The Gravity Modelling of the Relationship between Exchange Rate Volatility and Foreign Trade in Visegrad Countries

Gravitační modelování vztahu mezi volatilitou devizového kurzu a zahraničním obchodem ve Visegrádské skupině

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Abstract

The paper focuses on the relationship between exchange rate volatility and foreign trade. The aim of this study is to evaluate the effect of exchange rate volatility on the foreign trade of Visegrad Countries on bilateral level as well as on the commodity level for different traded product groups determined by SITC classification. An empirical analysis uses territorial and commodity structuring of foreign trade data and is realized for the period 1999:Q1 – 2014:Q3. We use panel regression applied to the gravity model of foreign trade for analyzing the exchange rate volatility effects. Exchange rate volatility leads to decreasing of foreign trade turnover on the bilateral level. In the case of Slovakia, a negative effect on foreign trade was identified in all groups except chemicals, raw materials and raw materials for food purposes. For Poland was these effects detected for trade with mineral fuels, lubricants, animal fats, oils and waxes, while other products show their negative effects of exchange rate volatility on international trade. For Hungary, all statistically significant coefficients are negative and thus confirm the assumption of reduction of foreign trade turnover with increased exchange rate volatility. For the Czech Republic, the negative effect of exchange rate volatility was reflected in trade flows of food and live animals, animal and vegetable fats, machinery, transport equipment and miscellaneous manufactured articles.

Keywords

exchange rate volatility, foreign tade, gravity model, Visegrad Countries, sectoral analysis

Abstrakt

Článek se zaměřuje na vztah mezi kurzovou volatilitou a zahraničním obchodem. Cílem této studie je zhodnotit vliv kurzové volatility na zahraniční obchod zemí Visegrádské skupiny na bilaterální a komoditní úrovni pro různé druhy obchodovaných kategorií výrobků určených na základě SITC klasifikace. Empirická analýza tak využívá územní a komoditní strukturování zahraničního obchodu a je realizována v období 1999:Q1 - 2014:Q3. Pro analýzu účinků volatility devizového kurzu je využita panelová regrese, která je aplikována na model gravitačního zahraničního obchodu. Volatilita devizového kurzu vede ke snížení obratu zahraničního obchodu na bilaterální úrovni. V případě Slovenska je negativní vliv na zahraniční obchod identifikován ve všech skupinách s výjimkou chemikálií, surovin a surovin pro potravinářské účely. Pro Polsko jsou tyto účinky zjištěny pro obchod

s minerálními palivy, mazivy, živočišnými tuky, oleji a vosky, zatímco ostatní produkty potvrzují negativní dopady volatility kurzu na zahraniční obchod. V případě Maďarska, všechny statisticky významné koeficienty jsou negativní a potvrzují tak předpoklad snížení obratu zahraničního obchodu se zvýšenou volatilitou devizového kurzu. Pro Českou republiku, se negativní vliv kurzové volatility odráží v obchodních tocích s potravinami a živými zvířaty, živočišnými a rostlinnými tuky, stroji, dopravními prostředky a průmyslovým spotřebním zbožím.

Klíčová slova
volatilita devizových kurzů, zahraniční obchod, Visegrádská skupina, sektorová analýza

JEL Codes
C51, F14, F31

Introduction

The exchange rate volatility usually means uncertainty in international markets, therefore increasing of exchange rate volatility translates into decrease of the volume of foreign trade. This basic assumption, however, can not be applied across all countries. In this paper we expect that different product categories are characterized by different price elasticity of traded goods and exchange rate uncertainty faces to various degrees of risk aversion in every country. There are subjects with a variety of consumer and producer behavior patterns. This approach allows to isolate the specific effects of foreign currency fluctuations on specific product categories and also eliminates the shortcomings of previous studies caused by the use of aggregate data.

For the purpose of analyzing the effect of exchange rate volatility on foreign trade is chosen Visegrad Four (V4), which includes the Czech Republic (CZ), Hungary (HU), Poland (PL) and Slovakia (SK). From an economic perspective, it is a group of geographically close open economies located in Central Europe, which has successfully completed the transition process to the market economies. After significant political transformation and reforms, the V4 countries experienced significant changes in their foreign trade issues as well. This process began with redirecting trade from east to west, thus the structure and intensity of trade flows has significantly changed. Their initial limited interaction with the world economy was based more on the state restrictions then the market decisions and prices. Nowadays this former relatively isolated trade bloc has turned into a region which as a whole represents a significant share of world foreign trade.

In the area of international trade, it is not a completely homogeneous group, despite many common economic features of this countries. It can be presented in the openness of individual country which has been growing in time for each economy, but the total rate varies across them. This fact can be illustrated by using the share of foreign trade on their GDP between 1993 - 2014. For the Czech Republic this rate has increased from 74% to almost 150%, for Hungary from 63% to 156%, for Poland from 39% to 78% and for Slovakia from 91% to 173%. The transformation process in the V4 countries also reflected in the development of foreign exchange rates. Country abandoned the fixed exchange rate regimes and moved through different strategies in different times toward a flexible exchange rate regime. Moreover, Slovakia, as the first of V4 countries has joined the euro area. For the rest

economies results of this study may serve as one of the arguments for further decisions on their exchange rate policy. The country with the high rates of participation in foreign trade and a gradual inclination to floating exchange rates make the V4 countries eligible for this research. Paper takes into account the territorial and commodity structure of V4 foreign trade. Therefore the aim of this paper is to evaluate the effect of exchange rate volatility on the V4 foreign trade on bilateral level as well as on the commodity level for different traded product groups.

To this end, the next section reviews relevant literature published in the examined field. The following section introduces the empirical model and data used in estimation. The next section presents and discusses the empirical results. Finally, the last section makes conducting remarks.

1 Literature Review

Sustained misalignment of exchange rates away from levels that reflect inflation or cost differentials sends incorrect price signals which could destabilize international trade flows. Furthermore, variability of exchange rate could inflict adjustment and resource misallocation costs on an economy if it changed investment decisions and results in shifts in resources between the sectors of an economy that were not justified by relative cost and productivity differentials; and may destabilize levels of protection against foreign competition provided by price-based trade restrictions, generating pressure for compensating trade restrictions to protect current patterns of supply (IMF, 1984). Economic literature shows the general assumption of negative effects of exchange rate risks on foreign trade, but this assumption is highly conditional. There can be found a theoretical explanation for the negative but also for the positive impact of exchange rate volatility on foreign trade.

