Narodowy Bank Polski

NBP Working Paper No. 268

Exchange Rate Volatility and Exports in the run-up to the EMU accession

Łukasz Goczek, Dagmara Mycielska

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Warsaw, 2017

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This research project was conducted under the VII NBP open competition for research projects and was financed by Narodowy Bank Polski.

Published by:
Narodowy Bank Polski
Education & Publishing Department
ul. Świętokrzyska 11/21
00-919 Warszawa, Poland
www.nbp.pl

ISSN 2084-624X

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Abstract

According to theory of monetary integration, lower exchange rate variability is believed to be the main positive effect of a common currency. However, empirical studies do not confirm this negative and significant impact of exchange rate volatility on trade. In this report, we analyze the relationship between the exchange rate volatility and the export performance of Central and Eastern European non-euro EU countries: Poland, Czechia, Hungary, and Romania. We use monthly frequency data on export flows to the euro area and the European Union. The sample covers the period from 2000M1 till 2015M6 and we control for the financial crisis of 2008-2009 when exchange rate variability increased considerably. We measure exchange rate volatility using traditional standard deviation approach and GARCH models. The main hypothesis is verified using both aggregated data and sectoral trade data. The effects of euro exchange rate volatility on Polish trade are explored with more focus by estimating a series of vector error correction models and by assessing impulse-response functions. For the panel data estimation, we employ second-generation dynamic panel cointegration model with PMG estimator. The results suggest that the elimination of the exchange rate volatility through euro adoption will not necessarily increase the export performance of the countries integrating with the euro area.

JEL classification: F14, F15, F45

Key words: exchange rate volatility, exports, EMU, GARCH, cointegration, PMG estimator

1. Introduction

The elimination of exchange rate risk is the most common out of all arguments in favor of monetary integration. The never-ending fluctuations of exchange rates under floating exchange rate regimes may significantly increase costs of foreign trade. According to this dominant view, the elimination of unfavorable exchange rate fluctuations through a single currency should promote trade between integrated economies. The results of the survey carried out among exporters and importers show that the main problem is not so much the level of the exchange rate but its fluctuations that result in uncertainty and high costs of hedging (NBP, 2011). In the case of the firms with risk aversion, the introduction of a single currency leads to the elimination of exchange rate risk, which lowers the cost of doing business and thus has a positive impact on exports. It turns out, however, that such a common sense representation of the relationship between exchange rate volatility and trade is weakly reflected in the results of theoretical and empirical research. The impact, if any, is difficult to estimate. Even if the firm conclusion for all countries may not be possible to obtain, nowadays answering this question is essential to the analysis of benefits for countries deliberating on their accession to the EMU.

The aim of the report is to answer the question whether the elimination of currency risk associated with the introduction of the common currency may increase trade between Eurozone and countries with a derogation in terms of the euro adoption, namely Poland, Czechia, Hungary, and Romania. So far, the studies of this subject were conducted mainly ex-post of the accession, focusing on the effects of monetary integration on trade, especially in the case of countries - new members of the Eurozone (Cieślik et al., 2009, 2014). This report aims to determine the current importance of the variation of the euro exchange rate for exports, particularly in light of the results of the reviewed studies indicating a significant variable exchange rate risk for the currencies in the region.

Verification of the hypothesis that nominal exchange rate volatility lowers exports is carried out using a series of econometric models. As a measure of exchange rate volatility, a standard deviation of the first differences of logarithms of the nominal exchange rate of the euro is used, which is one of the most widely used measures of exchange rate variation (Ozturk, 2006). However, for robustness subject to the measurement error problem, we compare the obtained results using an implied conditional variance from a Generalized Autoregressive Conditional Heteroskedasticity family of models (GARCH, TARCH, EGARCH) to capture possible asymmetrically time-varying variance of exchange rates.

The empirical part of the project consists of three parts. Firstly, we estimate the model on aggregated data for Poland using Vector Error Correction Mechanism (VECM) modeling. Unlike most related studies, which solely use aggregated data, in addition to aggregate study we model the trade in all of the SITC sections using global variables. In this part, we use Global Vector Error Correction (GVECM) modeling to capture the endogenous dynamics of exports in all of the analyzed sections. The third part of the analysis is the panel estimation. We do not constrain the volatility estimates to be the same across all sectors of the economy and therefore we avoid troubles of aggregated responses. Moreover, our estimation methods allow for capturing the cross-dependencies in panels and allow for short and long run heterogeneity. In each part of the report, the analyzed trade and economic data come from public databases of the statistical offices of the respective countries, and Eurostat.

Verification of hypotheses enable answering a series of questions about the cost of exchange rate volatility in Poland and other EU countries with a derogation, both at the macroeconomic level and broken down by sectors of trade. McKenzie (1999) suggested that the effects of exchange rate volatility on export might vary across sectors. That might explain insignificant results of analyses on aggregated data. The different export flows' reaction to exchange rate fluctuations is not only the result of the degree of heterogeneity of goods among sectors. Other causes may be the difference in the level of competition, the invoicing currencies, and the different elasticities of firms' reaction to changing export prices, production scale, access, or use of hedging instruments that vary across sections. Therefore, we expect very different results for different categories of industrial activities of enterprises. Cost assessment of variation in these aspects is essential for the analysis of the benefits of Polish accession to the EMU related to the irrevocable bonding of the currencies' exchange rates with the euro. It will also allow for a comparison of these costs with other countries with a derogation.

In the empirical part of the presented report we incorporated wide range of econometric models. However, the achieved results do not allow to fully answering research questions, mainly due to the low statistical significance of the results. We believe that exports performance is the result of many factors, with the exchange rate variability being only one of many. We find this to be another argument in favor of our hypothesis. The exchange rate stability might have marginal effect for export increase in the case of non-euro EU countries we analyzed.

The report is structured as follows. The next section reviews the literature. The third part discusses the data and the measures of exchange rate volatility used in the study. The fourth part involves the analysis of macroeconomic demand for Polish exports to determine the endogenous elasticity of exports to the exchange rate volatility. The main hypothesis of a negative impact of volatility on exports is verified using a VECM model and appropriate parametric hypotheses verification. This allows determining the casual impact of exchange rate volatility on export fluctuations robust to reverse causality. The findings indicate that the integration of the analyzed companies into global value chains meant that transaction costs and currency risks ceased to be as important as they were before the economic integration with the euro area.

Based on the results of the fourth section, the fifth part of the study is conducted on the monthly data of Polish exports broken down into basic categories of trade. In this part, we join the method known as Global Vector Autoregressive (GVAR) modeling with the cointegrated error correction mechanism to arrive at the Global Vector Error Correction (GVECM) modeling to capture the endogenous dynamics of exports in all of the analyzed sections with global values of all other variables. The sixth section of the report is based on the results of the panel data estimation for non-euro European Union Member States with the derogation in terms of the euro: Czechia, Hungary, Poland, and Romania. This analysis, in addition to traditional methods, uses the latest methods of estimation of the second-generation dynamic panel cointegration, including the presence of unit root tests, cointegration, spatial relationships (or cross-dependencies), and methods of analysis panels with heterogeneous units of observation. In the seventh section, we discuss the models estimated in order to check the robustness of the results. We introduced Germany as a partner country, the level of exchange rate and the total trade of partner country and we change the measure of export flows. The analysis of the obtained results follows in the last section that concludes with policy implications.

2. Literature review

According to the prevailing view, high exchange rate volatility leads to a reduction in the volume of trade (Ozturk, 2006). In the simplest terms, high exchange rate volatility increases costs and thus it should have a negative impact on international trade. Those costs are associated with a gap in time between the invoice and the actual payment settlement. In the case of high exchange rate volatility, the value of income or expense of a transaction is difficult to predict, which reduces the attractiveness of foreign trade in relation to sales on the domestic market. Moreover, the management of foreign exchange risk through hedging instruments is not available for most firms, due to the high cost of such protection or lack of such possibility in the underdeveloped financial markets.

The relationship between exchange rate stability and enhanced international trade lies at the core of the optimum currency area theory (OCA). As postulated by OCA, the introduction of a single currency on an optimal currency area allows reducing trading costs, i.e. by removing exchange rate risks and costs of risk hedging altogether. In addition, through enhancing price transparency, the single currency reduces market segmentation. The economic and financial integration thus promote reciprocal trade and this advantage is believed to be the most substantial gain from monetary integration.

However, the results from theoretical and empirical research indicate that the impact of exchange rate volatility, and in fact, the impact of uncertainty regarding prices resulting from changes in the exchange rate on exports is ambiguous. A broad discussion of theoretical work was carried out in McKenzie (1999). He showed that it is possible to construct theoretical models postulating a negative but also a positive relationship between the variance of the exchange rate and exports. This depends largely on assumptions regarding the trader's preferences for risk, time horizon, and the level of development of the financial market, especially in the context of the availability of derivative instruments on currencies. De Grauwe (1988) and Dellas and Zilberfarb (1993) showed that exchange rate volatility affects trade through two opposite effects: substitution and income. The uncertainty resulting from increased exchange rate volatility reduces trade volume. The income effect is associated with changes in the amount of expected revenues from trading due to changes in exchange rate: the increased volatility in the exchange rate leads companies to increase exports to offset the decline in expected revenue. Whichever of the effects dominates depends on the degree of preference for risk. In the case of low-risk aversion, the first effect dominates and the effects of decreasing trade foreign exchange risk are in line with the prevailing views. However, at sufficiently high propensity to risk, the income effect dominates and the high exchange rate volatility would actually increase international trade.

Some theoretical considerations point out that the exchange rate volatility might be simply irrelevant for trade. Baldwin and Krugman (1989) showed that due to the existence of sunk cost the entry or exit decisions might not be reversed even if the exchange rate changes in unfavorable direction. The same might be true for firms which credits are denominated in foreign currencies (Puchalska and Tymoczko, 2013).

The conclusions of the empirical research are equally ambiguous. One can formulate a thesis that in the case of empirical research more emphasis was put on the confirmation of the existence of the relationship between exchange rate volatility and international trade than to determine the direction of this relationship. A comprehensive review of existing empirical studies is conducted by Ozturk (2006), Coric and Pugh (2010), Bouoiyour and Selmi (2013). The conclusions of their meta-analysis indicate that exchange rate volatility has an impact on trade, but the strength and direction of this impact are dependent on a number of assumptions. Some researchers obtained results suggesting that high volatility can support the export (including Bredin et al., 2003; Achy and Sekkat, 2003; Bouoiyour and Selmi, 2013). For the most, however, these results indicate a very weak or the apparent lack of impact of exchange rate volatility on exports (including Aristotelous, 2001; Tenreyro, 2007; Boug and Fagereng, 2010; Hutchet-Bourdon and Korinek, 2011).

Hall et al. (2010) suggest that the high volatility of the exchange rate will be more important for small economies. The effects of high volatility will be more felt by small traders, especially in countries with low levels of development of the financial market and strong economic relations with one (dominant) economy (Doroodian, 1999). In the sample of emerging countries, the authors obtained a negative but statistically insignificant result.

The argument put forward in the introduction seems to be consistent with the results of surveys on currency risk perception and management carried out among Polish and Czech firms (Tymoczko, 2009; Cadek et al., 2011; Hrubosova et al., 2013; Puchalska and Tymoczko, 2013; NBP, 2013). It turns out that exchange rate fluctuations influence export decisions to a lesser extent than it is commonly believed. In this context, the need to gain and hold a presence in foreign markets, to uphold cooperation with foreign customers and the scale of export dependence on imported manufacturing process, or debt in foreign currencies are actually more important than even volatile exchange rate. In addition, a decreasing number of companies point to the exchange rate as a barrier to growth (NBP, 2013). On the one hand, these results may indicate a steady stabilization of the currency market and greater predictability of changes in exchange rates. On the other hand, it may be the effect of greater risk awareness and a more active management of currency risk. According to various studies, 40-60% of firms of CEE countries involved in international trade hedge the risk. Analysis of responses to open-ended questions, however, shows that despite greater market stability and a better understanding of the problem of exchange rate risk, the situation on the currency market is still seen as uncertain by the companies themselves. Probably this is related to a more active management of currency risk by companies. As of 2007, nearly 50% of companies affected by the currency risk reported hedging an open currency position (Tymoczko, 2009), while in 2012 it was already 70.2% of the respondents (Puchalska and Tymoczko, 2013). What is interesting, most firm hedge the risk when the domestic currency is depreciated by historical comparison or when appreciation is expected. Therefore, the hedging might be seen as seasonal and rather infrequent. That also might influence ambiguous results of empirical analyses.

It should be noted, however, that one of the methods to deal with the currency risk is simply to accept it and take on potential losses. Marczewski (2002) distinguishes five basic types of response to changes in exchange rates: price adjustments, adjustments in volumes, pushing sales on the domestic foreign market, the adjustment cost and bring profits. The last type is virtually no reaction and holding out the effects of exchange rate movements. Survey results indicate that Polish companies frequently decide to reduce their currency risk by natural hedging - adjusting the budget structure by retaining profit and balancing flows. This type of safety measure is one of the easiest undertakings that can be applied by both exporters and importers, i.e. those most experienced by the currency risk. Some of the companies also actively manage currency risk in the financial market, though not many. According to the latest data, only 22% of the companies facing the risk reach for derivatives, most of which are simple forwards. Interestingly, contrary to popular opinion the reasons for not having hedged currency positions are not related to costs - only 11% of the companies surveyed that accept the unhedged risk admit that the reason for their lack of protection are high costs. It turns out that the most common reason is their perception of a low level of risk. Such a reason is declared by 19% of the companies that accept the unhedged risk (Tymoczko, 2009).

Analysis of the results of surveys carried out among Polish companies gives two insights directly related to our subject. More than 58% of enterprises declared to avoid currency risk by conducting activities, which does not involve making settlements in foreign currencies. This does not necessarily mean a lack of sales on foreign markets because it is possible to acquire trading partners accepting the settlement in the national currency of the exporter. However, this shows that Polish exports volume does not need to be sensitive to changes in exchange rates. On the other hand, over 60% of companies declare risk management, if not through derivatives, then through the adjustment expenses, gains, or natural hedging. What's more, companies prefer to reduce the risks associated with transactions in export than import, which shows that they care more about income than expenses. It follows that the change in the exchange rate may not be significant for exports.

The relationship between exchange rate volatility and trade could also be analyzed using trade endogeneity framework using the theoretical difference between intra- and extra- industry trade. The term intra-industry trade refers to the international trade in comparable goods produced by the same industry in different countries as opposed to extra-industry trade that occurs in very dissimilar industries. In the intra-industry trade, since the countries produce very similar products, a sudden volatility in the exchange rate could render their products at a disadvantage in the competitive international markets.

Both theoretical and empirical studies do not deliver firm conclusions. The relationship between the exchange rate volatility and trade seems to be country and sample specific. In this study, we concentrate on the fact that opinion that higher exchange rate uncertainty reduces international trade is recalled in relation to a single currency adoption. Therefore, we discuss the actual gains from monetary unification in terms of trade in relation to the non-euro EU countries with derogation in terms of euro. The literature on this problem is rather limited.

The impact of exchange rate volatility on trade in the context of Polish integration with the Eurozone was analyzed by Cieślik et al. (2009). The authors use a gravity model to find that forex volatility was statistically significant and had a negative impact on trade. Another study, of an ex-post basis, repeated for the same sample of countries - new members of EMU, i.e. Cyprus, Malta, Slovakia and Slovenia, confirmed that limiting the volatility of the exchange rate had a positive impact on exports of these countries to the EU countries (Cieślik et al., 2014).

Tomanova (2013) analyzed the exchange rate volatility's impact on exports to euro area in the case of the Visegrad Group countries: Poland, Czechia, Slovakia, and Hungary. Using monthly frequency aggregated data and GARCH model as a volatility measurement and ARDL and VECM methods she showed that the impact of exchange rate volatility on export is inconsistent. The results indicate no significant short-run relationship between export and exchange rate volatility. Exports is positively related to changes in foreign income what is consistent with traditional export demand function. Though insignificant, the results of VEC model suggest that exchange rate volatility enhances export for Czechia, Hungary and Slovakia and reduces in case of Poland. However, estimated parameters are small indicating rather limited influence of volatility on trade. According to ARDL model Czechia export flows are negatively influenced by exchange rate volatility in very short run. Results for other countries are insignificant. What is interesting, results suggest that CEE countries' export is highly dependent on non-domestic factors and development in euro area or EU countries.

Some studies concentrate on individual countries. Sandu and Ghiba (2011) analyzed the exchange rate impact on Romanian exports using VAR model and quarterly data for real exchange rate and export flows from 2003 till 2011. The estimated model is quite simple as no other explanatory variable is being used. The shock in the exchange rate has significant effects on exports, though variance decomposition shows a weaker relationship.

The Romanian case was also analyzed in Gherman et al. (2013). They use the monthly frequency data and estimate impact of the exchange rate volatility on export for six different groups of goods. They showed that the dependence between exchange rate and export is higher in case of food then for other analyzed goods (transport equipment, fuels, chemicals, and capital goods).

The impact of exchange rate volatility on export of agricultural goods in case of Romania was analyzed by Fogarasi (2011). Using gravity model and yearly data for 1999-2008 and with moving standard deviation of the first differences as a measure of volatility he showed that exchange rate volatility has negative effect on Romanian exports of agricultural goods. The agriculture goods are homogeneous and less storable then other goods. Contracts are rather short-term and the firms face strong market competition. Therefore agriculture trade is more influenced by exchange rate variation then trade of other products (e.g. manufactured sector, Huchet-Bourdon and Korinek, 2011).

The impact of exchange rate volatility on trade was also analyzed in case of Czechia. Simakova (2014) used GARCH model to estimate volatility and VEC model on quarterly data over the years 1997-2012. The empirical results are mixed. Only for some partner countries expected negative effects of volatility on export flows were confirmed. For some countries data suggests positive dependency. On the contrary, Babecká-Kucharčuková (2014) estimated the impact of nominal exchange rate volatility on trade flows in case of Czechia using static and dynamic models and quarterly data till 2008. The result pointed to negative and significant relation. As both papers differ in the volatility measure, sample and period analyzed no firm conclusion for Czechia can be obtained.

3. Empirical methodology

3.1. Introduction and hypotheses

We employ traditional export demand function:

$$EX_{ij,t} = f\left(Vol_t, {P_t^j}/{P_t^i}, Y_t^j, Y_t^i\right), \tag{3.1}$$

where $EX_{ij,t}$ denotes the aggregate export volume of reporting country i to the partner country j in period t, Vol_t represents a measure of exchange rate volatility, P^j_t/P^i_t represents relative prices, which approximate external competitiveness, Y_t^j – denotes foreign demand and Y_t^i – denotes domestic demand in period t.

After taking the logarithms, equation (1) can be rewritten as:

$$ex_{ij,t} = \beta_0 + \beta_1 vol_t + \beta_2(p_t^j - p_t^i) + \beta_3 y_t^j + \beta_4 y_t^i + \varepsilon_t, \tag{3.2}$$

where ε_t is the error term.

Summing up the disscussion above - the parametric hypotheses can be outlined as follows:

H0: $\beta_1 < 0$. The impact of the exchange rate volatility on exports is negative. However, as it was shown in the literature review both positive and negative exchange rate volatility parameter can be expected. Also, as it was pointed out in the discussion in the preamble, in the case of Poland this parameter may be irrelevant for exports to the Eurozone and the European Union.

H0: $\beta_2 > 0$ the impact of relative prices on exports is positive.

H0: $\beta_3 > 0$ the impact of foreign demand on exports is positive.

H0: $\beta_4 < 0$ the impact of domestic demand on exports is negative.

3.2 The data

We use data for individual country or group of countries, depending on the estimated model. Reporting countries (i) are: Czechia (CZK), Hungary (HUN), Poland (PLN), and Romania (ROM). We define European Union (EU) as a group of 27 countries, whereas Eurozone (EA or euro) is defined as a group of 18 countries. Germany (GER) was introduced as a main trading partner for all four countries of interest. The models are estimated by using monthly and daily data over the period 2000.01-2015.06[1]. Most studies use aggregated data for exports. However, as it was discussed earlier, the effects of exchange rate volatility on export may vary across sectors. The use of aggregated data assumes that exports' elasticities against exchange rate volatility are equal across different groups of traded goods. This assumption is rather restrictive and unlikely to be confirmed in reality. As it was explained earlier, the reaction of export volume in a given sector to changes in exchange rate volatility depends on many factors, related to the nature of markets in which goods are produced and traded. In effect, the analysis on aggregated data may fail to properly assess the effects of volatility on exports. Therefore, in addition to aggregated data, we also use data on exports in trade sections using SITC nomenclature.

We decided to use the SITC nomenclature as it is recommended by the United Nation Statistics Division for use in the analyses of international merchandise trade. As it is explained in SITC description, commodity grouping reflects, among others, the material used in production, the processing stage and market practices and uses of products[2]. This type of grouping allows for catching different nature of markets in which given goods are traded (Peridy, 2003).

[1] See detailed discussion of the data used in Appendix.
[2] http://unstats.un.org/unsd/iiss/Print.aspx?Page=Standard-International-Trade-Classification

The further data disaggregation to divisions or groups could provide some useful information. However, this approach has two drawbacks. Firstly, comprehensive analyses on data on SITC trade divisions would require estimation of nearly 70 models for each division. This would dilute any firm conclusions on the possible relationship and potentially make results incomparable to previous studies. Secondly, such a study should include industry-specific variables instead of aggregated independent variables, what is questionable since many industry or country data are not available with monthly frequency. For example, Peridy (2003) while arguing the need for more disaggregated analyses on international trade, limits his study to 20 manufacturing industries due to data availability. Moreover, analysis on too detailed export data might be biased due to volume fluctuation that stems from other, non-economic factors (e.g. introduction of trade embargo for a group of products).

As the measure of exports, we use monthly data on the export volume. The monthly average of the nominal exchange rate, defined as a price of euro in reporting countries' currencies, was calculated based on the average daily quotations of the euro in each currency. We employ two different measures of exchange rate volatility, see the discussion below. Due to lack of monthly data for the GDP or income, we used industrial production indices as proxy variables of the foreign and domestic demand.

There are various approaches in literature on how to measure the relative competitiveness between domestic and foreign goods. We employ two proxies. Firstly, we use producer prices indices as a proxy for import and export prices. Secondly, we use the idea introduced by Boug and Fagereng (2010). We calculate the export price index (P^i_t) for each SITC sector for each reporting country. Then we assume that domestic exporters compete on the EA or EU markets with exporters from other countries. Therefore, the competing price facing exporters may be described as a weighted sum of import prices indices of the partner countries. We calculated the import price indices for each SITC sector for each reporter using the following formula:

$$P^*_{i,SITC,t} = P^*_{i,SITC,t-1} \times \left[1 + \sum_m \left(k_m \times \left[\frac{PI^m_t}{PI^m_{t-1}} - 1\right]\right)\right], \quad (3.3)$$

where $P^*_{i,SITC,t}$ is the import price index facing country i in period t, calculated separately for each SITC section, with initial value normalized to unity. m represents three of the most important trading partners for each reporter, k_m are trade weights[3]. PI_t^m represents import price index for each SITC section in country m in period t.

All data, except for quotations of exchange rates, was obtained from Eurostat and ComExt. The quotes of the exchange rates were taken from data made available by the statistical offices. We tested extensively all of our variables for a unit root/stationarity with the use of Dickey-Fuller Test with GLS Detrending (ERS test), The Phillips-Perron, the Kwiatkowski, Phillips, Schmidt, and Shin (1992) stationarity test, and Vogelsang and Perron (1998) unit root breakpoint test. The results of the tests are in Table 3A.1a-e (in Appendix). All variables turned out to be I(1).

3.3 Exchange rate volatility measures

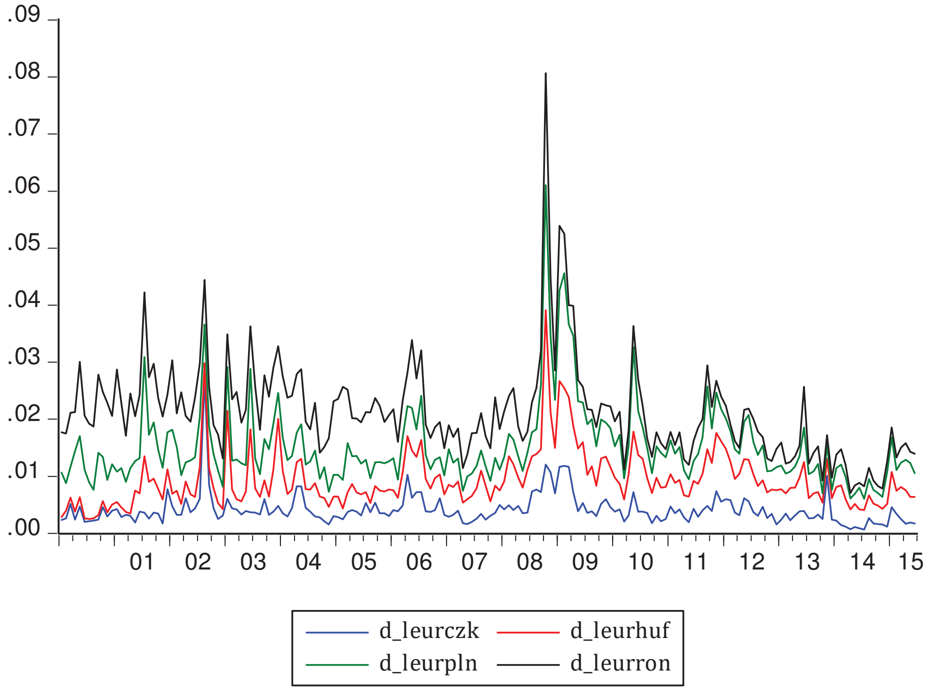
The basic question in the context of the impact of exchange rate volatility on trade is whether the decisions of enterprises are affected by changes in the real or nominal exchange rate. Changes in the nominal exchange rate, which could have caused a decline in exports, could be offset by an adjustment of the prices and costs. On the other hand, basing the study on the real exchange rate implies taking into account risks arising from factors other than the nominal exchange rate that could be significant for relative prices. Moreover, some studies have proved that nominal and real exchange rate

[3] See the Appendix for further details.

generates almost identical empirical results (McKenzie, 1999). In the case of a floating exchange rate, it seems reasonable to use the nominal exchange rate. Its high variance should have a dominant influence on changes in the real effective exchange rate and this enables us to measure how this volatility is affecting the trade.

We ran the estimation in two steps. Firstly, we estimate the volatility of nominal exchange rate of each currency against the euro; secondly, we verify the impact of volatility on export. However, there is no widely accepted method in the literature for calculating volatility. Most commonly used measure is the standard deviation of the first differences or moving average standard deviation of exchange rate changes (Bouoiyour and Selmi, 2013). Therefore, as our first measure of volatility, a standard deviation of the first differences of logarithms of euro exchange rate is employed. The average monthly rate was calculated based on the average daily quotations of the euro in each currency. Figure 3.1 plots these volatilities.

