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Do Exchange-Rate Fluctuations Have Asymmetric Impacts on Visegrad–German Sectoral Trade?

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Abstract

Understanding the determinants of trade flows between countries is of particular interest to policymakers, central bankers, business owners and investors. The study examines the long-run impact of the real exchange rate, exchange-rate volatility, and output on the trade balances of 10 SITC (Standard International Trade Classification) sectors between three Visegrad countries and Germany. Because the linear Autoregressive Distributed Lag (ARDL) approach shows little effect across countries and sectors, we decompose the impacts into positive and negative changes via the Nonlinear ARDL approach. The paper adds value in the following respects. The first is that while the overall macroeconomic determinants have a relatively weak connection to these trade balances, the strongest connections are in the primary-product-producing sectors. The second finding is that while most of these trade flows often depend on the country, the sector analyzed, and the method used, there are interesting, stylized results, including the region's chemical sector and manufacturing in Hungary, for example. The third finding is that nonlinear models show cointegration between the real exchange rate and the trade balance in Visegrad-Germany trade for a higher number of industries, even though the long-run coefficients continue to be insignificant in many cases.

Keywords: trade balances, Visegrad, exchange-rate volatility, asymmetric effects
JEL: F14, F41

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Introduction

Understanding the determinants of trade flows between countries is of particular interest to policymakers, central bankers, business owners and investors. Since the abolition of the Bretton-Woods system, the economic literature has examined the influence of exchange rates on exports and imports. The economic theory indicates that there is a long-run relationship between exchange rates and bilateral trade. According to the Marshall-Lerner condition, depreciation of the foreign currency improves the trade balance if import-export elasticities are higher than one (Davidson 2009:125). This happens because the rise of domestic currency decreases the relative prices of foreign goods, which increases imports in the long run. In the case of depreciation of the domestic currency, the opposite effect appears. The nexus was confirmed by Bahmani-Oskooee (1991) and has been explained by Bahmani-Oskooee, Hegerty, and Harvey (2013).

Similarly, but using a different mechanism, this relationship was shown by Alexander (1952:265), who argued that devaluation influences the trade balance in two ways. First, it alters the production of goods and services, which in turn influences national income and, consequently, the absorption of goods and services. This change in absorption impacts the trade balance. Second, devaluation directly affects the absorption of goods and services, which also influences the trade balance.

On the other hand, Mundell (1963:477) looked at the problem from a monetaristic perspective, explaining that expansive monetary policy increases the money supply, leading to outflows and currency depreciation. This improves exports and deteriorates imports. Mundell (1971: 7–12) showed it in the context of the American deficit, suggesting the same mechanism.

Apart from the impact of the exchange rate on the trade balance, some papers demonstrate the influence of exchange rate volatility. Clark (1973) used the example of a single firm to show a negative nexus between exchange rate volatility and trade. He assumed that the exporter operates under perfect competition, has limited options to hedge strategies, and is risk-averse (preferring fixed profits over time). Clark showed that when exchange rates fluctuate and are uncertain, the exporter is uncertain about its income calculated in domestic currency. Thus, when the exchange rate increases, it is likely to reduce output and exports to avoid unexpected losses caused by an unfavorable foreign exchange rate.

In the years that followed, up to the early 1990s, other publications also identified a negative relationship between exchange rate volatility and trade (Hooper and Kohlhagen 1978; Giovannini 1988). An important similarity between these papers is that they are based on strict assumptions. However, when other authors relaxed those assumptions, the relationship was found to be less clear-cut (Auboin and Ruta 2013). Additionally, the relationship is influenced by the rapid development of financial derivatives, which enabled currency risk hedging strategies. Because of these increasingly complex mechanisms, the conclusions drawn from more recent research are often contradictory (Jiang and Liu 2023).

Analyses have expanded to examine trade at a disaggregated level – including sector- or industry-level data – using various cointegration methods that distinguish between short-run and long-run processes (Kashi and Lynn 2012; Muteba and Dube 2014; Pruchnicka-Grabias, Piekunko-Mantiuk, and Hegerty 2024). A relatively new innovation has been the application of nonlinear methods to further separate the effects of positive and negative changes in explanatory variables. Studies have demonstrated that currency appreciations and depreciations can have asymmetric effects (Bahmani-Oskooee and Harvey 2021a; Xu, Bahmani-Oskooee, and Karamelikli 2021).

This study extends the literature by focusing on an important set of partnerships in Central Europe: the trade relationships between Germany and the floating-currency economies of Czechia, Hungary, and Poland (three of the four Visegrad countries). The fourth Visegrad country, Slovakia, uses the euro. Large amounts of agricultural and manufacturing trade move between each pair every day. Here, we examine the period from 2004 to 2023 using monthly data.

The history of trade between Germany and these three Visegrad countries (V3)1 dates back to the 1990s, when the German–Central European supply chain developed. As a result, Germany and the V3 quickly increased their bilateral trade, which grew more rapidly than for other CEE countries (International Monetary Fund 2013: 1, 3). According to Eurostat data and our own calculations, total exports between Germany and V3 amounted to €4.3 billion, while in 2013, this figure had nearly doubled to €7.3 billion, and by 2023, it again doubled to €14.5 billion. Imports followed a similar trajectory. In 2004, the figure was €3.3 billion, by 2013, it had more than doubled to €7.5 billion, and in 2023, it had more than doubled again to € 17.5 billion. Over 20 years, this represents a 335% rise in exports and a 537% increase in imports. Such a tremendous increase warrants a separate analysis of its determinants.

Given these trends, the paper examines the long-term impact of the real exchange rate, output, and exchange-rate volatility on trade balances between the V3 and Germany.

Since the variables under consideration have little effect across countries and sectors, it is worthwhile decomposing the exchange rate into positive and negative changes via the Nonlinear ARDL approach of Shin, Yu, and Greenwood-Nimmo (2014). It helps show the difference between the influence of positive and negative changes in the examined variables. Following Bahmani-Oskooee, Harvey, and Hegerty (2017), who analyzed Japanese trade with twelve partners, we apply both linear and nonlinear models for V3-Germany trade. Our findings indicate no clear pattern in trade flows across industries or countries and that more industries are cointegrated with the real exchange rate and industrial production using the nonlinear method. The key focus here is the disaggregated exchange-rate variables, which clearly show asymmetric effects. Exchange-rate volatility, as expected based on previous studies such as McKenzie (1999) and Bahmani-Oskooee and Hegerty (2007), has an ambiguous effect on trade balances.

Using nonlinear models helps monitor complex relationships that linear models – which consider only the simplest connections – cannot detect. Specifically, since currency appreciations might hurt a country's exports more than depreciations help them, decomposing the real exchange rate into its positive and negative changes can also reveal this asymmetry. The opposite may also be true, and this asymmetry can similarly affect imports. Additionally, if positive

1 For the purposes of this article, we refer to these countries as the V3, although historically, the V3 referred to the unified country of Czechoslovakia along with Hungary and Poland.

and negative changes have significant results that are opposite in sign, their combined impact might lead to an insignificant aggregated variable. Comparing the results of the nonlinear model to those of the aggregate model will help explore these differences.

The paper extends the existing literature by analyzing the V3 countries' trade balances with Germany for 10 SITC (Standard International Trade Classification) sectors. This topic has not yet been discussed in the literature in this context. This paper offers a novel perspective by showing differences between different sectors and their sensitivity to changes in the real exchange rate and its volatility, as well as to domestic and foreign industrial production.