1.1 Negative Effect of Exchange Rate Volatility on Foreign Trade

Clark (1973) models situation with hypothetical company operating in perfect market conditions, which produces only one kind of commodity. Its production does not import any intermediate inputs and is intended solely for export markets. The company only accepts payments in foreign currency, thus the total revenue from its exports in local currency are dependent on (unpredictable) exchange rate level. Uncertainty about future exchange rates is directly reflected in uncertainty about future income in local currency. Therefore, in a situation in which the variability of profits depends only on the exchange rate, greater exchange rate volatility results in a reduction of production and exports, reflecting exposure to risk. Ethier (1973) shares this view, arguing that exchange rate volatility has a negative impact on the volume of foreign trade, while the negative effect is not removed even by the existence of a forward or futures hedging, as their markets can not completely neutralize the risk. Baron (1976) removes almost unreal perfect competitive markets and analyzes the effect of exchange rate volatility on price developments, with a focus on the role of invoicing currency. According to Baron (1976) the exporters may diversify its foreign exchange risk by mixed billing in domestic and foreign currency (depending on their market power) but still face a certain amount of risk. If the exporter invoiced in foreign currency, the quantity demanded for its exports is unchanged, as prices in foreign markets

remain the same. However, it changes the realized and expected revenues as well as its cost. On the other hand, if the exporter invoiced in the local currency, the uncertainty facing the demanded quantity of goods to buyers because enters the uncertainty associated with prices. Unless the company invoicing in foreign currency, then the increase in risk translates into rising prices, because higher price minimizes the expected returns, but also increases the expected benefits. In case of invoicing in local currency, the overall effect changes depend on the characteristics of demand in the export market.

Paper by Hooper and Kohlhagen (1978) differs from previous studies as it does not focus on one side of the market, but defines the market equilibrium, which includes export supply and import demand. Importers and exporters, who bear the foreign exchange risk are companies maximizing their revenues. Overall, this model aimed at the effects of exchange rate volatility in prices and volume of trade preferences crucial importers and exporters regarding risk, market share of the parties on the level of risk and hedging against exchange rate risk. From the perspective of the importer (the exporter applies vice versa), part of the contract is nominated in local currency and only a sub-importer's contract is hedged. This creates uncertainty which affects the equilibrium price and quantity of goods on the market. Risk aversion can then have a double impact on the price. Risk averse importers inquire fewer goods, thus will decrease the amount of traded goods, and its price. Risk averse exporters reduce the total quantity of offered goods, the price will rise because of the risk premium. In both cases, with increasing exchange rate volatility, the total trade volume decreases.

Uncertainty generated by currency fluctuations can be eliminated by hedging instruments. However, companies have equal access to hedging and may behave differently depending on which side they are. Baron (1976) shows that if the sole source of uncertainty just exchange fluctuations, perfect forward markets neutralize the effects of exchange rate volatility on trade volume. Viaene and de Vries (1992) add that the forward markets create winners and losers among exporters and importers who are on opposite sides of the forward transactions. Caporale and Doroodian (1994) suggest that although companies have hedging instruments relate to them the costs and problems associated with the lack of foresight of participating companies, especially as regards the timing and volume of foreign exchange transactions. Furthermore, Obstfeld and Rogoff (1998) state that cost of the foreign exchange risk hedging leads to higher export prices, resulting in a negative impact on production and consumption.

1.2 Positive Effect of Exchange Rate Volatility on Foreign Trade

In some theoretical models, the impact of increased exchange rate volatility on trade flows depends largely on trader's aversion to risk. The risk-neutral traders are unlikely to be affected by exchange rate uncertainty. Paradoxically, the very risk-averse traders might just trade more, as a response to increased volatility in order to offset the expected decline in revenue per exported unit. De Grauwe (1988) states that in general, exporters are negative affected by exchange rate volatility, however, they can decide to export larger volumes of goods. The positive impact is determined by the dominance of the income effect over the substitution effect. According to Franke (1991), the increase in export volumes of companies facing exchange rate volatility depends on the optimal time adjustment of en-

tries and exits from foreign markets. Franke (1991) explains that the company in a time of increased volatility may earlier or later enter or leave the international markets. As a result of timing differences can increase the number of internationally trading companies and thus the volume of foreign trade. Viaene and de Vries (1992) attribute the positive effect of volatility due the fact that importers and exporters are on opposite sides of risk aversion, their position is reversed and thus leads to a positive effect of volatility for one of them.

Several theoretical models illustrate the effects of the exchange rate volatility more depending on the composition, than on the gross level of activities. Kumar (1992) shows that while the relationship between exchange rate fluctuations and gross value of trade is ambiguous, fluctuations have a positive impact on inter-trade. The logic of the argument is that the risk of exchange rate acts as a tax on the comparative advantage of the exporting sector versus sector locating production in the domestic market and intra-trade will increase. In this model, the exchange rate risk reduces net trade, which is the difference between gross and intra-trade. The existence of a positive relationship between exchange rate volatility and export is theoretically confirmed for companies that are able to respond flexibly to changes in exchange rates and are able to allocate the products between domestic and foreign markets (Broll and Eckwert, 1999). By using such a process, it is possible to optimize the trade revenues in an environment of increased volatility. Redistribution has its limitations and it works only if the traders have a sufficient domestic market, where they can place their productions. In this case, the domestic market acts as a market sure (Auboin and Ruta, 2013).

1.3 Empirical Testing of Exchange Rate Volatility on Foreign Trade

Early studies were performed mainly at the aggregated level. Aggregated data of foreign is given there as a volume of trade flows from respective country to all trading partners, respectively, to the rest of the world. Early studies are performed by using basic regression methods, while the dependent variable is mostly export, which is given as a function of world GDP, relative prices and exchange rate volatility. Aggregate trade flows analysis can be found for example in papers by Arize (1998), Arize and Ghosh (1994), Arize and Malindretos (1998), Doroodian (1999), Arize et al. (2000), Bahmani-Oskooee (2002), and Arize et al. (2003). The results of studies presented at the aggregate level, provides mixed results, but there is a clear dominance of proved negative impact of exchange rate volatility on the import and export flows. Bahmani-Oskooee and Hegerty (2004) attributes the mixed results to usage of different econometric analysis, a proxy variable for the choice of exchange rate volatility and also aggregation bias.

Hooper and Kohlhagen (1978) conducted one of the first bilateral studies. For the US – Germany trade in the period 1966 – 1975 they conclude that volatility has no statistically significant impact on the volume of bilateral trade, but also notes that this fact is obviously influenced by short-term volatility, the use of which is thought to cause a failure to effect long-term volatility. Cushman (1986) models the volume of exports from the US to the UK, the Netherlands, France, Germany, Canada and Japan, while the OLS model adds to the risk of a third country. Cushman (1986) concludes that these effects must be included in the formulation of business model to capture the indirect and direct risks, and notes that not including these factors can lead to an overestimation result of direct (bilateral) risks.

Although Cushmann (1986) confirms the negative impact of volatility on foreign trade, the current trend is to omit the effects of third countries (Bahmani-Oskooee and Hegerty, 2004). Cushman (1988) with further analysis of foreign trade of the United Kingdom, the Netherlands, France, Germany, Canada and Japan shows the expected negative effect of exchange rate volatility for 10 of the 12 trade flows, trade flows with Japan in this study show a positive impact. The cause of the disparity of results was considered by Cushmann (1988) as a result of proxy calculation of exchange rate volatility and the forward rate. Negative effect of exchange rate volatility on the volume of foreign trade is also confirmed in other bilateral studies, for example Dell'Ariccia (1999), Rose (2000), Tenreyro (2007). By the contrast, studies by Frank (1991) and Sercu Vanhulle (1992) show a positive impact.