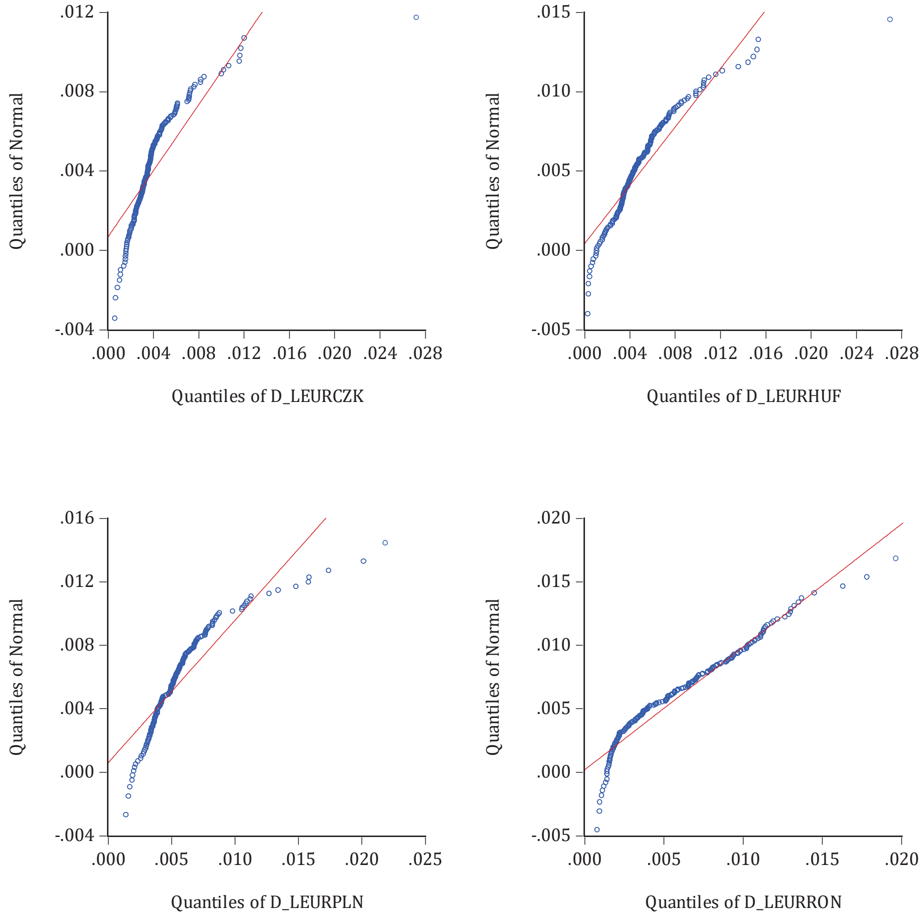
Figure 3.1 Volatility series for standard deviation of the first differences of logarithms EUR/PLN, EUR/CZK, EUR/HUF, and EUR/RON exchange rates



Source: own

Such measures as the standard deviation, however, have been questioned by Pagan and Ullah (1988) on the ground that they lack a parametric model for the time-varying variance of exchange rates. Moreover, as assessed by the authors these measures are likely to suffer from the measurement error problem and produce biased estimates of the impact of exchange rate risk. We follow this study to take a closer look at the quantile-quantile regression plots of the standard deviation of the first differences of logarithms of exchange rates shown in Figure 3.2. The deviations from the 45-degree curve at both ends allow speaking of an asymmetric or threshold effect of volatility. In other words, very positive and very negative news may have a different effect in the foreign exchange market. We will investigate this issue using our second measure of volatility.

Figure 3.2 Quantile-quantile regression plot for standard deviation of the first differences of logarithms EUR/PLN, EUR/CZK, EUR/HUF, and EUR/RON exchange rates



Source: own

For some time now, modeling volatility with the use of ARCH models gained importance in the financial literature. In these models, volatility clustering occurs - large changes in returns are likely to be followed by further large changes caused by behavioral dynamics (herding behavior, panics, and runs). Therefore, more efficient volatility estimates can be obtained if heteroscedasticity in error terms is handled properly. Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized ARCH (GARCH) allow us to capture the time-varying conditional variance and unexpected volatility. It is claimed that it is a proper measure for flexible exchange rate system (Doroodian, 1998). ARCH(q) postulated that the conditional variance is a linear function of the past q squared innovations. To obtain the best-fitted volatility combination of ARMA and GARCH model can be used. Then the mean of the process can be modeled as ARMA and the variances as GARCH. Moreover, we will use various specifications of these models as we expect that different aspects of volatility may have a differentiated impact on exports. Therefore, we consider:

- Standard GARCH model
- Threshold GARCH (TARCH) Model
- Exponential GARCH (EGARCH) Model
- Power ARCH (PARCH) Model

Standard GARCH models assume that positive and negative error terms have a symmetric effect on the volatility. In other words, good and bad news have the same effect on the volatility in this model. In practice, this assumption is frequently violated; in particular, the volatility increases more after bad news than after good news. A very simple but plausible explanation for this effect is that not all of the market participants can agree to take negative returns to the same extent, which leads to a higher volatility. Thus, the volatility reacts asymmetrically to the sign and magnitude of the change. The two typical models to analyze this effect are the TARCH and EGARCH model. TARCH or Threshold ARCH and Threshold GARCH were introduced by Zakoïan (1994) and Glosten, Jaganathan, and Runkle (1993). The generalized specification for the conditional variance is given by:

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \sum_{i=1}^{p} \alpha_i \epsilon_{t-i}^2 + \sum_{k=1}^{r} \gamma_k \epsilon_{t-k}^2 I_{t-k}^- \tag{3.4}$$

where $I_{t=1}^- = 1$ if $\varepsilon_t < 1$ and 0 otherwise. In this model, good news ($\varepsilon_{t-i} > 1$) and bad news ($\varepsilon_{t-i} < 1$) have differential effects on the conditional variance; good news has an impact of α_i, while bad news has an impact of $\alpha_i + \gamma_i$. If gamma is nonzero, bad news increases volatility, and we say that there is a leverage effect for the i-th order. If $\gamma_i \neq 0$, the news impact is asymmetric.

The EGARCH or Exponential GARCH model was proposed by Nelson (1991). The specification for the conditional variance is:

$$\log(\sigma_t^2) = \omega + \sum_{j=1}^{q} \beta_j \log(\sigma_{t-j}^2) + \sum_{i=1}^{p} \alpha_i \left| \frac{\epsilon_{t-i}}{\sigma_{t-i}} \right| + \sum_{k=1}^{r} \gamma_k \frac{\epsilon_{t-k}}{\sigma_{t-k}} . \tag{3.5}$$

The left-hand side is the log of the conditional variance. This implies that the leverage effect is exponential, rather than quadratic, and that forecasts of the conditional variance are guaranteed to be nonnegative. The presence of leverage effects can be tested by the hypothesis that $\gamma_i < 0$. The impact is asymmetric if $\gamma_i \neq 0$.

In the Power ARCH model, the power parameter δ of the standard deviation can be estimated rather than imposed, and the optional parameters γ are added to capture asymmetry of up to order I:

$$\sigma_t^\delta = \omega + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^\delta + \sum_{i=1}^{p} \alpha_i (|\epsilon_{t-i}| - \gamma_i \epsilon_{t-i})^\delta \tag{3.6}$$

where $\delta > 0$, $|\gamma_i| < 1$ for all *i* up to *r*, and $\gamma_i = 0$ for all *i* over *r*.

In order to test for the presence of a time-varying conditional variance for our series, we needed to estimate the best fitting ARMA model (Box-Jenkins methodology). The models have been estimated using a general-to-specific framework based on the minimization problem Schwarz-Bayes Information Criterion (SIC). In all cases ARMA(1,1) model was selected to be the baseline specification. The only exception was an ARMA(2,2) model for the more volatile Romanian leu (RON) exchange rate. Due to p-value=0,95 in serial correlation LM test we cannot reject the null hypothesis suggesting no serial correlation and use Lagrange multiplier (LM) test for ARCH. As a result, we have an ARCH effect in all four of our exchange rates series (Table 3.2).

Table 3.2. Heteroskedasticity ARCH test results

PLN	F-statistic	189.2558	Prob. F(1,4007)	0
	Obs*R-squared	180.8104	Prob. Chi-Square(1)	0
CZK	F-statistic	929.3967	Prob. F(1,4007)	0
	Obs*R-squared	754.7917	Prob. Chi-Square(1)	0
HUF	F-statistic	198.7228	Prob. F(1,4007)	0
	Obs*R-squared	189.4275	Prob. Chi-Square(1)	0
RON	F-statistic	107.6022	Prob. F(1,4006)	0
	Obs*R-squared	104.8399	Prob. Chi-Square(1)	0

Source: own

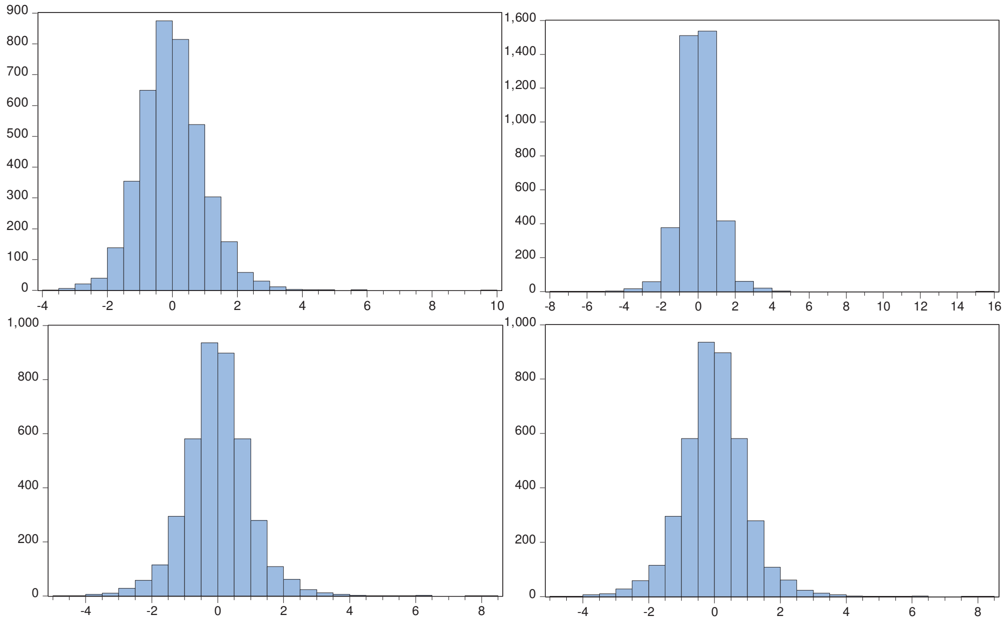
Then all four models were estimated to make volatility groups to provide our GARCH implied volatility series. We ran diagnostics for a GARCH model. Correlogram–Q-statistics is a correlogram (autocorrelations and partial autocorrelations) of the standardized residuals. All Q statistics are insignificant which means that mean equation is correctly specified and there is no remaining serial correlation. Correlogram of the squared standardized residuals says that the variance equation is correctly specified, as no Q-statistics are significant. As indicated by the test statistics in Table 3.3, there is no remaining ARCH term in data. Residuals are normally distributed at 10% level of significance and less. However, this result heavily depends on the right long tail of volatility achieved during the peak of the financial crisis, when all of the currencies of the region significantly depreciated (Figure 3.4). This consideration should be accounted for using a dummy variable for the crisis period and this is done in the following investigations.

Table 3.3. Heteroskedasticity ARCH test results

PLN	F-statistic	0.243280	Prob. F(1,4006)	0.6219
	Obs*R-squared	0.243386	Prob. Chi-Square(1)	0.6218
CZK	F-statistic	0.243280	Prob. F(1,4006)	0.6219
	Obs*R-squared	0.243386	Prob. Chi-Square(1)	0.6218
HUF	F-statistic	0.000333	Prob. F(1,4006)	0.9854
	Obs*R-squared	0.000333	Prob. Chi-Square(1)	0.9854
RON	F-statistic	0.014462	Prob. F(1,4004)	0.9043
	Obs*R-squared	0.014470	Prob. Chi-Square(1)	0.9043

Source: own

Figure 3.4 Normality of the GARCH volatility series for PLN (upper left) CZK (upper right), HUF (lower left) and RON (lower right) exchange rates



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Figures 3.5a and 3.5b plot all 16 of the estimated GARCH volatilities for each pair of exchange rates. There are no significant differences between the plots showing that the asymmetries in the reactions of the exchange rates are significant statistically, but not economically. To obtain this preferred volatility specification SIC minimization method was applied as displayed in Table 3.4.

Figure 3.5a GARCH volatility series for Polish zloty (PLN) and Czech koruna (CZK) exchange rates

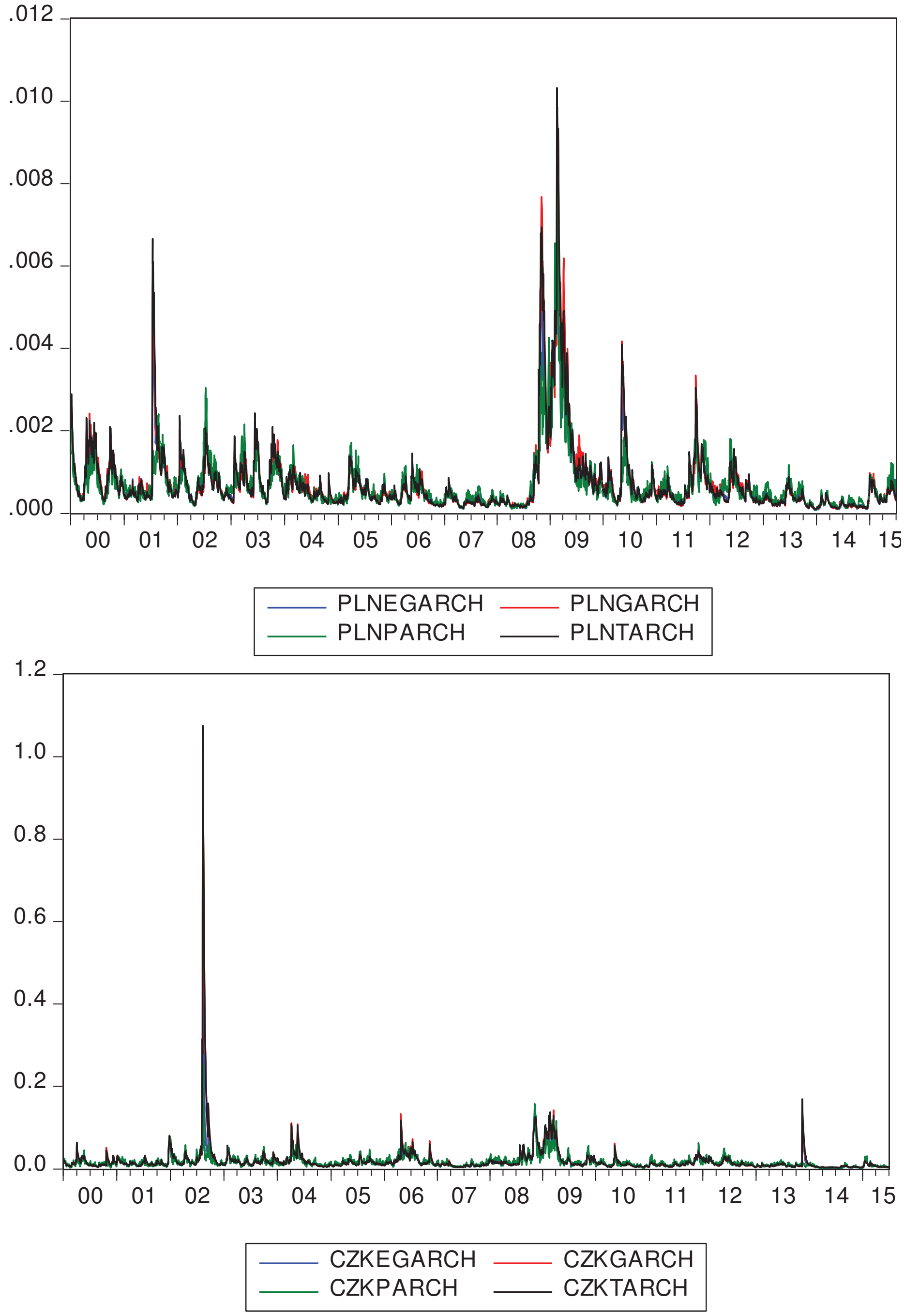

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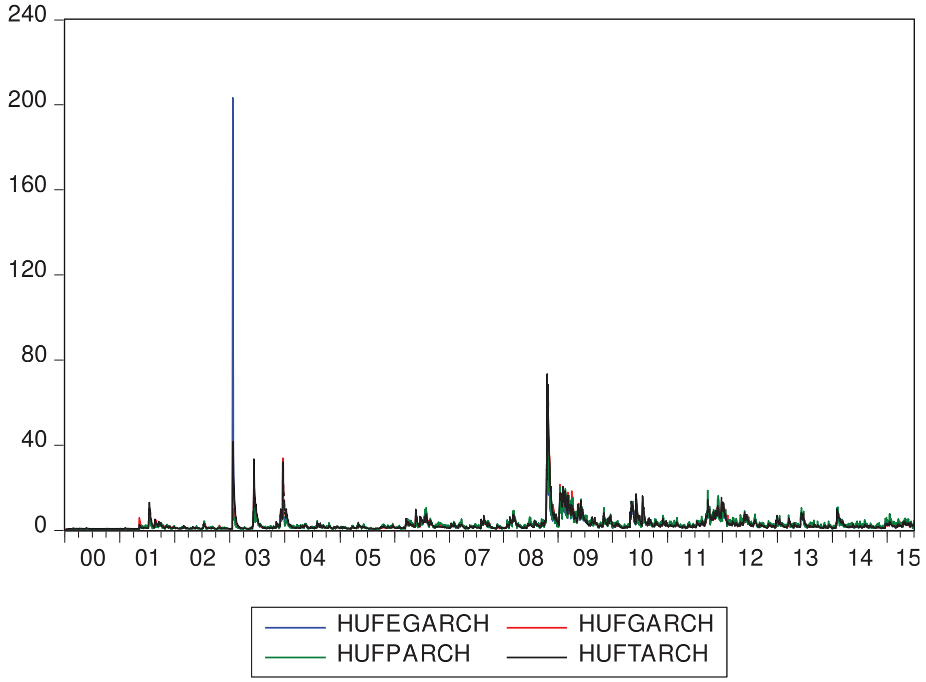
Figure 3.5b GARCH volatility series for Hungarian forint (HUF) and Romanian leu (RON)



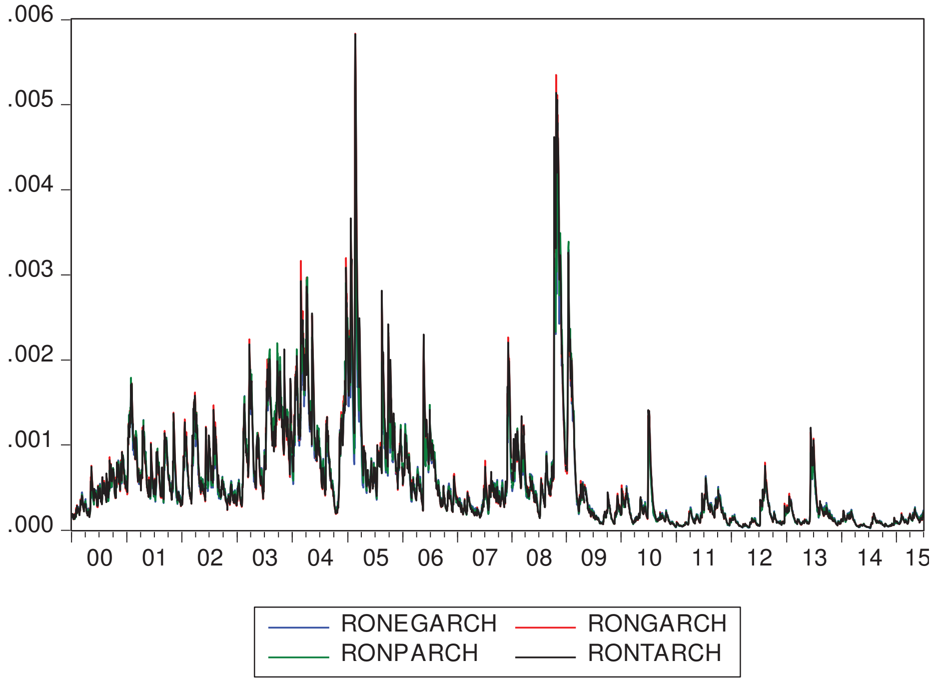


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Table 3.4. Summary of SIC values (* denotes selection)

	PLN	CZK	HUF	RON
GARCH	-4.70909	-1.48261	3.515322	-5.09092
TARCH	-4.71102	-1.49352	3.507087	-5.08929
EGARCH	-4.71891*	-1.51239*	3.504467	-5.09386*
PARCH	-4.7154	-1.46333	3.499054*	-5.09101

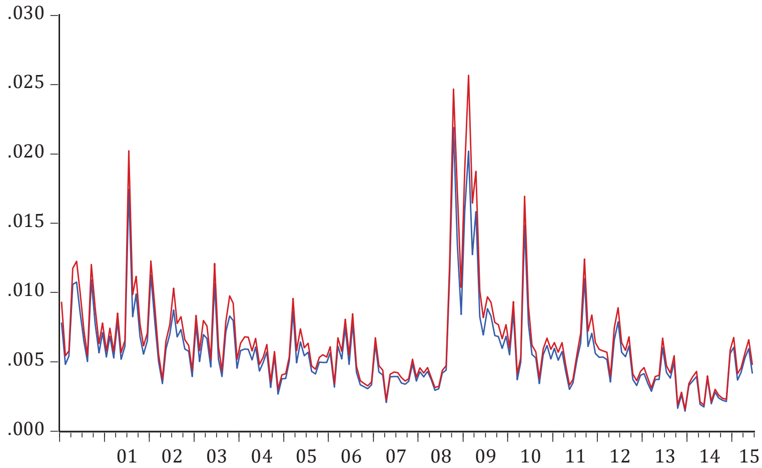
Source: own

Therefore, only one GARCH specification was used for each type of the final model and compared with volatility obtained using a more traditional approach through the estimation of deviation of the first differences of exchange rate changes.

Figures 3.6a and 3.6b plot a comparison of normalized GARCH and standard deviation of the first differences of logarithms series. The data have been normalized to scale and rebased to allow a better comparison (there is a large difference in means of the two types of measures of volatility).

The investigation of both these measures shows that they indeed measure the same thing. However, the plots for the Hungarian forint (HUF) and most notably Romanian leu (RON) volatilities show some significant differences. We attribute this result to the asymmetries present in the series. This allows attributing some novelty to the use of the GARCH series as a measure of volatility. In the following investigations, the GARCH measure will be used as our measure of volatility. Moreover, we find the necessity to use a dummy variable for the financial crisis period.

Figure 3.6a Comparison of normalized GARCH (blue) and standard deviation of the first differences of logarithms series (red) for PLN and CZK



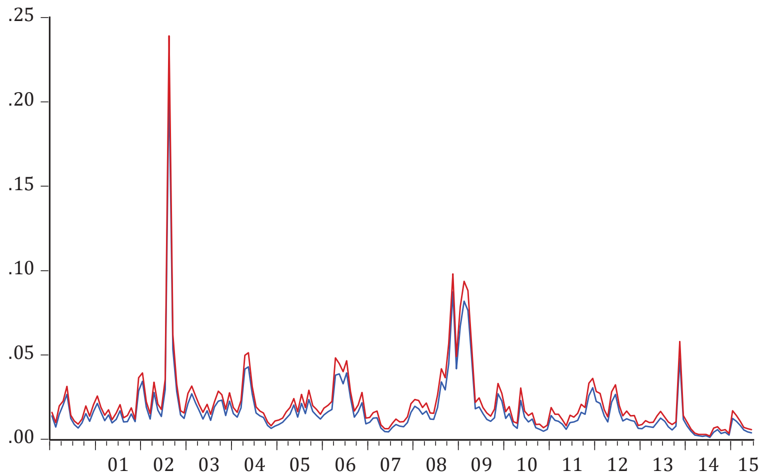


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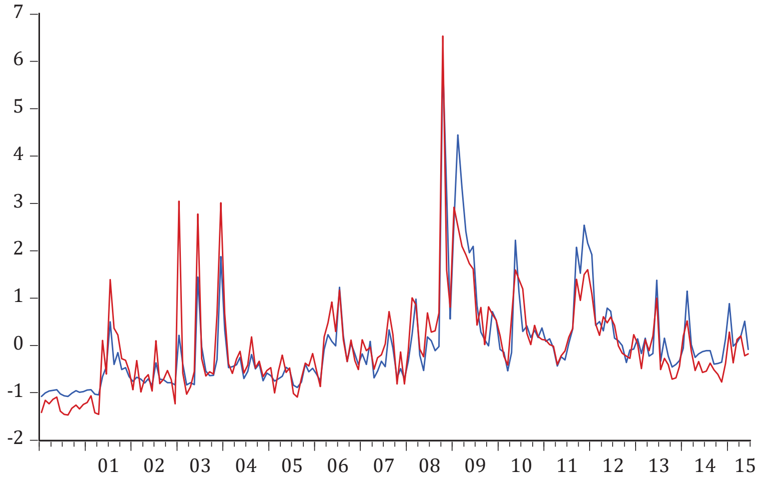
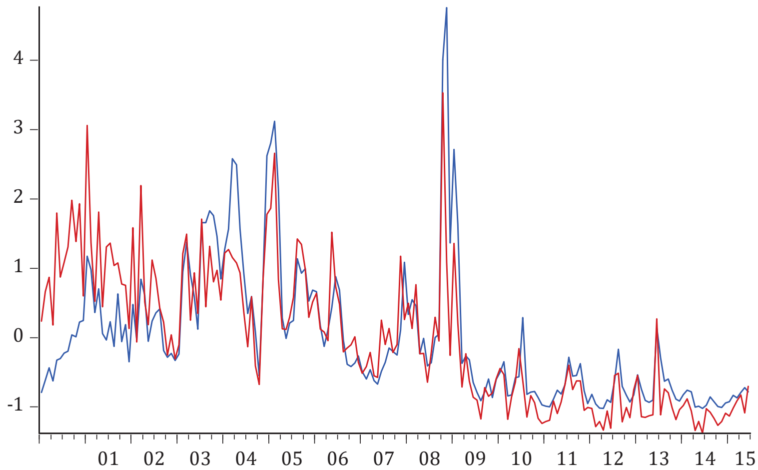
Figure 3.6b Comparison of normalized GARCH (blue) and standard deviation of the first differences of logarithms series (red) for HUF and RON





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4. Aggregate VECM estimation: the Polish case

The first part of analysis the demand for Polish export is carried out using exchange rate volatility as one of the explanatory variables and data for export on the aggregated level. All of the estimated specifications can be attributed to the two groups: estimation results for Eurozone or EU as a partner country.

In this study, we use VECM methodology, though we would like to concentrate on the short run impact of exchange rate volatility on exports. The main and other postulated hypotheses (3.1) are discussed in terms of results of impulse response functions to the one standard deviation shock in a given variable. However, all steps needed to establish those reaction functions are depicted below and all results are presented in Appendix.

The first step was to develop an unrestricted Vector Autoregressive (VAR) model to determine the optimal number of lags using information criteria.[4] The Schwarz Information Criterion (SIC) has pointed to one lag as the optimal lag length (Table 4A.1 in Appendix). Moreover, the lag exclusion testing provided the result that this lag is significantly different from zero.

Subsequently, the Johansen Cointegration Test was performed in its three versions: based on the trace statistic, the maximum eigenvalue, and the minimization of the information criteria. All three methods were used to test using various cointegrating equation assumptions and data trends specifications giving the four tested models. The results in various specifications of the Trace test and the Maximum Eigenvalue test are summarized in Table 4A.2 (in Appendix) showing the indicated number of cointegrating relations by each model and assumption.

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[4] The method has been spelled out in detail in Goczek, Mycielska (2013), Goczek Mycielska (2014b).

The results indicate that there are between two and four cointegrating relationships in the tested systems. In all analyzed cases, except for the assumption of a no trend in the data, the selected number of cointegrating equations was equal to two or three. The case of no trend should be rejected, however, both under theoretical considerations and due to statistical results pointing towards the existence of a trend in the data. As in the lag-length selection problem, choosing the specification of the cointegration equation that minimizes the Akaike information criterion (AIC) provides a consistent estimator of the steady-state equilibrium. Table 4A.3 (in Appendix) summarizes the results.

Based on the results showed in Table 4A.2 it can be concluded that there exist three long-run cointegrating relationships. Furthermore, it was determined that in all models there exists an intercept in the cointegrating equation and a trend term. The Johansen tests for this specification that will be treated as the baseline for the models developed further. Results obtained point to the presence of three cointegrating relationships. Because we are interested in short run dynamics, we did not attempt to identify the matrix coefficients, as such an identification scheme does not influence the shapes of reaction functions of interest.

Based on the above results four VECM models were constructed with an intercept in VAR and a trend and constant in the three cointegrating equations. The results of the long run estimation are shown in Tables 4A.3a-b in Appendix.