The paper is structured as follows. Section 2 provides a literature overview. Section 3 describes the methodology used. Section 4 presents the results. Section 5 concludes.

Literature review

Previous studies have examined the influence of the exchange rate and other macroeconomic variables on the trade balance, but there has been no such analysis for the Visegrad countries and their partners. In this paper, we conduct such an analysis with regard to ten different SITC sectors. Furthermore, while much of the literature concentrates on the symmetric influence of appreciations and depreciations on the trade balance, we also consider asymmetrical relations using nonlinear models. This methodological approach allows us to demonstrate differences in how the trade balance reacts to changes in key variables. In this strand of the literature, papers commonly include output (often proxied by industrial production), the exchange rate, and often exchange rate volatility. Some authors focus on the impact of two or three of these factors. Below, we summarize the most important papers in this field, grouping them according to the scope of their analysis.

Conclusions on the role of exchange rate fluctuations on the trade balance vary significantly. They depend on the periods analyzed, the country, the trade sector, and the methodology – including the time span and the model used. Some papers show that a relationship exists, while others find none for some countries or sectors.

For instance, Bahmani-Oskooee and Cheema (2009) analyzed the trade balance of Pakistan with 13 trading partners and found a long-run link between the exchange rate and the trade balance for half of the countries examined. They used cointegration methods, including bounds-testing (ARDL) and Johansen approaches. Šimáková (2016) studied long-term relationships between exchange rates and trade in the Visegrad countries from 1999 to 2014 but used a simpler version of the trade balance model created by Rose and Yellen (1989). Šimáková revealed that connectedness depends on countries and product groups. Jiang and Liu (2023) analyzed relationships between China and their major trading partners, showing different conclusions for USD in China–US trade and EUR in China–Japan trade. In the former case, the currency depreciation improves the trade balance, while in the latter, it worsens it. Geldner (2024) analyzed the influence of the exchange rate on the trade balance between G10 and BRICS countries, applying quantile regression. He found that the relationship varies depending on whether the economy is advanced or emerging, likely due to differences in the goods that are exported and imported by these two groups of countries, so their liability to the exchange rate is non-identical.

Some recent studies considered differences in relations when the exchange rate rises or decreases. Some showed different conclusions for exchange rate appreciation and depreciation, while others found that the result depends on the method used and the countries and sectors analyzed.

For example, Bao et al. (2023) studied the links between the American dollar and the trade balance between the EU countries and India. They used the NARDL model to demonstrate that while India's currency depreciation does not increase trade, appreciation decreases it. Similarly, Wang (2023) noted that the depreciation of the Chinese currency does not have a significant impact on US trade. This is contrary to other papers (Barkat, Jarallah, and Alsamara 2023), which reported that the response to depreciation is stronger than to appreciation. Ren and Sakouba (2024) confirmed a long-term relationship between the exchange rate and trade balance between China and East African countries, regardless of whether the exchange rate appreciates, depreciates, or is devalued.

Some papers analyze the influence of exchange rates on the trade balance by focusing on individual countries or bilateral trade relationships. A key strength of our paper is that we examine a group of countries and sectors, allowing us to highlight differences between them. Omer, Kamal, and Haan (2023) analyzed the influence of exchange rates on Pakistan's imports and exports with the GMM estimator for the period from 1968 to 2019 and found that currency depreciation boosts exports and reduces imports. Siddique, Anwar, and Quddus (2020) used asymmetric ARDL methods to show the negative relationship between the exchange rate and Pakistan's exports. Wang (2023) studied the long-run asymmetric impact of the exchange rate on the trade balance between the USA and China with linear and nonlinear ARDL methods. She emphasized that while a relationship exists, it is subject to structural breaks. In contrast, we take a comprehensive approach by examining the V3 countries as a group and studying their trade with Germany.

Conclusions regarding the influence of exchange rate volatility on exports are mixed and depend on the countries and sectors analyzed. Many authors analyze aggregate exports rather than dividing them into sectors, while others concentrate on particular industry sectors. For example, Bosupeng, Naranpanawa, and Su (2024) noted that exchange rate volatility decreases the trade balance in developed countries but increases it in developed economies. Hall et al. (2010) compared the effect of exchange rate volatility on trade in emerging market economies and other developing countries, finding that open capital markets reduce the influence of volatility on exports. Šimáková and Stavarek (2015) showed that for Czechia's trade with its largest trading partners, higher exchange rate volatility increases the trade of some products, while for others, the adverse effect is observed.

Similar mixed results are observed for the impact of exchange rates on the trade balance. For instance, Muteba and Dube (2014) examined the influence of exchange rate volatility on trade between South Africa, China, and the United States, noting that the impact varies by industry and sector. Kashi and Lynn (2012) examined the trade between the US and OECD countries. They found that the exchange rate volatility influences the agricultural sector, while the exchange rate impacts the non-agricultural sector. Bahmani-Oskooee, Hegerty, and Zhang (2014) analyzed the influence of exchange rate volatility on exports and imports across different industries in South Korea with the U.S. and showed that it can be positive, negative, or insignificant, depending on the sector.

The next group of papers relevant to this study are those that focus on the influence of industrial production on trade flows. Studies examining industrial production – itself a key control variable in the current study are not as numerous as those for exchange rate or exchange rate volatility. Moreover, most of these studies consider aggregated production rather than distinguishing between SITC sectors, though some do focus on specific sectors.

For example, Sankaran, Krishna, and Vadivel (2021) studied the relationship between industrial output in the manufacturing sector and exports in ten emerging economies, finding that output increases exports but without distinguishing between sectors. Chit, Rizov, and Willenbockel (2010) showed a negative influence of exchange rate volatility on exports in five emerging Asian economies, again without sectoral analysis.

In contrast, Ali, Muzammil, and Umar (2022) showed a positive impact of exchange rate volatility on exports in most of the developed countries they investigated (the UK, Sweden, Germany, Poland, Italy, France, Denmark, Austria, and Belgium). However, no sectors were individually analyzed. Wa Cipamba (2015) showed that GDP stimulates exports in South Africa in the long run but did not conduct a disaggregated study. Awokuse (2005) showed a significant link between economic growth and exports in South Korea, while Sharma and Dhakal (2006) showed that economic growth increases export dynamics in some developing countries. Tyler (1981) also showed the nexus between economic growth and exports. Meanwhile, Hacker and Hatemi-J (2003) concluded that both domestic and foreign production influence exports in the case of Sweden. Abolagba, Onyekwere, and Agbonkpolor (2010) showed the significant influence of the industrial production of rubber and cocoa in Nigeria for exports.

Some studies, like ours, consider exchange rate, volatility, and industrial production together. For instance, Wang and Barrett (2007) showed that industrial production, the real exchange rate, and its volatility all influence trade between US and Taiwan. Bahmani-Oskooee and Hegerty (2009) showed that exchange rate volatility significantly influences trade flows between the US and Mexico for one-third of industries in the long run. They also confirmed the influence of the real exchange rate and industrial production, using non-linear models.

In addition, many existing studies of trade relations do not focus on asymmetrical relations. For instance, Akbostanci (2004) showed that for Turkey, depreciation stimulated the trade balance in the long run between 1987 and 2000. Bahmani-Oskooee and Kutan (2009) examined the relationship between foreign exchange rates and trade balance between emerging East European countries from January 1990 to June 2005, confirming the J-curve effect for Bulgaria, Croatia, and Russia. Šimáková (2014) analyzed the relationship between Slovakia and its main partners between 1997 and 2013. She used the Johansen cointegration and VECM model to demonstrate that the foreign rate depreciation positively influences Slovakia's trade balance in both the short and long terms. Khouiled, Chini, and Benrouina (2023) analyzed the long-term relationship between foreign exchange rates and trade balance for countries from North Africa between 1990 and 2019. They used a panel ARDL model to confirm long-term connectedness. Narayan and Smyth (2006) investigated the interdependence between the exchange rate and China's trade balance with the US, revealing that currency devaluation improves the trade balance in the long run. Puah et al. (2008) showed no long-term interdependence between exchange rates and trade balances in four out of five ASEAN countries from 1970 to 2004.