As can be seen, empirical results provide mixed results. It can be caused by the choice of the data sample, as the trade balance of the country tends to react differently to exchange rate shocks (Baum et al., 2004). According to Clark et al. (2004) may be reason for the diversity of effects of exchange rate volatility in the various traded product groups. Earlier studies mostly tested the relationship on aggregate data, but trade flows of various goods may react to exchange rate uncertainty in different ways. Such differences may be caused by different duration of trade contracts, availability and cost of hedging against exchange rate risk or sensitivity to price changes in various sectors of foreign trade. Then the whole structure of foreign trade may infuence the effect of volatility on foreign trade as a whole (Johannsen and Zarzoso, 2013).

First sectoral analyses are applied on the aggregate data of the country for various product categories. Coes (1981) analyzes 13 different industry groups (mineral products, rubber products, transport equipment, textiles and nine primary products) determining the volume of exports as a linear function of exchange rate volatility, relative prices and foreign income. The study uses OLS for the period 1957 - 1974. Coes (1981) finds that all manufactured goods are affected by a statistically significant effect of exchange rate volatility, most of which are positive. The negative effect appears only in the case of beverages and rubber products. The results for agricultural products show weaker effects compared to industrial goods. Coes (1981) in the first empirical study for sectoral data shows that the agricultural and industrial goods are affected by various effects of exchange rate volatility. Different effects of exchange rate volatility between industrial and agricultural products are showed also by Maskus (1986). In his study, data are divided not only to the sector level, but also to the geographical level and focuses on trade between the US and Japan, the United Kingdom, Germany and Canada. Analysis for the period 1974 - 1984 shows that the exchange rate volatility most affects trade flows with Germany and the most affected sector was agriculture. The results for agricultural trade show negative effect of exchange rate volatility what is contrary to Coes (1981). Maskus (1986) provides the basis for sectoral analysis and was followed by many others studies (e.g. Klein, 1990; Belanger et al., 1992; Stokman, 1995).

Even through disagregation to teritorial and bilateral trade, we can find mixed conclusions. Other empirical studies therefore apply this principle, but follow also the econometric progress. Many studies use various cointegration techniques, often reflect foreign trade as a simple linear function of income, relative prices and exchange rate uncertainty. Rapp and Reddy (2000) has applied the Johansen cointegration procedure on the export

flows from the US to the G-7 in the period 1978 - 1995. The analysis includes eight sectors and exchange rate volatility calculated as a standard deviation. However, this study again provides mixed conclusions. From the 39 cointegration vectors, 18 confirmed statistically significant negative coefficient of exchange rate volatility and vice versa 14 showed a statistically significant positive coefficient. These effects differ across sectors and countries and can not be generalized.

The other sectoral analysis based on cointegration technique use proxy for exchange rate volatility calculated on the basis of ARCH model. Doyle (2001) tests the trade flows between Ireland and the United Kingdom and notes that a small open economy and its producers placing goods on the international market have no choice, only to accept the foreign exchange risk. Multinational corporations, however, according to him, can diversify risk and reduce the impacts of uncertainty. ARCH modelling of the volatility is used in many other studies (e.g. Bredin et al., 2003; Chou, 2000; De Vita and Abbott, 2004; Bahmani-Oskooee and Wang, 2007; Bahmani-Oskooee and Mitra, 2008; Bahmani-Oskooee et. al, 2012), and gradually penetrates into the panel analysis. Peride (2003) applied panel regression to analyze export demand and import supply for the G-7 with its key trading partners. Author notes that competitors, pricing strategies, and costs are specific for each sector, and therefore every industry reacts different to fluctuations of foreign exchange rates. Peride (2003) concludes that the use of GARCH model in calculating the proxy exchange rate volatility provides in this case the results for all countries more statistically significant. He highlights not only the geographical but also the sector characteristics influencing the results. While some fuels, natural products, or textiles are heavily influenced by exchange rate volatility; industrial goods and machines have lower degree of influence. Peride (2003) suggests that the weaker effect of exchange rate volatility is caused by the product differentiation in this sector.

Ozturk (2006), or Auboin and Ruta (2013) provide a fairly comprehensive overview of other empirical surveys on the impact of exchange rate volatility. These reviews show that there is a relatively wide deviation of the conclusions. Some of them confirm the hypothesis of a negative relationship between exchange rate volatility and foreign trade, others not. Furthermore, Taglioni (2002) states that even some studies confirm the fact that exchange rate volatility decreases trade flows, this effect is definitely not great.

1.4 Empirical Studies for Visegrad Countries

Most of the empirical studies are focused on the major countries in terms of global economic power. Nevertheless, it is possible to find several analyzes focusing on the V4 countries. Égert and Morales- Zumaquero (2005) analyze the direct impact of exchange rate volatility on export performance in ten Central and Eastern European transition economies, as well as its indirect impact through changes in exchange rates regimes. Study looks not only on aggregate but also on bilateral and sectoral export flows. For this purpose, the authors analyze shifts in exchange rate volatility and subsequently construct the indicator variables utilized in the export function. The authors conclude that the exchange rate volatility reduces V4 export. Cociu (2007) also examines the relationship between exchange rate volatility and foreign trade of Eastern and Central European countries. Author uses a panel regression and applies it to the aggregate data for the period 1995 - 2006.

By using real effective exchange rate is found that exchange rate volatility has a negative impact on foreign trade. Author also divides the country into two groups according to the degree of openness. This study empirically shows that the negative impact is higher in countries with greater openness, which includes the Czech Republic, Hungary and Slovakia. Contrary, less influence was demonstrated for Poland, whose openness is lower. Tomanová (2013a) analyzes the impact of exchange rate uncertainty on exports of the Czech Republic. She focuses on three different periods with respect to the financial crisis. In her study is used vector error correction model. According to the reults, exchange rate volatility has no statistically significant relationship with exports even in the pre-crisis, crisis or post-crisis period. Tomanová (2013b) in another study estimates the impact of exchange rate volatility on export performance of Central European countries into the euro area, but even in this case there is no significant results.

Ozturk and Kalyoncu (2009) use gravity model and find evidence that exchange rate volatility has a negative impact on foreign trade of Poland, but in the case of Hungary these effects are positive. Gravity model was used also by Ferto and Fogarasi (2012). The study examines transition economies of Central Europe in 1999 - 2008. The results show that the nominal exchange rate volatility has a statistically significant negative effect on agricultural foreign trade. Šimáková (2013a) uses gravity model to analyze the effects of exchange rate volatility on bilateral trade of Poland with 19 trading partners in the period 1997 - 2012. Exchange rate volatility is calculated as a standard deviation. The results of panel regression confirmed for Poland statistically significant negative impact of exchange rate volatility of the Polish zloty on its foreign trade. The same econometric technique was also used by Šimáková (2014b), who analyzed the impact of exchange rate volatility on bilateral trade flows in Hungary. In panel regression in this analysis were included 12 major trading partners. The results also confirm that the nominal exchange rate volatility of the Hungarian forint have a statistically significant negative impact on bilateral trade over the period 1997 - 2012. For the Czech Republic, similar research was conducted by Šimáková (2014c) by using the data for 17 trading partners. Contrary, for exchage rate volatility calculation was used generalized ARCH model. Even for the Czech Republic, it is confirmed the negative impact of the volatility of nominal exchange rate on the total realized bilateral foreign trade. For Czechia, Babecká Kucharčuková (2014) applies both static and dynamic version of the gravity model on panel data for its 38 trading partners in the period 1999 - 2008. The study leads to the same conclusions as Šimáková (2014c) and also shows that magnitude of exchange rate volatility is greater while using a dynamic model.