Then in order to determine if the VECM model was stable, the AR Roots of the characteristic polynomial were shown in Figure 4A.3 (in Appendix). All roots except four lie inside the circle; these are of no concern since our VECM model imposes four Unit Roots by the definition of the error correction mechanism. More diagnostic tests followed. The results of LM autocorrelation of residuals test showed no significant problems. At that point, the Granger Block Exogeneity test was run in the VECM models. These results allow arguing that in the Granger sense the Polish exports are not a cause of exchange rate volatility while the opposite relationship holds. Hence, the hypothesized relationship is unidirectional.

As the core of the analysis, the Cholesky ordered impulse response functions shocks were estimated (Figures 4.4-4.13). Based on Benkwitz et al (2001) we plot bootstrapped 0.95 confidence bands for IRFs generated by the VECM models.

First, we analyze our variable of interest. The impulse response of Polish aggregate exports to EA and EU to a one standard deviation in volatility shock was shown in Figure 4.4 and 4.5, respectively. The cumulative impact of a permanent change in exchange rate volatility on exports is negative. It seems that the exporting firms respond to normal increases in exchange risk by exporting less: the uncertainty resulting from increased exchange rate volatility reduces trade volume. Our finding is in line with the prevailing view and the results obtained for other CEE countries, e.g. Czechia (Babecká-Kucharčuková, 2014) However, those results are not statistically significant.

As we explained above, including the dummy variable controlling for financial crisis do not improve the results according to the informational criteria. Figure 4A.4 (in Appendix) presents the impulse response of Polish aggregate exports to EA countries to one standard deviation shock in exchange rate volatility with the crisis dummy included. The results suggest that a huge volatility shock as the one during the financial crisis creates a general drop in exports as firms engage in the waiting option, but the result in not statistically significant.

Figure 4.4 Impulse response of Polish aggregate exports to one standard deviation shock in exchange rate volatility (GARCH) with 95 confidence band, trade partner: EA

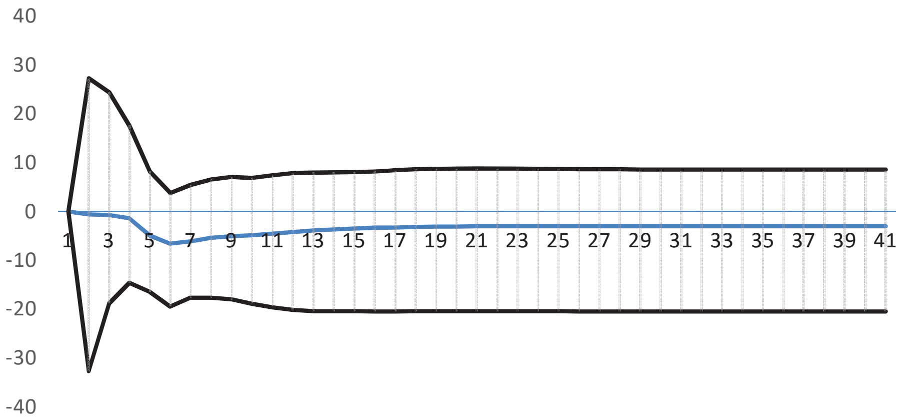

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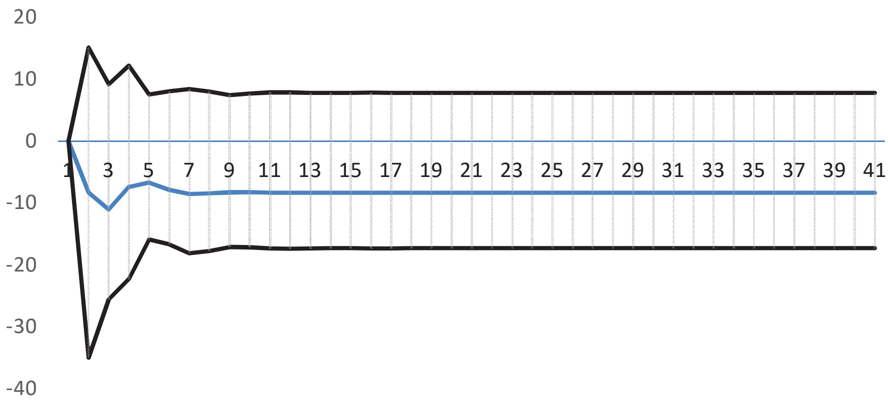
Figure 4.5 Impulse response of Polish aggregate exports to one standard deviation shock in exchange rate volatility (GARCH) with 95 confidence band, trade partner: EU



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Next, other variables were analyzed further in relation to hypotheses formulated in chapter 3.1. All of the obtained impulse reactions are shown in the Figures 4.6-4.13.

The cumulative impact of a permanent change in domestic prices results in the drop of export to EA and EU countries (Figure 4.6 and 4.7), which is in line with expectations. However, in the case of exports to EA countries, the decrease in export flows is rather short-lived. The data suggest that in the long run export to EU countries will fall.

The estimated reactions of Polish exports on shock in foreign prices are inconclusive (Figure 4.8 and 4.9). The permanent increase in foreign prices increases Polish export to EU countries as Polish goods become more competitive on foreign markets what is in line with theory. However, in the case of EA countries, the data suggest a drop in export flows. Probably this might be explained by the change in the EA countries imports structure and shift to goods imported from other countries. However, the estimated results for relative prices are insignificant in statistical terms.

The results of Polish export response to one standard deviation change in foreign demand, approximated by EA or EU industrial production are presented in Figures 4.10 and 4.11. The short run effects are in line with expectations: increased foreign demand results in increased Polish export. The result is statistically significant for EA countries.

The most striking result is the significant and positive reaction of export flows to shock in domestic demand (Figures 4.12 and 4.13). According to data, exports will increase in short run after the increase in domestic demand and will remain on the elevated level in the long-run. This result can be explained twofold. Firstly, in our model, we do not control for the global economic situation. The increase in exports volume may coincide with an increase in both foreign and domestic industrial production, which in our model represents demand. Secondly, the negative dependence between domestic demand and export may appear only during economic downturns, whereas during growth periods the trade-off between domestic sales and the foreign market could be observed. Bobeica et al. (2016) reported such an asymmetry and showed that only during the time of crisis the negative changes in domestic demand result in increasing exports as firms increase efforts to enter foreign markets. In other words, there are probably large sunk costs that would prevent exit from foreign markets and thus exports are not negatively affected by growth in domestic demand.

Figure 4.6 Impulse response of Polish aggregate exports to one standard deviation shock in domestic prices (PL_INPP) with 95 confidence band, trade partner: EA

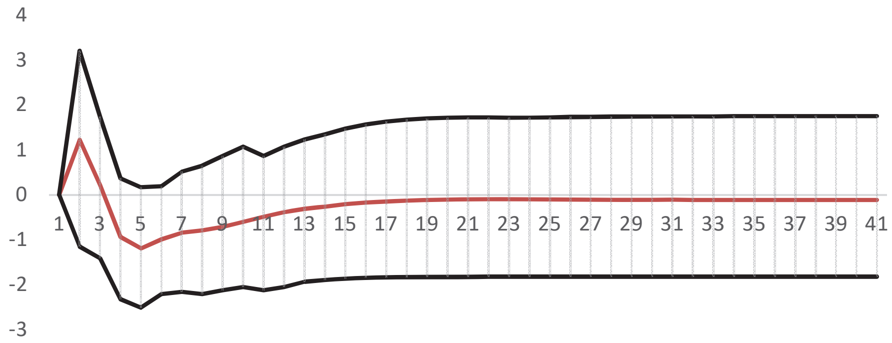

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Figure 4.7 Impulse response of Polish aggregate exports to one standard deviation shock in domestic prices (PL_INPP) with 95 confidence band, trade partner: EU

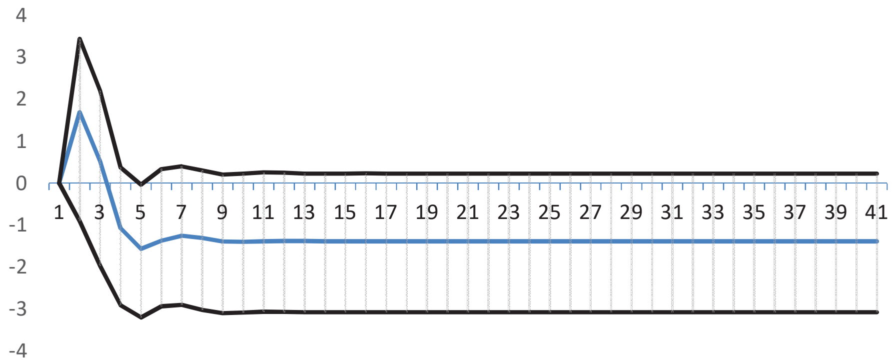

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Figure 4.8 Impulse response of Polish aggregate exports to one standard deviation shock in foreign prices (EA_INPP) with 95 confidence band, trade partner: EA

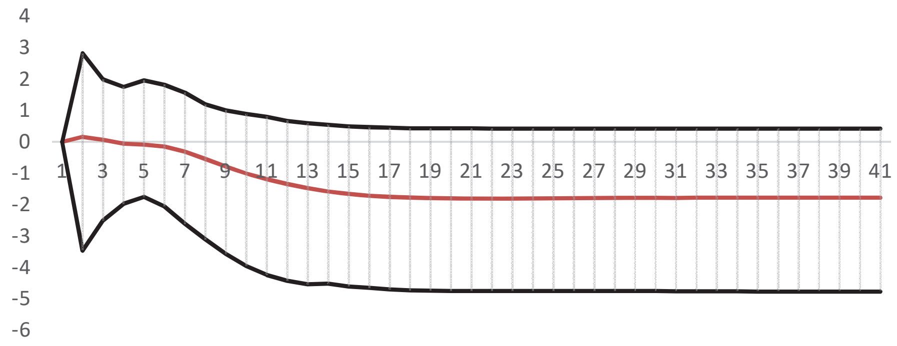

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Figure 4.9 Impulse response of Polish aggregate exports to one standard deviation shock in foreign prices (EU_INPP) with 95 confidence band, trade partner: EU

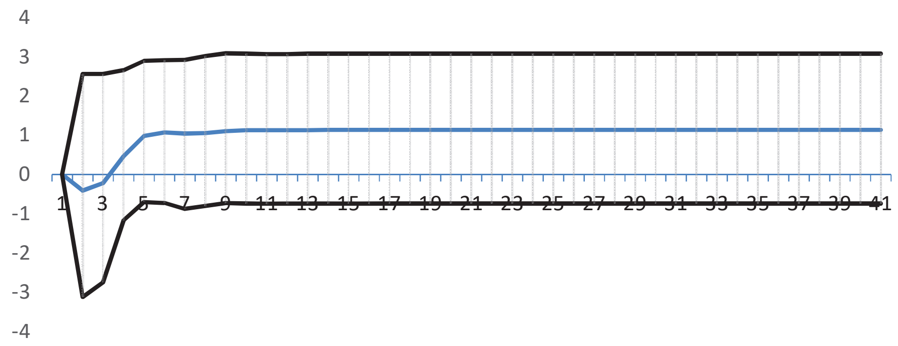

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Figure 4.10 Impulse response of Polish aggregate exports to one standard deviation shock in foreign demand (EA_INPR) with 95 confidence band, trade partner: EA

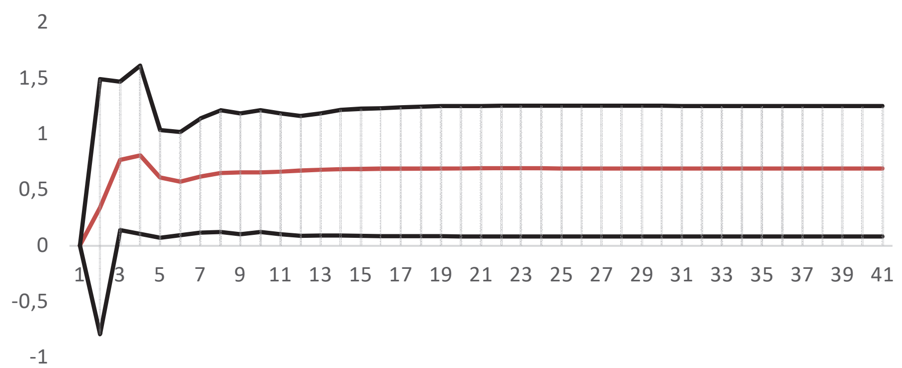

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Figure 4.11 Impulse response of Polish aggregate exports to one standard deviation shock in foreign demand (EU_INPR) with 95 confidence band, trade partner: EU

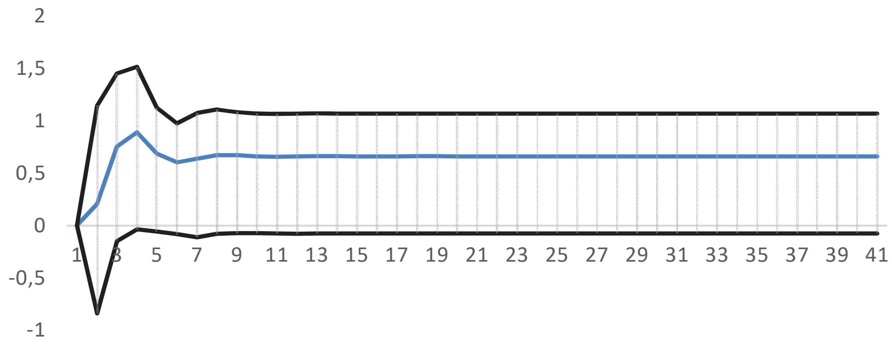

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Figure 4.12 Impulse response of Polish aggregate exports to one standard deviation shock in domestic demand (PL_INPR) with 95 confidence band, trade partner: EA

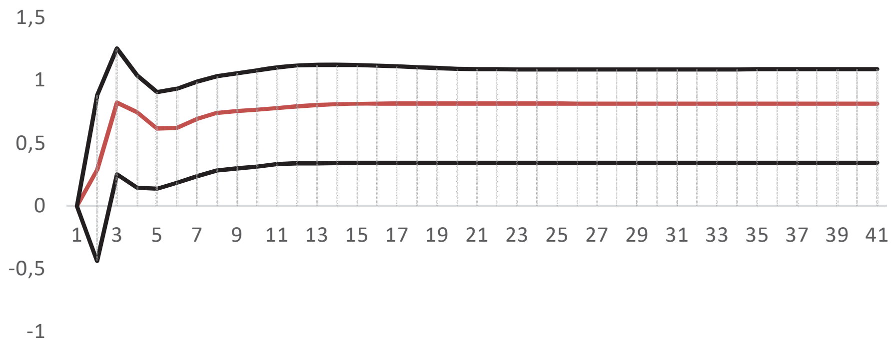

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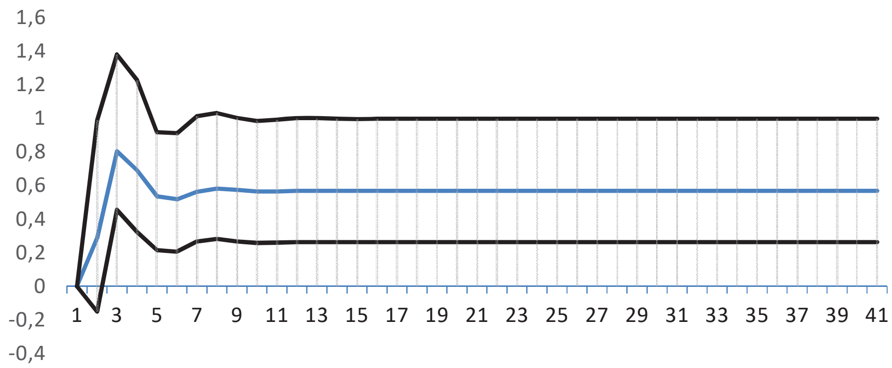
Figure 4.13 Impulse response of Polish aggregate exports to one standard deviation shock in domestic demand (PL_INPR) with 95 confidence band, trade partner: EU



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The last method used in the aggregate investigation was forecast error variance decomposition analysis. While impulse response functions estimate the effects of an endogenous variable shock on the other variables in the VAR, the variance decomposition exercise separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each exogenous innovation in affecting the variables in the VAR. Thereby the variance decomposition indicates the amount of information each variable contributes to the other variables.

As seen in Figures 4.14-4.15, the two most important variables in determining Polish aggregate exports are its own endogenous response and domestic production. This allows discussing the behavior of the Polish exports as mostly determined by domestic conditions and lends support for models explaining the exports as a part autoregressive and part endogenous process. The other variables, most importantly including the exchange rate volatility are mostly insignificant in the determination of exports.

Figure 4.14 Variance decomposition of Polish aggregate exports to EA

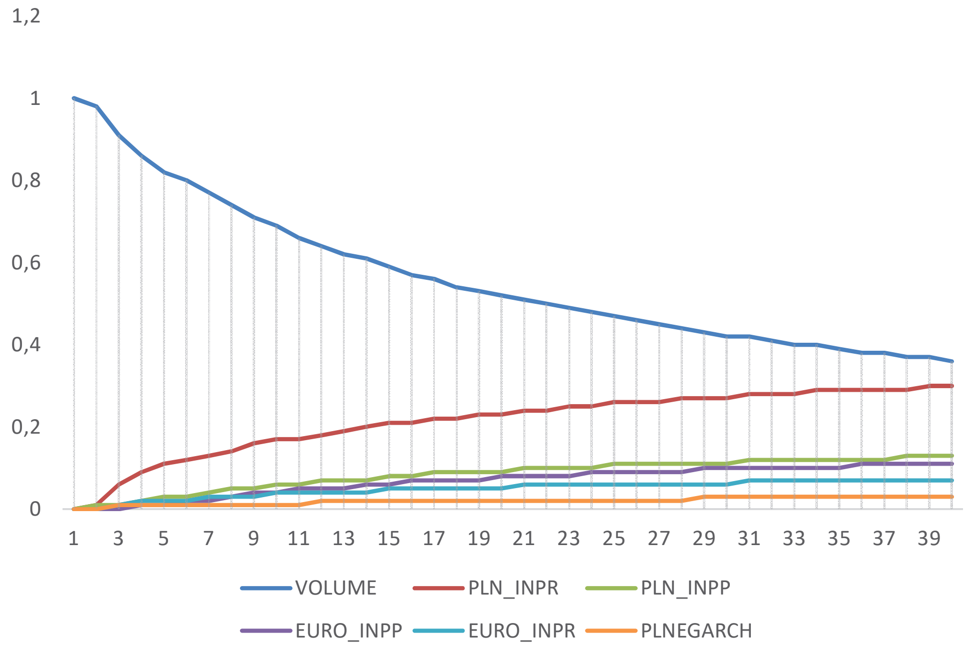

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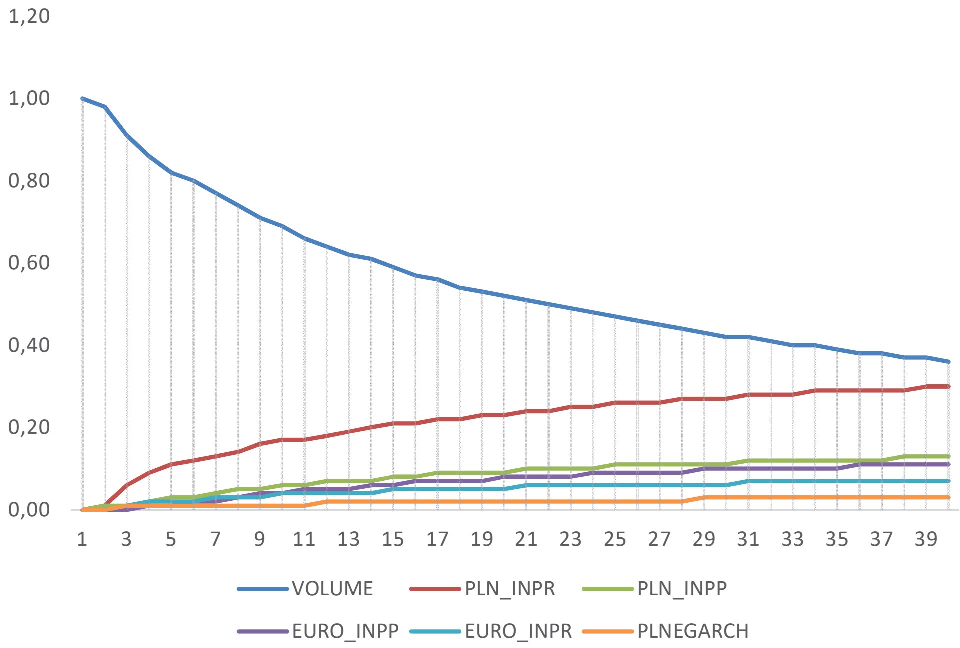
Figure 4.15 Variance decomposition of Polish aggregate exports to EU



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In the very last part of the analysis on aggregated trade data, we address the problem of the exchange rate as an omitted variable. As it was mentioned, the number of firms that report the exchange rate as a barrier of export growth is decreasing. However, it might be that for exporting firms the volatility of euro rate is not as important as the level of exchange rate. In this context, the scale of export dependence on imported intermediate goods or having debt in euros might be more important than volatile exchange rate, especially when over half of the Polish international traders hedge their risks. Taking this into consideration, we incorporated a nominal exchange rate as the independent variable into the model. The results are presented in Figures 4.16-4.19.

Figure 4.16 Impulse response of Polish aggregate exports to one standard deviation shock in exchange rate volatility (GARCH) with 95 confidence band, trade partner: EA (exchange rate included)

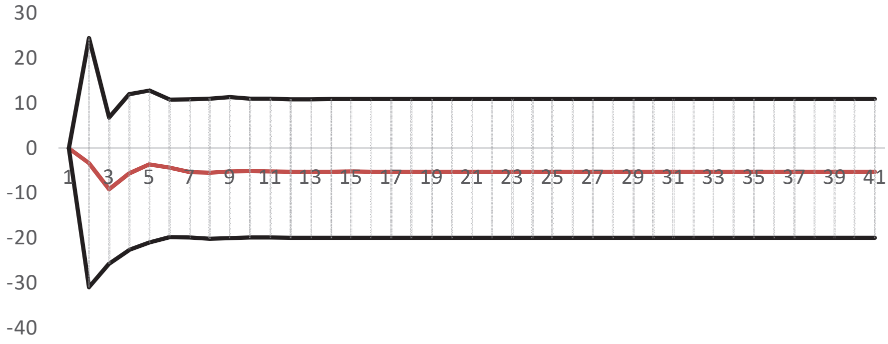

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Figure 4.17 Impulse response of Polish aggregate exports to one standard deviation shock in exchange rate volatility (GARCH) with 95 confidence band, trade partner: EU (exchange rate included)

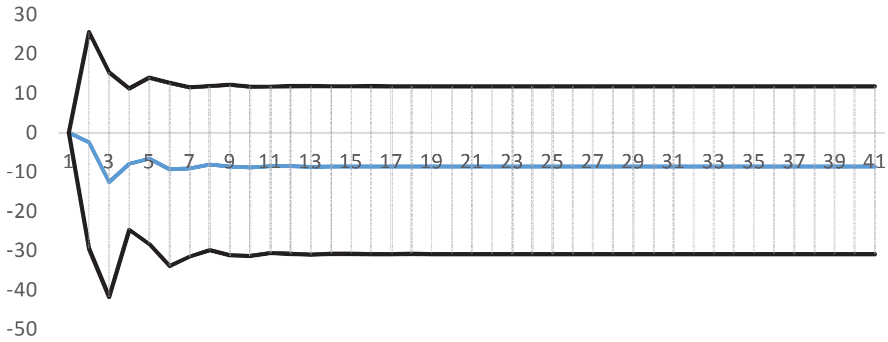

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Figure 4.18 Impulse response of Polish aggregate exports to one standard deviation shock in exchange rate with 95 confidence band, trade partner: EA (exchange rate included)

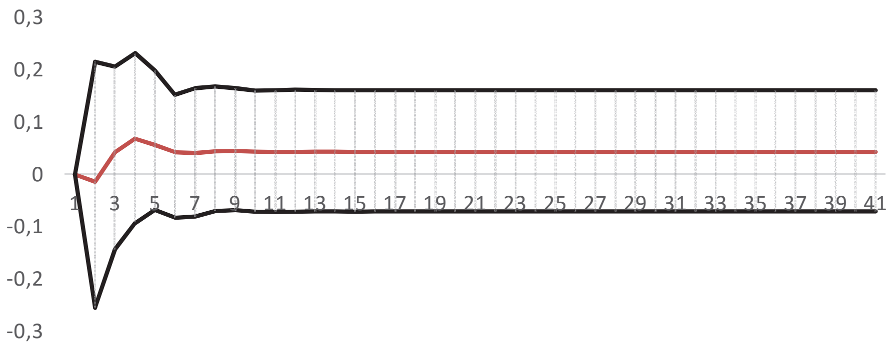

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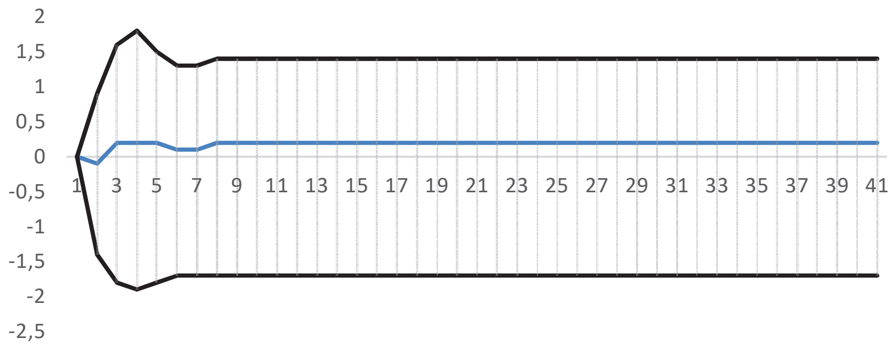
Figure 4.19 Impulse response of Polish aggregate exports to one standard deviation shock in exchange rate with 95 confidence band, trade partner: EU (exchange rate included)



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Once again, the results show that Polish export performance is affected by the euro exchange rate uncertainty and the findings are in line with original specification: increased exchange rate volatility decreased Polish export to EA and EU countries. The results also support the common view that depreciation of domestic currency enhances exports. However, all results are insignificant in statistical terms.

To sum up, the aggregate export flow model produced limited evidence as to the impact of exchange rate variability on export flows. The data suggest that there is the negative relationship between exchange rate volatility and export, though the impact of volatility on export is insignificant. Those inconclusive results need further examination by using disaggregated trade data as the effects of exchange rate volatility on export performance may vary across trade sections mainly due to the non-homogeneity of products.

5. Disaggregated VECM estimation: the Polish case

In the second part of the empirical analysis of the macroeconomic demand for Polish exports, we use disaggregated export data. As discussed in chapter 4, the assumption of equal elasticities across different sectors of trade is unrealistic. Aggregating export data may dilute possible relationship and generate conflicting results. As found in the literature, there is a significant heterogeneity in response of different types of production to the volatility of the exchange rate (McKenzie, 1999; Peridy, 2003; Baum et al., 2004). Therefore, the next step of the study will be performed on the data at the SITC section level. Study at a higher level of disaggregation would be potentially more interesting. Nonetheless, as it was already mentioned in chapter 3.2, concern would arise about the quality of the resulting estimates, since most of the disaggregated monthly data is quite unstable and prone to biases resulting from swings caused by large one-time transactions.

Due to the structure of the sample, modeling is performed using similar methods as in the previous section. The data used has a monthly frequency. The size of foreign production is estimated by means of the industrial production sold variable. Relative prices, expressing competitiveness, will be considered in two ways: using the approximate price indices of industrial production sold and calculated according to the method proposed by Boug and Fagereng (2010).

The results have been relegated to the Appendix to prevent cluttering. Tables 5A.1-5A.10 present the results of estimates for the cointegrating relationships for each of the SITC sections. The impulse responses of Polish export to EA or EU countries (for each SITC section) to a one standard deviation in volatility shock are shown in Figures 5.1-5.20.