We contribute to the existing literature by extending this analysis to trade between the V3 and Germany, employing both linear and nonlinear models. The argument for incorporating non-linear models is that the literature emphasizes their ability to show new relationships that linear models may overlook. Nonlinear approaches also allow us to distinguish the effects of positive and negative changes in variables, which aligns with Bahmani-Oskooee, Harvey, and Hegerty (2017), who examined Japanese trade with twelve partners. They applied both linear and nonlinear ARDL methods and noted that the latter showed stronger relationships. The linear model showed that in the long run, Japan's trade balance with three countries improved when the yen depreciated, whereas the nonlinear model revealed this effect for seven countries.

Similarly, Bahmani-Oskooee and Harvey (2021a) demonstrated the absence of asymmetric relationships between exchange rate volatility and trade between the US and Mexico when employing linear models. Bahmani-Oskooee and Fariditavana (2016) examined US trade with its six largest partners, finding that the linear ARDL model indicated a J-curve effect for trade with three countries while the nonlinear ARDL model revealed it for five. They also noted that the impact of the exchange rate on the trade balance is mostly asymmetric. Meanwhile, investigating the impact of the exchange rate on the balance in trade between Malaysia and Thailand, Bahmani-Oskooee and Aftab (2017) showed that depreciation increased the trade balance for most industries, and for 26 out of 61 industries, long-run effects were asymmetric. Bahmani-Oskooee and Harvey (2021b) focused on the asymmetric effects of volatility increases and decreases and its influence on US–Australia exports, finding that asymmetric effects exist in some sectors even where symmetric effects do not. Meanwhile, Xu, Bahmani-Oskooee, and Karamelikli (2021) analyzed China–US commodity trade, concluding that asymmetric and nonlinear methodologies yielded more accurate findings than symmetric and linear models. Their nonlinear analysis revealed a negative relationship between exchange rate volatility and trade, which was not evident in linear models (affecting 45% of US exports to China and 76% of Chinese exports to the US).

Methodology

The study utilized monthly data from May 2004 to July 2023 sourced from Eurostat, encompassing bilateral trade between Germany and the individual V3 countries. The dataset includes export and import values for ten one-digit SITC sectors, were taken. The period commences with the accession of the V3 countries to the European Union. Foreign exchange rates were obtained from the European Central Bank, while industrial production was retrieved from the International Monetary Fund's International Financial Statistics (IFS) database. These three Visegrad countries represent significant trading partners for German, the largest regional economy; Slovakia is excluded because of its adoption of the euro and consequent lack of an independently floating currency. Table 1 provides an overview of the import and export structure between the V3 and Germany. These three major economies in Central Europe have the potential to exhibit their own unique trade patterns.

The trade balance for each partner country is calculated as the ratio of its exports to Germany (in €) to its imports from Germany. Consequently, balanced trade would yield a ratio of one, while a partner's trade surplus (German deficit) would yield a value greater than one. These values for the ten sectors for all three countries are presented in Figure 1.

An examination of Figure 1 reveals no clear pattern in trade flows across industries or countries. For example, Sector 7 (Machinery and transport equipment) shows a trade deficit for Poland but a surplus for Czechia. Similar inter-sectoral and inter-country variations are evident throughout the sample.

Table 1. Most important import and export sectors in May of each year

Czechia-Germany											
2004				2013				2023			
Sector	Exports	Sector	Imports	Sector	Exports	Sector	Imports	Sector	Exports	Sector	Imports
7	756 (49%)	7	588 (52%)	7	1110 (46%)	7	1569 (55%)	7	2028 (47%)	7	3659 (60%)
6	342 (22%)	6	208 (18%)	6	488 (20%)	6	492 (17%)	6	768 (18%)	6	826 (13%)
8	188 (12%)	8	179 (16%)	5	342 (14%)	8	324 (11%)	5	643 (15%)	8	778 (13%)
T	1541	T	1132	T	2433	T	2848	T	4355	T	6123
Hungary-Germany											
2004				2013				2023			
Sector	Exports	Sector	Imports	Sector	Exports	Sector	Imports	Sector	Exports	Sector	Imports
7	693 (62%)	7	632 (72%)	7	823 (57%)	7	1014 (65%)	7	1707 (62%)	7	2403 (74%)
6	202 (18%)	8	89 (10%)	6	238 (16%)	8	182 (12%)	6	375 (14%)	8	278 (9%)
5	83 (7%)	6	83 (9%)	5	161 (11%)	6	181 (12%)	5	274 (10%)	6	220 (7%)
T	1110	T	880	T	1446	T	1558	T	2742	T	3235
Poland-Germany											
2004				2013				2023			
Sector	Exports	Sector	Imports	Sector	Exports	Sector	Imports	Sector	Exports	Sector	Imports
7	697 (42%)	7	501 (40%)	7	1245 (36%)	7	1134 (37%)	7	2915 (40%)	7	3348 (41%)
6	463 (28%)	6	253 (20%)	6	739 (22%)	6	662 (22%)	6	1335 (18%)	8	1414 (17%)
5	249 (15%)	8	233 (19%)	5	601 (18%)	8	507 (16%)	5	1114 (15%)	6	1297 (16%)
T	1672	T	1249	T	3419	T	3075	T	7373	T	8151

€ millions, % of total exports – imports, T – total exports – imports.

Source: data from Eurostat and own calculations.