Studies at the aggregate level provide important results about the prevalence of negative impact, but there can be possible bias of results. Distortion caused by the aggregation of data is a potential problem if the bilateral trade flows with different partners, although manifest as both positive and negative relationship with exchange rate volatility, but these interactions are smoothed at the aggregate level. Empirical analysis at the teritorial level allows the use the bilateral exchange rates (instead of effective exchange rate). Moreover, the response of the trade to fluctuations in exchange rate may vary by country, depending on the nature of trade. For these reasons, aggregating of data could obscure the fundamental individual and different dynamics of bilateral relations, which would lead to erroneous conclusions at a general level and neglect the consequences on the bilateral level. Recent studies disaggregate trade also on the level with respect to commodities or

sectors. Testing of sectoral data helps further reducing of distortion caused by aggregation. The use of product-level data also allows the identification of sectors that are more affected by fluctution of the exchange rates. This approach enables to isolate the specific effects of exchange rate volatility on specific goods. Hence this paper is based on the teritorial and product disaggregating.

2 Data and Methodology

A situation in which the observed relationship seems to be ambiguous and highly conditional, leads to the need for more sophisticated models with several countries, different commodities, and other factors directly related to foreign trade. The current tendency is to use gravity model. Leamer and Levinsohn (1995) argue that the gravity model produces the brightest and most robust findings in empirical economics, and thus represents a sufficient basis for assessing the impact of different variables on foreign trade. Foreign trade in the gravity models is usually based on the assumption that acceleration of their common trading activities is given by distance between the two countries and the size of their markets. This model is derived from Newton's law of gravity, thus describes the force of gravity in the form of trade flows between pairs of countries, commensurate with their economic "weight" (national income) and inversely proportional to the distance between them. Tinbergen (1966) uses this universal law to model the foreign trade as:

$$TT_{df} = \delta \frac{Y_d^{\beta_1} Y_f^{\beta_2}}{D_{df}^{\theta}} \tag{1}$$

where the volume of foreign trade between the two countries TT_{df} is directly proportional to their income $Y_{d(f)}$ and inversely proportional to the distance between them D_{df}.

Use of gravity model was initially based on intuition rather than on economic theory. This often criticized deficiency is gradually withdrawn, as gravity equation corresponds to basic microeconomic model of foreign trade. Some economists argue that this is not just a purely econometric tool without theoretical basis but it is considered a model consistent with trade theories with imperfect competition of Heckscher-Ohlin theory. Bergstrand (1989) shows that countries trade differentiated goods, because consumers prefer diversity. Deardorff (1998) adds that the gravity model can arise from the traditional business model based on the proportions of production factors. Eaton and Kortum (2002) derive a gravity equation from Ricardian model. Carrere (2005) explains his theoretical foundation by imperfectly competitive environment through increasing returns to scale and product differentiation at the company level, in perfect competition again through product differentiation at the national level. Helpman et al. (2008) and Chaney (2008) obtained it from the theoretical model of international trade in differentiated goods with the assumption of heterogeneity of companies. For the purpose of this paper is used Dell'Ariccia´s gravity model (1999), which extends the original gravity equation in the form:

$$\begin{aligned} lnTT_{df} = \alpha + \beta_1 lnY_d + \beta_2 lnY_f + \beta_3 lnPOP_d + \beta_4 lnPOP_f + \beta_5 lnD_{df} \\ + \beta_6 lnV(ER) + \beta_6 lnCB_{df} + u_{ij} \end{aligned} \tag{2}$$

which is based on the assumption that countries with greater economies tend to trade more (in absolute value) as they form larger demand and supply. In addition to the domestic (Y_d) and foreign (Y_f) income, the model includes variables of population $POP_{d(f)}$ to characterize their economic size. Hence, with increased demand and supply of internationally traded goods, we expect the increase of total volume of foreign trade and therefore positive coefficients of these parameters. Greater distance between countries D_{df} decreases the bilateral trade, as it means higher transportation costs, prolongation in delivery time and higher cost of finding alternative business opportunities. The estimated coefficient is thus assumed in negative signs. By analogy, these factors are eliminated by common borders *CB*, which should positively contribute to the volume of foreign trade between the countries. The model further assumes a direct relationship between the volatility of foreign exchange rates *V(ER)* and trade flows TT_{df}, as risk aversion subjects reduce the volume of business due to rising costs of hedging against exchange rate risk. Possibly they can leave international markets totally. For the sectoral analysis the model is adjusted to the equation:

$$lnTT_{p,df} = \alpha + \beta_1 lnY_d + \beta_2 Y_f + \beta_3 lnPOP_d + \beta_4 lnPOP_f + \beta_5 lnD_{df} + \beta_6 lnV(ER) + \beta_6 lnCB_{df} + u_{ij} \quad (3)$$

where$TT_{p,df}$ represents the volume of trade carried out within individual product categories.

2.1 Modelling of Exchange Rate Volatility

Although the earlier studies assessed the exchange rate volatility by using the standard deviation, it has some limitations that can be eliminated by using autoregressive model of volatility. In particular, ARCH model was first applied by Engle (1982). ARCH model is based on two predicates: (i) time series models are heteroscedastic, with the volatility variable over time; (ii) volatility is a simple quadratic function of the predicted past errors (deviations from the conditional averaging). The first ARCH models are affected by some drawbacks which can be eliminated by generalized ARCH (GARCH) model, which allows to model volatility as depending variable on its previous values. GARCH model (m, s) has the form:

$$y_t = \mu_t + e_t, \qquad e_t = \sigma_t \varepsilon_t, \qquad \sigma_t^2 = \alpha_0 + \sum_{i=1}^{m} \alpha_i e_{t-i}^2 + \sum_{j=1}^{s} \beta_j \sigma_{t-j}^2 \quad (4)$$