In general, impulse responses show that the impact of exchange rate volatility on Polish exports depends on the trade section. First, for some sections export flows intensify with the increase in exchange rate volatility (sections 0, 1, 4, 7), but is significant in statistic terms in two sections: 0 (Food and lived animals, Figures 5.1-5.2) and marginally in 1 (Beverages and tobacco, Figures 5.3-5.4). In case of sections 2, 3, 5, 6, and 8 the dependence is negative but significant only for sections: 2 (Crude materials, inedible, except fuels, Figures 5.5-5.6), 3 (Mineral fuels, lubricants and related materials, Figures 5.7-5.8), and marginally in 6: (Manufactured goods classified chiefly by material, Figures 5.13-5.14).

The first possible explanation for unexpected positive dependence could be based on the coincidence of events. The highest exchange rate variation was reported for period 2008-2009. At the same time, or until 2011-2012, the Polish export of tobacco manufactures and spirits (and generally alcohol beverages) reported noticeable growth. That was the result of pro-export strategy of Polish producers introduced a few years earlier. This means that there are probably large sunk costs that would prevent exit from foreign markets affected by the exchange rate volatility.

The more interesting is reported positive dependence between exchange rate variability and export of food and lived animals (Figures 5.1-5.2). As various studies confirmed, the agriculture export flows are significantly negatively affected by the volatility of exchange rate. This sector is typically considered as a notably competitive with flexible pricing strategies and short-term contracts. Moreover, agricultural products are relatively less storable then products of other sectors. However, the results of our study point to small significant positive effects of exchange rate variability on exports. That can be explained twofold. First, during the time of increased uncertainty (and thus volatility) and changing economic conditions firms engage in waiting option and do not decrease exports because of sunk costs of gaining and holding a presence in foreign markets. Secondly, the income effect associated with changes in the amount of expected revenues from trading due to changes in exchange rate dominates: the increased volatility in the exchange rate leads companies to increase exports to offset the decline in expected revenue.

Second interesting feature of our results is that there is a difference of sensitivity to exchange rate volatility between sections. Exports flow of sections with more differentiated and highly processed products is less sensitive to exchange rate variability, though results are insignificant: section 5 (Chemicals and related products, n.e.s., Figures 5.11-5.12), 7 (Machinery and transport equipment, Figures 5.15-5.16), and 8 (Mineral fuels, lubricants and related materials, Figures 5.17-5.18). Those sectors include products of industries with more elaborated and technologically advanced products (e.g. medical, optical instruments, pharmaceuticals, professional apparatus, communication equipment, computing machinery). In this case, the international competition is more associated with technological innovation then with prices and exchange rate.

Figure 5.1 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 0

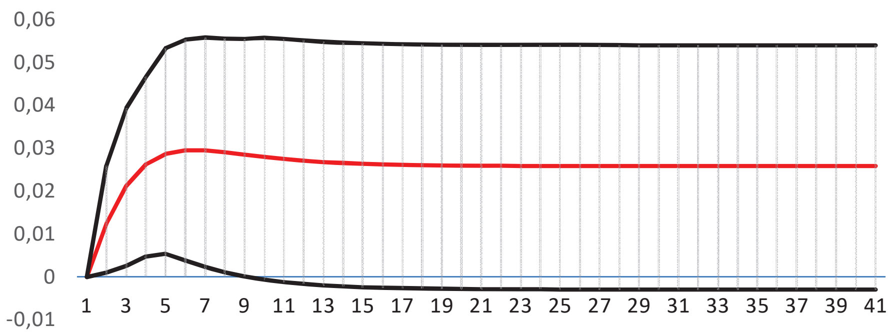

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Figure 5.2 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 0

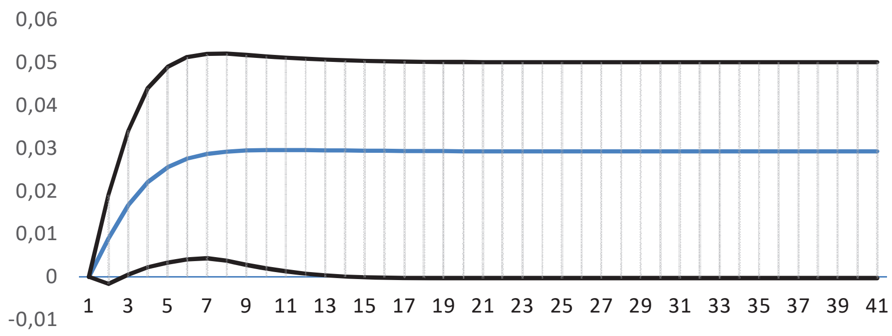

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Figure 5.3 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 1

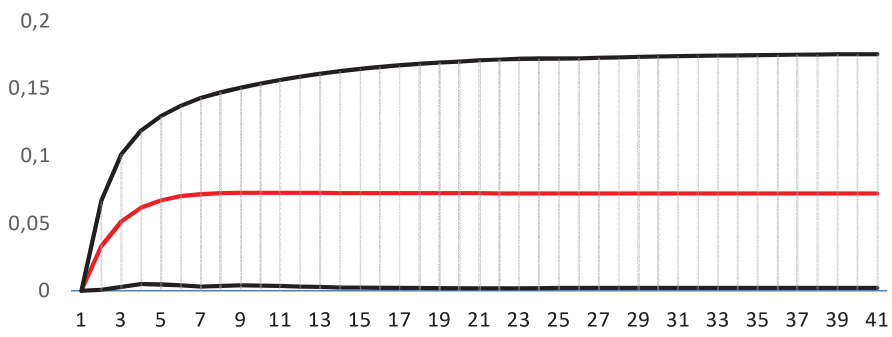

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Figure 5.4 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 1

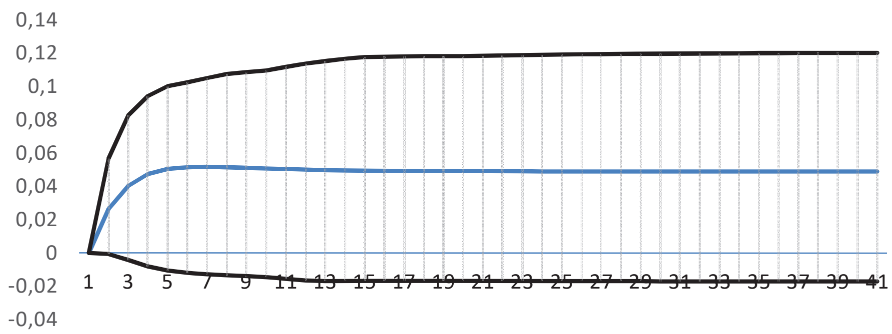

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Figure 5.5 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 2

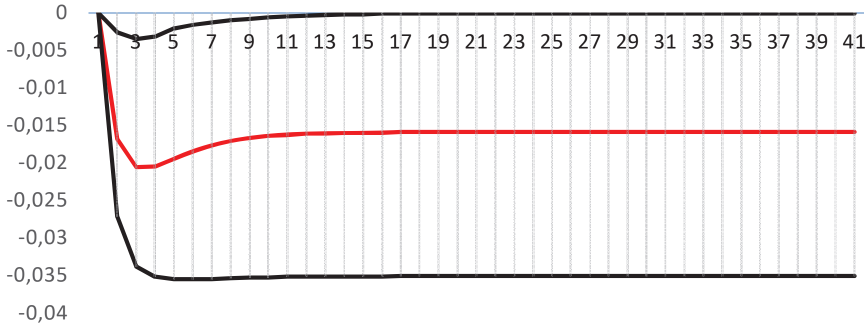

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Figure 5.6 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 2

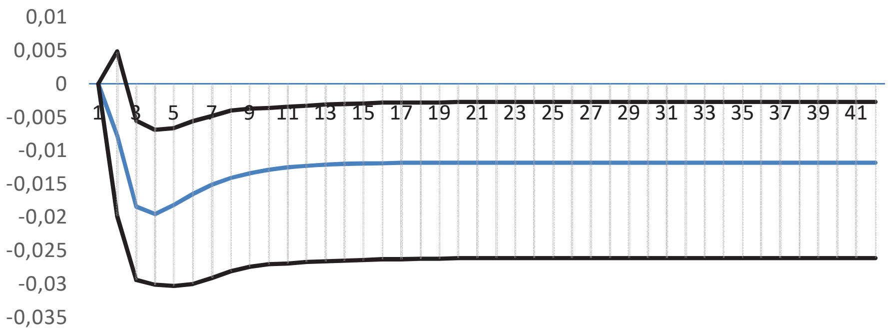

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Figure 5.7 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 3

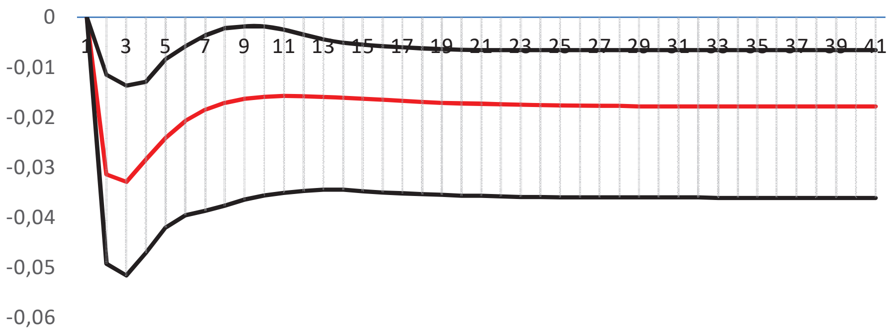

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Figure 5.8 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 3

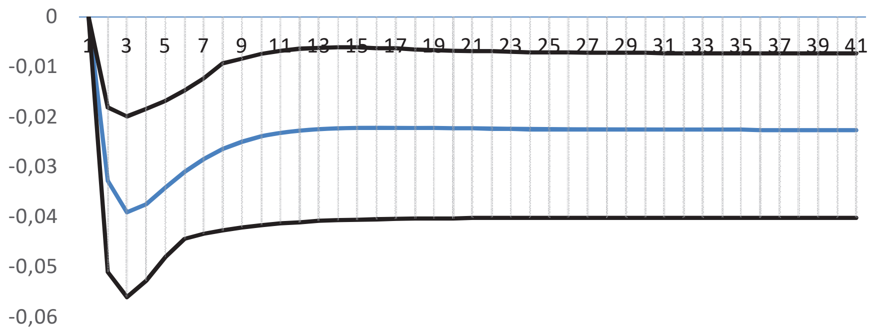

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Figure 5.9 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 4

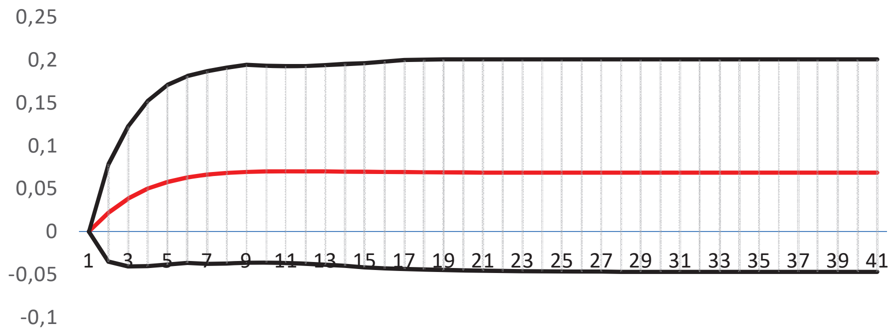

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Figure 5.10 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 4

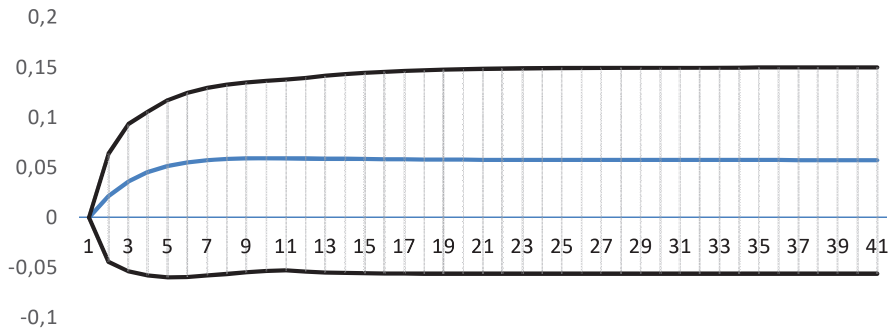

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Figure 5.11 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 5

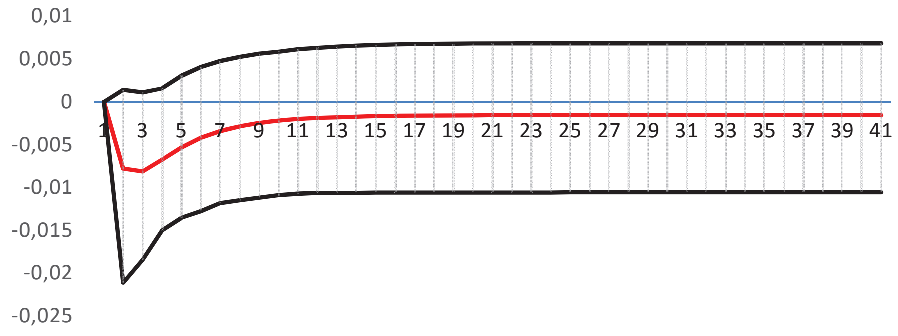

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Figure 5.12 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 5

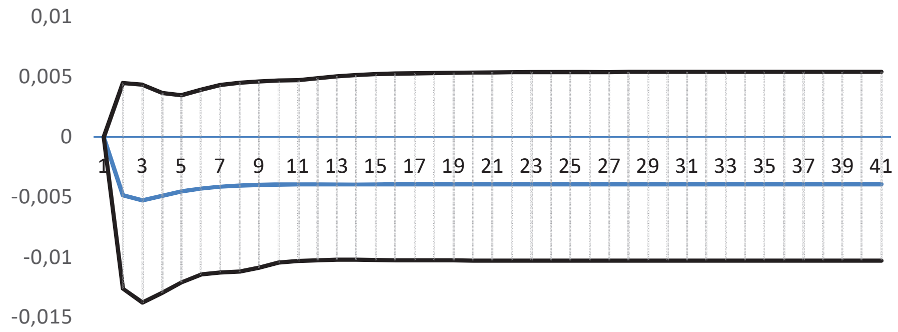

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Figure 5.13 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 6

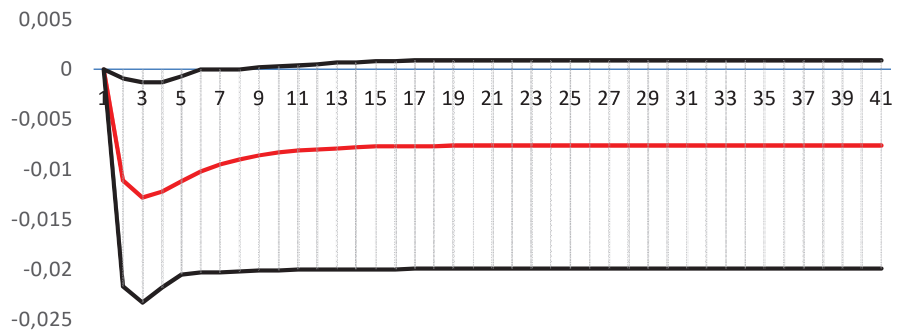

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Figure 5.14 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 6

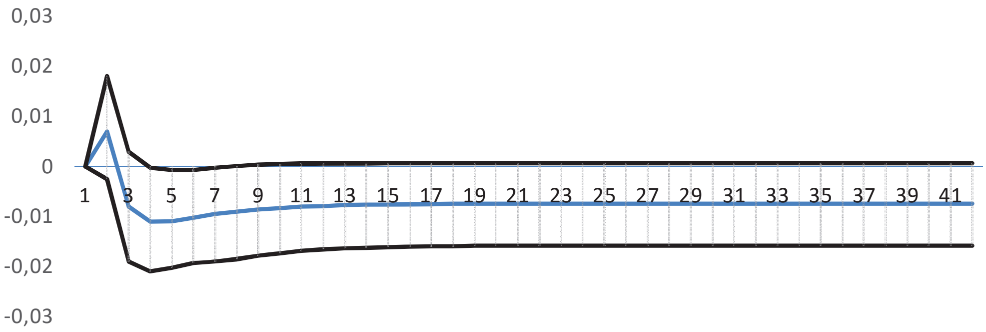

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Figure 5.15 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 7

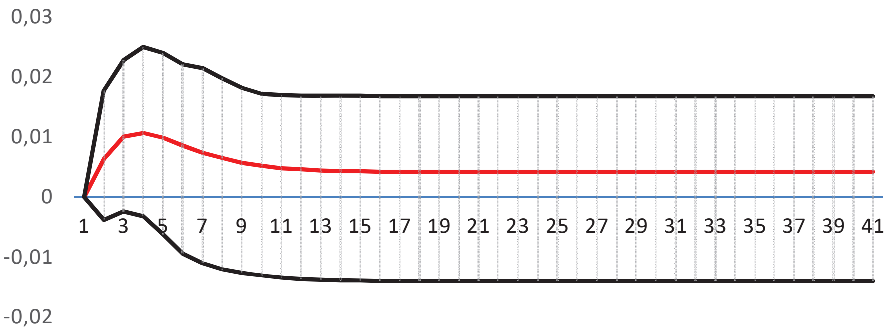

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Figure 5.16 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 7

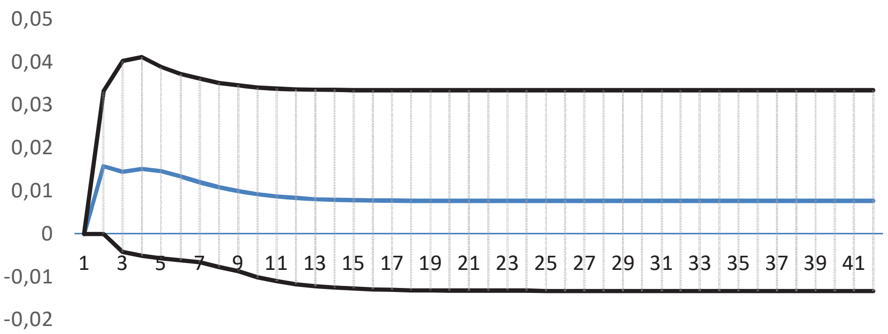

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Figure 5.17 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 8

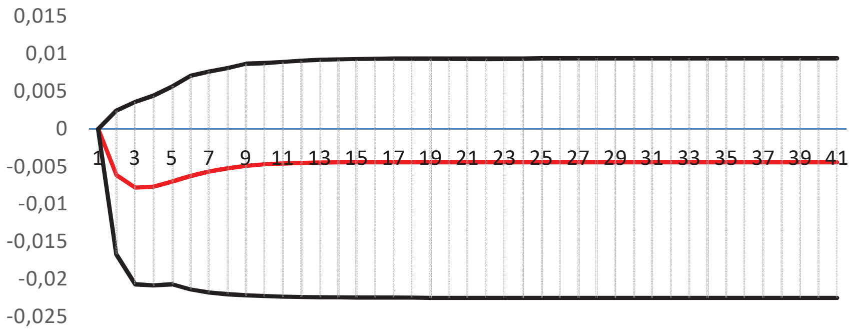

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Figure 5.18 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 8

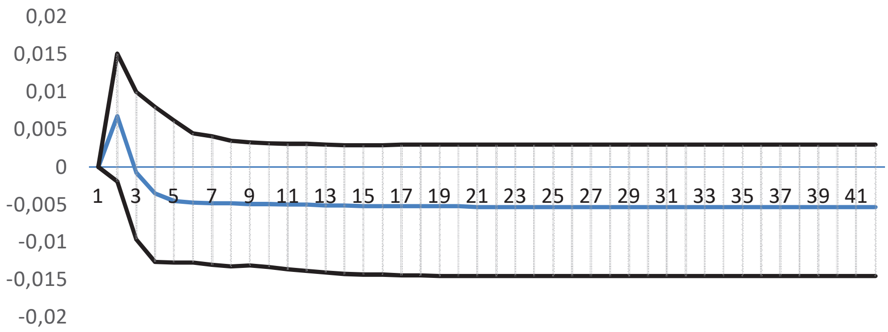

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Figure 5.19 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 9

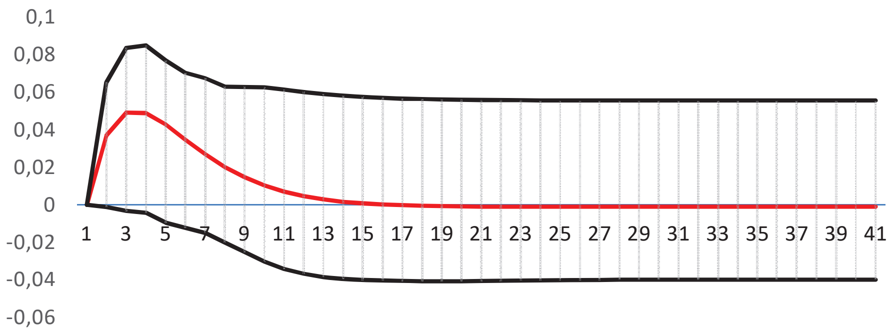

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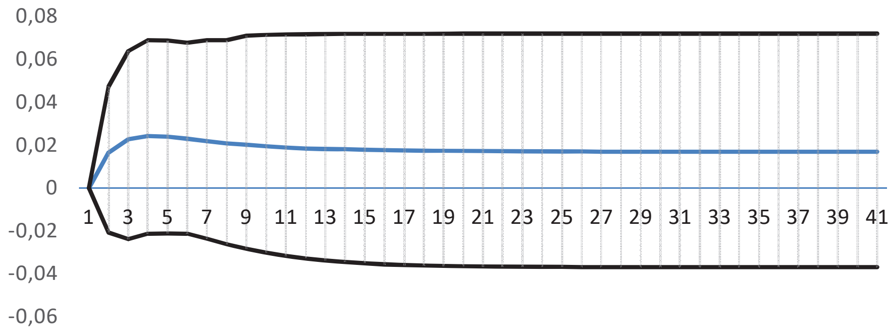
Figure 5.20 Impulse response of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 9



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The last method used in the aggregate investigation was forecast error. To sum up, the analysis of the disaggregated data gave some interesting insights on the relation between exchange rate volatility and Polish export to EA or EU. First, the impact of exchange rate variation on exports varies across trade sections. This might be a rationale for the inconclusive results of aggregated analysis and no statistically significant relationship being observed in the estimation. The aggregative nature of trade date weakens the effects of volatility to statistically and economically insignificant levels. However, even for disaggregated data, the estimated effect of volatility on export is rather small in economic terms in some sections. That might suggest that domestic firms are to lower extent sensitive to exchange rate volatility than it is commonly considered. That implies that stabilization of exchange rate through EA accession will not have far-reaching consequences for Polish exports to EA countries. For some sections export will fall, for some – will increase, but the overall effect will be rather small.

6. Panel estimation for Czechia, Hungary, Poland, and Romania

The third part of the study addresses the impact of volatility of the euro exchange rate on the exports of four EU countries with derogation: Polish, Czechia, Hungary, and Romania. The study has a similar design as the study in the second part.

The investigation is completed using the approaches used in estimating non-stationary panels.[5] A precondition for the estimation of these models is cointegration between the variables of interest. Therefore, the first step of inquiry is to find a unit root for all of the series to be at least first order integrated. The second is to test for cross-sectional independence. If cross sectional dependence occurs, it is most appropriate to run the second generation panel cointegration test proposed by Westerlund (2007). Once cointegration is identified, it is possible to estimate the parameters of a dynamic panel error correction model. In summary, the research in addition to traditional methods uses the state-of-the-art methods of estimation: second generation panel cointegration, under the presence of unit root tests, cointegration, cross-dependent (spatial) relationships and methods of analysis panels with heterogeneous units of observation.

In economics, it is common to analyze long macroeconometric panel datasets. It has been recognized that in such panels, even after conditioning on unit-specific regressors, individual units, in general, need not be crosssectionally independent. Thus, actual information of macroeconometric panels is often overstated since long data is likely to exhibit all sorts of cross-sectional and temporal dependencies (Cameron and Trivedi 2005). Therefore, erroneously ignoring possible correlation of regression disturbances over time and between subjects can lead to biased statistical inference (Petersen 2009).

[5] The method has been spelled out in detail in Goczek, Mycielska (2014a).

There is a variety of tests for cross-section dependence in the literature. We use the following tests:

- Breusch-Pagan (1980) LM
- Pesaran (2004) scaled LM
- Baltagi, Feng, and Kao (2012) bias-corrected scaled LM
- Pesaran (2004) CD

Table 6A.1 (in Appendix) shows the results of these tests indicating a serious problem of cross-dependency disturbances in panel data. Only 3 out of 160 tests carried out indicate lack of cross-dependence (all for the Pesaran (2004) for the SITC section 4).

The presence of cross dependency can cause a significant loss of power for panel cointegration tests. As a response, Westerlund (2007) developed four new panel cointegration tests that are based on structural rather than residual dynamics. The idea is to test the null hypothesis of no cointegration by inferring whether the error-correction term in a conditional panel error-correction model is equal to zero. These second-generation panel cointegration tests are all normally distributed and deal with unit-specific short-run dynamics, unit-specific trend and slope parameters, and cross-sectional dependence. The results of this test have been provided in Table 6A.2 (in Appendix). All of the calculated test statistics indicate rejection of the null hypothesis of no cointegration.

In large datasets, this assumptions underlying dynamic GMM are often inappropriate, and the estimator breaks down. In these cases, a popular alternative is the Pooled Mean Group (PMG) estimator of Pesaran, Shin and Smith (1999). This model takes the cointegration form of the simple ECM model and adapts it for a panel setting by allowing the intercepts, short-run coefficients and cointegrating terms to differ across cross-sections. The new estimator (PMG) assumes that constant, short run coefficients and variance of error terms differ between units, while the restriction is imposed on the long-term coefficient to be the same for all units. In terms of the relationship between exports and its determinants, the estimated equation is as follows:

$$
\begin{aligned}
\Delta export_{t}^{Country}{}_{i,t} = \\
& \sum_{z=1}^{p-1} \gamma_i \Delta export_{t}^{Country}{}_{i,t-z} + \sum_{z=0}^{q} \tau_i \Delta x_{t}^{Country}{}_{i,t-z} \\
& + \varphi_i \left(export_{t}^{Country}{}_{i,t-1} - \alpha_i - \sum_{j=1}^{k} \beta_j x_{t}^{Country}{}_{i,j,t-1} \right) + \varepsilon_{i,t}
\end{aligned}
\tag{6.1}
$$

The use of error-correction mechanism model and possibility of different adjustment coefficients for each country allows for estimating separately the short-term dynamics (coefficients γ, τ and φ) and long-term dynamics of dependent variable (coefficient β). In terms of equation 6.1, the short-term coefficients of export adjustments may be different across countries. However, long-term coefficients seem to converge to the average. PMG estimator imposes equality of long-term coefficients between countries and implies common cointegrating relationship, represented by the error-correction mechanism.

In order to provide the best possible Autoregressive-Distributed Lag (ARDL) structure of the PMG model we use general-to-specific modelling based on an information criterion. All of the candidates are evaluated by the information criterion and we select a statistical model by using those evaluations. Akaike information criterion value (AIC) is computed for each candidate, and the model whose AIC value is the smallest is selected as the best statistical model. The results of the global minimization based on AIC are shown in the Appendix through figures supplied with each model. The Table 6A.3 (in Appendix) summarizes the chosen ARDL structures for each model.

The long run coefficients that relate to the dynamic equilibrium of the cointegrating equations for each of the SITC sections are presented in Appendix (Tables 6.A4). However, as in the previous investigation we base our inference on the short-run behavior estimated using estimated impulse response functions. The impulse responses of exports flows to EA or EU countries (for each SITC section) to a one standard deviation in volatility shock are shown below (Figures 6.1-6.20).

In almost all sections, the exchange rate volatility turns out to have insignificant short-run impact on CEE countries' exports to EA or EU. The only exception is significant and negative estimated relationship for section 3 with EU as a partner country. The sign of the rest of estimated relationships is ambiguous. The results of the study show that it is very hard to formulate general conclusions when the exchange rate volatility influence on exports is being discussed. Even if the data for sections 0 and 1 for Poland suggested positive and significant dependence, the panel data point to negative and insignificant relation. That means that the relationship of interest might be country specific and thus inconclusive outcomes of previous studies, as they differ in terms of sample, period of analysis and definitions of variable of interest. Nonetheless, our results support the conclusions from the surveys among firms in CEE countries on the perception of the currency risk and ways to manage it: firms usually declare managing currency risk in some way and so exchange rate variability could be irrelevant to exports.

