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Winners and Losers of Oil Price Volatility in Slovakia

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ABSTRACT

The exposure of households to changes in global oil prices through price transmission mechanisms represents an important topic in relation to possible negative consequences for certain income groups. The results of the previous studies suggest two main possible channels through which the price pass-through could materialize: direct and indirect. Additionally, the asymmetric reaction of local prices to oil price volatility should be expected on the basis of empirical findings from previous research. Interestingly, the impact of the oil prices was not sizeable in the case of 3 service groups: one mainly publicly provided in Slovakia (Health) and two predominantly private-based (Recreation and Culture, and Restaurants and hotels). Our results for the analysed commodity and service categories together with property prices suggest significantly more frequent asymmetric effects, both in the long and short term. Finally, the findings demonstrate the more profound effects of local prices on oil price growth and suggest that the local price level is less responsive to decreases in global oil prices both in the short and long run.

KEYWORDS: price transmission; NARDL model; consumer prices; real estate

JEL CLASSIFICATION: Q410

Slovenskí víťazi a porazení pohybov svetovej ceny ropy

ABSTRAKT

Dopady zmien globálnych cien ropy na domácnosti prostredníctvom mechanizmu prenosu cien predstavuje dôležitú tému v súvislosti s možnými negatívnymi dôsledkami pre určité príjmové skupiny. Výsledky predchádzajúcich štúdií naznačujú dva hlavné možné kanály, prostredníctvom ktorých by sa mohol prejaviť prenos cien: priame a nepriame. Okrem toho na základe empirických zistení z predchádzajúceho výskumu je možné očakávať asymetrické reakcie domácich cien na volatilitu v cenách ropy. Zaujímavé je, že dopad cien ropy nebol výrazný v prípade 3 skupín služieb: jednej prevažne na Slovensku poskytovanej ako verejná služba (zdravotná starostlivosť) a dvoch dominantne privátne poskytovaných (rekreácia a kultúra, a reštaurácie a hotely). Naše výsledky pre analyzované komodity a služby spolu s cenami nehnuteľností naznačujú oveľa častejšie asymetrické efekty, a to tak v krátkodobom, ako aj v dlhodobom horizonte. Nakoniec zistenia ukazujú na výraznejšiu reakciu domácich spotrebiteľských cien na rast cien ropy a naznačujú, že úroveň domácich cien je menej citlivá na poklesy globálnych cien ropy a to tak v krátkodobom, ako aj v dlhodobom horizonte.

KĽÚČOVÉ SLOVÁ: prenos cien; model NARDL; spotrebiteľské ceny; nehnuteľnosti

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Contents

Introduction

We investigate the interactions of global crude oil prices with price formation across goods and services groups in Slovakia. To estimate the power of the oil price and local price relationship, the NARDL methodology with a single threshold is employed.

The relationship between oil prices and economic variables is a well-established area of research, with significant implications for policymakers, companies, consumers and economists (e.g., Meyer & von Cramon-Taubadel, 2004; Oladousu et al., 2018). Within this broad field, the specific transmission of oil price fluctuations to consumption basket categories presents a complex and multifaceted topic. While some categories within the consumption basket, such as transportation and energy, have been extensively investigated owing to their direct and immediate connection to oil prices, other categories have received comparatively less attention.

We contribute to the literature on price transmission in three distinct ways. First, our analysis does not focus solely on a single commodity group; rather, it embraces a more complex approach, and the whole spectrum of the household consumer basket is included. Second, our analysis is enriched by the analysis of the oil–real estate price nexus, as this expenditure category is relatively significant in Slovakia, where more than 93% of households own their residential property. Finally, our results suggest that reactions of local prices are, in the majority of the cases analysed, asymmetric. This holds both for long-term and short-term relationships.

The remainder of the paper is structured as follows. In the next section, the overview of the findings from other studies on the topic are summarized for consumer basket categories. This is followed by a description of the data and the NARDL methodology that is employed to analyse the oil price pass-through. The next section presents the results of the analysis, and the final section concludes and discusses the main findings.

1. Literature review

In many cases, the link between oil prices and individual consumption categories is assumed indirectly, primarily through the general impact of oil prices on overall economic conditions, inflation, and disposable incomes. Direct studies focusing explicitly on the price transmission mechanisms to specific categories within the consumption basket are relatively scarce. This literature review synthesizes the existing research, highlighting areas that have been well explored and identifying gaps where further investigation is needed to understand the nuanced impacts of oil price changes on various components of consumer spending. This section focuses on individual categories in consumption baskets.