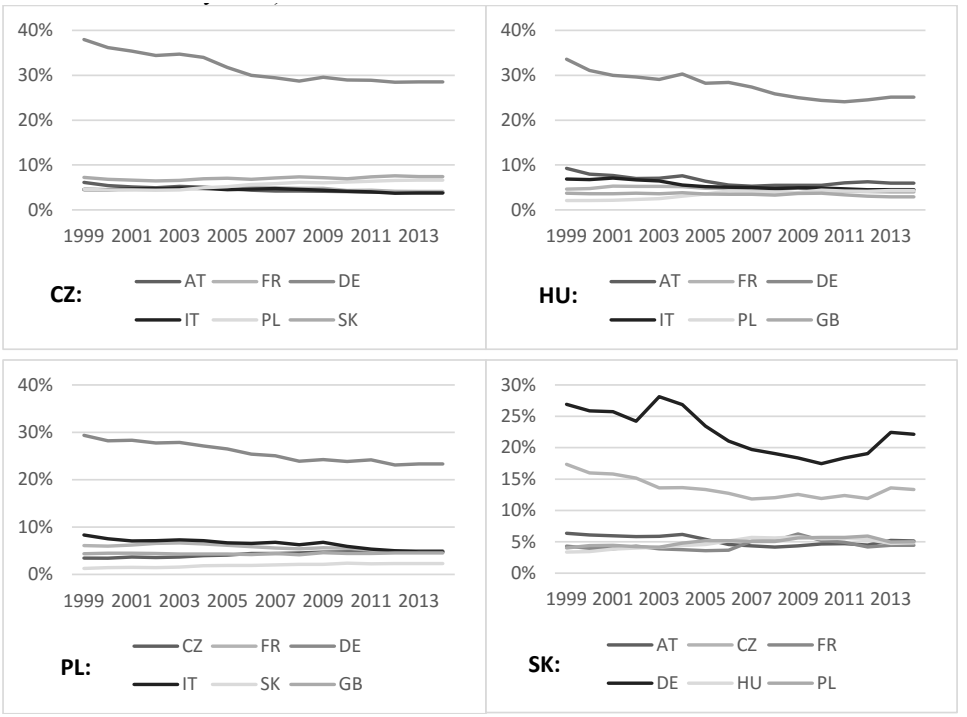
where ε_t are random variables with zero mean and unit variance and parameters of model meet $\alpha_0 > 0$; $\alpha_i \geq 0$; $\beta_j \geq 0$; $\sum_{i=1}^{max\{m,s\}} (\alpha_i + \beta_i) < 1$. Peride (2003), in his study focused on the analysis of panel data of foreign trade, concludes that the use of GARCH modeling in estimating the proxy for exchange rate volatility creates more statistically significant results. Therefore, this kind of volatility modeling will be also used in this paper.

2.2 Data

This paper analyzes effects of exchange rate volatility on V4 foreign trade in the period 1999:Q1 – 2014:Q3. The paper distinguishes foreign trade at two levels, namely the territory and commodity. Territorial composition of foreign trade is understood as a share of partner countries on total trade operations expressed in value. By the territorial view

can be seen which countries are the most important importers and exporters of V4 countries. Currently, approaches to the foreign trade statistics are fragmented in two basic approaches. The first is based on the principle of the transfer of goods across the border and is in line with the so-called traditional foreign trade statistics. Exports shall be understood as physical crossing of goods across the border to foreign countries. The exports and imports are counted as well as transactions by non-residents on the territory of the country. This statistic describes only the physical movement of goods across borders, regardless of whether there is trade between domestic and foreign entities. The second approach is based on the change of ownership and is thus consistent with the construction of balance of payments and national accounts. Although this statistic is a good starting point for the compilation of balance of payments of the country, cross-border statistics has its foothold in the global methodological manual of the International Merchandise Trade Statistics and the European Union legislation. If individual countries consistently applied the principle of change in ownership, the data would not be consistent bilaterally. Hence, for the purposes of this paper is used cross-border statistics, which is comparable internationally and can serve as an indicator of the value of trade in the selected countries.

Figure 1: Development of Territorial Structure of V4 Foreign Trade (share on total foreign trade of the country in %)



Source: authors' calculations based on data obtained from OECD database

Note: The abbreviation explanation: Austria (AT), France (FR), Germany (DE), Great Britain (GB), Italy (IT)

The bilateral analysis uses cross-border trade data between a particular country and its six major trading partners. The selection of partner countries represents at least 50% of

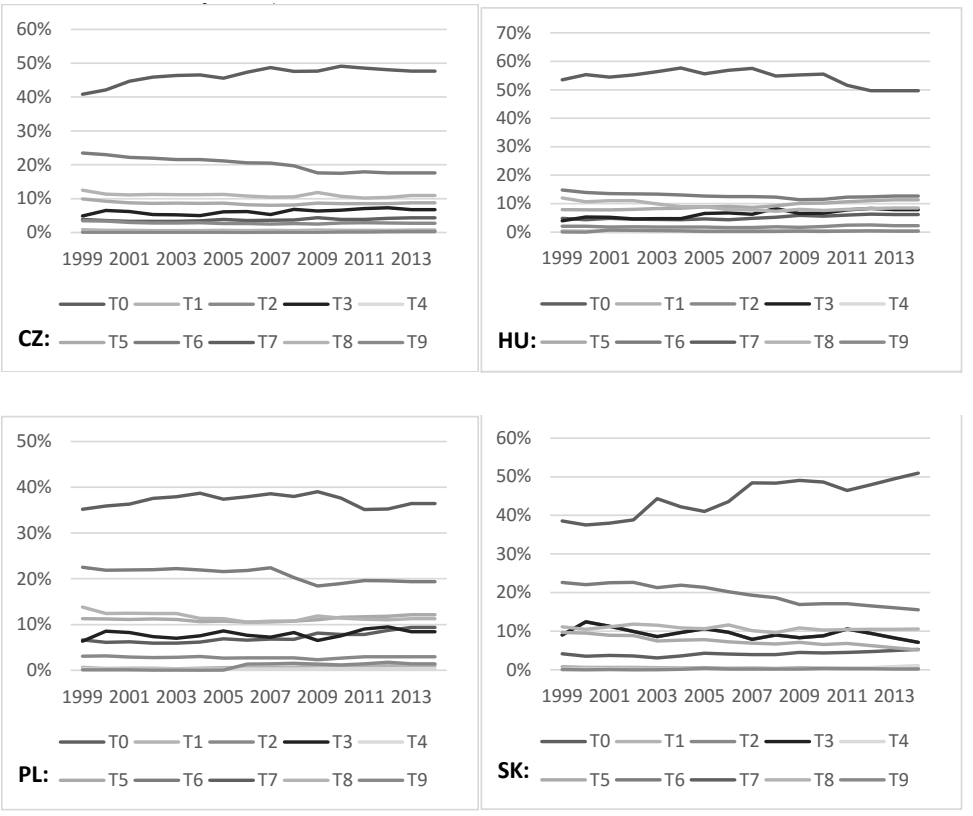
the total foreign trade turnover of each V4 country. Figure 1 shows the shares of major trading partners of the V4 countries on their total foreign trade turnover. It can be seen that the V4 countries focuse on the similar export markets and their regional similarity of consumer behavior translates also to their mutual trade. Approximately 25% of total V4 trade is realized with Germany. Foreign trade of the V4 is so clearly influenced by german economic development, although it must be noted that the share is decreasing in time. Slovakia has one more significant partner, which is beyond the average of other observed trade – the Czech Republic. Bilateral trade between these two countries is based on the long-term economic ties. Even from the perspective of the Czech Republic, Slovakia is the second most important foreign market. In general, the V4 countries implement foreign trade thanks to barrier-free trade with EU countries (almost 80% on average). Among major trading partners belonging to non-EU countries with lower share on V4 foreign trade are markets supplying goods in lower price levels (USA, China), long-term strategic partners (Russia) or territory of foreign direct investment (South Korea).