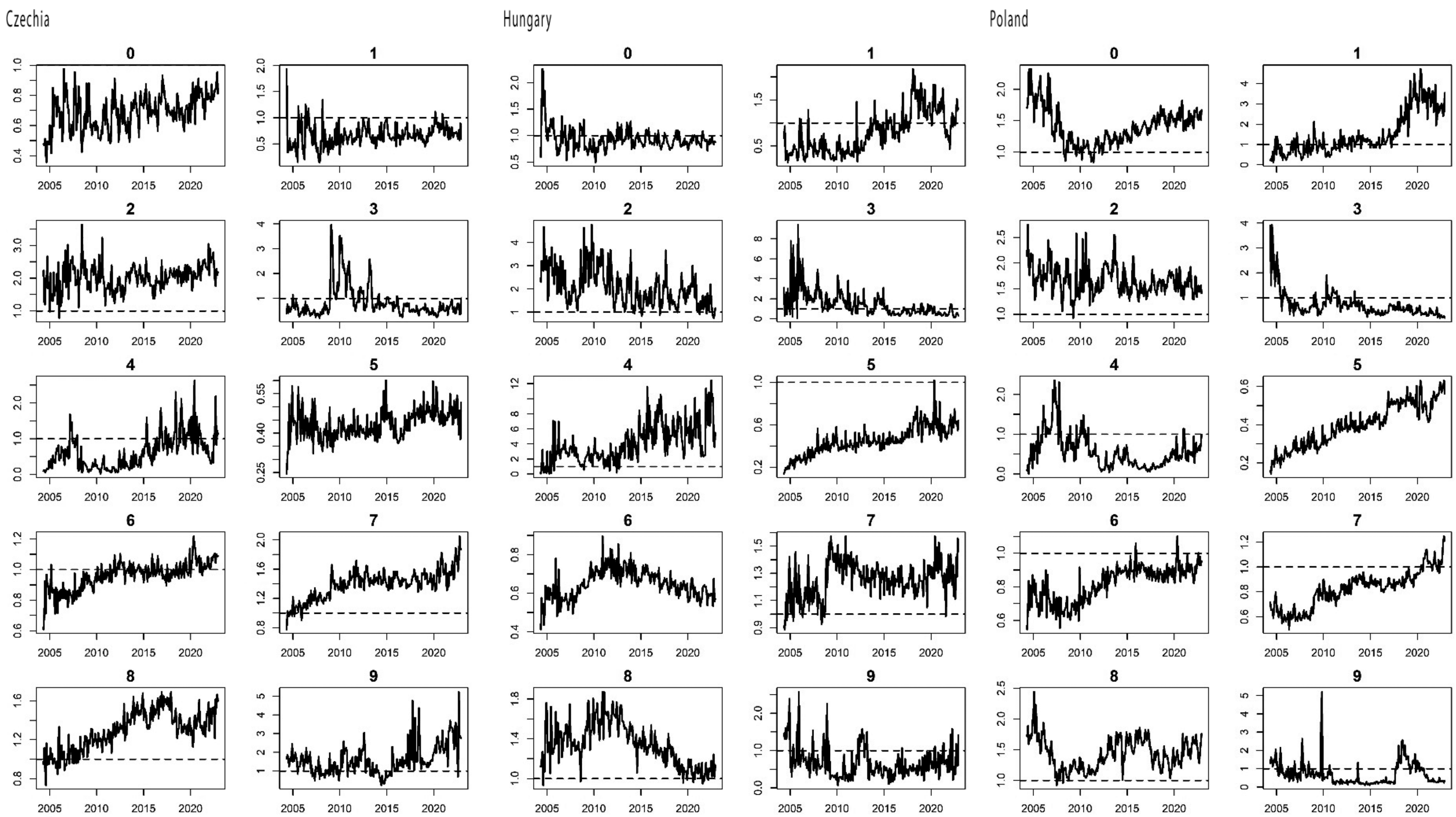

Figure 1. Bilateral trade balances with Germany

Sector titles are listed in Table 2. The horizontal line indicates balanced trade; values below this line represent a trade deficit.

Source: own calculations based on Eurostat data.

These balances serve as the dependent variable in a set of macroeconomic models. Following Bahmani-Oskooee and Hegerty (2009), as well as a host of related papers, the main determinants are domestic and foreign output (proxied by indices of industrial production), the real exchange rate, and a measure of exchange-rate volatility:

$$TB = f\left(IP^{H},\ IP^{F},\ q_i,\ qVOL\right). \tag{1}$$

Here, *TB* represents each individual sectoral trade balance, and IP^H and IP^F are domestic and foreign indices of industrial production. The real exchange rate is represented by *q*, which is itself calculated using both countries' Consumer Price Indices along with the nominal exchange rate. The exchange rate volatility measure is constructed using log changes in *q*. Following a GARCH(1,1) process (as in Bollerslev 1986) using an AR(1) process as the mean equation estimated for each country separately, the volatility is derived as:

$$\Delta \ln q_t = \alpha + \rho\, \Delta\, \ln q_{t-1} + \varepsilon_t, \tag{2a}$$

$$qVOL_t = h_t^2 = w + \varepsilon_{t-1}^2 + h_{t-1}^2. \tag{2b}$$

These are plotted to describe their behavior over time, before entering them into the models for the statistical analysis.

The main estimation techniques are the Autoregressive Distributed Lag (ARDL) cointegration approach of Pesaran, Shin, and Smith (2001), as well as its nonlinear extension, the NARDL methodology introduced by Shin, Yu, and Greenwood-Nimmo (2014). Natural logs are used for each variable.

The basic ARDL model for each country individually models the dependent variable (*y*) as a function of the independent variables (*x*, *z*, etc.) by combining both lagged level variables and first-differenced variables as follows:

$$\Delta y_t = \beta_0 + \sum_{i1=1}^{n1} \beta_{1i}\, \Delta\, y_{t-i} + \sum_{i2=0}^{n2} \beta_2\, \Delta\, x_{t-i} + \sum_{i3=1}^{n3} \beta_3\, \Delta\, z_{t-i} + \theta_1 y_{t-1} + \theta_2 x_{t-1} + \theta_3 z_{t-1} + \epsilon_t. \tag{3}$$

Each optimal lag length *n* is chosen by minimizing the Akaike Information Criterion. If a stable, cointegrating relationship among the variables exists, then all the short-run differenced variables would be zero, and only the lagged level variables would remain. This normalized vector would then yield long-run coefficient estimates.

An F-test for joint significance among these long-run coefficients is also conducted to provide evidence of cointegration. If the long-run variables are jointly significant, it indicates the presence of an equilibrium relationship among them, even if the short-run fluctuations are zero. The alternative hypothesis is that at least one of the variables is equal to zero.

This F-test is known as a "bounds test" because it is applicable to variables that are integrated of order 1 (nonstationary) or of order 0 (stationary). Therefore, it is not necessary to conduct unit-root testing to determine whether each variable is I(1) or I(0). Following Pesaran, Shin, and Smith

(2001), among others, critical values were calculated for two extremes: one in which all variables are I(0), and the other in which all are I(1). If the computed F-statistic exceeds the upper bound value, cointegration is confirmed. If it is less than the lower bound, it is definitively rejected. Intermediate cases can be assessed using an alternative test.

We expect that an increase in *Domestic income* (proxied by IP^H) will increase each V3 country's imports, thus reducing its trade balance. Similarly, increases in German income (proxied by IP^F) will raise V3 exports and trade balances. The real exchange rate (q), expressed as units per euro, is such that increases reflect a depreciation of the V3 currency, which will increase the trade balance. Exhange-rate volatility is often expected to reduce trade, though it may increase it in "risk-loving" industries. As McKenzie (1999) and Bahmani-Oskooee and Hegerty (2007) explain, the effect of exchange-rate volatility on trade flows is often ambiguous, particularly if traders hedge, limiting the impact of risk.

Using the nonlinear technique, the positive and negative effects of changes in an explanatory variable are assumed to be asymmetric. The variable of interest – in this case, changes to the log real exchange rate – is decomposed into its positive and negative components as follows:

$$POS_t = \sum_{i}^{t} \max(\Delta \ln q_t, 0), \quad (4a)$$

$$NEG_t = \sum_{i}^{t} \min(\Delta \ln q_t, 0). \quad (4b)$$

These two variables then replace the original q in the models. As Bahmani-Oskooee and Fariditavana (2016) note, if changes in the real exchange rate are to increase a country's trade balance, the coefficients on *POS* and *NEG* will both be significantly positive and similar in size.

Here, we also focus on the long-run estimates to show the effects of changes to income, relative prices, and risk on sectoral trade flows between the V3 countries and Germany. Overall, our results indicate that the effects vary by country, with sector 2, in particular, and Poland most affected by macroeconomic fluctuations. Our results are presented below.

Results and discussion

Figure 2 shows the volatilities that were generated using GARCH(1,1) processes. Volatility increased during the 2008 Global Financial Crisis. However, the secondary spike differs by country. While the Polish zloty registered a relatively small increase after 2020, there were two large spikes in the Czech koruna during that time. The Hungarian forint also experienced a lasting increase in volatility at that time.