1.1. Food products, restaurants and beverages

Baumeister and Kilian (2014) question whether oil price increases lead to higher food prices, concluding that while the relationship is complex, oil price hikes do contribute to rising food product prices, influenced by factors such as biofuel policies. Tahidu, Bilgic, and Aksoy (2017) use a BEKK approach to estimate price volatility transmission between world crude oil and selected food commodities, demonstrating that oil price volatility has a notable effect on the price volatility of food products, which are crucial components of the consumption basket. Roman, Górecka, and Domagała (2020) explore the linkages between crude oil and food prices and find that oil price changes significantly affect food product prices, particularly during economic disruptions, which are critical for consumption structure planning. Uddin, Hernandez, Dutta, Kang, and Yoon (2020) study the impact of food price volatility on the U.S. restaurant sector and highlight that volatility in food product prices within the consumption basket significantly affects the financial performance of restaurants, reflecting broader economic implications. Adeosun, Olayeni, and Ayodele (2021) investigate the oil–food price dynamics in an oil-dependent emerging economy, emphasizing how fluctuations in oil prices significantly impact food product prices within the consumption basket, thus affecting food security. Raza, Guesmi, Belaîd, and Shah (2022) analyse the time–frequency causality and connectedness between oil price shocks and world food prices, revealing that oil price shocks have varying impacts on different food products over time, indicating the interconnectedness of energy and food markets.

1.2. Alcohol and tobacco

Research on the impact of oil prices on the prices of alcoholic beverages and tobacco has demonstrated a limited direct transmission effect. Chen (2009) reported that while oil price changes have a minimal direct effect on these goods, there are indirect effects through increased transportation costs. Espasa and Albacete (2007) support this finding, noting that the overall impact of oil prices on alcoholic beverages and tobacco is relatively minor compared with other categories, largely due to their lower energy dependency. Additionally, Amberger and Fendel (2017) highlight how administered prices, such as regulated prices and taxes, significantly influence inflation dynamics across different euro area countries. This regulatory framework helps mitigate the direct effects of external shocks such as oil price fluctuations, further explaining the limited direct transmission effect on these goods.

1.3. Clothing and footwear

Yoshizaki and Haomori (2014) show that oil price increases significantly affect the prices of clothing and footwear due to higher raw material and transportation costs, which are passed on to consumers. Similarly, Sarwar et al. (2020) reported that in Pakistan, oil price changes have asymmetric effects on nonfood prices, including clothing and footwear, with rising oil prices leading to more rapid cost pass-throughs than falling prices. Zhang et al. (2014) reported that in China, international oil shocks reduce household disposable income, leading to decreased spending on nonessential items such as clothing and footwear, thereby affecting demand and pricing strategies. Mulangu (2015) discussed how external economic factors such as oil prices influence local manufacturing costs and export competitiveness in Ghana, impacting local market prices for goods, including clothing and footwear. These studies collectively underscore the significant and varied impacts of oil price fluctuations on the clothing and footwear sectors globally.

1.4. Housing, water, electricity, gas and other fuels

Recent studies have explored the significant impact of oil prices on the prices of housing, water, and gas, which are essential components of the consumption basket. Álvarez et al. (2011) find that oil price hikes significantly increase consumer price inflation in Spain and the Euro area, particularly in energy-dependent sectors such as housing and utilities, highlighting the direct correlation between oil prices and these essential services. Wheeler et al. (2020) emphasized that oil price spikes exacerbate inflationary pressures by increasing energy and transportation costs, directly impacting the prices of housing, water, and gas and thereby affecting overall living costs. Aloui and Dakhlaoui (2015) noted that the influence of the crude oil market on macroeconomic activity has evolved, with modern integrated energy markets making housing and utility costs more sensitive to oil price volatility, unlike in the 1970s. Gelos and Ustyugova (2017) discuss the differing inflation responses to commodity price shocks across countries, attributing variations to the degree of energy dependency and economic structure, which impacts essential consumption categories such as housing and utilities differently. Fratzscher et al. (2014) analyse the interplay between oil prices, exchange rates, and asset prices, showing that oil price fluctuations can significantly alter the cost of living by impacting the prices of housing, water, and gas through complex economic channels.

1.5. Furnishings, household equipment and routine maintenance of the house

Xuan and ChIn (2015) demonstrated that oil price increases lead to higher consumer prices for household furnishings and equipment due to the pass-through effect, where increased production and transportation costs are transferred to consumers. Fukunaga et al. (2011) find that industries reliant on oil, such as those producing household goods, face significant cost increases, which subsequently increase consumer prices, highlighting the broader industrial impact of oil prices on consumer goods. Herrera et al. (2011) revealed that oil price hikes result in increased costs for producing household equipment and maintenance services, contributing to higher prices for these goods in the consumer market. Alsalman and Karaki (2019) noted that oil supply shocks particularly lead to higher prices for household goods and services, thus impacting overall household expenditure patterns. Finally, Bednář et al. (2022) discuss how rising energy prices create an inflationary spiral, significantly impacting the costs associated with furnishings and household maintenance owing to increased energy costs in production and service delivery.