The product analysis of foreign trade monitors shares of individual product categories on total imports and exports. Classification of commodities used in the paper is determined by the Standard International Trade Classification (SITC), which divides traded goods in the 10 classes. Result of this classification is the segmentation of the commodities not only by the type of material from which they occurred but also by their economic purpose and level of processing. Basic SITC classes are:

- T0: Food and live animals;
- T1: Beverages and tobacco;
- T2: Crude materials, inedible, except fuels;
- T3: Mineral fuels, lubricants and related materials;
- T4: Animal and vegetable oils, fats and waxes;
- T5: Chemicals and related products;
- T6: Manufactured goods;
- T7: Machinery and transport equipment;
- T8: Miscellaneous manufactured articles;
- T9: Commodities and transactions not classified elsewhere in the SITC.

The share of individual SITC categories on total V4 foreign trade can be seen in Figure 2. There is visible dominance of traded SITC category T7, whose average share of trade flows in the sample period is 47% in Czechia, 57% in Hungary, 37% in Poland and 44% in Slovakia. Another important traded category is T6, which for the Czech Republic, Poland and Slovakia represents another 20% share, respectively 13% in case of Hungary. T8 group represents about 10% share in each analysed country. V4 economies are concentrated in trade of manufactured goods, machinery, transport equipment and other manufactured products with higher added value.

Figure 2: Development of Commodity Structure of V4 Foreign Trade (share on total foreign trade of the country in %)



Source: authors' calculations based on data obtained from OECD database

Exchange rates *ER* in the model are ussed in direct quotations of nominal bilateral exchange rates. This is in accordance to arguments of Auboin and Ruta (2013) that the choice between nominal and real exchange rate does not affect the econometric results. Data of exchange rates are derived from the Eurostat database. Income Yd respectively Yf, is represented by GDP of each country in current prices. Foreign trade and GDP are at a quarterly frequency and are derived from the OECD database. GDP is transferred to the index (unitless) form, as recommended by Bahmani-Oskooee (1991). Data of population $POP_{d(f)}$ are also obtained from the OECD database. Data of the distance between the V4 countries and their business partners are taken from the GeoDist database. The bilateral distances are measured using city-level data. Capital city is considered to be the economic center in all countries included in the estimations.

3 Results and Discussion

To examine the effect of exchange rate volatility on the foreign trade turnover is used a gravity model based on Dell'Ariccia (1999). *TT* is the sum of the values of total exports and imports in bilateral flows of major trading partners. The TT_p is trade turnover calculated as

the sum of exports and imports in individual SITC product category for each selected trading partner. To model the volatility of exchange rates is used GARCH model. Volatility is calculated on monthly data, while their quarterly values are calculated as a quarterly average of its monthly values. The panel regression modelling of foreign trade turnover in individual product categories includes six cross sections (trading partners) and 63 periods (1999:Q1 – 2014:Q3). Heteroscedasticity is examined by using White's test and the appropriateness of the model in terms of autocorrelation is verified by Durbin-Watson statistics which estimates in this analysis range from 1.7 to 2.2.

3.1 Results for Czechia

The majority of estimated parametres for Czechia are statistically significant. As shown in Table 1, the insignificance can be observed mainly in the distance coefficient, population size and common border. In product group analysis, we can observe the expected positive effect of GDP growth on foreign trade. Estimated impact effect of Czech GDP seems to be generally greater than that of foreign income (excluding product groups T1 and T2 representing 4% of the total foreign trade). Theoretical expectations of positive impact of the growth of population size are empirically validated for product groups T4, T5, T7, T8 and T9. This trade represents 68% of the total foreign trade. With an increase of population of Czechia and its trading partners we expect increased demand for goods traded between their markets. For product categories T5 and T7 is estimated negative effect of distance between economic centers. While in the product group T5 is estimated the expected inverse relationship of foreign trade turnover and the common border between trading partners.

Product-level analysis for each SITC category further shows that the impact of exchange rate volatility across the tested products is different. The negative impact on trade was estimated in groups T0, T4, T7 and T8. These groups represent together 63% of the total turnover of Czech foreign trade. By the contrast, a higher exchange rate volatility is accompanied by an increase in foreign trade turnover in the other product categories. The dominance of product-level trades with indirect relationship between exchange rate volatility and individual tested SITC category translates into a negative coefficient of total trade. Similar results were found on aggregated data by Cociu (2007) using the OLS method. Babecká Kucharčuková (2014) also confirmed the negative effect by using the dynamic and static gravity model. The theoretical assumption of the negative impact of exchange rate volatility on bilateral data was also verified by Šimáková (2014c). For categories T0 and T4 are results consistent with a study by Ferto and Fogarasi (2012), who also confirmed the negative effect of exchange rate volatility on the Czech agri-food trade.

Table 1: Estimated Parametres of Gravity Model of Czechia

	TT	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9
Y_d	1.68 ***	2.69 ***	1.22 ***	0.85 ***	1.52 ***	2.10 *	1.92 **	1.53 ***	2.15 ***	1.59 **	3.12 ***
Y_f	0.21 ***	0.11 ***	1.75 ***	1.15 ***	0.52 ***	0.46 ***	1.02 ***	1.15 ***	0.85 ***	1.02 ***	0.12 ***
POP_d	-1.56 **	-2.31	-0.28 ***	-2.15 **	-1.67 **	0.56 ***	0.22 ***	-0.69 ***	1.52 ***	0.85 ***	0.97 *
POP_f	0.37	-0.37 ***	-0.15 ***	-1.02 ***	-0.52	-5.21	1.25	0.54 **	0.56	-0.42	0.26
V(ER)	-0.05 **	-0.52 ***	1.38 ***	1.45 **	0.63 ***	-0.25 **	0.14 *	0.59 ***	-0.45 ***	-0.13 ***	0.12 **
D_{df}	1.39	0.36 ***	0.35 ***	3.88	1.89 *	4.53	-0.96 **	1.25	-1.28 **	-4.02	-2.03
CB_{df}	1.07 *	0.36 ***	0.31	2.75 ***	3.24	3.25	-0.52 *	3.01	2.01	1.03 ***	3.45

*Note: ***, **, * denote significance level at the 1%, 5% and 10% level, respectively.*
Source: authors' calculations

3.2 Results for Hungary

Results for Hungary stated in Table 2 show less statistically significant indicators in comparison to Czechia. In the case of total trade, there are found statistically significant coefficients in accordance with the stated assumptions of the positive effect of GDP growth, population growth and the negative effect of increased exchange rate volatility, or the distances between economic centers. Statistically significant parameters of domestic and foreign income in the product category T5 show that economic growth has a positive effect on foreign trade. In comparison to the Czech Republic, the average estimated impact of domestic income in this analysis is lower than impact of foreign income. The effects of population size for each trade volume are mixed and can not be generalized. Study by Martinez-Zarzosa (2003) states that with the economic growth (here approximated by the GDP and population) can be exported more goods as a result of economies of scale and import more with increasing of product demand. However, the country can export less when the absorption effect prevails and country´s output is consumed by domestic individuals as less products remain for export. Estimated effects for Hungary also shows that common borders or the distance between economic centers in comparison to other parameters do not significantly affect the trade. This fact is probably due to membership of trading partners in the European Union, which provides barier-free trade without significant additional costs for its implementation.