Figure 6.1 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 0

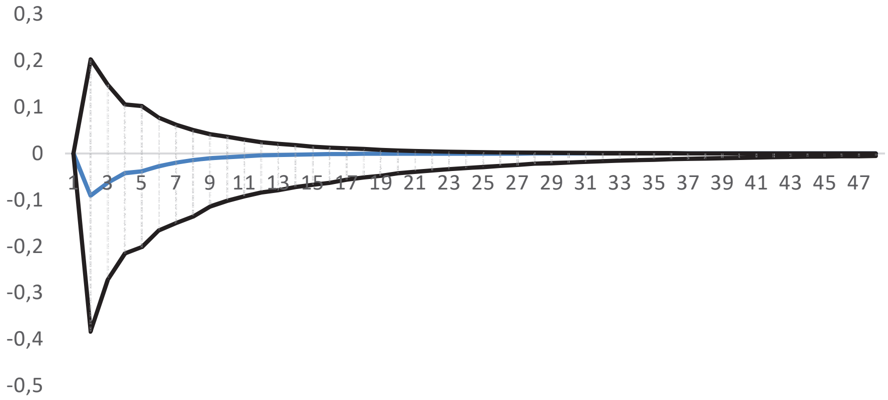

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Figure 6.2 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 0

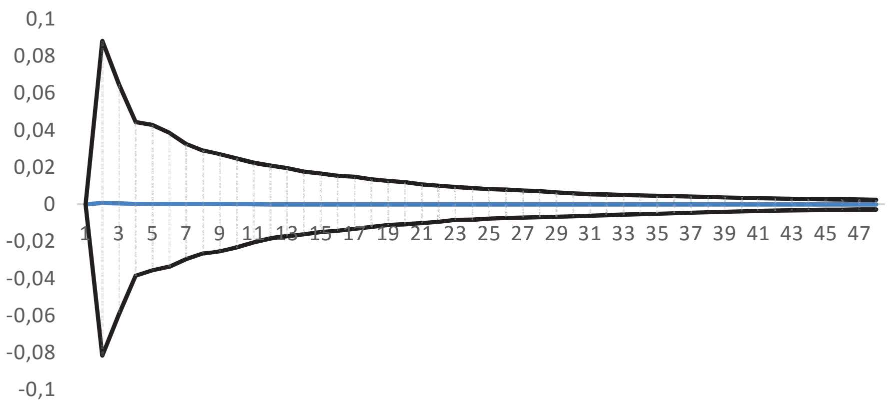

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Figure 6.3 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 1

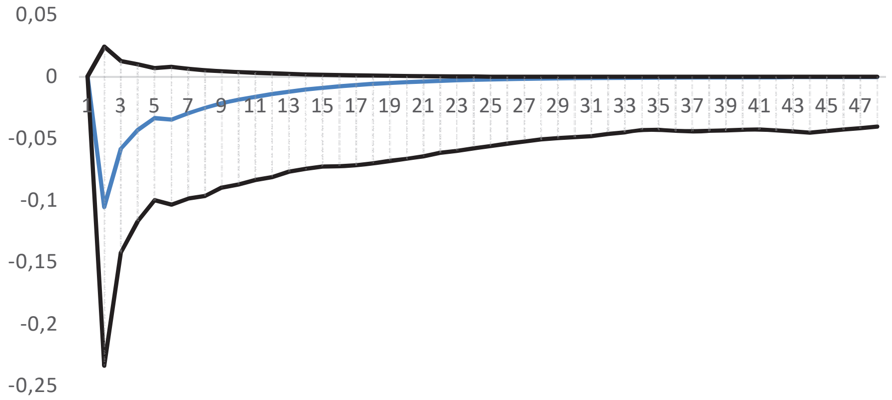

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Figure 6.4 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 1

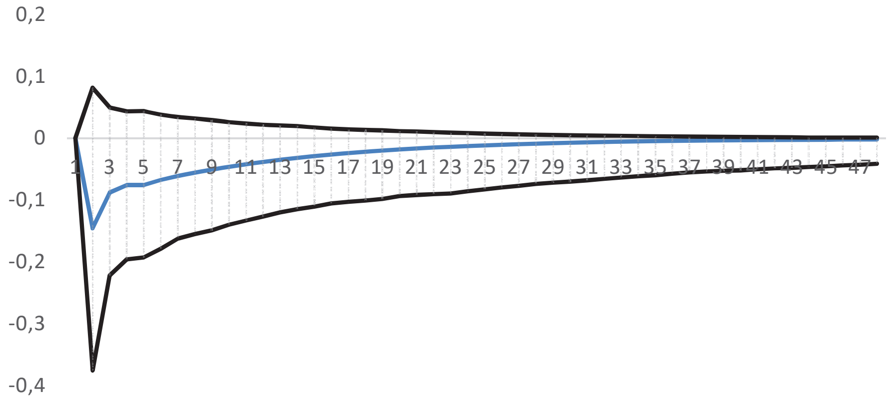

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Figure 6.5 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 2

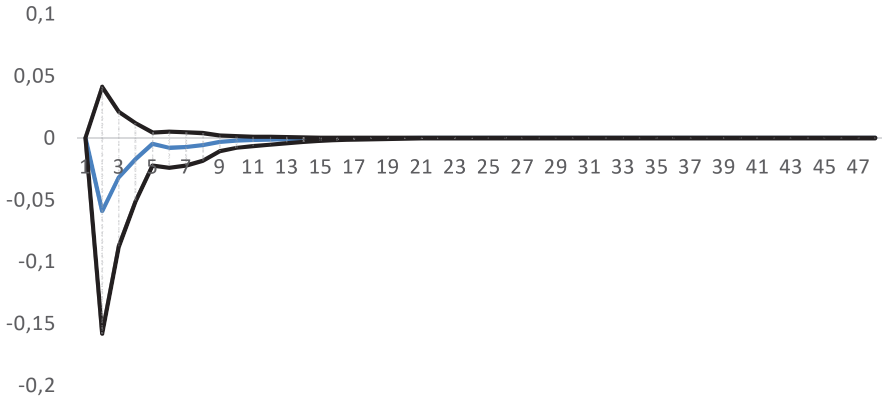

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Figure 6.6 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 2

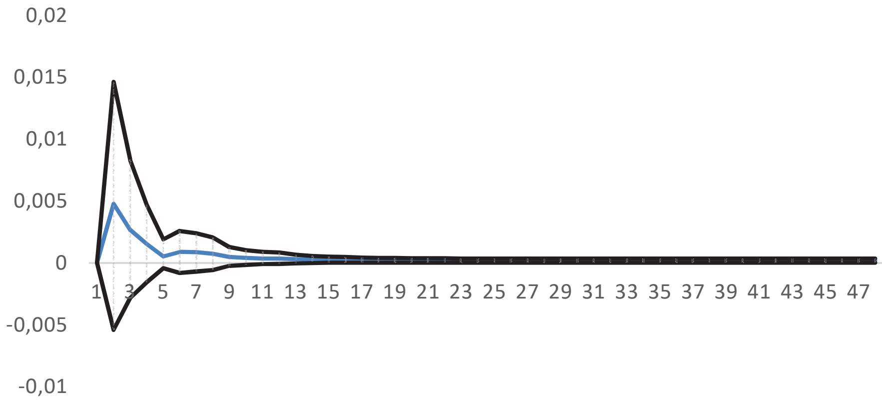

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Figure 6.7 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 3

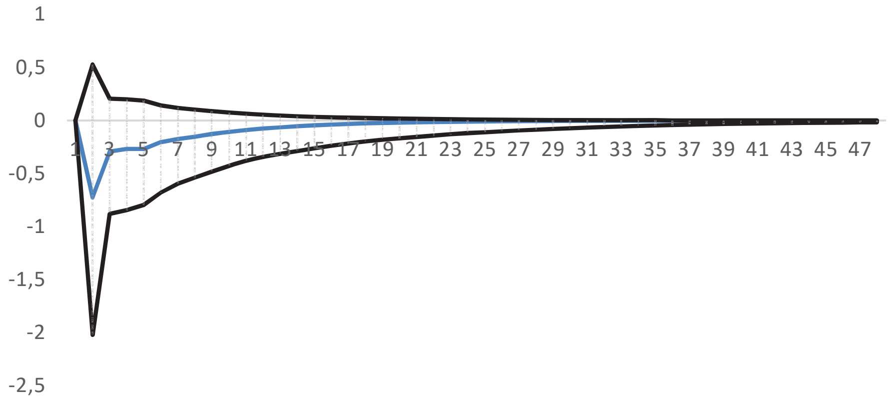

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Figure 6.8 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 3

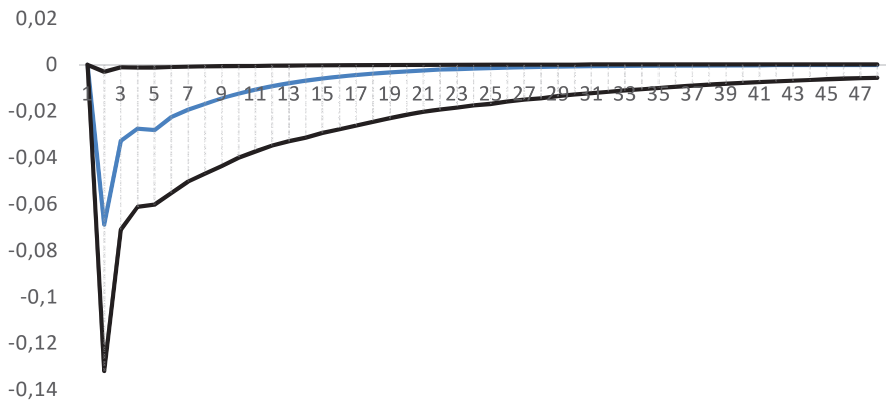

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Figure 6.9 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 4

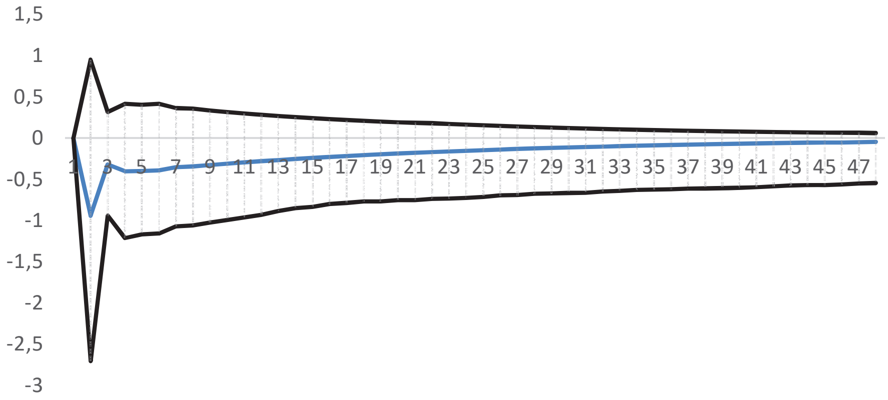

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Figure 6.10 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 4

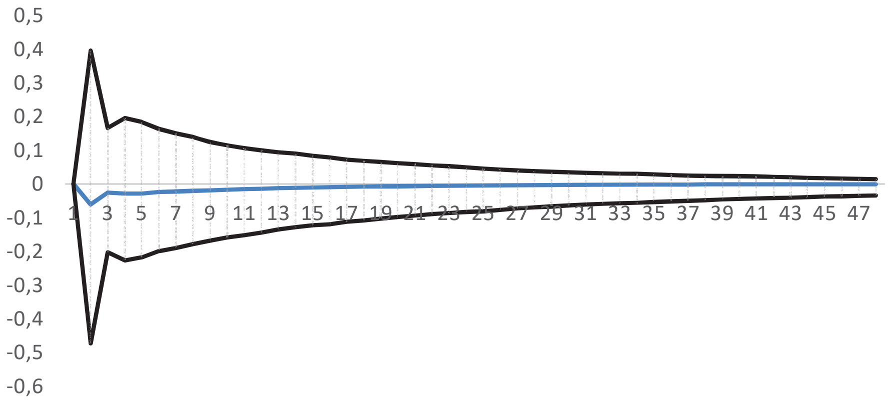

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Figure 6.11 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 5

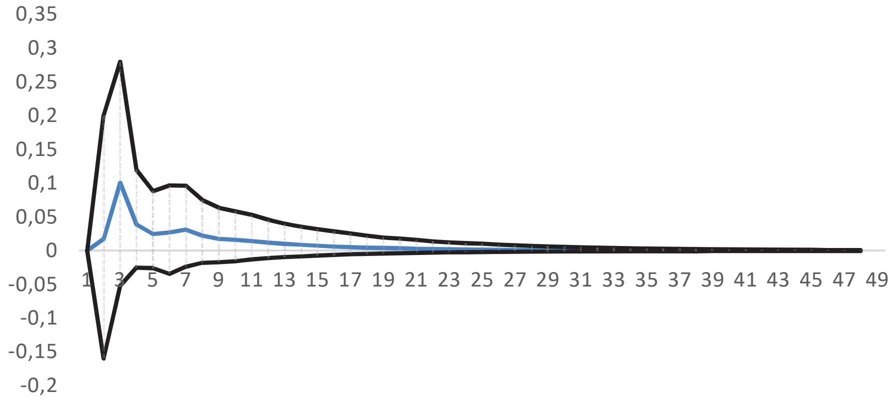

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Figure 6.12 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 5

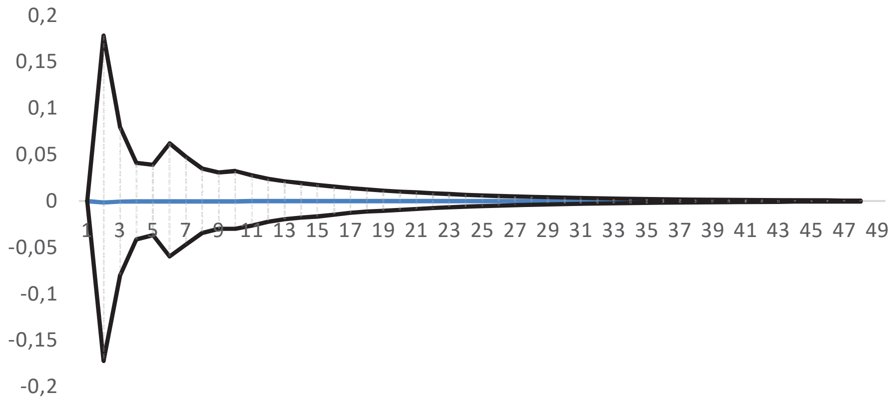

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Figure 6.13 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 6

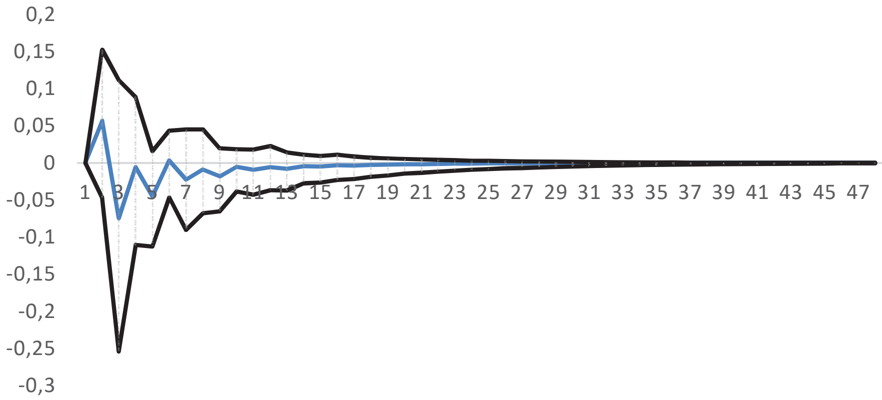

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Figure 6.14 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 6

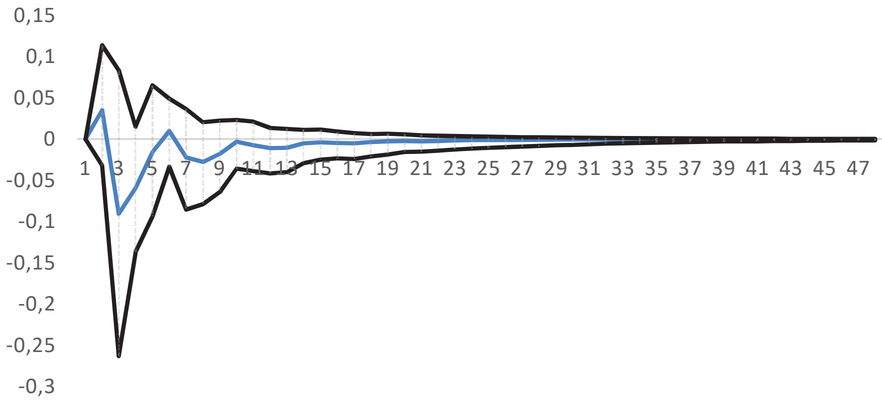

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Figure 6.15 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 7

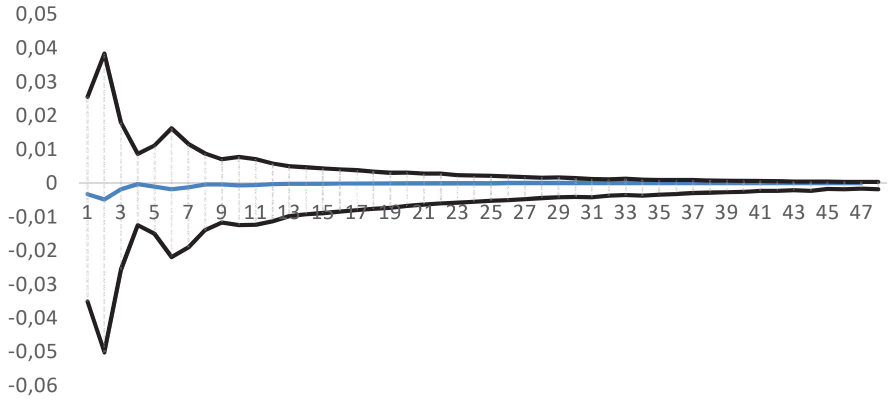

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Figure 6.16 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 7

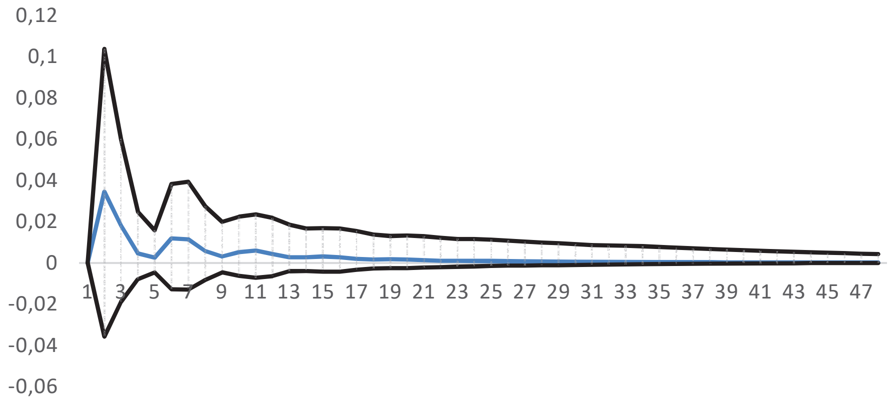

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Figure 6.17 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 8

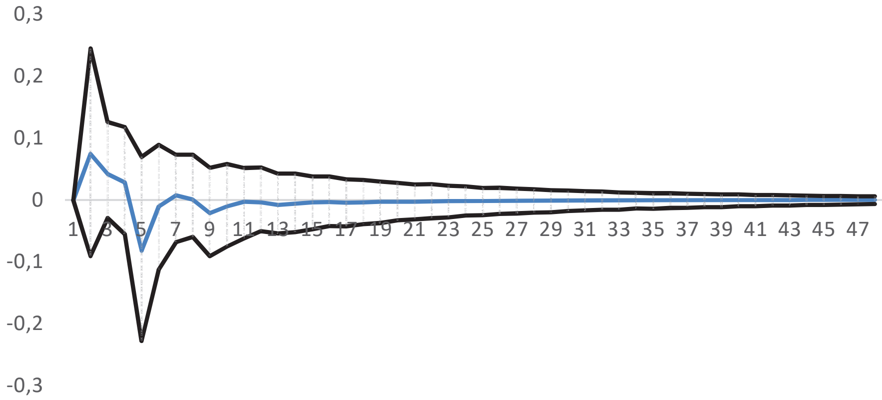

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Figure 6.18 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 8

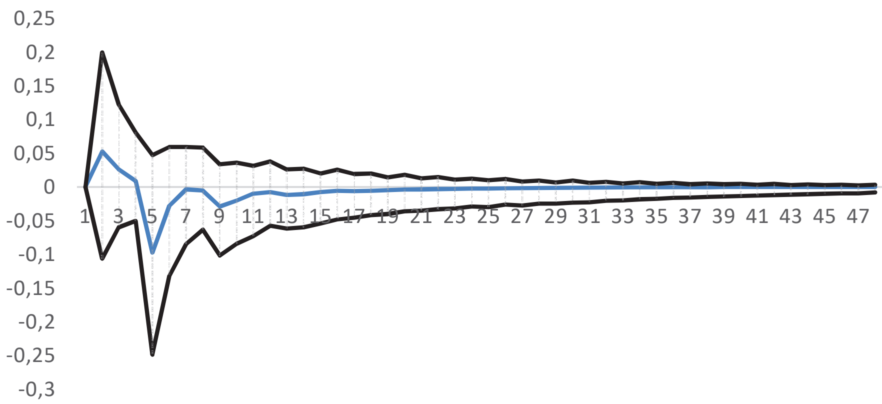

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Figure 6.19 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EA, SITC section 9

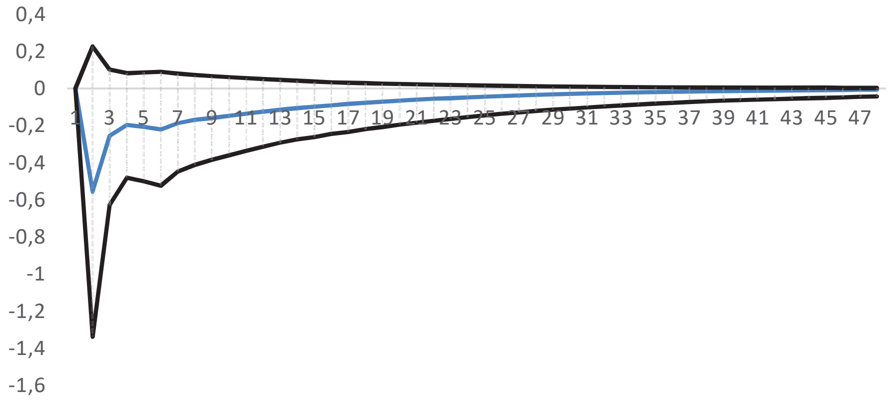

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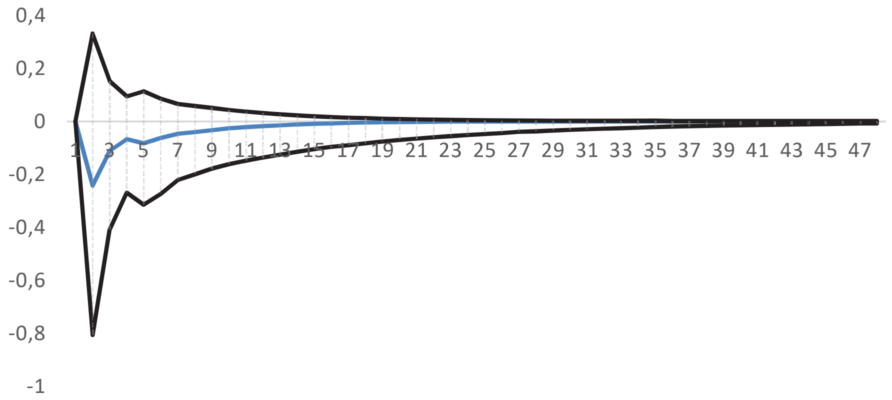
Figure 6.20 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with .95 confidence band, trade partner: EU, SITC section 9



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7. Panel analysis: robustness of the results

In the last part of empirical study, we wanted to address several possible concerns regarding obtained results for the panel analysis. This section will explain the rationale for different modifications and analyze robustness of the results to changes in the specification of the model.

First is the question if the approximation of foreign demand we use might have the influence on the results. Therefore, we repeated the panel estimation but we approximated foreign demand by Germany industrial production, as it is the main trading partner for all countries in almost all trade sections. The summary of estimation results is presented in Table 7A.1 and Figures 7A.1-20 (for EU and EA, respectively, in Appendix). The estimation outcomes are similar to the ones obtained in the previous study: in most cases, the volatility has negative, but insignificant impact on export. The reported impact of exchange rate volatility is small, if any. The only exceptions are sections 2 and 3 but this result is not robust to the choice of the partner country.

Furthermore, as in case of previous parts of the study, there are several additional potential robustness issues. The second concern is the exchange rate as an omitted variable. The estimation results are shown in Table 7A.2 (in the Appendix) and Figures 7A.21-40 (for EU and EA, respectively). Again, results point that euro exchange rate volatility is far less important for non-euro EU member CEE countries' export to EA than it is expected to be. The estimated reaction functions report insignificant results, irrespective to model specification.

Lastly, the issue of general total trade issue was investigated. It could be that observed change in export volume to EA or EU coincides with drop in total demand for country's export, driven by the global slowdown. This problem is addressed by including total export of each reporting country into the analyzed variable set. The summary of estimation results is presented in Table 7A.3 and Figures 7A.41-60 (in the Appendix, for EU and EA, respectively). This exercise did not bring any significant result. The only exception is section 2 for which data suggest negative and significant relationship. This result implies that when controlling for global economic conditions, the euro exchange rate variability does not have significant influence on export performance of CEE countries.

This exercise shows that original results of panel estimation for CEE countries are not robust to model specification. However, while results lose statistical significance with additional variables being incorporated into the model, the overall result of very small and sector depending impact of exchange rate variability on exports holds. This finding suggests that for non-euro EU countries introducing euro as a national currency will not enhances trade as it is expected. Thus traditional view that increasing export to EA is one of the main positive effects of the common currency might not be observed in reality.

8. Discussion and conclusions

The aim of the study was to determine the effect of exchange rate volatility on exports in case of four non-euro EU countries with derogation in terms of joining the European Monetary Union (EMU), with special attention to Poland. In the prevailing literature on monetary integration, it is commonly assumed that the reduction in uncertainty regarding future changes in the exchange rate lowers the currency risk, which could be a significant cost to companies. Therefore, it is frequently assumed that irreversibly joining the currencies together eliminates exchange rate volatility and thus eliminates the risk and should have a positive impact on exports. In fact, this is postulated to be one of the two most significant benefits arising from monetary integration.

We aimed to assess whether a relationship between volatility and exports can be indeed observed in the case of Czechia, Hungary, Poland, and Romania. The choice of countries was based on the fact, that these are the countries with a temporary derogation before joining the Eurozone. However, introducing the single currency in those countries will be beneficial if it is accompanied by a significant intensification of trade between these economies and the Eurozone. Thus, the report aims to provide a significant and comprehensive empirical validation of the postulated positive effects of eliminating volatility in a larger discussion of the expected benefits and costs of monetary integration.

We survey the empirical literature on volatility and exports to find that it is most inconclusive. The results of many studies show that even if there is impact of volatility on trade, it is usually insignificant and condition. In addition, most of the studies are largely incomparable as they use varying methodologies, samples of countries and periods. Analysis of the results of surveys carried out among Polish and Czech firms on the perception of risk and ways to manage it suggested that usually firms manage currency risk, if not through advanced financial instruments, then by reducing risk without significantly reducing the presence in international markets. This would suggest that exchange rate volatility could be irrelevant to trade.