1.6. Health

Lindblom (2023) discussed the inflationary effects of oil price changes on both advanced and developing economies and noted that rising oil prices contribute to higher healthcare costs because of increased energy expenses for medical facilities and the production of healthcare-related goods. Choi et al. (2018) provide evidence from various economies on how oil prices affect inflation dynamics, highlighting that healthcare prices are significantly impacted as oil price increases, leading to higher costs for energy-intensive medical services and the production of pharmaceutical products. Cao et al. (2024) explore the influence of oil price shocks on inflation in G20 countries, showing that these shocks can drive overall inflation, including in the healthcare sector, as increased operational and transportation costs in healthcare facilities are passed on to consumers. Baumeister and Peersman (2013) examine the role of time-varying price elasticities in the crude oil market and find that volatility in oil prices can lead to significant changes in healthcare costs, as higher oil prices increase the costs of medical supplies and transportation, subsequently increasing healthcare service prices. Kilian and Zhou (2020) present a new model linking oil prices, gasoline prices, and inflation expectations, demonstrating that expectations of higher oil prices can lead to preemptive increases in healthcare prices as providers anticipate rising costs and adjust their pricing strategies accordingly. These studies collectively emphasize the impact of oil price fluctuations on healthcare costs, affecting overall inflation and the affordability of medical services, especially medical drugs.

1.7. Transportation

Buljan and Badovinac (2023) analyse the impact of the 2021--2022 energy shock on transport service prices across EU countries, revealing that higher energy prices led to substantial increases in transportation costs for consumers, directly contributing to inflationary pressures within the EU. Groß, Hayden, and Butz (2012) discuss how rising oil prices affect logistics networks and transportation greenhouse gas emissions, indicating that higher oil prices not only increase transportation costs but also have environmental implications, further influencing the overall cost structure of transport services. Dillon et al. (2013) examine the pass-through effect of global oil prices on local maize prices in East Africa and find that transportation costs play a critical role in this transmission, as higher oil prices increase the cost of transporting goods, thereby affecting local prices. Dillon and Barrett (2016) find that global oil price fluctuations significantly influence local food prices in East Africa through increased transportation costs, which are a direct result of higher fuel prices, emphasizing the interconnectedness of global oil markets and local economies.

1.8. Recreation and culture

Huang, Silva, and Hassani (2018) examine the causality between oil prices and local tourism and find that higher oil prices reduce the number of tourist arrivals due to increased travel costs, which ultimately increases the overall cost of tourism. Hadi (2023) further demonstrated that oil price shocks significantly affect tourism stock prices globally, indicating that higher oil prices lead to increased costs for travel and accommodation, thereby increasing overall tourism prices. Kisswani, Zaitouni, and Moufakkir (2020) find that oil prices have an asymmetric effect on tourism receipts, with price increases having a more substantial negative impact on tourism income than price decreases do, reflecting higher operational and travel costs passed on to consumers. Kisswani and Harraf (2021) explored the asymmetric impact of oil price shocks on tourism in selected MENA countries and reported that rising oil prices increase travel costs, which in turn increase the prices of tourism services and decrease tourism demand. Hesami et al. (2020) discuss the implications of oil price fluctuations for tourism receipts in oil-exporting countries, noting that increased oil prices lead to higher costs for tourism services, which are reflected in higher prices for tourists and reduced tourism revenues. Awan et al. (2023) conduct a bibliometric analysis on fuel price fluctuations and tourism, highlighting that sustainable development in tourism is challenged by volatile oil prices, which increase transportation and operational costs, thereby increasing tourism prices.

1.9. Education

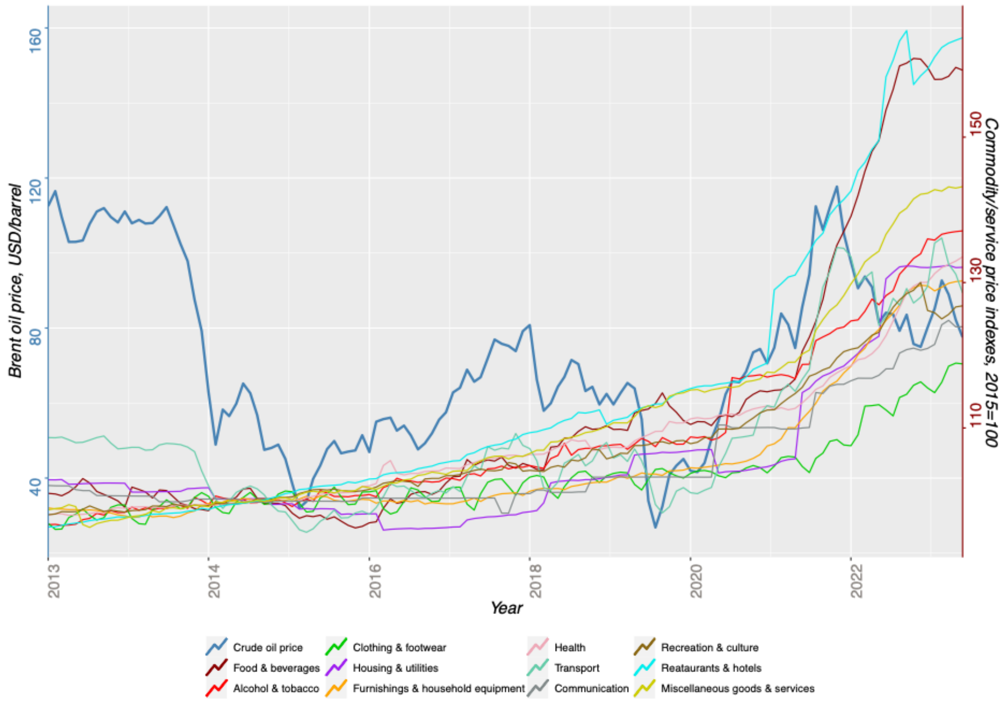
Widarjono and Hakim (2019) examine the asymmetric pass-through of oil prices to disaggregated consumer prices in Indonesia and find that rising oil prices significantly increase transportation and operational costs for educational institutions, which in turn increases tuition fees and other education-related expenses. Hernández (2016) explored the broader socioeconomic effects of oil price booms and noted that while oil price increases can fuel economic growth, they can also lead to higher educational costs, as resources are reallocated to more immediate, profit-driven sectors. Farzanegan and Thum (2017) provide evidence that increased oil revenues can lead to a lower quality of education in oil-rich countries, suggesting that higher oil prices divert resources away from education, thereby increasing the cost of private education services as public education quality deteriorates. Brueckner and Gradstein (2016) analyse the relationship between international oil price shocks and income, showing that higher oil prices can reduce household disposable income, leading to increased reliance on private education and higher associated costs. Balza et al. (2021) discuss the local human capital costs of oil exploitation, highlighting that areas with intensive oil activities often experience higher costs for goods and services, including education, owing to the increased demand and reduced supply of skilled labour.

