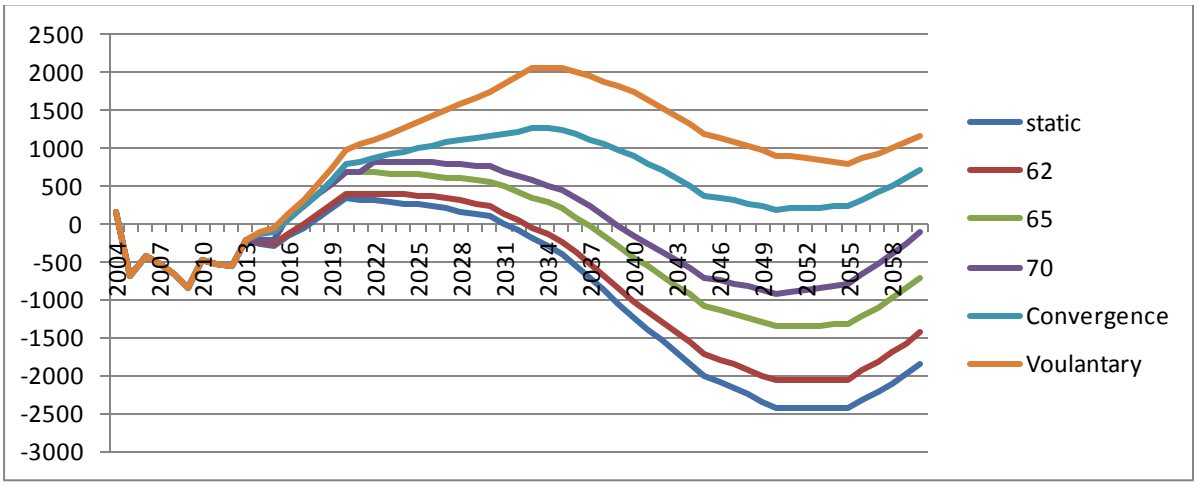

**Source: Authors**

Comparison of the two parametric setups shown that last year changes in PAYG system will increase its sustainability and significantly reduce the deficits – 27.8% - 79.6% average reduction depending on the scenario. Even though that there would be significant reduction of the deficits as

result of parametric changes deficits will still occur. In deal case PAYG system balance would be around 0 and all collected funds should be redistributed to pensioners. In case that PAYG system turn to this case and would not create further budget deficits average pensions need decrease by 5-19% depending on scenario in comparison to pre-reform setup. This would decrease replacement rate of pensions from its current level around 40% to approximately 20%. This indicates necessity of further income in the pension age, either from pension system (second and/or third pillar) or from other source, to maintain at least current level of pensioners' welfare.

In the next step we analyzed possibility of second pillar cancelation which would lead to higher future incomes of PAYG system. It needs to be stressed that we do not favor this possibility as analysis of current setup shown necessity of additional income to PAYG pensions. Results of the simulations support this assumption as increased contribution rate turn PAYG system balance in to permanent surplus only in case of convergence and voluntary scenarios occurrence of which is relatively unlikely. If we applied the 0 balance rule average pensions would increase by approximately 1 – 19%, but would leave the whole burden of future pensions payments on the PAYG system.

**Graph 16: PAYG balances after the 2013 adjustments (decreasing unemployment rate), mill. EUR, nominal**




**Source: Authors**

Fairly similar development to the one presented in case of second pillar cancelation would occur in case of decreasing unemployment rate to level of 10% in 2020 and to approximate level of voluntary unemployment (5%) in 2060. If the current parametric setup was maintained in most scenarios between years 2030-40 after initial surpluses increasing budget deficits would occur. To support sustainability of pension system lower average pension would be paid from the PAYG pension system. This shortage would be replaced by the pensions from second pillar that would remain and provide additional source of income for pensioners in the future. In case the voluntary unemployment occurred then there would be only around 100.000 unemployed at the horizon of the simulations which indicates requirement to adopt further measures aiming at education system.

As it was stressed in Sivák et al. (2011) wages and inflation would significantly influence the performance of PAYG system. To control for this option we developed scenarios with different development of wages and prices. One with relatively higher growth rate of wages (5% p.a.) and modest inflation (2% p.a.) and other with slowly increasing wages (2.5%) and almost flat price growth (1% p.a.). Results of simulations for first combination produced surpluses of PAYG system in all scenarios. Interestingly also for second wage/inflation combination results for contribution rate of 18% (cancelation of second pillar) produced surpluses of the system for all of the scenarios. In case of current contribution rates alternative wage/inflation combination was not producing deficits in case of 70, convergence and voluntary scenario.

## *5. Conclusions*

As results of model simulations shown parametric adjustments of PAYG pension system will not be sufficient to eliminate the deficits. Currently deficits of PAYG system are paid by transfers from other social insurance funds that are in surplus. This method is not sustainable in the long term perspective and will demand further adjustments of the pension system. To maintain sustainability we proposed to adjust the average pension paid from PAYG system with respect to total expected income to level the balance.