In the empirical part of the study, we carried out three types of analyses. Firstly, we used a VECM model to determine the actual impact of the exchange rate volatility on aggregate Polish exports fluctuations. Next, we used VECM model on disaggregated data for Polish exports and we verify if investigating the heterogeneity of products across sectors might give results that are more true to the subject than the aggregate investigation. The last part of analysis consists of panel data estimation for four non-euro European Union Member States for the disaggregated data.

The results indicate that employing country-level trade data suffers from the aggregation bias in estimating the cointegration parameters for the exchange rate volatility. The findings imply that the impact of the exchange rate volatility on Polish exports differs across trade sectors, the analysis for both the trade sections and country-level trade strongly implies that the domestic considerations are more prominent than the exchange rate and exchange rate volatility in determining exports.

Possible explanations for our results can be structured in the following four categories. First as Hall et al. (2010) finds, the open capital markets of EMEs may have reduced the effects of exchange-rate fluctuations on exports compared with those effects in the cases of other developing countries. This could be the case of Poland and other EU countries.

Second, weakness in the domestic market translates into increased efforts to serve markets abroad, but, conversely, during times of boom, exports are not negatively affected by the increasing domestic sales (Bobeica, et al., 2016). The explanation of this asymmetry might be the existence of large fixed sunk cost of entering a foreign market.

The third explanation refers to the concept of Global Value Chains. According to this concept, change in the spot euro exchange rate does not necessarily have an impact on the economic situation of CEE resident companies, because the companies work within a global value-added chain, existing within a single multinational company (OECD, 2013). The CEE companies use in their production intermediate goods imported from countries of the euro area, the employees are paid in equivalent of euro, and then the exported final goods are paid for in euro. As a result, multinational company profits are not sensitive to fluctuations in the euro exchange rate.

A fourth explanation refers to the significant price differentials between the current and future-to-be members of the EMU. In such an environment, even large swings in exchange rate may not influence the general price-competitiveness of the investigated countries. Therefore, their exports are not influenced by the volatility of their exchange rates.

The main limitation of our results is the low statistical significance. The exchange rate stability is one of many factors that influence international trade. The costs of entering foreign markets or the scale of export dependence on imported manufacturing process are actually more important than even volatile exchange rate. The statistical insignificance of the results might be therefore interpret in favor of our main hypothesis that exchange rate variability is much less important for export performance of non-euro EU countries than it is commonly thought.

The research should further concentrate on determining possible explanations for the observed low impact of exchange rate stability on exports, especially in the disaggregated level analysis. However, the formulation of such hypotheses requires a far more in-depth research then presented here. As suggested in the literature (Peridy 2003), a more detailed analysis of the disaggregated data should include data that carry the information on the production process in a given section, the market structure, and methods and costs of FX risk management, practiced by companies in a particular trade section.

Our analysis shows that the principal argument for monetary integration may not hold in case of the four non-euro EU countries with derogation in terms of adopting euro. Probably the extent of integration of these economies with the European Union and the Eurozone, observed in many aspects, is already so far-reaching that the additional stages of monetary unification will not necessarily increase their trade with the EA countries.

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Appendix

Data

EXPORT_i_j - monthly aggregated data on exports volume in euros from country *i* to country *j* for the period 2000M1 – 2015M6, measured as an index (2000 = 100), where *i* = Poland, Czechia, Romania, Hungary, *j* = EA, EU or Germany (GER). Source: Eurostat (ComExt).

EXPORT_i_j_SITC – monthly aggregated data on exports volume in euros from country *i* to country *j* for the period 2000M1 – 2015M6, for each SITC section, measured as an index (2000 = 100), where *i* = Poland, Czechia, Romania, Hungary, *j* = EA, EU or Germany (GER). Source: Eurostat (ComExt).

i_INPR - monthly seasonally and working day adjusted data for on production in industry in country i for 2000M1 – 2015M06, measured as an index (2000 = 100), where i = Poland, Czechia, Romania, Hungary, EU, EA, or Germany (GER). Source: Eurostat.

i_INPP – producer prices in industry in i country, monthly data measured as an index, expressed in national currency, period 2000M1 – 2015M06, where i = Poland, Czechia, Romania, Hungary, EU, EA, or Germany (GER). Source: Eurostat.

P_i_SITC – export price index (2000M1 = 1) for country i, calculated on a basis of the export unit price in euro for each SITC section. Source: Eurostat (ComExt).

PF_i_SITC – trade weighted competitive price index (2000M1 = 1) for i country and each SITC section, calculated on the basis of import price indices, denominated in euro, and trade weights (k_m) of the country *i's* main trading partners (for each SITC section). We calculate weight k_m as a share of export flow to main trading partners in total exports of country *i*. We set m=3 and for each country *i*, separately for each SITC section, we determined three main trading partners using average export volume in sample period. We kept k_m time independent. Source: Eurostat (ComExt)

GARCH – estimated implied conditional variance of nominal exchange rate from GARCH model; the average monthly rate calculated based on the average daily quotations of the euro exchange rate in reporter countries' currencies. Source: countries' statistical offices.

D_LEUR – standard deviation of the first differences of logarithms of euro exchange rate; the average monthly rate calculated based on the average daily quotations of the euro exchange rate in reporter countries' currencies. Source: countries' statistical offices.

EURi – nominal exchange rate; the average monthly rate calculated based on the average daily quotations of the euro exchange rate in reporter countries' currencies. Source: countries' statistical offices.

EX_i –monthly, seasonally and working day adjusted aggregated data on total exports from country *i* for the period 2000M1 – 2015M6, export value expressed in euros (million), where *i* = Poland, Czechia, Romania, Hungary. Source: Eurostat (ComExt).

Table 3A.1a. Summary of unit root tests - Poland

Poland	EA Export_PLN in levels	First differences Export_PLN	EU Export_PLN in levels	First differences Export_PLN	PLN_INPP in levels	First differences of PLN _INPP	PLN _INPR in levels	First differences of PLN _INPR	FX PLN in levels	First differences of FX PLN
DF-GLS test										
DF tau statistic	1.600422	-0.816899	1.422030	-0.834650	0.959047	-8.722880	1.598117	-15.00153	-2.998528	-14.20704
1% Critical	-2.578476	-2.578476	-2.578476	-2.578476	-2.577522	-2.577522	-2.577522	-2.577522	-2.577522	-2.577522
5% Critical	-1.942688	-1.942688	-1.942688	-1.942688	-1.942555	-1.942555	-1.942555	-1.942555	-1.942555	-1.942555
10% Critical	-1.615474	-1.615474	-1.615474	-1.615474	-1.615559	-1.615559	-1.615559	-1.615559	-1.615559	-1.615559
Kwiatkowski-Phillips-Schmidt-Shin test										
KPSS statistic	1.775875	0.156804	1.772136	0.087119	1.593513	0.209090	1.620534	0.094701	0.153019	0.040261
1% Critical	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000
5% Critical	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000
10% Critical	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000
Phillips-Perron test for unit root										
Adj. t-Stat	-1.586533	-32.46986	-1.197137	-31.79380	-1.423020	-9.128224	-0.225676	-17.39153	-2.735270	-9.503249
1% Critical	-3.465780	-3.465977	-3.465780	-3.465977	-3.465585	-3.465780	-3.465780	-3.465780	-3.465585	-3.465780
5% Critical	-2.877012	-2.877099	-2.877012	-2.877099	-2.876927	-2.877012	-2.877012	-2.877012	-2.876927	-2.877012
10% Critical	-2.575097	-2.575143	-2.575097	-2.575143	-2.575051	-2.575097	-2.575097	-2.575097	-2.575051	-2.575097
Vogelsang and Perron (1998) unit root breakpoint test										
Minimum t-stat	-1.475122	-3.628172	-1.907691	-3.465236	-2.342040	-9.128224	-2.288599	-19.40025	-3.719668	-9.963158
1% Critical	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133
5% Critical	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649

Source: own

Table 3A.1b. Summary of unit root tests - Czechia

Czechia	Export_EA CZK in levels	First differences EA Export_ CZK	EU Export_CZK in levels	First differences EU Export_ CZK	CZK _INPP in levels	First differences of CZK _INPP	CZK _INPR in levels	First differences of CZK _INPR	FXCZK in levels	First differences of FXCZK
DF-GLS test										
DF tau statistic	0.945074	-0.326531	0.949235	-0.374572	0.015559	-11.00820	1.489040	-4.474737	-0.006460	-8.902390
1% Critical	-2.578476	-2.578555	-2.578476	-2.578555	-2.577522	-2.577522	-2.577522	-2.577522	-2.577522	-2.577522
5% Critical	-1.942688	-1.942699	-1.942688	-1.942699	-1.942555	-1.942555	-1.942555	-1.942555	-1.942555	-1.942555
10% Critical	-1.615474	-1.615467	-1.615474	-1.615467	-1.615559	-1.615559	-1.615559	-1.615559	-1.615559	-1.615559
Kwiatkowski-Phillips-Schmidt-Shin test										
KPSS statistic	1.751147	0.082888	1.743108	0.082420	1.429021	0.060336	1.425708	0.146226	1.448322	0.345780
1% Critical	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000
5% Critical	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000
10% Critical	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000
Phillips-Perron test for unit root										
Adj. t-Stat	-2.446823	-18.12025	-2.268263	-29.53143	-0.943172	-10.98228	-1.629992	-16.32594	-2.192836	-10.66553
1% Critical	-3.465585	-3.465780	-3.465780	-3.465977	-3.465585	-3.465780	0.739000	-3.465780	-3.465585	-3.465780
5% Critical	-2.876927	-2.877012	-2.877012	-2.877099	-2.876927	-2.877012	0.463000	-2.877012	-2.876927	-2.877012
10% Critical	-2.575051	-2.575097	-2.575097	-2.575143	-2.575051	-2.575097	0.347000	-2.575097	-2.575051	-2.575097
Vogelsang and Perron (1998) unit root breakpoint test										
Minimum t-stat	-2.926247	-11.74503	-2.615740	-3.589745	-3.032877	-11.39708	-2.469151	-17.12442	-3.208086	-11.32356
1% Critical	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133
5% Critical	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649

Source: own

Table 3A.1c Summary of unit root tests - Hungary

Hungary	Export_EA HUN in levels	First differences EA Export_HUN	EU Export_HUN in levels	First differences EU Export_HUN	HUN_INPP in levels	First differences of HUN_INPP	HUN_INPR in levels	First differences of HUN_INPR	FXHUN in levels	First differences of FXHUN
DF-GLS test										
DF tau statistic	1.215088	-0.180510	0.963082	-0.296560	1.117979	-8.535866	1.008218	-17.01537	-1.567261	-9.640942
1% Critical	-2.578397	-2.578555	-2.578397	-2.578555	-2.577522	-2.577522	-2.577522	-2.577522	-2.577522	-2.577522
5% Critical	-1.942677	-1.942699	-1.942677	-1.942699	-1.942555	-1.942555	-1.942555	-1.942555	-1.942555	-1.942555
10% Critical	-1.615481	-1.615467	-1.615481	-1.615467	-1.615559	-1.615559	-1.615559	-1.615559	-1.615559	-1.615559
Kwiatkowski-Phillips-Schmidt-Shin test										
KPSS statistic	1.606891	0.138277	1.633043	0.309227	1.645437	0.082763	1.245779	0.131721	1.420071	0.053544
1% Critical	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000
5% Critical	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000
10% Critical	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000
Phillips-Perron test for unit root										
Adj. t-Stat	-3.372311	-57.49831	-2.374838	-38.99697	-1.098726	-9.185282	0.131721	-17.39153	-1.513202	-9.190347
1% Critical	-3.465780	-3.465977	-3.465780	-3.465977	-3.465585	-3.465780	0.739000	-3.465780	-3.465585	-3.465780
5% Critical	-2.877012	-2.877099	-2.877012	-2.877099	-2.876927	-2.877012	0.463000	-2.877012	-2.876927	-2.877012
10% Critical	-2.575097	-2.575143	-2.575097	-2.575143	-2.575051	-2.575097	0.347000	-2.575097	-2.575051	-2.575097
Vogelsang and Perron (1998) unit root breakpoint test										
Minimum t-stat	-3.047725	-17.83776	-3.150429	-4.487995	-2.278455	-8.480124	-2.288599	-19.40025	-2.833509	-10.42653
1% Critical	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133
5% Critical	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649

Source: own

Table 3A.1d. Summary of unit root tests - Romania

Romania	EA Export_ROM in levels	First differences of EA Export_ROM	EU Export_ROM in levels	First differences EU Export_ROM	ROM_INPP in levels	First differences of ROM_INPP	ROM_INPR in levels	First differences of ROM_INPR	FXROM in levels	First differences of FXROM
DF-GLS test										
DF tau statistic	3.136666	-13.51661	2.585556	2.585556	0.598670	-12.84326	-1.914273	-3.663434	0.542666	-8.176131
1% Critical	-2.577454	-2.577590	-2.578397	-2.578397	-2.577522	-2.577522	-2.577522	-2.577522	-2.577522	-2.577522
5% Critical	-1.942545	-1.942564	-1.942677	-1.942677	-1.942555	-1.942555	-1.942555	-1.942555	-1.942555	-1.942555
10% Critical	-1.615565	-1.615553	-1.615481	-1.615481	-1.615559	-1.615559	-1.615559	-1.615559	-1.615559	-1.615559
Kwiatkowski-Phillips-Schmidt-Shin test										
KPSS statistic	1.615790	0.130890	1.710823	0.070281	1.585345	0.157353	0.348018	0.111982	1.349007	0.389984
1% Critical	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000	0.739000
5% Critical	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000	0.463000
10% Critical	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000	0.347000
Phillips-Perron test for unit root										
Adj. t-Stat	0.358793	-24.37752	-1.980821	-19.81172	-4.197444	-13.63290	-1.980434	-14.64935	-2.835285	-9.208048
1% Critical	-3.465585	-3.465780	-3.465780	-3.465977	-3.465585	-3.465780	0.739000	-3.465780	-3.465585	-3.465780
5% Critical	-2.876927	-2.877012	-2.877012	-2.877099	-2.876927	-2.877012	0.463000	-2.877012	-2.876927	-2.877012
10% Critical	-2.575051	-2.575097	-2.575097	-2.575143	-2.575051	-2.575097	0.347000	-2.575097	-2.575051	-2.575097
Vogelsang and Perron (1998) unit root breakpoint test										
Minimum t-stat	-2.134999	-14.31786	-2.146745	-5.641685	-4.721149	-16.70765	-3.519867	-5.948058	-3.996155	-10.24855
1% Critical	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133	-4.949133
5% Critical	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649	-4.443649

Source: own

Table 3A.1e. Summary of unit root tests - EA

EA	EA_INPP in levels	First differences of EA_INPP	EA_INPR in levels	First differences of EA__INPR
DF-GLS test				
DF tau statistic	0.679320	-7.365242	-1.914273	-3.663434
1% Critical	-2.577522	-2.577522	-2.577522	-2.577522
5% Critical	-1.942555	-1.942555	-1.942555	-1.942555
10% Critical	-1.615559	-1.615559	-1.615559	-1.615559
Kwiatkowski-Phillips-Schmidt-Shin test				
KPSS statistic	1.585345	0.157353	0.348018	0.111982
1% Critical	0.739000	0.739000	0.739000	0.739000
5% Critical	0.463000	0.463000	0.463000	0.463000
10% Critical	0.347000	0.347000	0.347000	0.347000
Phillips-Perron test for unit root				
Adj. t-Stat	-1.478422	-7.497513	-1.980434	-14.64935
1% Critical	-3.465585	-3.465780	-3.465780	-3.465780
5% Critical	-2.876927	-2.877012	-2.877012	-2.877012
10% Critical	-2.575051	-2.575097	-2.575097	-2.575097
Vogelsang and Perron (1998) unit root breakpoint test				
Minimum t-stat	-2.796344	-2.796344	-3.519867	-5.948058
1% Critical	-4.949133	-4.949133	-4.949133	-4.949133
5% Critical	-4.443649	-4.443649	-4.443649	-4.443649

Source: own

Table 4A.1 Schwarz Information Criterion VAR lag order selection

Lag	EA	EA_dummy	EU	EU_dummy
1	3.233118*	3.278183*	2.778751*	2.801271*
2	3.586979	3.597389	3.140505	3.129534
3	4.286471	4.315657	3.857360	3.868568
4	4.999317	4.984401	4.606348	4.571554
5	5.751824	5.750796	5.319514	5.304785
6	6.349394	6.341804	5.809667	5.798057
7	7.105540	7.107328	6.582004	6.577531
8	7.679639	7.702648	7.125246	7.143926
9	8.464956	8.472965	7.788715	7.795886
10	9.090248	9.099676	8.424626	8.432961
11	9.791326	9.794843	9.073250	9.057757
12	10.08332	10.08895	9.343696	9.314859

* indicates lag order selected by the criterion
Source: own

Table 4A.2 Summary of cointegrating relations by model

	EA				
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	4	4	3	3	3
Max-Eig	4	4	3	3	3
	Akaike Information Criteria by Rank (rows) and Model (columns)				
0	3.032799	3.032799	2.99533	2.99533	3.042826
1	2.619431	2.57795	2.529628	2.275061	2.311765
2	2.442673	2.403423	2.351197	2.063838	2.091817
3	2.398516	2.311791	2.250151	1.961034*	1.982706
4	2.400058	2.304197	2.289553	2.000277	2.011186
5	2.50013	2.402669	2.384112	2.075235	2.08354
6	2.622886	2.514085	2.514085	2.199998	2.199998
	EU				
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	4	3	3	3	3
Max-Eig	4	3	3	3	3
	Akaike Information Criteria by Rank (rows) and Model (columns)				
0	2.566867	2.566867	2.537692	2.537692	2.585486
1	2.150743	2.154196	2.114188	1.813549	1.850503
2	1.96547	1.944914	1.904854	1.578928	1.606866
3	1.953497	1.871875	1.828088	1.496894*	1.519338
4	1.971751	1.895608	1.879203	1.533646	1.545613
5	2.072823	1.992579	1.975119	1.615633	1.623566
6	2.196337	2.104886	2.104886	1.742277	1.742277

Notes: based on 0.05 level critical values based on MacKinnon-Haug-Michelis (1999)
Source: own

Table 4A.3a Cointegrating equations (long-run) results

		EA			EU		
		EXPORT	PLN_INPP	PLN_INPR	EXPORT	PLN_INPP	PLN_INPR
Main	EA/EU_INPR	-1.84856	-1.01503	0.779511	-2.14421	-1.29098	0.836269
		-0.66516	-0.38882	-0.25316	-0.50969	-0.33576	-0.24284
		[-2.77914]	[-2.61056]	[3.07911]	[-4.20694]	[-3.84491]	[3.44375]
	EA/EU_INPP	-0.65362	-1.80985	-1.09081	-1.13688	-1.83497	-0.75925
		-1.33643	-0.78121	-0.50865	-0.91025	-0.59964	-0.43368
		[-0.48908]	[-2.31673]	[-2.14452]	[-1.24898]	[-3.06013]	[-1.75070]
	D_LEUR	-46183.1	-27877.8	18275.48	-34734.1	-23003.3	17831.42
		-5601.14	-3274.14	-2131.81	-4191.62	-2761.28	-1997.07
		[-8.24530]	[-8.51455]	[8.57274]	[-8.28656]	[-8.33067]	[8.92879]
	@TREND	-0.56968	-0.19139	0.03096	-0.44907	-0.12176	-0.01946
		-0.22367	-0.13075	-0.08513	-0.16679	-0.10988	-0.07947
		[-2.54696]	[-1.46387]	[0.36368]	[-2.69234]	[-1.10815]	[-0.24492]
	C	257.2301	229.667	-85.8173	312.4194	247.5192	-118.5

Note: standard errors in parentheses, t-stats in brackets

Source: own

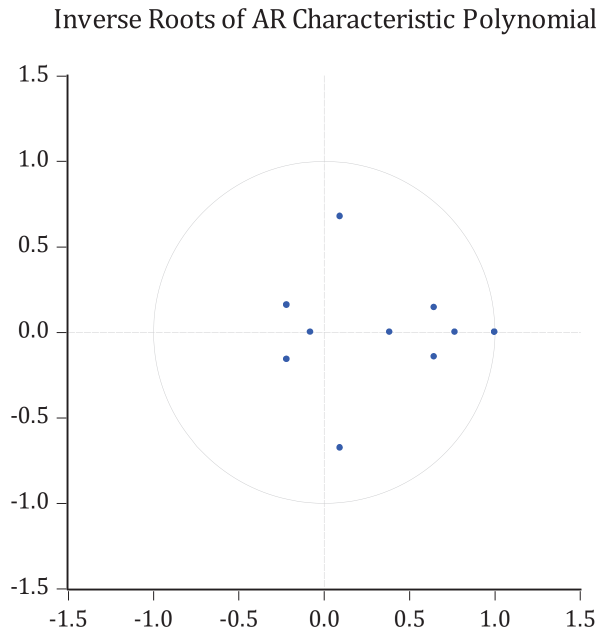
Table 4A.3b Cointegrating equations (long-run) robustness results

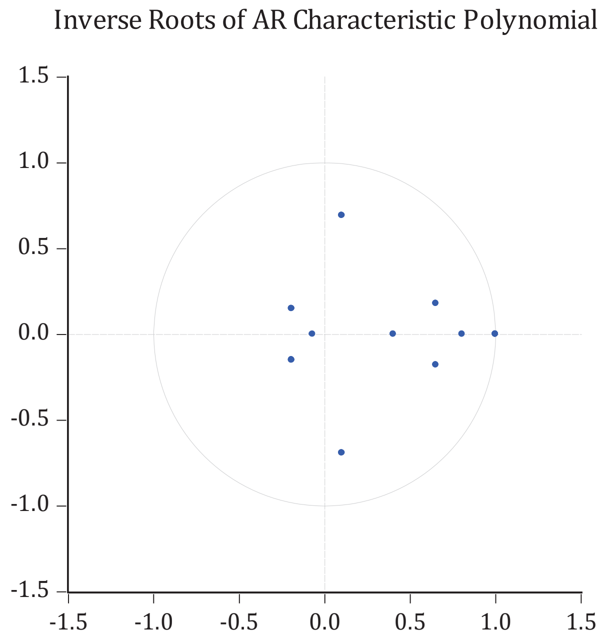
		EA			EU		
		EXPORT	PLN_INPP	PLN_INPR	EXPORT	PLN_INPP	PLN_INPR
Exchange Rate	EA/EU_INPR	-4.82817	-2.65479	1.499858	-3.69796	-1.90925	1.667817
		(-1.97761)	(-1.08768)	(-0.5783)	(-1.01945)	(-0.54086)	(-0.51264)
		[-2.44142]	[-2.44079]	[2.59359]	[-3.62739]	[-3.53005]	[3.25339]
	EA/EU_INPP	0.536	-1.24528	-1.52771	-2.12963	-2.20844	-0.19624
		(-4.2719)	(-2.34953)	(-1.2492)	(-1.90637)	(-1.0114)	(-0.95863)
		[0.12547]	[-0.53001]	[-1.22295]	[-1.11711]	[-2.18355]	[-0.20471]
	GARCH	-135428	-76832.3	39897.68	-66831.6	-36360.5	34599.35
		(-18419.4)	(-10130.6)	(-5386.25)	(-7967.08)	(-4226.82)	(-4006.3)
		[-7.35242]	[-7.58415]	[7.40732]	[-8.38847]	[-8.60231]	[8.63623]
	EURPLN	-64.5435	-34.9046	16.97781	-18.3021	-8.25153	9.105172
		(-35.5646)	(-19.5604)	(-10.3999)	(-17.6878)	(-9.38403	(-8.89444)
		[-1.81482]	[-1.78445]	[1.63250]	[-1.03473]	[-0.87932]	[1.02369]
	@TREND	-1.04995	-0.44234	0.172124	-0.341	-0.08142	-0.08209
		(-0.71771)	(-0.39474)	(-0.20988)	(-0.35642)	(-0.18909)	(-0.17923)
		[-1.46291]	[-1.12058]	[0.82012]	[-0.95674]	[-0.43058]	[-0.45803]
	C	818.9052	543.6182	-215.225	651.715	385.0647	-299.569
Crisis Dummy	EA/EU_INPR	-0.59287	-0.29586	0.337391	-1.73668	-1.01818	0.646663
		(-0.51548)	(-0.30306)	(-0.19446)	(-0.53092)	(-0.35792)	(-0.24173)
		[-1.15013]	[-0.97624]	[1.73506]	[-3.27109]	[-2.84470]	[2.67515]
	EA/EU_INPP	1.080198	-0.88516	-1.68907	-1.24544	-1.90572	-0.70234
		(-1.03323)	(-0.60744)	(-0.38976)	(-0.92266)	(-0.62202)	(-0.42009)
		[1.04546]	[-1.45718]	[-4.33358]	[-1.34984]	[-3.06377]	[-1.67187]
	GARCH	-24946.9	-15210.6	10465.48	-23101.3	-15268.4	12310.93
		(-5623.13)	(-3305.88)	(-2121.2)	(-5275.54)	(-3556.56)	(-2401.98)
		[-4.43649]	[-4.60107]	[4.93375]	[-4.37894]	[-4.29302]	[5.12532]
	@TREND	-0.77173	-0.29623	0.098447	-0.40125	-0.09019	-0.04296
		(-0.17301)	(-0.10172)	(-0.06527)	(-0.16908)	(-0.11399)	(-0.07698)
		[-4.46055]	[-2.91232]	[1.50842]	[-2.37309]	[-0.79125]	[-0.55803]
	C	-34.3165	67.91596	16.24805	268.4675	217.9958	-98.4665

Note: standard errors in parentheses, t-stats in brackets

Source: own

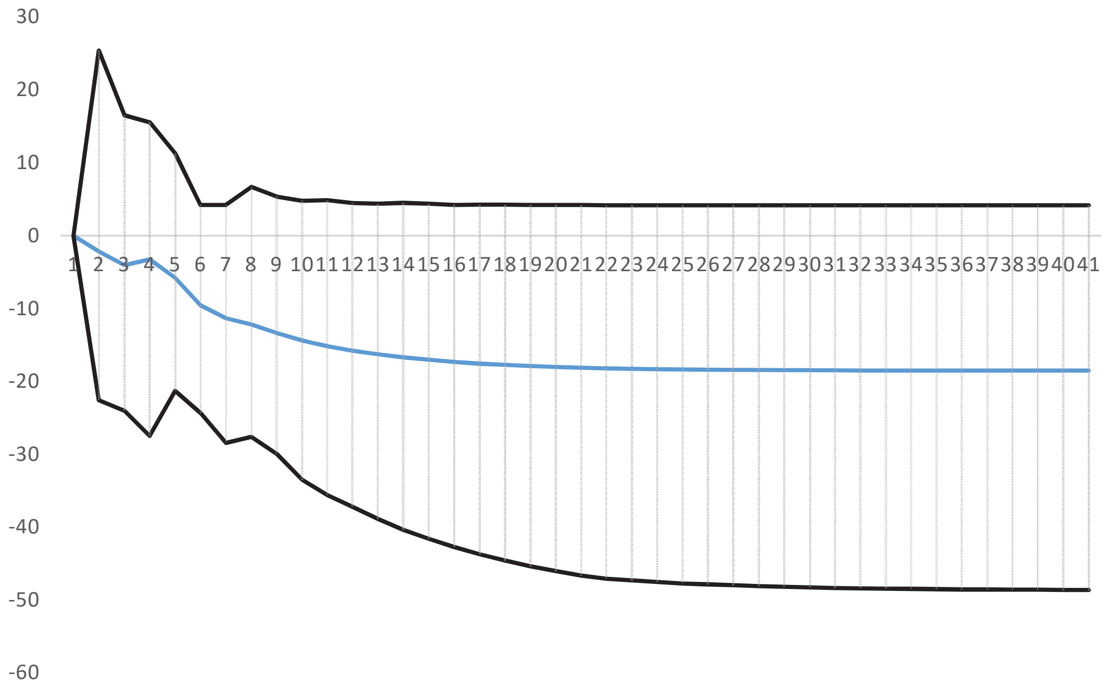
Figure 4A.3 Inverse Roots of AR Characteristic Polynominal for the EA (upper panel) and EU (lower panel) models





Source: own

Figure 4A.4 Impulse response of Polish aggregate exports to EA countries to a one standard deviation shock in exchange rate volatility (crisis dummy included)