2. Methodology

2.1. Data

To analyse the effect of global crude oil prices on domestic commodity (service) prices, we employ monthly observations spanning from January 2013 to December 2023. Commodity (service) prices are measured by consumer price indices for 12 main group categories. They are sourced from the Statistical Office of the Slovak Republic (*DATAcube database, 2024*). The global oil prices are the U.S. dollar prices per Brent Crude barrel obtained from the Federal Reserve Bank of St. Louis (*Federal Reserve Economic Data (FRED), 2024*). All the variables have been log-transformed to obtain more robust and consistent results.

Figure 1 Development of oil and commodity/service consumer prices, January 2013--December 2023, monthly



2.2. Methods

We start our research with preliminary tests to identify time series properties and detect that none of the variables are greater than I(1). First, we perform unit root tests for each of the time series of logarithmic variables, namely, the sieve bootstrap ADF test (Smeekes, 2013). Classical unit root tests, such as the ADF test (Dickey and Fuller, 1981), rely on asymptotic inferences and suffer from potential size distortions. For this reason, bootstrap unit root tests have become a commonly used alternative to asymptotic inference (Smeekes and Wilms, 2022). The bootstrap approximates the exact distribution of the test statistic by repeatedly drawing new samples from the original sample, thus capturing the features of the price series. The optimal lag order is determined in accordance with the Bayesian information criterion (BIC).

To analyse the relationships between domestic commodity prices and global oil prices, we apply the nonlinear autoregressive distributed lag (NARDL) model introduced by Shin et al. (2014). The NARDLs have resulted from linear ARDL models developed by Shin and Pesaran (1999) and Pesaran et al. (2001). The NARDL is an extension of the ARDL in such a way that it allows the modelling of asymmetric effects. The nonlinear version of the model has several advantages over widely used empirical techniques such as the VAR and VECM approaches. First, the model is estimable by ordinary least squares, and reliable long-run inference can be achieved by bounds testing regardless of the integration orders of the variables (in contrast to ECMs, which impose the assumption that all regressors should be integrated of the same order). However, NARDLs are not applicable if the regressors are I(2) or higher since the presence of I(2) variables renders the computed F statistic for testing cointegration invalid (Meyer et al., 2018). Second, it allows the joint modelling of asymmetries and cointegration dynamics. Third, the model performs better than other cointegration techniques in the case of a small sample size (Sek, 2019).

Following Shin et al. (2014), we decompose the exogenous variable (oil price) into partial sums of positive and negative changes, which can be defined as follows:

$$O_t^+ = \sum_{j=1}^{t} \Delta O_j^+ = \sum_{j=1}^{t} \max(\Delta O_j, 0)$$
$$O_t^- = \sum_{j=1}^{t} \Delta O_j^- = \sum_{j=1}^{t} \min(\Delta O_j, 0) \qquad (1)$$

where O_t^+ and O_t^- are the partial sums of positive and negative changes in oil prices (O_t), respectively.

On the basis of Equation (1), the traditional ARDL model of Pesaran et al. (2001) can be extended to analyse asymmetric effects and rewritten in unrestricted error correction form (Shin et al., 2014):

$$\Delta C_t = \beta_0 + \beta_1 C_{t-1} + \beta_2 O_{t-1}^+ + \beta_3 O_{t-1}^- +$$
$$+ \sum_{j=1}^{k} \beta_{4_j} \Delta C_{t-j} + \sum_{j=1}^{p} (\varphi_j^+ \Delta O_{t-j}^+ + \varphi_j^- \Delta O_{t-j}^-) + \upsilon_t \qquad (2)$$

where C_t is the commodity (service) price index at the consumer level (proxy for original prices); β_0 is an intercept; O_t is the s pot oil price; Δ denotes the difference operator; *k, m, n, and p* are lag orders; β_1, β_2, and β_3 are long-run parameters; β_4 and φ^+, φ^- are short-run parameters; $\sum_{j=0}^{p} \varphi_j^+$ measures the short-run effect of Brent oil price increases on the commodity (service) price; $\sum_{j=0}^{p} \varphi_j^-$ determines the short-run impact of oil price reduction on the commodity (service) price; and υ_t is a vector of i.i.d. random errors.