Exchange rate volatility shows in case of total trade statistically significant negative coefficient, what means negative impact on the volume of foreign trade caused by the volatility increasing. However, the results on the product level show that a statistically significance of exchange rate volatility causes reduction of the trades, but this reduction is not as high as evidenced at the overall level. Statistically significant regression of the parameters shows that

the exchange rate volatility leads to a decrease of the group T2, T3, T5 and T6. These groups represent 30.21% of foreign trade activities in the monitored flows. For other categories are not estimated statistical significant coefficient. The results of the study correspond to Cociu (2007) who also estimated the negative effect of exchange rate volatility on the volume of foreign trade at the agregated level through panel regression by using standard deviation to calculate a proxy for the foreign exchange volatility. The standard deviation was also used in the study by Šimáková (2014c) who through the gravity model estimated similar effects at bilateral level. The different results may be found in a study by Ozturk and Kalyoncu (2009). Differences in estimates are attributable to both, the use of different econometric techniques (Engle-Granger cointegration), and also its application to time series data since 1980. The analyzed data include the period durin foreign trade had been influenced more by central planning then the exchange rates.

Table 2: Estimated Parametres of Gravity Model of Hungary

	TT	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9
Y_d	0.11 ***	0.16 ***	1.13 ***	-0.06	0.11	0.23	-0.13 ***	0.11 ***	0.16 ***	0.01	-0.47
Y_f	0.25 ***	0.30 ***	0.16	0.58 **	0.51	0.62	0.24 **	0.14 ***	0.41 ***	0.30 ***	-0.04
POP_d	1.24 **	3.02 **	-0.95	1.33	-0.56	1.29	-0.23 *	-0.40 ***	-0.48	-1.18	-1.71
POP_f	-1.85	0.62	-0.41 *	0.59	-1.13	0.33	-0.51	-2.71	1.13	-1.04 **	-0.86
V(ER)	-0.19 **	0.00	-0.01	-0.01 **	-0.00 **	-0.00	-0.01 ***	-0.00 ***	-0.00	-0.00	-0.00
D_{df}	-0.00 *	-0.00	0.00	-0.00 **	0.00	-0.01	0.00	0.00	-0.00	-0.00	-0.16
CB_{df}	-0.00	0.00	0.00	-0.00	0.01	0.00	0.00 **	0.00	0.00	0.00	0.02

*Note: ***, **, * denote significance level at the 1%, 5% and 10% level, respectively.*
Source: authors' calculations

3.3 Results for Poland

Estimated results for Poland are summarized in Table 3. The analysis shows a direct link between the volume of foreign trade and GDP size of the economies involved in the tested foreign trade. One exception is a whole product category T9, whose coefficient of foreign GDP is negative. Poland as an only country (except coefficient T5) has statistically significant coefficients which show the expected effects of population size, population growth and the expanding demand and supply of goods causes increasing of the total volume foreign trade. For product groups T0, T1, T2, T7 and T8 are all statistically significant parameters in accordance with economic assumptions. Product categories representing 44% of the foreign trade of Poland are positively affected by domestic and foreign GDP, by the size of their populations and the existence of the common border. On the other hand, the volume of trade in

these categories decreases with the increase of exchange rate volatility and is also negatively affected by the distance between economic centers of trading partners. In the other product groups, the results within product categories in several ways differ. Product category T9 shows opposite effects of the foreign population and also of the foreign income. Regarding the effects of income (expect product group T2) can be stated that Poland's foreign trade is influenced more by domestic than foreign GDP. Similar results are confirmed in the Czech Republic. Product groups T3 and T4 evidenced positive effect of increasing exchange rate volatility on the volume of realized trade.

Cociu (2007) also demonstrated the negative impact of exchange rate volatility on the Polish foreign trade turnover. Effect of exchange rate volatility in his study compared to other countries is lower. This fact was explained by arguing that small open economies are affected more by the exchange rate volatility. However, when comparing the results of this paper for Poland and Hungary the hypothesis can not be confirmed. The negative impact of exchange rate volatility calculated by the standard deviation for Poland has also been confirmed by using Engle-Granger cointegration in the study Ozturk and Kalyoncu (2009) and using the panel regression model applied by Šimáková (2013b). At sectoral level in the categories of food and agriculture products are results comparable to the study by Ferto and Fogarasi (2012).

Table 3: Estimated Parametres of Gravity Model of Poland

	TT	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9
Y_d	0.51 ***	0.48 ***	1.25 ***	0.41 **	0.23 *	1.26 *	1.03 ***	1.26 ***	1.87 ***	1.01 *	0.23
Y_f	0.43 ***	0.30 ***	0.74 **	0.58 **	0.01 **	1.02	0.24 **	0.14 ***	0.41 ***	0.84 ***	-0.04 *
POP_d	2.31 **	1.25 **	-2.03	0.85 **	1.41 ***	0.15 *	0.94 *	0.54 ***	1.23 ***	1.15 **	-0.54
POP_f	1.81 **	2.54 ***	2.34 ***	1.43 **	0.24 *	1.25	-0.01 **	0.15 **	0.82 ***	1.37 **	-0.01 *
V(ER)	-0.52 **	-1.36 ***	-1.99 **	-0.54 **	0.01 **	0.15 **	-0.96 ***	-1.25 ***	-1.00 ***	-0.05 ***	-0.40 **
D_{df}	-0.45 *	-0.25 **	-0.10 ***	-0.05 **	0.10 **	0.01 ***	0.22 ***	-0.71 ***	-0.52 ***	-1.41 ***	-1.96 ***
CB_{df}	1.50 ***	0.96 **	1.52 ***	2.05 ***	3.01 ***	1.63 ***	1.22 **	-0.25 **	1.58 ***	1.42 ***	1.02

*Note: ***, **, * denote significance level at the 1%, 5% and 10% level, respectively.*
Source: authors' calculations

3.4 Results for Slovakia

Estimated parameters derived from a panel regression for Slovakia are reported in Table 4. The product level analysis shows the expected positive impact of GDP on foreign trade turnover of the country. For groups T2, T4, T6 and T9 dominate the effects of foreign income

over the effects of domestic income. Especially in the case of category T6 it is probably due to a significant predominance of export over import of this products. Interesting finding is the fact that the foreign income has approximately the same impact on the trade turnover in all product categories. Estimates of the impact of population size can not be clearly generalized. Theoretical expectations of positive impact of the growth of population size are empirically validated only for product categries T5, T7 and T9, what is consistent with results for Czechia.

Disaggregation to product level further shows that the impact of exchange rate volatility varies across the tested product categories. The negative impact on trade was observed in all product categories except T2, T5 and T9. These groups together represent only 16% of the total turnover of Slovak foreign trade. The fact that a reduction in exchange rate volatility may be reflected in the increased foreign trade turnover is confirmed by the summary indicator of total trade. The same result for aggregated data can be found in paper by Cociu (2007). If we approximate food and agricultural products by category T0, T1 and T4, then the results also correspond with results of a study by Ferto and Fogarasi (2012).