Source: own

Table 5A.1 Cointegrating relationship for SITC section 0 – Polish export

Cointegrating Eq:	LOG(EXPORT)	LOG(PLN_INPR)	LOG(P_PLN SITC0)
EA			
LOG(EA_INPR)	9.816097	-1.152174	-10.57940
	(3.67640)	(0.19624)	(2.63792)
	[2.67003]	[-5.87125]	[-4.01050]
LOG(PF_PLN_SITC0)	-0.412164	-1.630518	-3.266899
	(1.03240)	(0.05511)	(0.74078)
	[-0.39923]	[-29.5877]	[-4.41008]
PLNEGARCH	2318.862	-123.9843	-1859.158
	(296.938)	(15.8500)	(213.061)
	[7.80925]	[-7.82235]	[-8.72594]
C	-51.20923	1.505728	50.96153
EU			
LOG(EU_INPR)	30.28777	-1.090832	-23.55528
	(9.49128)	(0.19864)	(6.15637)
	[3.19112]	[-5.49153]	[-3.82616]
LOG(PF_PLN_SITC0)	2.160664	-1.528457	-4.698533
	(2.38187)	(0.04985)	(1.54497)
	[0.90713]	[-30.6616]	[-3.04119]
PLNEGARCH	6006.357	-96.50449	-4094.767
	(719.765)	(15.0637)	(466.865)
	[8.34489]	[-6.40644]	[-8.77078]
C	-149.1595	1.161495	112.8999

Note: standard errors in parentheses, t-stats in brackets

Source: own

Table 5A.2 Cointegrating relationship for SITC section 1 – Polish export

Cointegrating Eq:	LOG(EXPORT)	LOG(PLN_INPR)	LOG(P_PLN SITC1)
EA			
LOG(EA_INPR)	-60.74025	-5.778262	-19.98664
	(12.6227)	(1.13030)	(5.08782)
	[-4.81200]	[-5.11215]	[-3.92833]
LOG(PF_PLN_SITC1)	-0.306148	-0.035634	-0.084764
	(0.04712)	(0.00422)	(0.01899)
	[-6.49656]	[-8.44446]	[-4.46254]
PLNEGARCH	-8785.210	-758.1200	-3169.211
	(965.950)	(86.4963)	(389.346)
	[-9.09489]	[-8.76477]	[-8.13983]
C	289.2386	23.44714	95.72535
EU			
LOG(EU_INPR)	-100.4033	-9.610707	-35.05437
	(20.4123)	(1.87073)	(8.10267)
	[-4.91876]	[-5.13740]	[-4.32627]
LOG(PF_PLN_SITC1)	-0.318938	-0.038079	-0.096988
	(0.06785)	(0.00622)	(0.02693)
	[-4.70084]	[-6.12401]	[-3.60125]
PLNEGARCH	-13882.31	-1252.567	-5159.947
	(1498.86)	(137.366)	(594.973)
	[-9.26192]	[-9.11844]	[-8.67258]
C	475.9093	41.50967	166.8376

Note: standard errors in parentheses, t-stats in brackets

Source: own

Table 5A.3 Cointegrating relationship for SITC section 2 – Polish export

Cointegrating Eq:	LOG(EXPORT)	LOG(PLN_INPR)	LOG(P_PLN SITC2)
EA			
LOG(EA_INPR)	3.869002	0.829076	-4.843638
	(0.93189)	(0.34153)	(0.98317)
	[4.15178]	[2.42754]	[-4.92653]
LOG(PF_PLN_SITC2)	-0.390802	-0.464217	-1.138680
	(0.09977)	(0.03656)	(0.10526)
	[-3.91708]	[-12.6959]	[-10.8179]
PLNEGARCH	757.8387	213.4600	-727.4853
	(74.3321)	(27.2421)	(78.4228)
	[10.1953]	[7.83567]	[-9.27645]
C	-22.55143	-8.106731	23.16712
EU			
LOG(EU_INPR)	4.422196	1.179548	-6.431366
	(1.14591)	(0.44501)	(1.35035)
	[3.85911]	[2.65060]	[-4.76275]
LOG(PF_PLN_SITC2)	-0.493888	-0.470310	-1.080747
	(0.10957)	(0.04255)	(0.12912)
	[-4.50749]	[-11.0527]	[-8.37022]
PLNEGARCH	844.3778	261.7712	-925.5111
	(84.6682)	(32.8807)	(99.7734)
	[9.97278]	[7.96123]	[-9.27613]
C	-25.07517	-9.750582	30.57026

Note: standard errors in parentheses, t-stats in brackets

Source: own

Table 5A.4 Cointegrating relationship for SITC section 3 – Polish export

Cointegrating Eq:	LOG(EXPORT)	LOG(PLN_INPR)	LOG(P_PLN)
EA			
LOG(EA_INPR)	-1.382000	3.163034	7.410271
	(1.45116)	(1.83981)	(3.63427)
	[-0.95234]	[1.71921]	[2.03900]
LOG(PF_PLN_SITC3)	-0.160448	-0.008146	-0.161700
	(0.15775)	(0.19999)	(0.39506)
	[-1.01713]	[-0.04073]	[-0.40931]
PLNEGARCH	-692.6170	1199.255	2470.373
	(117.878)	(149.448)	(295.212)
	[-5.87571]	[8.02455]	[8.36812]
C	2.446781	-19.91715	-37.07662
EU			
LOG(EU_INPR)	-0.072399	2.784508	7.353364
	(0.61122)	(1.72467)	(3.56098)
	[-0.11845]	[1.61452]	[2.06498]
LOG(PF_PLN_SITC3)	0.067539	-0.217364	-0.562991
	(0.05952)	(0.16794)	(0.34676)
	[1.13474]	[-1.29427]	[-1.62359]
PLNEGARCH	56.58100	940.9534	2095.908
	(44.7157)	(126.173)	(260.512)
	[1.26535]	[7.45767]	[8.04532]
C	-4.416316	-17.76929	-36.12541

Note: standard errors in parentheses, t-stats in brackets

Source: own

Table 5A.5 Cointegrating relationship for SITC section 4– Polish export

Cointegrating Eq:	LOG(EXPORT)	LOG(PLN_INPR)	LOG(P_PLN)
EA			
LOG(EA_INPR)	-55.92817	-2.628463	-13.03800
	(14.6339)	(0.67060)	(6.47030)
	[-3.82181]	[-3.91959]	[-2.01505]
LOG(PF_PLN_SITC4)	-6.618312	-0.679665	-1.975076
	(1.32141)	(0.06055)	(0.58425)
	[-5.00853]	[-11.2243]	[-3.38053]
PLNEGARCH	-10180.11	-457.7342	-4008.254
	(1127.16)	(51.6519)	(498.367)
	[-9.03162]	[-8.86191]	[-8.04277]
C	266.6517	8.467791	63.87015
EU			
LOG(EU_INPR)	-66.68201	-3.255247	-15.26612
	(20.5833)	(0.95185)	(7.73568)
	[-3.23961]	[-3.41992]	[-1.97347]
LOG(PF_PLN_SITC4)	-6.428764	-0.658938	-1.780801
	(1.65491)	(0.07653)	(0.62195)
	[-3.88466]	[-8.61030]	[-2.86325]
PLNEGARCH	-13243.24	-613.1801	-4471.646
	(1496.18)	(69.1888)	(562.297)
	[-8.85138]	[-8.86242]	[-7.95246]
C	317.9338	11.44220	74.28040

Note: standard errors in parentheses, t-stats in brackets

Source: own

Table 5A.6 Cointegrating relationship for SITC section 5 – Polish export

Cointegrating Eq:	LOG(EXPORT)	LOG(PLN_INPR)	LOG(P_PLN_SITC5)
EA			
LOG(EA_INPR)	3.514291	0.560649	-0.689821
	(0.80912)	(0.33665)	(0.63750)
	[4.34333]	[1.66538]	[-1.08207]
LOG(PF_PLN_SITC5)	-1.812843	-0.891357	-1.880489
	(0.14194)	(0.05906)	(0.11183)
	[-12.7721]	[-15.0935]	[-16.8154]
PLNEGARCH	588.5361	114.7367	-297.6802
	(64.9815)	(27.0366)	(51.1982)
	[9.05697]	[4.24375]	[-5.81427]
C	-19.71742	-6.520644	3.883584
EU			
LOG(EU_INPR)	4.086104	0.884815	-1.378104
	(1.02405)	(0.41620)	(0.85836)
	[3.99013]	[2.12593]	[-1.60550]
LOG(PF_PLN_SITC5)	-1.880391	-0.878972	-1.919308
	(0.16050)	(0.06523)	(0.13453)
	[-11.7155]	[-13.4743]	[-14.2662]
PLNEGARCH	700.5408	170.9986	-418.2733
	(75.4213)	(30.6532)	(63.2183)
	[9.28836]	[5.57849]	[-6.61633]
C	-22.37321	-8.062844	7.171160

Note: standard errors in parentheses, t-stats in brackets

Source: own

Table 5A.7 Cointegrating relationship for SITC section 6 – Polish export

Cointegrating Eq:	LOG(EXPORT)	LOG(PLN_INPR)	LOG(P_PLN_SITC6)
EA			
LOG(EA_INPR)	-0.189017	-0.329412	0.934617
	(0.62804)	(0.78496)	(0.19430)
	[-0.30096]	[-0.41965]	[4.81007]
LOG(PF_PLN_SITC6)	-1.636818	-2.177811	-1.650075
	(0.17738)	(0.22171)	(0.05488)
	[-9.22754]	[-9.82298]	[-30.0673]
PLNEGARCH	-265.2681	-507.2275	-13.25966
	(51.2722)	(64.0832)	(15.8627)
	[-5.17372]	[-7.91514]	[-0.83590]
C	-3.032453	-1.976482	-4.489266
EU			
LOG(EU_INPR)	-0.916606	-1.116021	0.680763
	(0.95501)	(1.04380)	(0.30240)
	[-0.95978]	[-1.06919]	[2.25117]
LOG(PF_PLN_SITC6)	-2.187386	-2.251567	-1.816186
	(0.24146)	(0.26391)	(0.07646)
	[-9.05897]	[-8.53162]	[-23.7539]
PLNEGARCH	-458.1579	-630.1221	-112.4524
	(69.1324)	(75.5594)	(21.8908)
	[-6.62725]	[-8.33943]	[-5.13698]
C	0.648312	1.764102	-3.194590

Note: standard errors in parentheses, t-stats in brackets

Source: own

Table 5A.8 Cointegrating relationship for SITC section 7 – Polish export

Cointegrating Eq:	LOG(EXPORT)	LOG(PLN_INPR)	LOG(P_PLN SITC7)
EA			
LOG(EA_INPR)	2.323531	1.745530	1.356948
	(0.98977)	(0.48850)	(0.53980)
	[2.34755]	[3.57323]	[2.51380]
LOG(PF_PLN_SITC7)	-1.490066	-0.889746	-1.626849
	(0.23229)	(0.11465)	(0.12668)
	[-6.41475]	[-7.76081]	[-12.8417]
PLNEGARCH	692.7089	397.2020	124.2887
	(77.9908)	(38.4925)	(42.5345)
	[8.88193]	[10.3189]	[2.92206]
C	-15.08050	-12.54439	-6.154370
EU			
LOG(EU_INPR)	3.212521	2.271180	1.623412
	(1.31293)	(0.61252)	(0.60038)
	[2.44683]	[3.70790]	[2.70398]
LOG(PF_PLN_ SITC7)	-1.792570	-0.950225	-1.676694
	(0.27528)	(0.12843)	(0.12588)
	[-6.51177]	[-7.39892]	[-13.3197]
PLNEGARCH	875.9019	459.6856	156.5573
	(95.9760)	(44.7758)	(43.8880)
	[9.12626]	[10.2664]	[3.56720]
C	-19.17214	-14.98799	-7.384288

Note: standard errors in parentheses, t-stats in brackets

Source: own

Table 5A.9 Cointegrating relationship for SITC section 8 – Polish export

Cointegrating Eq:	LOG(EXPORT)	LOG(PLN_INPR)	LOG(P_PLN SITC8)
EA			
LOG(EA_INPR)	-11.45424	-14.78683	1.942631
	(4.55724)	(4.98450)	(0.38262)
	[-2.51342]	[-2.96656]	[5.07720]
LOG(PF_PLN_SITC8)	-11.01311	-11.63593	-0.133657
	(1.86737)	(2.04244)	(0.15678)
	[-5.89767]	[-5.69707]	[-0.85251]
PLNEGARCH	-2881.929	-3345.303	264.3913
	(372.817)	(407.771)	(31.3011)
	[-7.73013]	[-8.20388]	[8.44670]
C	56.90690	72.98314	-9.119714
EU			
LOG(EU_INPR)	-16.27753	-16.47752	1.265646
	(5.43213)	(5.09929)	(0.39365)
	[-2.99653]	[-3.23133]	[3.21512]
LOG(PF_PLN_SITC8)	-10.69624	-9.570896	-0.740585
	(1.99083)	(1.86885)	(0.14427)
	[-5.37276]	[-5.12129]	[-5.13330]
PLNEGARCH	-3434.515	-3319.684	86.41205
	(408.681)	(383.641)	(29.6162)
	[-8.40390]	[-8.65311]	[2.91773]
C	79.32016	79.49920	-5.506020

Note: standard errors in parentheses, t-stats in brackets

Source: own

Table 5A.10 Cointegrating relationship for SITC section 9 – Polish export

Cointegrating Eq:	LOG(EXPORT)	LOG(PLN_INPR)	LOG(P_PLN_SITC9)
EA			
LOG(EA_INPR)	-2.576575	1.749136	28.09825
	(1.64098)	(0.45899)	(9.66348)
	[-1.57014]	[3.81082]	[2.90767]
LOG(PF_PLN_SITC9)	-0.190239	-0.068758	-0.185002
	(0.02990)	(0.00836)	(0.17610)
	[-6.36177]	[-8.22057]	[-1.05057]
PLNEGARCH	97.02842	356.8571	4959.622
	(132.433)	(37.0423)	(779.878)
	[0.73266]	[9.63376]	[6.35948]
C	8.350033	-12.47682	-135.4871
EU			
LOG(EU_INPR)	-2.576575	1.749136	28.09825
	(1.64098)	(0.45899)	(9.66348)
	[-1.57014]	[3.81082]	[2.90767]
LOG(PF_PLN_SITC9)	-0.190239	-0.068758	-0.185002
	(0.02990)	(0.00836)	(0.17610)
	[-6.36177]	[-8.22057]	[-1.05057]
PLNEGARCH	97.02842	356.8571	4959.622
	(132.433)	(37.0423)	(779.878)
	[0.73266]	[9.63376]	[6.35948]
C	8.350033	-12.47682	-135.4871

Note: standard errors in parentheses, t-stats in brackets

Source: own

Table 6A.1 Panel cross-section dependence test results

	Breusch -Pagan LM	Pesaran scaled LM	Bias-corrected scaled LM	Pesaran CD	Breusch-Pagan LM	Pesaran scaled LM	Bias-corrected scaled LM	Pesaran CD
SITC	EA				EU			
0	59.99	15.59	15.57	6.94	169.06	47.07	47.06	8.51
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
1	91.59	24.71	24.70	7.00	91.73	24.75	24.74	6.82
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2	142.60	39.43	39.42	10.79	128.26	35.29	35.28	10.19
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
3	29.64	6.82	6.81	3.32	29.33	6.73	6.72	3.31
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
4	26.94	6.04	6.03	2.19	32.97	7.79	7.77	-1.47
	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)	(0.14)
5	89.53	24.11	24.10	7.38	82.41	22.06	22.05	7.43
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
6	361.26	102.55	102.54	18.57	390.47	110.99	110.98	19.43
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
7	364.93	103.61	103.60	17.46	375.57	106.69	106.67	17.61
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
8	172.49	48.06	48.05	8.30	49.42	12.53	12.52	1.97
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
9	188.40	52.65	52.64	12.81	188.40	52.65	52.64	12.81
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Note: p-values in parentheses

Source: own

Table 6A.2. Westerlund (2007) panel cointegration test statistics (p-value in parentheses)

	EA				EU			
	Gt	Ga	Pt	Pa	Gt	Ga	Pt	Pa
0	-11.3	-206.2	-22.9	-188.8	-11.9	-225.6	-23.3	-193.1
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
1	-11.3	-302.2	-21.3	-276.1	-11.5	-297.2	-20.2	-262.7
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2	-10.5	-357.2	-19.5	-320.3	-10.6	-361.6	-20.4	-330.4
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
3	-11.6	-310.0	-19.9	-284.8	-12.0	-290.5	-20.7	-282.1
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
4	-10.0	-301.7	-19.9	-331.9	-11.4	-286.9	-19.4	-269.4
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
5	-11.4	-357.4	-17.5	-345.5	-10.6	-362.7	-18.9	-358.7
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
6	-10.8	-451.3	-19.2	-450.1	-12.0	-425.7	-23.3	-383.9
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
7	-11.9	-570.4	-23.3	-569.3	-11.6	-523.1	-23.0	-528.4
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
8	-10.3	-346.6	-18.3	-274.9	-10.2	-342.3	-16.5	-286.5
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
9	-13.8	-296.9	-28.7	-285.9	-12.9	-322.6	-31.0	-286.3
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Note: p-values in parentheses

Source: own

Table 6A.3 Autoregressive-Distributed Lag (ARDL) structure of the PMG model

	EA	EU
1	ARDL(4, 1, 1, 1, 1, 1)	ARDL(3, 1, 1, 1, 1, 1)
2	ARDL(4, 1, 1, 1, 1, 1)	ARDL(3, 1, 1, 1, 1, 1)
3	ARDL(4, 1, 1, 1, 1, 1)	ARDL(4, 1, 1, 1, 1, 1)
4	ARDL(3, 1, 1, 1, 1, 1)	ARDL(3, 1, 1, 1, 1, 1)
5	ARDL(4, 1, 1, 1, 1, 1)	ARDL(4, 1, 1, 1, 1, 1)
6	ARDL(4, 2, 2, 2, 2, 2)	ARDL(4, 1, 1, 1, 1, 1)
7	ARDL(4, 4, 4, 4, 4, 4)	ARDL(4, 4, 4, 4, 4, 4)
8	ARDL(4, 1, 1, 1, 1, 1)	ARDL(4, 1, 1, 1, 1, 1)
9	ARDL(4, 4, 4, 4, 4, 4)	ARDL(4, 4, 4, 4, 4, 4)
10	ARDL(4, 1, 1, 1, 1, 1)	ARDL(3, 1, 1, 1, 1, 1)

Source: own

Table 6A.4 Cointegrating vectors (long run coefficients): panel estimation for each SITC section, EU and EA as partner countries

	Variable	0	1	2	3	4	5	6	7	8	9
EA	P _SITC	-0.25	-0.12	0.10	-0.22	-1.50	0.12	0.11	0.02	-0.05	0.05
		(0.00)	(0.53)	(0.16)	(0.09)	(0.03)	(0.20)	(0.39)	(0.76)	(0.31)	(0.11)
	INPR	1.12	3.63	0.94	-0.28	6.08	1.79	0.21	1.19	1.12	1.05
		(0.00)	(0.00)	(0.00)	(0.38)	(0.00)	(0.00)	(0.06)	(0.00)	(0.00)	(0.00)
	PF _SITC	0.79	0.03	0.15	0.61	2.61	0.26	1.17	0.43	0.47	0.02
		(0.00)	(0.32)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)
	EA_INPR	-2.26	-3.52	-0.77	0.04	-8.20	-1.52	0.14	0.12	-0.77	2.58
		(0.00)	(0.01)	(0.02)	(0.95)	(0.00)	(0.00)	(0.51)	(0.55)	(0.00)	(0.00)
	GARCH	-0.01	-0.06	0.02	-0.01	0.04	0.00	0.02	0.00	0.04	0.06
		(0.32)	(0.21)	(0.12)	(0.49)	(0.41)	(0.88)	(0.07)	(0.51)	(0.29)	(0.16)
EU	P _SITC	-0.24	-0.11	0.05	-0.42	-1.50	0.14	-0.08	-0.01	-0.06	-0.04
		(0.00)	(0.13)	(0.45)	(0.01)	(0.03)	(0.08)	(0.51)	(0.94)	(0.32)	(0.40)
	INPR	0.80	2.26	0.94	0.15	6.08	1.68	0.05	1.28	1.00	1.93
		(0.00)	(0.00)	(0.00)	(0.58)	(0.00)	(0.00)	(0.66)	(0.00)	(0.00)	(0.00)
	PF _SITC	0.63	0.04	0.10	0.32	2.61	0.16	1.37	0.48	0.43	0.01
		(0.00)	(0.05)	(0.06)	(0.10)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)	(0.30)
	EU_INPR	-1.71	-2.12	-0.62	0.45	-8.20	-1.53	-0.09	-0.34	-1.13	0.37
		(0.00)	(0.01)	(0.04)	(0.36)	(0.00)	(0.00)	(0.66)	(0.14)	(0.00)	(0.82)
	GARCH	-0.01	-0.01	0.02	-0.01	0.04	-0.02	0.01	-4.90	0.03	0.08
		(0.26)	(0.36)	(0.11)	(0.45)	(0.41)	(0.41)	(0.39)	(0.13)	(0.47)	(0.14)

Note: p-values in parentheses

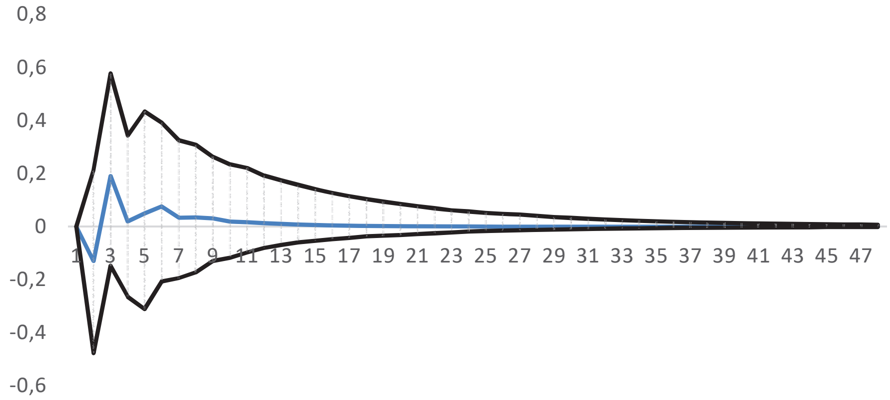
Source: own

Table 7A.1 Cointegrating vectors (long run coefficients): panel estimation for each SITC section, EU and EA as partner countries, Germany demand

	Variable	0	1	2	3	4	5	6	7	8	9
EA	P _SITC	-0.10	-0.11	0.01	-0.22	-0.63	0.03	-0.01	0.24	-0.10	0.05
		(0.42)	(0.03)	(0.91)	(0.09)	(0.06)	(0.68)	(0.95)	(0.01)	(0.09)	(0.12)
	INPR	2.25	-0.55	0.58	-0.23	5.78	0.96	0.19	1.13	1.04	1.11
		(0.00)	(0.22)	(0.00)	(0.47)	(0.00)	(0.00)	(0.15)	(0.00)	(0.00)	(0.00)
	PF _SITC	0.82	0.06	0.36	0.60	1.95	0.53	1.16	0.31	0.56	0.02
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.02)
	EA_INPR	-2.37	1.66	-0.41	-0.13	-6.32	-0.22	0.54	0.61	-0.03	2.38
		(0.00)	(0.00)	(0.11)	(0.83)	(0.00)	(0.33)	(0.13)	(0.02)	(0.93)	(0.00)
	GARCH	-0.06	-0.01	0.02	-0.01	0.04	0.03	0.01	0.03	0.04	0.06
		(0.22)	(0.50)	(0.06)	(0.42)	(0.27)	(0.39)	(0.18)	(0.00)	(0.35)	(0.16)
EU	P _SITC	-0.11	-0.16	0.00	-0.42	-1.50	0.18	-0.08	0.13	-0.04	-0.04
		(0.15)	(0.00)	(0.98)	(0.01)	(0.03)	(0.03)	(0.53)	(0.14)	(0.54)	(0.40)
	INPR	0.39	0.60	0.60	0.15	6.08	0.68	-0.08	0.93	0.15	1.93
		(0.16)	(0.16)	(0.00)	(0.58)	(0.00)	(0.00)	(0.52)	(0.00)	(0.55)	(0.00)
	PF _SITC	0.97	0.08	0.24	0.32	2.61	0.46	1.21	0.29	0.61	0.01
		(0.00)	(0.00)	(0.00)	(0.10)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.30)
	EU_INPR	-0.87	0.24	-0.05	0.45	-8.20	0.02	0.74	0.43	0.57	0.37
		(0.09)	(0.67)	(0.85)	(0.36)	(0.00)	(0.94)	(0.03)	(0.05)	(0.13)	(0.82)
	GARCH	-0.01	-0.02	0.02	-0.01	0.04	0.00	0.00	0.01	0.02	0.08
		(0.39)	(0.21)	(0.04)	(0.45)	(0.41)	(0.96)	(0.67)	(0.03)	(0.19)	(0.14)

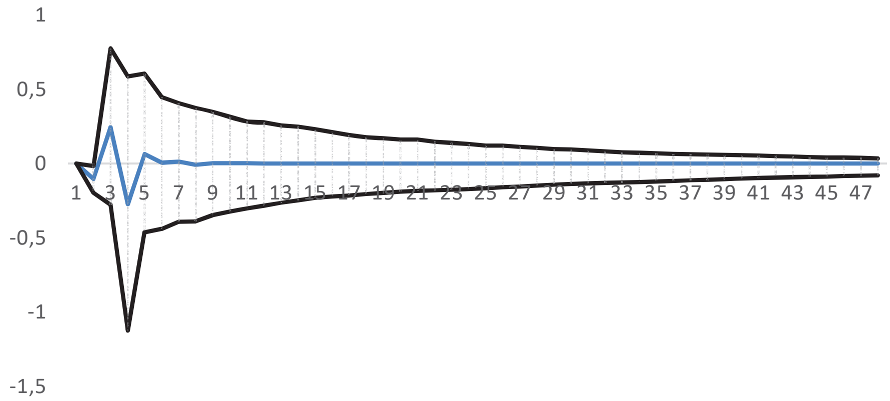
Note: p-values in parentheses

Figure 7A.1 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 0, GERMANY demand



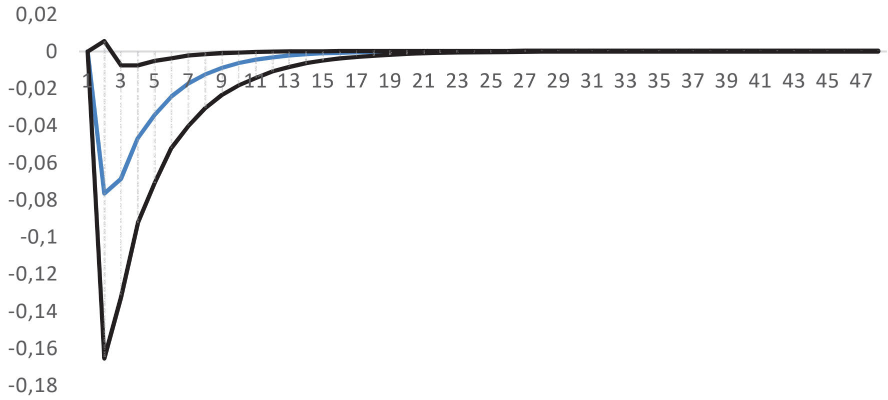
Source: own

Figure 7A.2 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 1, GERMANY demand



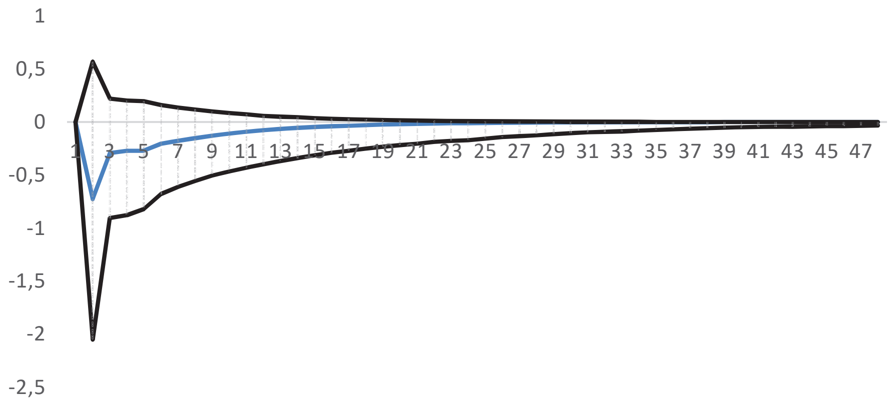
Source: own

Figure 7A.3 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 2, GERMANY demand