To fit the regression model, we use an OLS estimator. As a next step, the null of no cointegration among interesting variables is tested ($H_0: \beta_1 = \beta_2 = \beta_3 = 0$) via the 'bounds-testing' approach (Pesaran et al., 2001; Shin et al., 2014). After cointegration assessment, the Wald test is applied to analyse the long-term ($H_0: \beta_2 = \beta_3$) and short-term ($\sum_{q=0}^{p} \varphi_q^+ = \sum_{q=0}^{p} \varphi_q^-$) asymmetries between the pair of prices. Equation (2) reveals a symmetric (asymmetric) long-term Brent price transmission to the commodity price (in the event of oil price increases, it leads to large (small) fluctuations in the commodity price in comparison with the commodity price effect of Brent price reductions of the same magnitude; i.e., $\beta_2 > \beta_3$ or $\beta_2 < \beta_3$).

3. Results

3.1. Commodity and services subgroups and oil–price development connections

In accordance with the analytical strategy defined above in this research, we investigate the asymmetric links between oil and various commodity (service) prices as a control variable and utilize the industrial production index (to capture the effects of overall economic activity in the country). In other words, we plan to run regressions with 2 variables.

Initially, the stationarity of the logged transformation of the time series of interest was tested, and the results of the stationarity tests (bootstrapping ADF) indicated that all the variables are I(1). The only exception was the results of the price developments of second-order education services (i.e., I(2)). This variable was thus not included in the further analysis under the NARDL approach because of the violation of the underlying assumption.

In the next step of the procedure leading to the application of the NARDL approach, cointegration between the logged oil price and commodity/services price indices was tested to identify possible long-run relationships. Among the 11 remaining commodity groups for which only eight cointegrations were identified, those are further used in the analysis. Health, recreation, culture, restaurants and hotels are not included.

Table 1 Bounds test of cointegration

Model	**F-statistic**	**Critical values (k=2)**		**Conclusion**
		I (0)	**I (1)**	
Food & Beverages	7.969	3.79	4.85	Cointegration
Alcohol & Tobacco	4.78	3.79	4.85	Cointegration
Clothing & footwear	16.31	3.79	4.85	Cointegration
Housing & utilities	5.63	3.79	4.85	Cointegration
Furnishings & household equipment	3.96	3.79	4.85	Cointegration
Health	3.43	3.79	4.85	No Cointegration
Communication	5.51	3.79	4.85	Cointegration
Recreation & Culture	3.42	3.79	4.85	No Cointegration
Restaurants & hotels	2.701	3.79	4.85	No Cointegration
Transport	7.887	3.79	4.85	Cointegration
Miscellaneous goods & services	19.495	3.79	4.85	Cointegration

Note: *The asymptotic critical values are obtained from Pesaran* et al. *(2001) for an unrestricted intercept and no trend (the number of long-term regressors equals 2).*

Below, we present the results of NARDL (Shin et al, 2014) for cointegrated variables in error correction terms representation. To obtain the NARDL specification with lags, we used a backwards elimination technique with a threshold of p value =0.05. As our analysis is based on monthly data, we initially set the NARDL specification with a maximum lag of 12. To obtain the results, the R function "ols_step_backward_p" of the package "olsrr" was applied. We eliminated nonsignificant variables to reduce the noise and imprecision of the estimates (Katrakilidis and Trachanas, 2012).

For the commodity groups with the indicated long-run relationships in Table 1, we tested long- and short-run asymmetry. The null hypothesis of the Wald test–symmetric relation–was rejected for 5 commodity groups (food and beverages, housing and utilities, communication, transport and miscellaneous goods and services). The results of the short-term asymmetry tests revealed symmetric reactions to oil price changes in the case of two commodities—clothing and footwear—and transport. Occurrences of asymmetric reactions to oil price changes are slightly more frequent in the short term than in the long term.

Table 2 Long-run and short-run asymmetry tests

Commodity	W_{LR}	W_{SR}
Food & Beverages	13.491 [0.000] - asymmetry	9.571 [0.003] - asymmetry
Alcohol & Tobacco	1.39 [0.000] - symmetry	NA^{+}
Clothing & footwear	0.396 [0.531] - symmetry	0.5 [0.481] - symmetry
Housing & utilities	9.86 [0.002] - asymmetry	NA^{+}
Furnishings & household equipment	2.36 [0.128] - symmetry	NA^{+}
Communication	8.501 [0.004] - asymmetry	24.013 [0.000] - asymmetry
Transport	13.249 [0.000] - asymmetry	1.05 [0.307] - symmetry
Miscellaneous goods & services	15.112 [0.000] - asymmetry	NA^{-}

Note: *W_{LR} and W_{SR} refer to Wald statistics. The results in brackets are p values. NA refers to the inability of the Wald test statistic and subscripts + and – indicate that only positive or negative changes were significant for a given commodity group*.