Effects of increasing retirement age on the economic activity were taken in to account and two alternative scenarios (convergence and voluntary) were developed. As result shown it will be necessary to implement additional measures to increase the economic activity of people in pre-retirement age to increase the sustainability of the PAYG system. This should postpone the deficits of PAYG system by more than 20 years and provide valuable additional time necessary for further reforms.

Current parametric setup of PAYG system would lead to decreasing old age pensions replacement rate from current 40% to approximately 20% in 2060. Thus additional sources of income for pensioners will be necessary in future to at least maintain current state of the pensioners' welfare. Additional attention will need to be paid to development and maintenance of diversified pension system in Slovakia.

As results shown balance of PAYG system is significantly dependent on the development of wages and prices. If the gap between the wages and prices growth rates is around 2% in favor of wages PAYG system at its current parametric setup is not generating deficits. Higher the gap is the more positive development of PAYG balance surplus occurs and vice versa.

As a result of population ageing shortages on the supply side of labour market are expected. It will be vital not only to increase the participation rates, but also to adjust educational system to provide necessary skills and knowledge.

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# IMPACTS OF AGEING ON PUBLIC FINANCES AND LABOUR MARKETS IN EU REGIONS

## *THEORETICAL MODELS AND EMPIRICAL ANALYSES*

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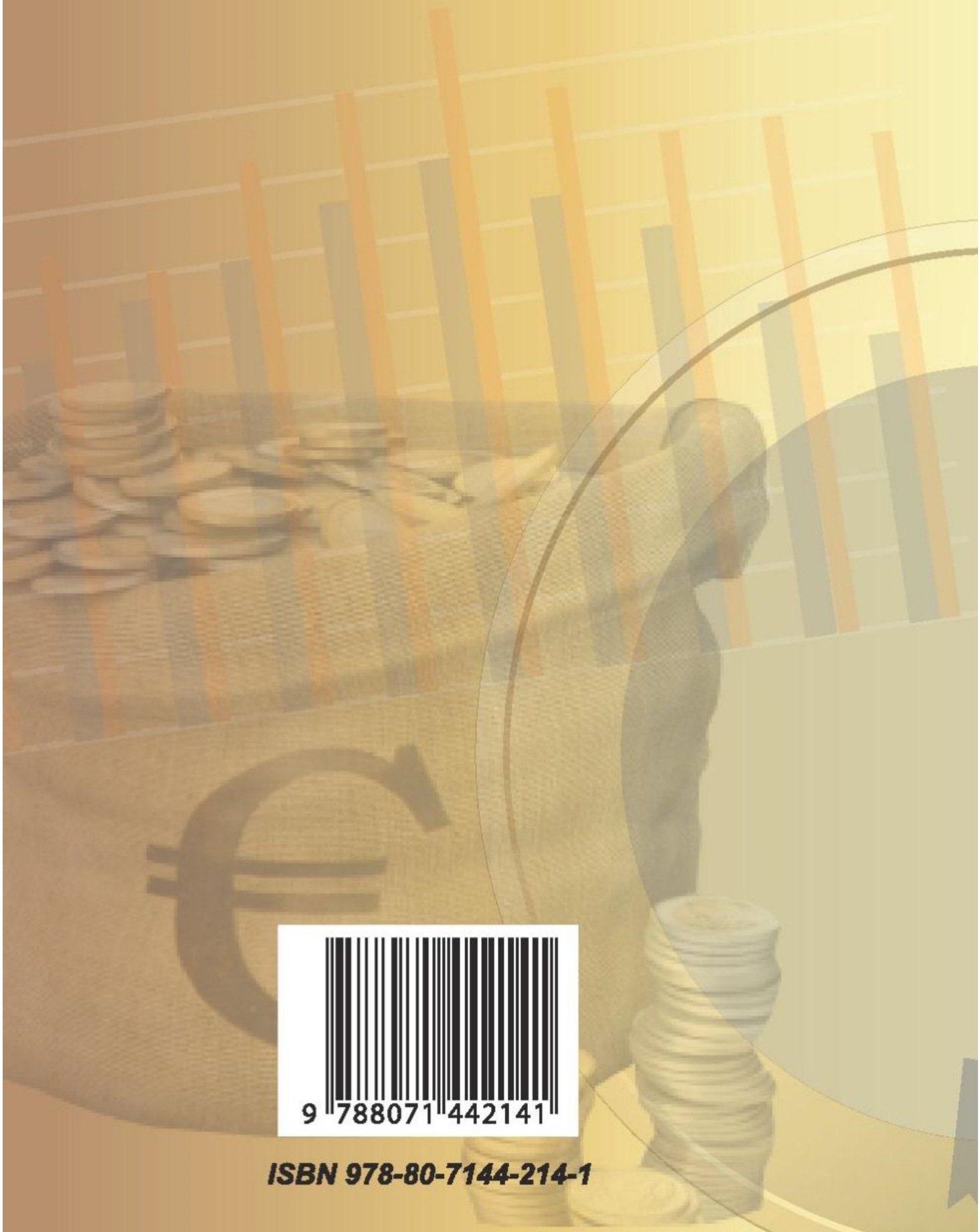


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