The key focus of this study is the ARDL estimations and their long-run coefficient estimates. Table 2 shows the lag order, as well as the F-statistics for cointegration and R-bar-squared for goodness of fit. Most industries show evidence of cointegration (a significant joint test, with a p-value for the F-statistic below 0.05); notable exceptions are Sectors 5 and 8 for Czechia, Sectors 5 and 9 for Hungary, and a larger share of sectors for Poland (0, 3, 6, 7, 8, 9). This insensitivity of Polish–German trade to the traditional macroeconomic determinants merits further study.

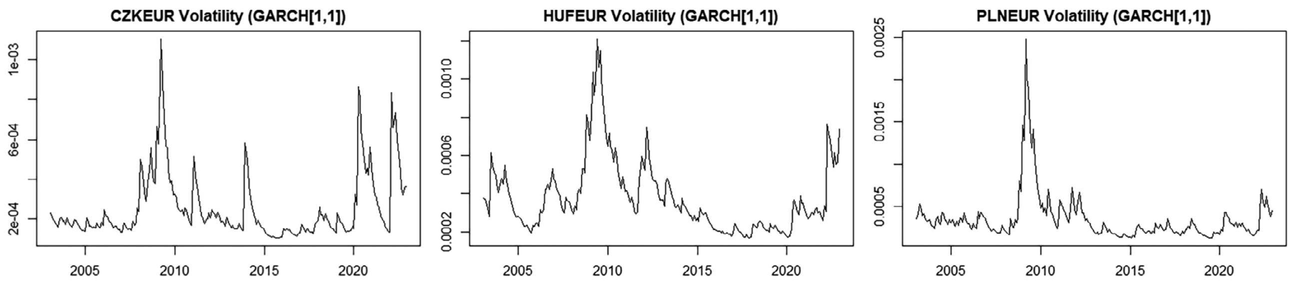

Figure 2. GARCH(1,1)-generated volatility series
Source: own calculations based on Eurostat data.

Table 2. ARDL Orders, Cointegration Tests, and Goodness of Fit

	Czechia			Hungary			Poland		
Ind.	ARDL Order	F (p-val.)	R2	ARDL Order	F (p-val.)	R2	ARDL Order	F (p-val.)	R2
0	(3,3,3,2,5)	6.788 (0.001)	0.395	(4,0,1,4,3)	10.456 (0.000)	0.329	(3,1,3,1,0)	2.665 (0.284)	0.775
1	(2,0,2,0,0)	10.826 (0.000)	0.210	(5,0,6,0,0)	4.917 (0.012)	0.694	(5,0,0,5,2)	6.187 (0.002)	0.773
2	(2,1,0,0,3)	10.511 (0.000)	0.227	(5,0,5,1,3)	11.372 (0.000)	0.529	(4,6,1,0,4)	9.066 (0.000)	0.317
3	(4,6,4,1,0)	5.568 (0.004)	0.712	(3,6,2,0,4)	5.455 (0.005)	0.482	(3,4,3,0,2)	4.261 (0.035)	0.697
4	(5,6,3,0,0)	5.659 (0.004)	0.654	(5,6,0,5,0)	4.880 (0.013)	0.515	(5,6,6,4,0)	1.943 (0.560)	0.733
5	(4,2,4,1,5)	3.350 (0.129)	0.424	(5,4,4,3,4)	2.799 (0.245)	0.784	(4,4,4,0,0)	4.746 (0.016)	0.909
6	(4,5,1,3,0)	4.506 (0.024)	0.684	(5,4,4,1,0)	3.513 (0.103)	0.584	(3,2,0,0,0)	2.494 (0.339)	0.725
7	(3,4,1,3,0)	5.665 (0.004)	0.773	(4,3,0,3,4)	5.496 (0.005)	0.402	(5,1,3,5,6)	2.434 (0.361)	0.905
8	(5,5,1,4,0)	1.614 (0.702)	0.784	(5,6,5,4,6)	9.564 (0.000)	0.747	(3,4,0,2,0)	3.300 (0.137)	0.719
9	(3,0,1,0,1)	3.52 (0.102)	0.481	(5,0,3,0,3)	2.802 (0.244)	0.282	(3,0,0,0,0)	3.164 (0.160)	0.665
	Sector Name								
0	Food and live animals								
1	Beverages and tobacco								
2	Crude mats, inedible, ex. fuels								
3	Min. fuels, lubricants and rel. mats								
4	Animal and veg oils, fats and waxes								
5	Chemicals and related prod, n.e.s.								
6	Manufactured goods								
7	Machinery and transport equipment								
8	Misc manufactured articles								
9	Commodities and trans., n.e.s.								

Source: own calculations based on data from Eurostat.

The long-run coefficients (Table 3) show that the key macroeconomic determinants of income and relative price are not universally significant in driving the three Visegrad countries' trade balances. Exchange rate risk appears to have even less of an effect. Czechia, for example, has seven sectors (0, 1, 2, 3, 4, 6, and 7) where cointegration is established. Hungary also has seven, which overlap Czechia's to some extent (0, 1, 2, 3, 4, 7, and 8). However, Poland has only four cointegrated specifications (1, 2, 3, and 5). Notably, industries where cointegration is common include beverages, crude materials, and mineral fuels. Meanwhile, commodities (Sector 9) and other manufactured goods are commonly not cointegrated. We can conjecture that the macroeconomic relationship specified in our model holds primarily for the former group rather than the latter.

Table 3. Long-Run ARDL Coefficients

Sector		Czechia	Hungary	Poland
0	Constant	– 3.117 (0.255)	**– 7.238 (0.047)**	– 3.137 (0.489)
	IP(H)	**0.861 (0.004)**	**– 0.414 (0.044)**	– 0.058 (0.805)
	IP(F)	– 0.544 (0.362)	**0.880 (0.035)**	– 0.294 (0.774)
	Q	0.465 (0.251)	0.876 (0.111)	**2.754 (0.007)**
	qVOL	0.034 (0.631)	– 0.005 (0.937)	– 0.138 (0.173)
1	Constant	2.661 (0.538)	**– 23.768 (0.024)**	**– 8.417 (0.041)**
	IP(H)	0.582 (0.219)	**1.886 (0.002)**	**2.024 (0.000)**
	IP(F)	– 0.788 (0.393)	1.069 (0.471)	– 1.497 (0.077)
	Q	– 0.813 (0.207)	1.237 (0.377)	**3.667 (0.010)**
	qVOL	– 0.054 (0.592)	– 0.300 (0.059)	– 0.095 (0.433)
2	Constant	– 2.518 (0.259)	**22.089 (0.000)**	1.937 (0.236)
	IP(H)	0.565 (0.052)	**– 0.659 (0.032)**	– 0.118 (0.178)
	IP(F)	0.149 (0.737)	**– 2.337 (0.003)**	– 0.225 (0.543)
	Q	0.330 (0.404)	– 1.493 (0.057)	– 0.308 (0.423)
	qVOL	**0.145 (0.021)**	– 0.129 (0.134)	– 0.072 (0.086)
3	Constant	**41.796 (0.000)**	17.307 (0.333)	1.418 (0.888)
	IP(H)	**– 3.829 (0.000)**	**– 2.885 (0.004)**	**– 1.115 (0.039)**
	IP(F)	– 1.683 (0.377)	0.233 (0.920)	1.993 (0.406)
	Q	**– 5.885 (0.000)**	– 0.816 (0.741)	– 3.47 (0.208)
	qVOL	– 0.346 (0.067)	0.003 (0.991)	0.136 (0.583)
4	Constant	**– 38.782 (0.000)**	– 7.676 (0.642)	**56.607 (0.018)**
	IP(H)	**9.204 (0.000)**	**2.136 (0.033)**	0.751 (0.525)
	IP(F)	**– 6.297 (0.002)**	– 2.127 (0.227)	**– 12.128 (0.029)**
	Q	**7.015 (0.000)**	1.131 (0.669)	– 5.125 (0.356)
	qVOL	– 0.128 (0.535)	– 0.27 (0.331)	– 0.336 (0.513)