The results of the NARDL estimations presented in Table 3 for the long-run relationship between oil price changes and commodity/service consumer prices in Slovakia are uniformly positive and significant. The only exception is the alcohol and tobacco commodity group, which is positive but not significant. This result indicates that other factors, such as local taxation policies related to alcoholic drinks and tobacco consumption, are more influential.[1]

[1] Additionally, the statistical tests for this commodity group indicated the presence of heteroscedasticity which might be the partial source of insignificance of the long-term relation.

Table 3 NARDL estimation of the impact of oil prices on various commodity/service groups[2]

	Food & Beverages	*Alcohol & Tobacco*	*Clothing & footwear*	*Housing & utilities*	*Furnishings & household equipment*	*Communication*	*Transport*	*Miscellaneous goods & services*
				Long-term coefficients				
Constant	0.198***	0.018	-0.330**	0.163*	0.068*	0.271**	0.571***	0.119**
	(0.062)	(0.12)	(0.157)	(0.083)	(0.038)	(0.116)	(0.015)	(0.047)
C_{t-1}	-0.043***	-0.004	0.073**	-0.035*	-0.015*	-0.059**	-0.121***	-0.026**
	(0.013)	(0.026)	(0.034)	(0.018)	(0.008)	(0.025)	(0.033)	(0.010)
Oil^{+}_{t-1}	0.017***	0.005	0.0078***	0.011***	0.0038***	0.011***	0.035***	0.008***
	(0.003)	(0.003)	(0.002)	(0.003)	(0.001)	(0.003)	(0.007)	(0.001)
Oil^{-}_{t-1}	0.012***	0.003	0.0073***	0.007*	0.0031***	0.008***	0.029***	0.005***
	(0.003)	(0.002)	(0.002)	(0.021)	(0.001)	(0.002)	(0.006)	(0.001)
				Short-term coefficients				
ΔC_{t-1}	-0.305***	-0.305***	-0.273***					
	(0.089)	(0.089)	(0.100)					
ΔC_{t-2}			-0.274***		0.289***			
			(0.088)		(0.083)			
ΔC_{t-3}			-0.327***		0.235***			
			(0.082)		(0.084)			
ΔC_{t-4}			-0.482***					
			(0.081)					
ΔC_{t-5}			-0.278***					
			(0.098)					
ΔC_{t-6}	-0.195**				0.214**			
	(0.090)				(0.097)			
ΔC_{t-8}	0.285***	-0.187**	-0.342***				-0.211***	
	(0.090)	(0.085)	(0.087)				(0.073)	
ΔC_{t-9}		-0.248***	-0.354***					
		(0.086)	(0.088)					
ΔOil^{+}_{t}				0.05**		0.037**	0.065**	
				(0.021)		(0.015)	(0.026)	
ΔOil^{+}_{t-1}			-0.030**	-0.059***	0.015**		0.076***	
			(0.013)	(0.020)	(0.006)		(0.023)	
ΔOil^{+}_{t-6}					0.016**			
					(0.006)			
ΔOil^{+}_{t-7}		-0.032**						
		(0.014)						
ΔOil^{+}_{t-9}		0.046***						
		(0.015)						
ΔOil^{+}_{t-10}		0.046***						
		(0.016)						
ΔOil^{+}_{t-11}	0.037**							
	(0.015)							
ΔOil^{-}_{t}	0.027**						0.073***	

[2] The variable *C* denotes the logged development of the variable of interest (commodity/service subgroup price) and *Oil* refers to the logged development of global oil prices.

	(0.011)						(0.016)	
ΔOil^{-}_{t-1}	-0.027**							
	(0.013)							
ΔOil^{-}_{t-2}	-0.033***							-0.012**
	(0.012)							(0.005)
ΔOil^{-}_{t-3}			-0.022**					-0.013**
			(0.009)					(0.005)
ΔOil^{-}_{t-10}						-0.053***		
						(0.010)		

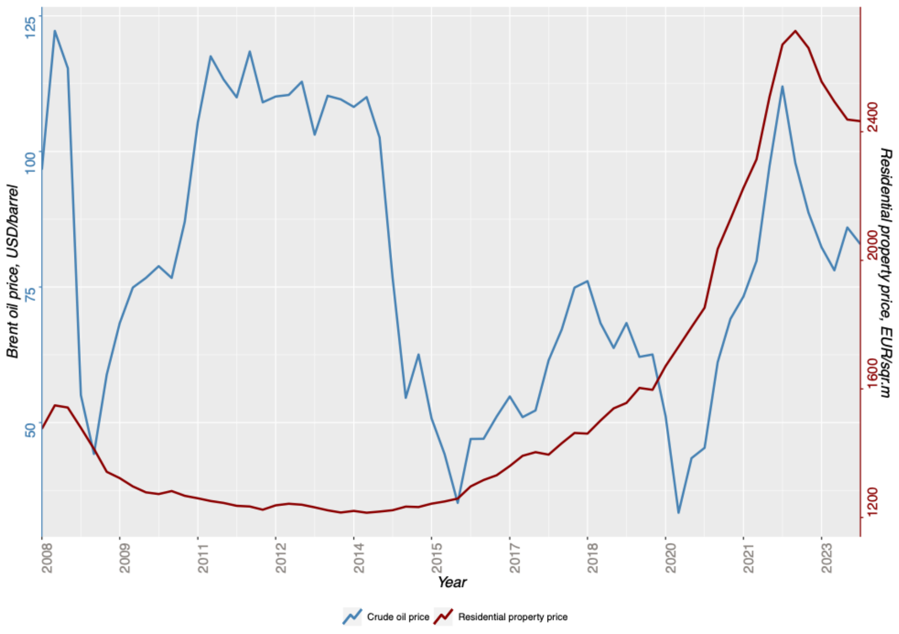
The long-term multipliers suggest that a 10% increase in global oil prices leads to a 0.46–2.04% annualized increase in local commodity/service price development. On the other hand, decreases in the Brent oil price translate in the long run to annualized decreases in the local price indices in the range of 0.36–3.48%. The resulting price pass-through effects are relatively limited between local prices and the development of global oil prices and suggest possibly more intensive responses in the short run.