Table 4: Estimated Parametres of Gravity Model of Slovakia

	TT	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9
Y_d	1.35 ***	2.04 ***	1.56 ***	0.87 ***	1.52 ***	1.32 ***	2.90 **	1.09 ***	2.26 ***	2.59 **	1.02 ***
Y_f	1.21 ***	1.05 ***	1.22 ***	1.13 ***	1.30 ***	1.36 ***	1.17 ***	1.15 ***	1.22 ***	1.19 ***	1.12 ***
POP_d	0.52 **	-1.05 ***	-0.20 ***	2.05 **	1.67 ***	0.62 **	0.23 ***	-0.68 ***	1.12 ***	0.96 ***	0.93 **
POP_f	0.37 **	-0.37 **	-0.15 **	-1.02 **	-0.52 *	-5.21 *	1.25 *	0.54 **	0.56 **	-0.42 **	0.26 ***
V(ER)	-0.25 ***	-0.72 ***	-0.63 ***	0.15 **	-0.03 ***	-0.24 **	0.17 **	-0.25 ***	-0.16 ***	-0.14 ***	0.12 **
D_{df}	-0.39 ***	0.38 ***	-0.05 ***	-1.78 **	0.59 *	2.09	-0.15 **	1.27 **	-1.26 **	-1.27 **	-3.12
CB_{df}	1.76	0.39 *	4.31	2.63	2.14	1.25	1.63	2.73	1.59	1.68	1.25

*Note: ***, **, * denote significance level at the 1%, 5% and 10% level, respectively.*
Source: authors' calculations

3.5 Discussion of Results for V4 countries

Results of this paper correspond to the existing empirical literature at the aggregated level, which also confirmed the negative effects of exchange rate volatility on V4 foreign trade. Product-level analysis further shows that the impact of exchange rate volatility across the tested product categories can differ. Results show disunity with economic theory in some ways and can not be clearly generalized. Estimated coefficients can be divided in categories with statistically insignificant or economic minimal effects and to categories with important effects. Crude materials, mineral fuels, lubricants and related materials are mostly traded in

the world currencies. This fact translates to the regression coefficients approaching the zero effect of the exchange rate of national currency for the whole Visegrad Four. The world currencies are also used for the trade of transit goods, which entitles roughly the same share of export and import flows. On the other hand, goods produced in a V4 country and afterwards exported to the partner country are affected by exchange rates volatility more significantly, what can be resulted by companies' revenues and expenditures realized in different currencies. Trade with food, live animals, beverages, tobacco and less competitive goods like chemicals and manufactured goods are affected by exchange rate volatility in a positive way as fluctuations in the exchange rate may be used to seize temporary business opportunities. The demand of these goods is more elastic and subsequent delay in exchanging currency to earn a profit.

Ambiguous exchange rate volatility effect on foreign trade which do not verified the economic theory can be explained by several characteristics of V4 participation in international commodity movements. V4 countries have import-intensive exports, the share of imported goods in GDP in 2014 was over 60%, suggesting the economy heavily dependent on imports. Another typical feature is a significant presence of foreign direct investment. Many foreign companies with subsidiary branches in countries surveyed include multinational corporations operating on different territories. This fact implies their strong involvement in export and import transactions within multinational companies.

World economic environment is constantly changing and the current trend of global supply chains and multinational companies is also accompanied by an expansion of the total international trade flows due to intermediate crossing national borders several times during production. In this situation, the relationship between the exchange rate and trade flows can vary significantly. Kiss and Schuszter (2014) also discuss the implications of corporate financing through loans in foreign currencies. All these attributes result in the fact that the bulk of international trade is related to the natural hedging. Čadek et al. (2011) provided such analysis of hedging in case of Czech companies and found that the majority of exports are realized through the euro. The incoming and outgoing payments of foreign trade are carried out without the use of local currency. The paper states that in 2009, almost 60% of Czech exports used natural hedging and the rest was covered mainly by financial derivatives. Similar conclusions can also be found for the other V4 countries in the study by Égert-Zumaquera and Morales (2008). According to Abrams (1980) is a determinant of the relationship and potential export capacity of the country, its structure and consumption, which affects the elasticity of the demand for export and import and, therefore, the effect of exchange rate volatility on trade flows. An important factor in the characteristics of foreign trade V4 is the degree of integration of trading partners. According to Martinez-Zarzoso and Ramos (2008), with the higher integration of economies, the volume of trade between them is increasing and exchange rates as one of the determinants and act to a lower extent. V4 clearly shows the importance of integrity for the implementation of foreign trade and for trade within the EU.

Conclusions

Paper was focused on the relationship between exchange rate volatility and foreign trade. The aim of this paper was to evaluate the effect of exchange rate volatility on the V4 foreign trade on bilateral level as well as on the commodity level for different traded product

categories. Empirical analysis of the effects of foreign currency fluctuations on the foreign trade of the Czech Republic, Hungary, Poland and Slovakia was realized for the period 1999 - 2014. This period represents an environment for analyzing the effects of currency fluctuations on foreign trade in economies based mainly on market principles without government intervention, with floating regime of exchange rates. This work was based on the assumption that the different product categories are characterized by different price elasticity, in every country there are subjects with a variety of consumer and production patterns of behavior and therefore exchange rate uncertainty effects may be different across territorial and product level. Paper provides relatively new insight into the considerations discussed as it represents comprehensive study for the V4 countries provided by relatively new territorial-commodity approach to foreign trade. This paper contributes to the analysis dealing with the post-communist countries, which are fully transformed into a market economy. Conclusions expand the knowledge of empirical studies applied on the V4 region that have been made in the past, mostly for shorter periods of time and on aggregated data. This paper eliminates possible distorted conclusions caused by aggregation of different product categories and countries.

Disaggregating of foreign trade data for each product category shows that the impact of exchange rate volatility across the tested product categories can differ. In the case of Slovakia, a negative effect on foreign trade was identified in all groups except chemicals, raw materials and raw materials for food purposes. For Poland was these effects detected for trade with mineral fuels, lubricants, animal fats, oils and waxes, while other products show their negative effects of exchange rate volatility on international trade. For Hungary, all statistically significant coefficients are negative and thus confirm the assumption of reduction of foreign trade turnover with increased exchange rate volatility. For the Czech Republic, the negative effect of exchange rate volatility was reflected in trade flows of food and live animals, animal and vegetable fats, machinery, transport equipment and miscellaneous manufactured articles. This diversity in estimating of the effects of exchange rate volatility on foreign trade can be found also in the papers relating to the product-level analysis in other countries (e.g. Bahmani-Oskooee and Wang, 2007; Bahmani-Oskooee et al., 2014). This paper provides evidence that the increased exchange rate volatility, which presents a risk for companies operating in international markets, is not clearly translated into decrease of the turnover of the foreign trade.

This paper demonstrates that the exchange rate volatility clearly affects the foreign trade but there is a need to differentiate regional characteristics of the markets where can be placed the production as well as the types of products that will be given for trading in selected foreign markets. The results can be considered by national central banks of V4 countries in assessing the potential impact of the current exchange rate policy. Conclusions can also be used in the creating economic policies to promote foreign trade of specific products.

Acknowledgement

Publication of this paper was supported by the Student Grant System of Silesian University [project SGS/7/2013].

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