Sector		Czechia	Hungary	Poland
5	Constant	– 1.880 (0.423)	2.218 (0.831)	**– 10.257 (0.000)**
	IP(H)	**0.776 (0.001)**	**1.417 (0.016)**	**0.935 (0.000)**
	IP(F)	– 0.898 (0.076)	– 0.498 (0.716)	0.876 (0.055)
	Q	0.452 (0.188)	– 1.271 (0.359)	0.787 (0.091)
	qVOL	– 0.013 (0.835)	0.021 (0.887)	0.033 (0.461)
6	Constant	1.725 (0.200)	10.124 (0.118)	– 2.070 (0.279)
	IP(H)	0.275 (0.068)	0.062 (0.847)	**0.348 (0.003)**
	IP(F)	– 0.257 (0.364)	– 0.792 (0.380)	– 0.251 (0.546)
	Q	**– 0.603 (0.003)**	– 1.235 (0.109)	0.866 (0.084)
	qVOL	– 0.014 (0.630)	0.016 (0.837)	– 0.002 (0.697)
7	Constant	**5.148 (0.004)**	**– 8.969 (0.046)**	– 1.571 (0.569)
	IP(H)	**0.460 (0.019)**	– 0.235 (0.327)	**0.845 (0.000)**
	IP(F)	**– 0.768 (0.037)**	0.885 (0.059)	– 0.360 (0.568)
	Q	**– 1.142 (0.000)**	**1.381 (0.047)**	– 0.030 (0.965)
	qVOL	– 0.040 (0.293)	**0.206 (0.004)**	0.107 (0.189)
8	Constant	2.234 (0.706)	**– 6.817 (0.030)**	– 1.138 (0.721)
	IP(H)	– 0.031 (0.965)	**– 1.114 (0.000)**	– 0.0020 (0.990)
	IP(F)	0.503 (0.678)	**1.755 (0.000)**	– 0.462 (0.504)
	Q	– 1.105 (0.215)	**1.012 (0.023)**	**1.967 (0.017)**
	qVOL	0.061 (0.653)	**0.188 (0.000)**	– 0.099 (0.202)
9	Constant	15.772 (0.117)	– 15.279 (0.527)	– 46.051 (0.065)
	IP(H)	2.178 (0.073)	0.138 (0.918)	– 1.706 (0.204)
	IP(F)	**– 4.789 (0.028)**	2.244 (0.504)	9.675 (0.069)
	Q	– 1.957 (0.229)	0.675 (0.836)	9.116 (0.134)
	qVOL	– 0.356 (0.176)	0.032 (0.934)	0.577 (0.304)

P-values in parentheses. Bold = significant at 5 percent.

Source: own calculations based on Eurostat data.

The long-run coefficients also highlight the limitations of the model. The expected signs – negative for Domestic IP, positive for Foreign IP, positive for q, and ambiguous for qVOL – rarely hold. Only in Sector 3 (mineral fuels and lubricants) does higher domestic income lead to increased imports in all three countries. A real appreciation of the euro helps V3 trade for two sectors in Poland (0 and 2: Food and Live Animals and Crude materials), confirming that the model holds better for primary materials. Czechia has a significantly positive coefficient in Sector 4, while Hungary exhibits a similar effect in Sector 7 (Machinery and Transport Equipment) – the only effect of this type, which likely reflects a distinctive aspect of the German–Hungarian trading relationship that warrants further investigation.

Table 4. NARDL Orders, Cointegration Tests, and Goodness of Fit

	Czechia			Hungary			Poland		
Industry	ARDL Order	F (p-val.)	R-bar-Sq.	ARDL Order	F (p-val.)	R-bar-Sq.	ARDL Order	F (p-val.)	R-bar-Sq.
0	(3,3,3,0,4,1)	7.276 (0.000)	0.394	(4,0,1,0,3,5)	8.844 (0.000)	0.268	(3,3,0,0,0,0)	3.415 (0.091)	0.765
1	(2,0,2,0,0,0)	8.403 (0.000)	0.197	(2,0,0,5,0,0)	5.483 (0.002)	0.686	(5,6,1,0,0,4)	3.346 (0.101)	0.774
2	(2,3,0,2,2,2)	7.715 (0.000)	0.255	(5,0,5,0,0,3)	9.607 (0.000)	0.519	(4,5,1,3,3,4)	11.38 (0.000)	0.381
3	(4,6,4,0,0,5)	3.498 (0.081)	0.705	(4,3,2,0,0,5)	3.425 (0.090)	0.481	(4,4,3,5,0,2)	4.987 (0.006)	0.687
4	(3,2,0,1,4,0)	4.447 (0.017)	0.664	(5,0,0,0,5,0)	6.213 (0.001)	0.530	(2,3,0,4,0,0)	3.592 (0.070)	0.719
5	(4,1,5,5,5,0)	4.276 (0.023)	0.457	(5,4,4,2,0,2)	4.077 (0.032)	0.788	(4,2,6,0,1,0)	4.804 (0.008)	0.908
6	(4,1,1,0,0,0)	3.407 (0.092)	0.670	(4,4,4,1,3,1)	2.836 (0.209)	0.590	(4,2,2,3,3,4)	1.612 (0.713)	0.736
7	(3,4,2,1,2,1)	4.166 (0.027)	0.761	(4,3,4,3,1,3)	4.397 (0.019)	0.394	(4,6,0,6,6,5)	3.395 (0.094)	0.913
8	(5,5,1,3,2,2)	1.355 (0.822)	0.790	(5,0,5,0,4,6)	7.736 (0.000)	0.745	(3,4,0,1,1,1)	3.070 (0.152)	0.717
9	(3,1,1,0,3,0)	3.140 (0.137)	0.486	(5,0,6,0,1,3)	3.224 (0.121)	0.266	(4,5,0,3,4,1)	1.873 (0.587)	0.664

Source: own calculations based on Eurostat data.

Given that changes in the real exchange rate have little effect across countries and sectors, we decompose the impacts into positive and negative changes via the Nonlinear ARDL (NARDL) approach. Table 4 presents the NARDL orders, F-tests, and goodness of fit statistics are given in Table 4. This method reveals cointegration in a larger number of industries than was the case when the linear ARDL model was applied. For Czechia, eight out of ten sectors (0, 1, 2, 3, 4, 5, 6, and 7, but not 8 or 9) have significant joint tests; the same is true for Hungary (0, 1, 2, 3, 4, 5, 7, and 8, but not 6 or 9). Poland shows cointegration in six sectors when this method is applied (sectors 0, 2, 3, 4, 5, and 7, but not 1, 6, 8, or 9). Notably, Sector 9 is never cointegrated in any country, which was also true with the linear ARDL model. Sectors 6 and 8 are not cointegrated for two of the three countries, while Sector 7 (Machinery) exhibits cointegration across all three countries.