The second panel of Table 3 presents the short-term effects of the Brent oil price on local consumer commodity/service prices. The results of the analysis suggest that increased oil prices (ΔOil^{+}_{t}) cause instant growth in Housing and Utilities, Communication and Transportation consumer local prices (0.05, 0.037 and 0.065, respectively). Only in the Housing and Utilities consumer basket group is there evidence for a counterbalancing impact, with a lag of one month (ΔOil^{+}_{t-1}) of relatively similar size of -0.059. In the case of transportation prices, a short-term response to an oil price decrease (ΔOil^{-}_{t}) off-setting of price increases in the case of oil price growth is suggested by a coefficient of 0.078. This also reflects the results of the short-run Wald, which indicated the symmetry for this commodity/services group. Although short-run asymmetry was only indicated for the Food and Beverages and Communication commodity, almost all the commodity groups had significant positive short-run coefficients (with the exception of the Miscellaneous goods and services group). Decreases in global oil prices influence only commodities with the indicated short-run symmetry presented in Table 2 and food and beverages together with miscellaneous goods and services groups in the short run. The results suggest a more elastic response of local consumer prices to oil price increases, as in the case of decreasing global crude oil price levels. Thus, Slovak households are more exposed to price changes in times of increasing global crude oil prices.

3.2. Oil real estate price analysis

Another important area of interest for households is the prices of housing properties. This is even more profound in Slovakia, where more than 93% of households reside in flats or houses with their own property (Eurostat, 2024). To analyse the interconnection between oil prices and residential property prices, we utilized quarterly data from the National Bank of Slovakia macroeconomic database for the period of 2008--2023. These data are combined with crude oil quarterly data from the same data source that was used in the previous analysis (*FRED, 2024*).

Figure 2 Development of property and Brent oil prices 2008--2023, quarterly



As in the case of consumption, commodity and service categories above the analytical process followed the same methodological steps and first tested the stationarity of our time series. The results of the bootstrap version of the ADF test indicate that all the variables are integrated in the first order, i.e., I(1). As underlying statistical preconditions for the application of the NARDL methodology, the long-term cointegration of property real estate prices and Brent oil prices was tested. The results of the cointegration test are provided in Table 4 and indicate the cointegration of our variables of interest. In other words, the additional conditions for the application of the NARDL approach were satisfied.

Table 4 Bounds test of cointegration

Model	**F-statistic**	**Critical values (k=2)**		**Conclusion**
		I (0)	**I (1)**	
Residential property price	4.49	3.79	4.85	Cointegration

Note: *The asymptotic critical values are obtained from Pesaran* et al. *(2001) for an unrestricted intercept and no trend (the number of long-term regressors equals 2).*

Applying the Wald test, we identified asymmetry in the long- and short-run relationships between oil and real estate prices. In the case of both tests, the null hypothesis was rejected. The F statistic for long-term asymmetry was 9.475, and in the short-term case, it was 14.346, both of which are significant at the 1% level.

Table 5 suggest that in the log-term, only an increase in global oil prices significantly affects local real estate prices,[3] and a one percent increase in oil prices causes a 0.5% annualized

[3] Although, only on the 5% level of significance.

increase in the property price level. This partially reflects the overall increase in real estate prices in Slovakia during the period under analysis.

Table 5 NARDL model estimates – property real estate and Brent oil prices

	Long-term coefficient		*Short-term coefficient*
Constant	0.773*** (0.257)	ΔC_{t-1}	0.485*** (0.093)
C_{t-1}	-0.117*** (0.038)	ΔOil^{+}_{t}	0.197*** (0.039)
Oil^{+}_{t-1}	0.042** (0.020)	ΔOil^{-}_{t}	-0.088*** (0.027)
Oil^{-}_{t-1}	0.005 (0.009)	ΔOil^{-}_{t-1}	0.071** (0.026)

From a short-term perspective, contemporaneous price adjustments of real estate prices to oil price volatility are significantly more pronounced. The coefficients of the immediate reaction of real estate prices to oil price increases (ΔOil^{+}_{t} *and* ΔOil^{-}_{t}) of 0.197 and -0.088, respectively, correspond with the results of short-term asymmetry indicated by the Wald test. The contemporaneous negative reactions of the oil price decrease are compounded by a positive reaction with lag 1 (ΔOil^{-}_{t-1}) to this development of 0.071. The partial explanation of this lagged reaction is the adjustment time of the indirect construction work and input prices.

Conclusions and Discussion

This paper presents an analysis of the global oil prices measured by Brent oil prices and local consumer prices and property price pass-throughs and asymmetrical reactions of those groups to the data for the Slovak Republic. For the 12 commodity/service categories, it was not possible to utilize the NARDL methodology in 4 cases. The development of the education services prices was integrated of second order (i.e., I(2)) and was not included because of the violation of the underlying statistical assumption. Among the 11 remaining commodity groups for which only eight cointegrations were identified, those are further used in the analysis. The Health, Recreation and Culture and Restaurants and Hotels categories were not included, as no cointegration was identified between their respective prices and Brent oil price.

The asymmetric reactions to oil price developments in the long run were identified for 5 commodity groups (Food and Beverages, Housing and Utilities, Communication, Transport and Miscellaneous goods and services). On the other hand, short-term symmetric effects of an oil price change on local consumer prices were found for two commodities—clothing and footwear—and transport. Occurrences of asymmetric reactions to oil price changes are slightly more frequent in the short term (6) than in the long term (5).

The long-term coefficients for all the analysed commodity and service categories were positive and significant, with the exception of alcoholic beverages and tobacco. In the case of this commodity group, the other factors have a more significant influence in the long run. The long-term reactions of local consumer basket categories to increases in global oil prices are rather heterogeneous, ranging between 0.4 and 2.04% on an annualized scale.

The short-term coefficients of the Brent oil price on local consumer commodity/service prices suggest that an increase in oil prices (ΔOil^{+}_{t}) causes instant growth in Housing and Utilities, Communication and Transportation consumer local prices (0.05, 0.037 and 0.065, respectively). The results indicated that decreases in global oil prices influenced, in the short run, only commodities with the indicated short-term symmetric reactions and food and beverages, together with miscellaneous goods and services categories. These results indicate a more elastic response of local consumer prices to oil price increases, as in the case of decreasing global crude oil price levels. In other words, Slovak households are more exposed to price changes in times of increasing global crude oil prices. Thus, selective subsidy programmes should be deployed in times of high increases in global oil prices to offset the increased expenditure pressures on households below (or close to) the poverty line.

To complement the analysis of the household consumer basket, an analysis of the price pass-through between global prices and local property was conducted. The results suggest that an increase in global oil prices of one percent causes an annualized 0.5% increase in the property price level. This partially reflects the overall increase in real estate prices in Slovakia during the period under analysis. From a short-term perspective, instant price adjustments of property prices to oil price volatility are significantly more pronounced. The coefficients of the immediate effect of real estate prices on the oil price moves (ΔOil^{+}_{t} *and* ΔOil^{-}_{t}) are 0.197 and -0.088, respectively, and resonate with the results of the short-term asymmetry test. The negative reaction of the oil price decrease is partially compensated by a positive reaction with lag 1 (ΔOil^{-}_{t-1}) to this development of 0.071. The explanation for this lagged reaction should be the necessary adjustment time of the construction work and input prices, which form real estate prices (de La Paz and Pérez, 2017).

On the basis of the findings of the paper, several policy recommendations can be made to mitigate the adverse effects on households and the broader economy:

First, targeted subsidies should be considered a potential option for essential goods and services such as food, housing, and transportation during periods of rising global oil prices. However, before implementation, a thorough discussion of the design and structure of such a subsidy system is crucial to ensure that it effectively supports low-income households without causing market distortions. Second, while direct price controls may not align with market economy principles, measures to enhance transparency in pricing mechanisms and encourage competition should be considered. This could involve promoting better information flow between suppliers and consumers and facilitating long-term contracts or price stabilization agreements, helping to manage price volatility in a market-friendly manner. Third, the government should continue its efforts to promote energy efficiency and the adoption of alternative energy sources, as the energy transition is already underway. By maintaining momentum and expanding these initiatives, Slovakia can reduce its dependency on oil and mitigate the impact of global price fluctuations on local markets. Fourth, existing schemes to support the real estate market, such as low-interest loans and tax incentives for energy-efficient home upgrades, should be further improved. Strengthening these initiatives will help stabilize property prices and make housing more affordable and sustainable, especially during periods of high oil prices. Finally, enhancing data collection and monitoring systems remains crucial for understanding the real-time impacts of oil price fluctuations on different sectors. Improved data accuracy will allow for more timely and effective policy responses, ensuring that interventions are well targeted and based on the latest economic trends. Together, these policies aim to shield the most vulnerable populations from the harshest impacts of energy price volatility while fostering a more resilient and sustainable economy.

Options for further research in the topic include testing the impacts of additional explanatory variables (e.g. exchange rates, level of production), search for methodologically advancements, wider geographical coverage (e.g. V4 countries) and better visual representation of the results.

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