The significance of the coefficients remains limited. Again, domestic income drives Sector 3, but the real exchange rate (*POS* and *NEG*) has few significant coefficients. The negative component is significantly positive in Czechia's Sectors 0 and 5, Hungary's Sectors 4, 5, and 7, and Poland's Sectors 2 and 5. This again highlights the model's strength in the primary-material sectors, as well as a common pattern in the Chemical sector. The positive component has a significant coefficient in Poland's Sectors 2 and 3 (negative), and 5 (positive). In the other two countries, only Hungary's Sector 7 has a significantly positive coefficient – which corresponds to the results from the linear ARDL model.

Table 5. Long-Run NARDL Coefficients

		Czechia	Hungary	Poland
0	Constant	– 0.227 (0.892)	– 2.230 (0.095)	5.745 (0.180)
	IP(H)	**0.655 (0.013)**	– 0.232 (0.121)	0.337 (0.235)
	IP(F)	– 0.643 (0.257)	0.604 (0.081)	– 1.843 (0.094)
	POS	0.069 (0.488)	– 0.002 (0.794)	1.610 (0.241)
	NEG	**0.423 (0.045)**	0.000 (0.985)	2.176 (0.202)
	qVOL	0.021 (0.706)	– 0.053 (0.378)	– 0.185 (0.164)
1	Constant	– 0.986 (0.728)	– 7.621 (0.055)	– 9.114 (0.176)
	IP(H)	0.819 (0.067)	**2.571 (0.000)**	**2.406 (0.000)**
	IP(F)	– 0.680 (0.472)	**– 1.939 (0.047)**	– 0.37 (0.829)
	POS	– 0.022 (0.903)	0.021 (0.632)	1.623 (0.330)
	NEG	0.113 (0.495)	– 0.015 (0.532)	0.277 (0.887)
	qVOL	0.017 (0.843)	**– 0.492 (0.010)**	0.041 (0.833)
2	Constant	0.294 (0.881)	**12.122 (0.000)**	**5.667 (0.000)**
	IP(H)	0.352 (0.194)	**– 1.077 (0.000)**	**– 0.168 (0.014)**
	IP(F)	0.196 (0.702)	**– 1.427 (0.022)**	– 0.479 (0.128)
	POS	– 0.632 (0.077)	– 0.003 (0.774)	**– 5.864 (0.000)**
	NEG	0.622 (0.062)	**0.022 (0.038)**	**5.990 (0.000)**
	qVOL	**0.238 (0.010)**	– 0.040 (0.621)	**0.222 (0.005)**

		Czechia	Hungary	Poland
3	Constant	7.048 (0.427)	11.397 (0.153)	– 6.519 (0.473)
	IP(H)	– 2.426 (0.080)	**– 2.774 (0.001)**	**– 1.232 (0.006)**
	IP(F)	2.013 (0.512)	0.766 (0.718)	3.673 (0.132)
	POS	0.039 (0.938)	– 0.017 (0.632)	**– 12.706 (0.033)**
	NEG	0.263 (0.589)	0.027 (0.487)	– 5.469 (0.082)
	qVOL	**0.631 (0.039)**	0.205 (0.513)	0.640 (0.076)
4	Constant	4.384 (0.651)	1.854 (0.783)	**42.76 (0.005)**
	IP(H)	**6.909 (0.000)**	**2.596 (0.000)**	– 0.021 (0.980)
	IP(F)	**– 10.036 (0.001)**	– 2.213 (0.141)	**– 8.542 (0.018)**
	POS	– 0.237 (0.800)	– 0.028 (0.393)	– 15.33 (0.071)
	NEG	– 0.189 (0.893)	**0.293 (0.012)**	6.404 (0.227)
	qVOL	**– 1.070 (0.009)**	0.251 (0.413)	0.390 (0.443)
5	Constant	3.432 (0.063)	– 4.344 (0.268)	**– 7.751 (0.000)**
	IP(H)	0.404 (0.087)	**1.146 (0.004)**	**1.004 (0.000)**
	IP(F)	**– 0.995 (0.042)**	0.031 (0.976)	0.571 (0.157)
	POS	**– 0.943 (0.017)**	– 0.064 (0.069)	– 0.410 (0.314)
	NEG	**0.840 (0.013)**	**0.047 (0.025)**	**1.915 (0.013)**
	qVOL	0.152 (0.127)	0.218 (0.110)	0.061 (0.178)
6	Constant	– 0.844 (0.528)	3.088 (0.308)	1.717 (0.513)
	IP(H)	0.427 (0.068)	– 0.306 (0.170)	**0.448 (0.000)**
	IP(F)	– 0.136 (0.772)	– 0.091 (0.896)	– 0.860 (0.117)
	POS	0.090 (0.329)	– 0.044 (0.111)	– 0.848 (0.683)
	NEG	**0.212 (0.029)**	0.053 (0.076)	2.187 (0.355)
	qVOL	0.063 (0.169)	0.177 (0.103)	– 0.009 (0.939)
7	Constant	– 2.917 (0.278)	0.494 (0.767)	– 0.167 (0.958)
	IP(H)	**0.901 (0.020)**	0.175 (0.260)	**0.883 (0.000)**
	IP(F)	– 0.341 (0.673)	– 0.249 (0.564)	– 0.296 (0.605)
	POS	1.027 (0.058)	**0.051 (0.033)**	– 0.362 (0.910)
	NEG	– 0.335 (0.417)	– 0.021 (0.243)	5.925 (0.185)
	qVOL	– 0.053 (0.652)	0.011 (0.885)	0.321 (0.152)
8	Constant	– 3.076 (0.466)	0.658 (0.491)	– 0.090 (0.981)
	IP(H)	0.411 (0.488)	**– 0.819 (0.000)**	0.289 (0.215)
	IP(F)	0.486 (0.687)	**1.030 (0.000)**	– 0.931 (0.287)
	POS	0.373 (0.608)	0.000 (0.954)	4.614 (0.107)
	NEG	0.562 (0.371)	0.013 (0.165)	– 6.613 (0.051)
	qVOL	0.093 (0.595)	**0.154 (0.000)**	**– 0.372 (0.033)**

		Czechia	Hungary	Poland
9	Constant	8.656 (0.199)	– 13.071 (0.237)	– 42.248 (0.157)
	IP(H)	**3.505 (0.004)**	0.449 (0.620)	– 0.626 (0.619)
	IP(F)	**– 5.956 (0.014)**	2.699 (0.340)	6.431 (0.275)
	POS	0.550 (0.248)	– 0.027 (0.503)	29.504 (0.158)
	NEG	– 0.616 (0.451)	0.076 (0.232)	– 38.864 (0.153)
	qVOL	– 0.325 (0.206)	0.250 (0.504)	– 1.516 (0.254)

P-values in parentheses. Bold = significant at 5 percent.

Source: own calculations based on Eurostat data.

Exchange-rate volatility, as expected, has an ambiguous effect on trade balances. It is negative in Sector 4 (Czechia) and 1 (Hungary) but is positive for Sectors 2 and 3 in Czechia, and Sector 2 in Poland. Notably, Sector 2 stands out due to its sensitivity to the overall macroeconomic environment across all three countries.

Two main results emerge here. First, while the macroeconomic model is stronger for primary-product sectors than for manufacturing, it appears weak overall. Second, the results appear idiosyncratic, warranting further detailed exploration to reveal country- and sector-specific dynamics, such as in Hungarian manufacturing. Additionally, common results across countries within a given sector, such as Chemicals, deserve similar investigation.

Our findings align with those of Bahmani-Oskooee, Halicioglu, and Hegerty (2016), who analyzed Mexico's trade with other countries and found that results depended on the country, sector, and model applied. Like Muteba and Dube (2014), Hasanov and Baharumshah (2014), and Bahmani-Oskooee, Harvey, and Hegerty (2014), we observe that the final effect depends on both the country and sector. This echoes the finding of Jiang and Liu (2023) for China and its major trading partners, Bao et al. (2023) for EU–India trade, Barkat et al. (2023) for GCC (Gulf Cooperation Council) countries, and Yaya (2021) for African countries. We further demonstrate the existence of differences between currency appreciation and depreciation for V3–Germany trade. Although Hall et al. (2010) noted that an open capital market reduces the influence of exchange rate risk on trade, and Svarnali et al. (2017) suggest a recent decrease in the interdependence between exchange rate and trade, we demonstrate that this relationship persists for certain sectors.

Following Bahmani-Oskooee, Harvey, and Hegerty (2017), who analyzed Japanese trade with twelve partners, we apply both linear and nonlinear models, showing that the latter reveals new relationships. Contrary to Wang (2023), who stresses that the depreciation of Chinese currency does not have a significant impact on US trade, and Aftab and Ismail (2018), who noted that exchange-rate volatility does not influence Chinese trade significantly, we demonstrate the existence of these interdependences for specific sectors.

As an additional robustness check, we investigate potential cyclical patterns or structural breaks in our exchange-rate series. This will allow us to determine whether periods of overvaluation or undervaluation exert differing influences on the trade balances in question. To achieve this, we decompose each (log) rate using the Hodrick-Prescott filter. The preliminary results of this analysis are illustrated in Figure 3.

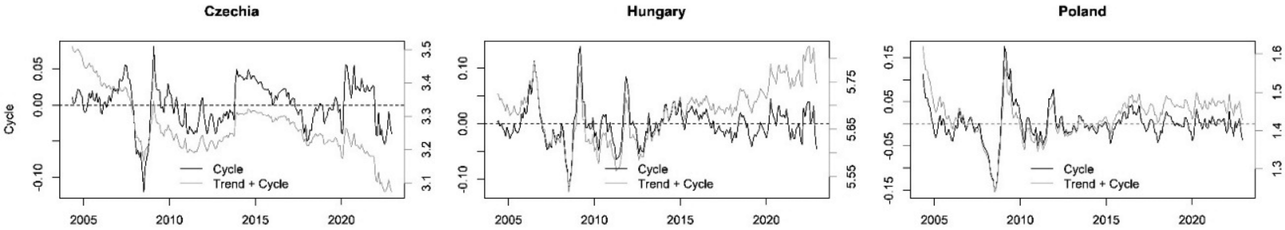

Figure 3. Real exchange rates (q) and their cyclical components
Source: own analysis based on Eurostat data.

The primary finding is that the cycles dominate the series, so there is little difference between them and the variables themselves. As a result, cyclical analysis might not be appropriate in this context. However, an unexpected finding is that for Hungary and Poland, the cycle and (trend + cycle) series deviated after an apparent break around 2015. For Czechia, the divergence seems to be persistent throughout the sample. Since a structural-break analysis falls outside the scope of the cointegration-based study provided here, we leave that for future research.

Conclusions

Since the introduction of cointegration models, many studies have re-examined the influence of exchange rates and their volatility on trade balances worldwide. Early research used aggregated data, while subsequent work incorporated sectoral differences. More recently, studies have considered asymmetric relationships, showing the distinct effects of positive and negative changes. While previous studies examined various country pairs, none focused on V3–Germany trade, a notable omission given the deep German–Central European supply chains that have existed since the 1990s.

Furthermore, existing research has yielded ambiguous results, depending on the research method, countries, and sectors analyzed. Although many studies analyzed the influence of exchange rate depreciation and appreciation on trade between developed and developing countries, few consider exchange rate risk, and ever fewer consider output. Our study addresses this gap.

We focus on the long-run estimates to show how changes in income, relative prices, and risk affect sectoral trade flows between the V3 countries and Germany. The paper adds value in the following respects. We find a weak link between these trade flows and their macroeconomic determinants, though primary products have the strongest connections. We also identify important sectoral and country-specific effects that merit further investigation. Additionally, we observe that the import-export structure of the V3 countries remained relatively unchanged over the examined period.

Another added value of this paper is the methodology, which considered both linear (ARDL) and nonlinear models (NARDL) together with asymmetries in response to the examined variables. In contrast to Sankaran, Krishna, and Vadivel (2021), who found that industrial production boosts exports in emerging economies, Chit, Rizov, and Willenbockel (2010), who demonstrated a negative influence of exchange rate volatility for exports in five emerging Asian economies, and Wa Cipamba (2015), who noted that GDP stimulates exports in South Africa, our results indicate that these relationships are not universal and depend on the sector in question. Consistent with Bahmani-Oskooee and Hegerty (2009), but for different countries, we show that exchange rate volatility, the real exchange rate, and industrial production significantly influence trade flows for certain industries.

Furthermore, our findings also show that the current economic environment is more complex than that studied by Alexander (1952), Mundell (1963), and Davidson (2009). They align more with Kashi and Lynn (2012) and Muteba and Dube (2014), who showed that sectors react differently, and with Bosupeng, Naranpanawa, and Su (2024), who found that the influence depends on the country.

These conclusions have important implications for policymakers, investors, business owners and central bank authorities, who should consider them when making decisions that affect the examined variables, as these decisions may have far-reaching consequences. Policymakers can stimulate certain sectors to increase industrial production and manage the trade balance. Governments can stimulate exports by creating stimuli for industrial production in certain sectors. Business owners should consider them while preparing market risk hedging strategies, either with financial derivative instruments or traditional methods. Central banks, through their interest rate policies, influence both the real exchange rate and its volatility. Investors especially those who speculate should be aware that their actions in the foreign exchange market may have far-reaching consequences for the real economy.

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Czy zmiany kursu walutowego wykazują asymetryczny wpływ na handel zagraniczny pomiędzy krajami Grupy Wyszehradzkiej i Niemcami?

Zrozumienie determinant przepływów handlowych pomiędzy krajami jest szczególnie ważną kwestią dla decydentów, banków centralnych i inwestorów. Artykuł bada długoterminowy wpływ realnego kursu walutowego i jego zmienności, jak również produkcji na bilanse handlowe 10 sektorów SITC pomiędzy krajami Grupy Wyszehradzkiej i Niemcami. W związku z tym, że liniowy model ARDL pokazał niewielki wpływ dla krajów i sektorów, przeprowadzono dekompozycję tych wpływów na wpływy pozytywne i negatywne za pomocą nieliniowego modelu NARDL. Artykuł tworzy wartość dodaną w następujących kwestiach. Po pierwsze, podczas gdy determinanty makroekonomiczne mają względnie słaby związek z bilansem obrotów bieżących, najmocniejsze zależności widać w podstawowych sektorach. Po drugie, chociaż większość badanych przepływów uzależniona jest od kraju, sektora, zastosowanej metody, badania wskazują na jednoznaczne rezultaty, na przykład dotyczące sektora chemicznego we wszystkich krajach oraz produkcyjnego na Węgrzech. Po trzecie, nieliniowe modele wskazują na występowanie kointegracji pomiędzy realnym kursem walutowym i bilansem handlowym pomiędzy analizowanymi krajami dla większości badanych przemysłów, choć długoterminowe współczynniki pozostają nieistotne w wielu przypadkach.

Słowa kluczowe: bilans handlowy, Grupa Wyszehradzka, zmienność kursu walutowego, asymetryczne efekty