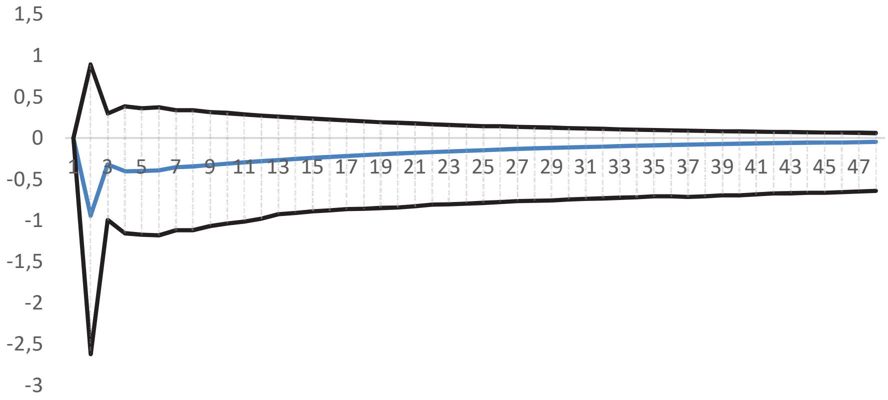
Source: own

Figure 7A.4 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 3, GERMANY demand



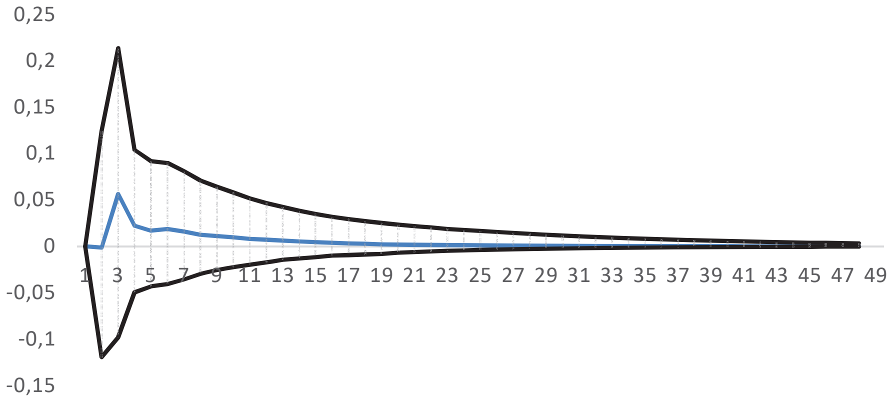
Source: own

Figure 7A.5 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 4, GERMANY demand



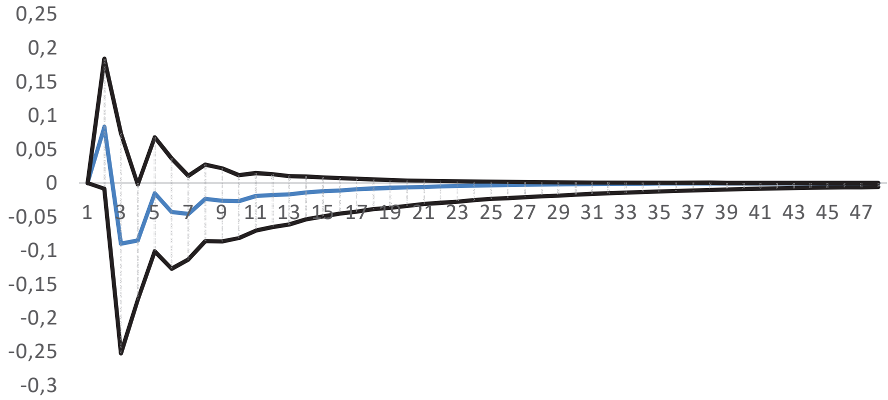
Source: own

Figure 7A.6 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 5, GERMANY demand



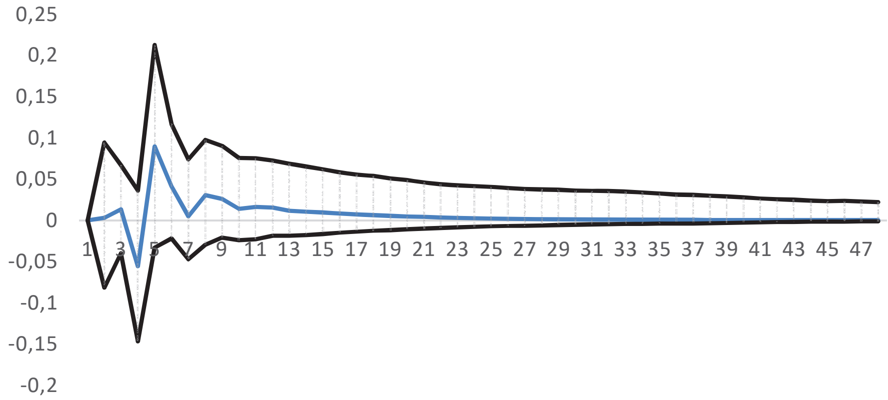
Source: own

Figure 7A.7 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 6, GERMANY demand



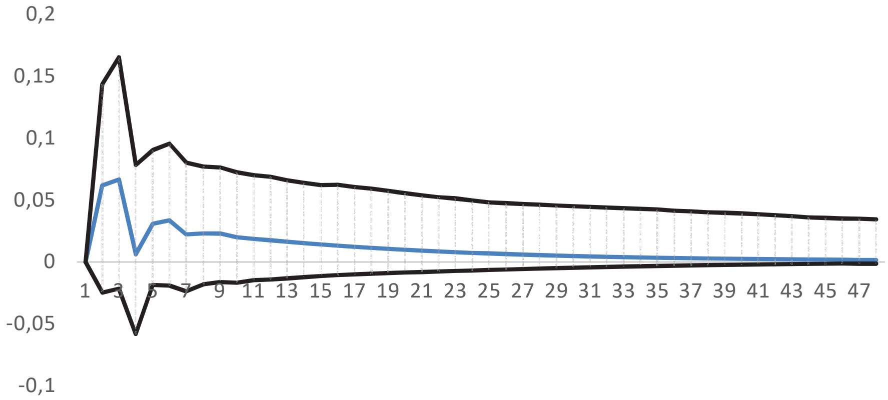
Source: own

Figure 7A.8 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 7, GERMANY demand



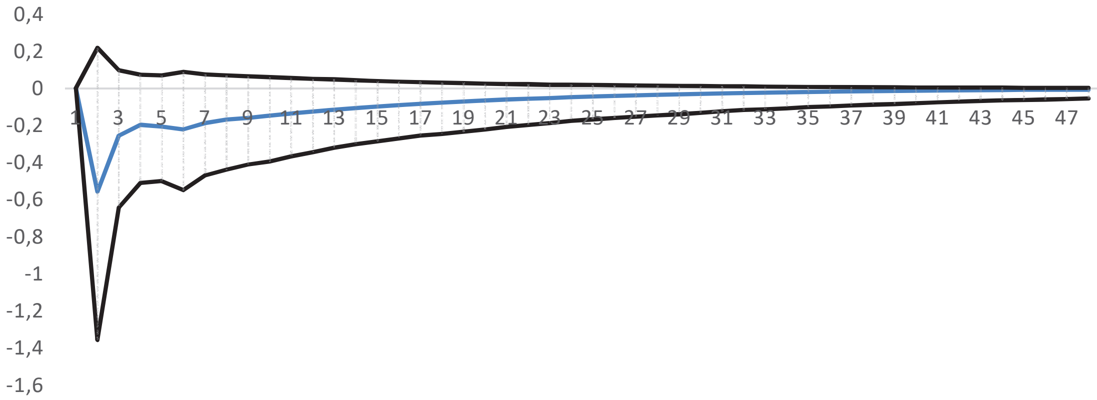
Source: own

Figure 7A.9 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 8, GERMANY demand



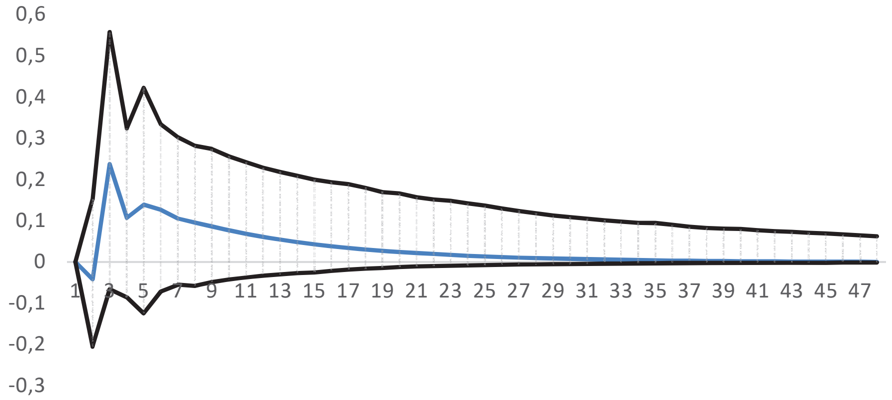
Source: own

Figure 7A.10 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 9, GERMANY demand



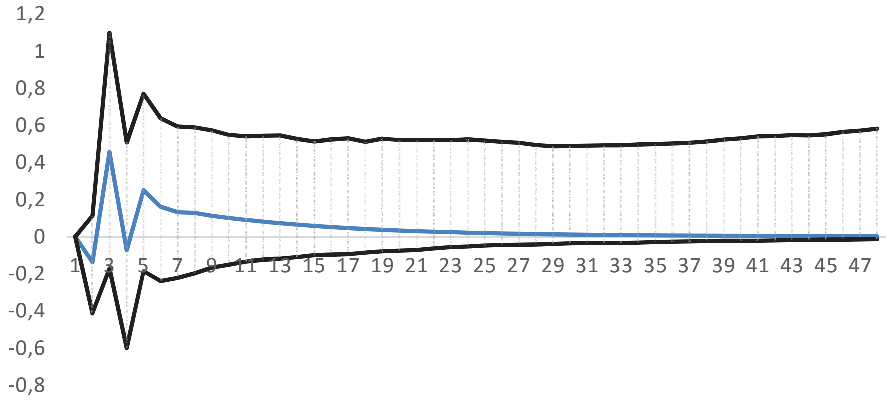
Source: own

Figure 7A.11 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 0, GERMANY demand



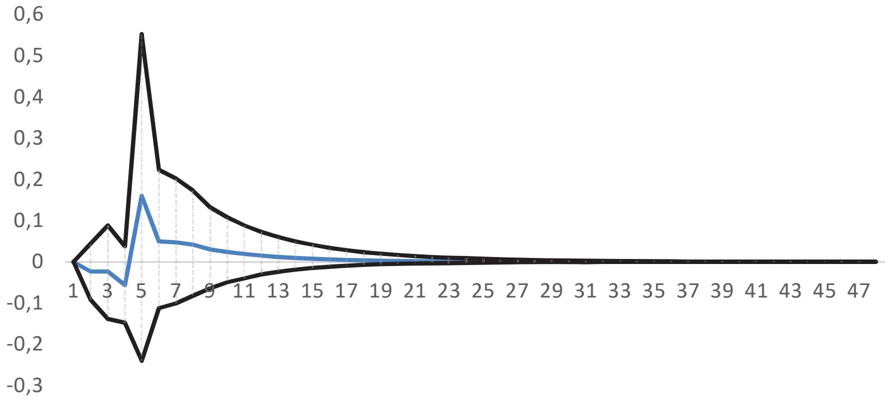
Source: own

Figure 7A.12 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 1, GERMANY demand



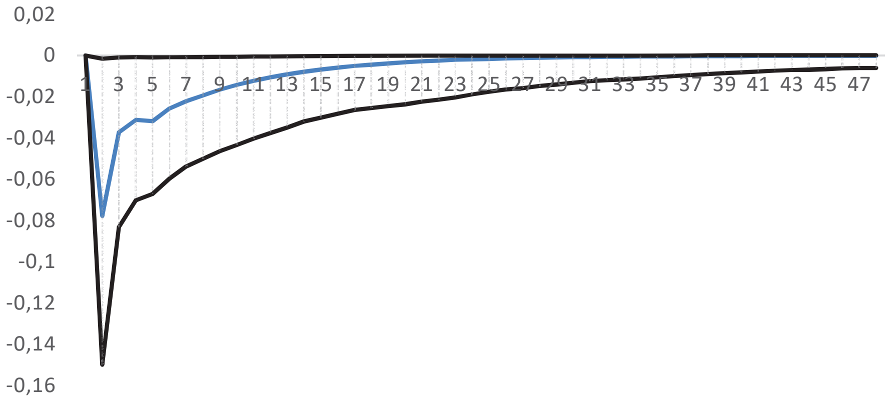
Source: own

Figure 7A.13 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 2, GERMANY demand



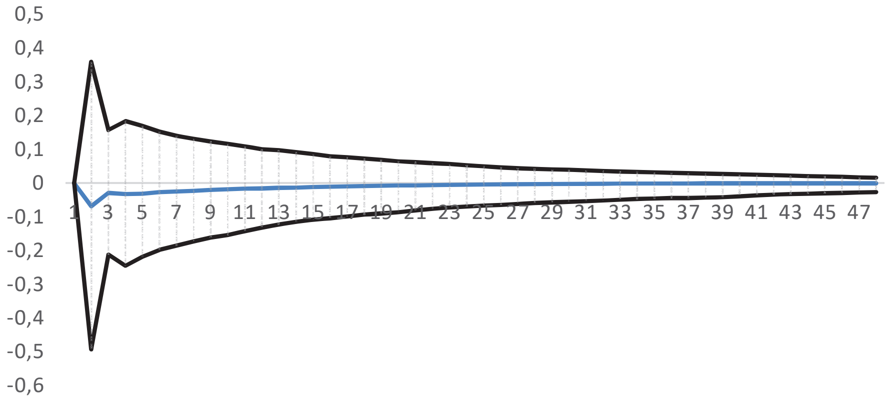
Source: own

Figure 7A.14 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 3, GERMANY demand



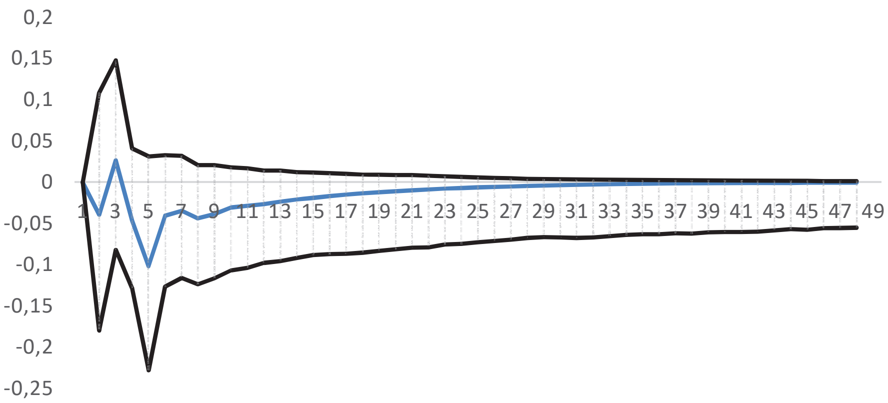
Source: own

Figure 7A.15 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 4, GERMANY demand



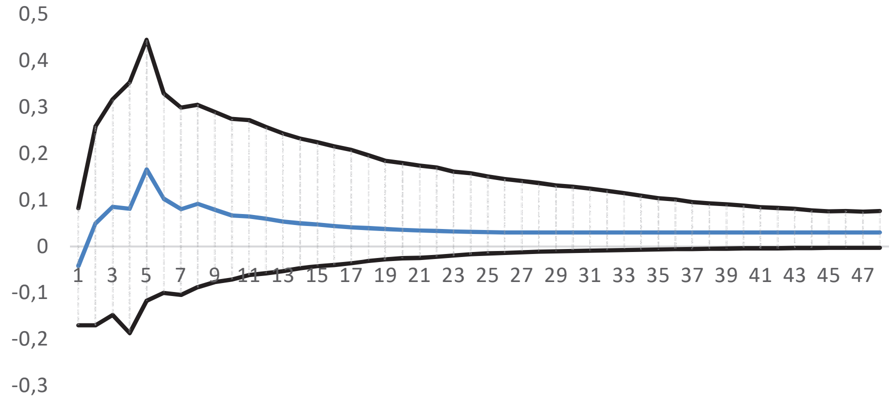
Source: own

Figure 7A.16 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 5, GERMANY demand



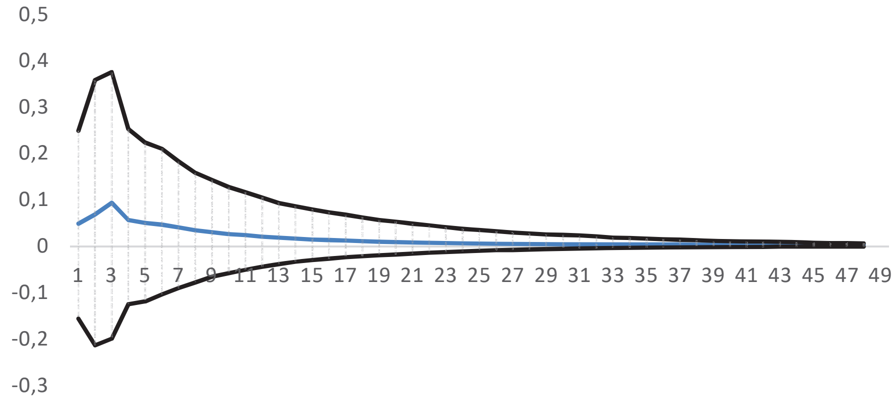
Source: own

Figure 7A.17 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 6, GERMANY demand



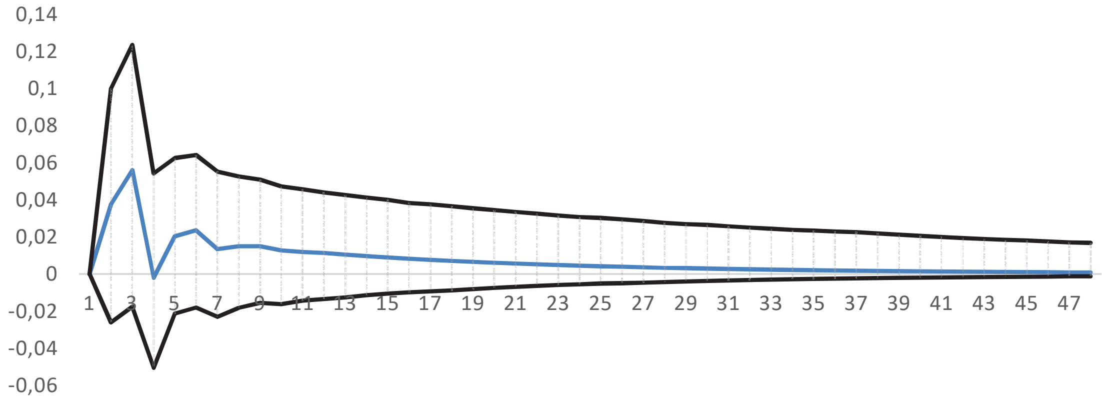
Source: own

Figure 7A.18 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 7, GERMANY demand



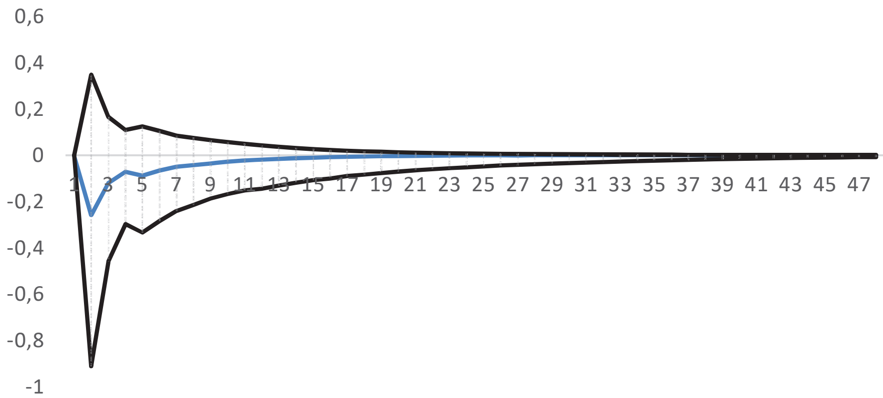
Source: own

Figure 7A.19 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 8, GERMANY demand



Source: own

Figure 7A.20 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 9, GERMANY demand



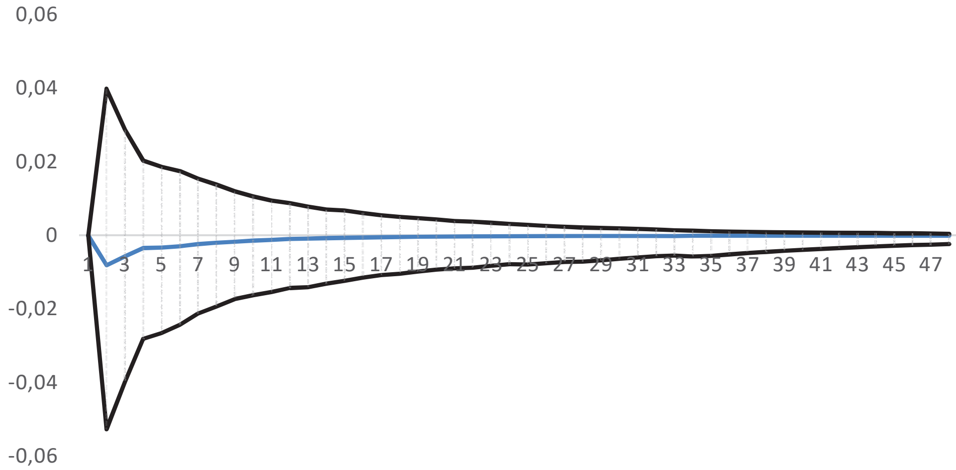
Source: own

Table 7A.2 Cointegrating vectors (long run coefficients): panel estimation for each SITC section, EU and EA as partner countries, exchange rate included

	Variable	0	1	2	3	4	5	6	7	8	9
EA	P _SITC	-0.27	-0.03	0.05	-0.26	-1.37	0.06	-0.09	0.03	-0.02	-0.02
		(0.00)	(0.74)	(0.49)	(0.13)	(0.06)	(0.45)	(0.49)	(0.67)	(0.76)	(0.66)
	INPR	0.53	3.15	0.94	0.16	6.07	1.90	0.10	1.21	1.03	1.73
		(0.06)	(0.00)	(0.00)	(0.59)	(0.00)	(0.00)	(0.41)	(0.00)	(0.00)	(0.00)
	PF _SITC	0.75	0.01	0.12	0.10	2.53	0.11	1.29	0.42	0.37	0.01
		(0.00)	(0.63)	(0.04)	(0.64)	(0.00)	(0.19)	(0.00)	(0.00)	(0.00)	(0.25)
	EA_INPR	-1.09	-4.37	-0.79	-0.13	-8.15	-1.88	-0.22	0.06	-1.55	4.43
		(0.03)	(0.00)	(0.02)	(0.82)	(0.01)	(0.00)	(0.37)	(0.81)	(0.00)	(0.02)
	GARCH	-0.01	-0.01	0.01	-0.01	0.04	-0.01	0.01	0.00	0.02	0.08
		(0.19)	(0.71)	(0.26)	(0.60)	(0.46)	(0.62)	(0.15)	(0.72)	(0.49)	(0.14)
	EURPLN	0.11	-0.29	-0.06	-0.12	0.05	-0.06	-0.02	-0.01	-0.15	1.00
		(0.07)	(0.01)	(0.24)	(0.25)	(0.91)	(0.25)	(0.67)	(0.69)	(0.01)	(0.00)
EU	P _SITC	-0.27	0.04	0.08	-0.20	-0.62	0.08	0.08	0.01	-0.03	0.04
		(0.00)	(0.84)	(0.23)	(0.12)	(0.08)	(0.33)	(0.47)	(0.87)	(0.54)	(0.16)
	INPR	1.01	4.26	0.93	-0.48	5.88	1.86	0.24	1.34	1.14	1.13
		(0.00)	(0.00)	(0.00)	(0.14)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)
	PF _SITC	0.83	0.01	0.18	0.66	2.07	0.24	1.12	0.66	0.44	0.01
		(0.00)	(0.74)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.04)
	EU_INPR	-1.85	-6.55	-0.95	0.77	-6.04	-1.86	0.14	0.68	-0.92	3.41
		(0.00)	(0.00)	(0.01)	(0.30)	(0.01)	(0.00)	(0.56)	(0.10)	(0.00)	(0.00)
	GARCH	-0.01	-0.04	0.01	-0.02	0.04	0.00	0.02	0.01	0.04	0.07
		(0.28)	(0.44)	(0.25)	(0.22)	(0.31)	(0.91)	(0.02)	(0.17)	(0.22)	(0.08)
	EURPLN	0.11	-0.51	-0.06	0.15	0.31	-0.07	0.04	0.02	-0.07	0.30
		(0.16)	(0.00)	(0.20)	(0.11)	(0.31)	(0.16)	(0.26)	(0.65)	(0.08)	(0.05)

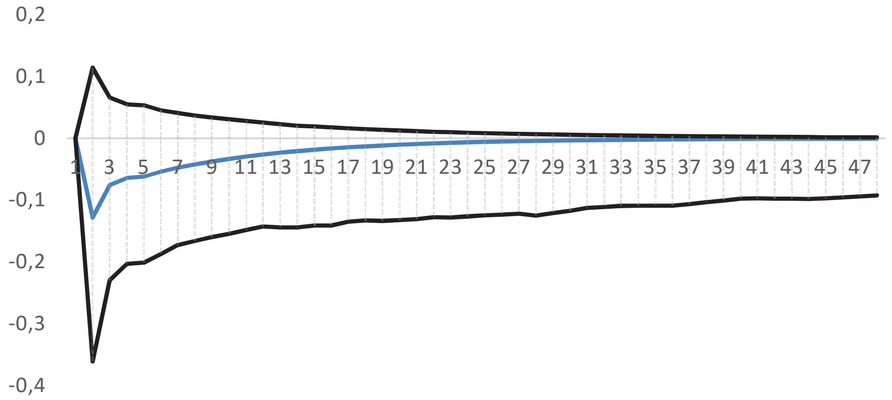
Note: p-values in parentheses
Source: own

Figure 7A.21 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 0, Exchange rate



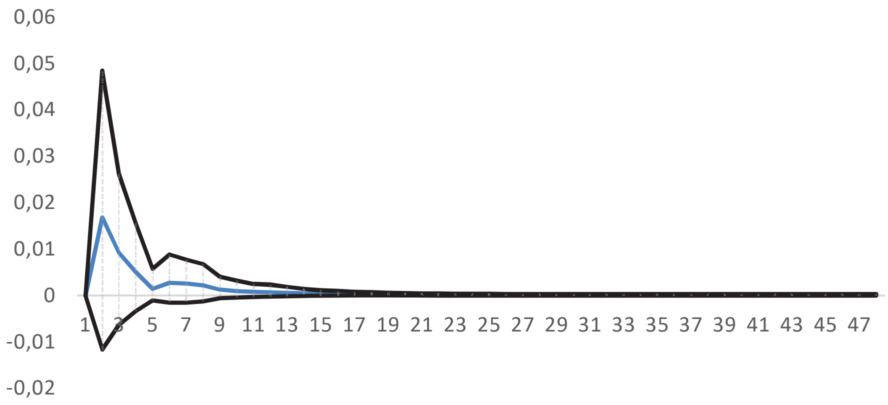
Source: own

Figure 7A.22 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 1, Exchange rate



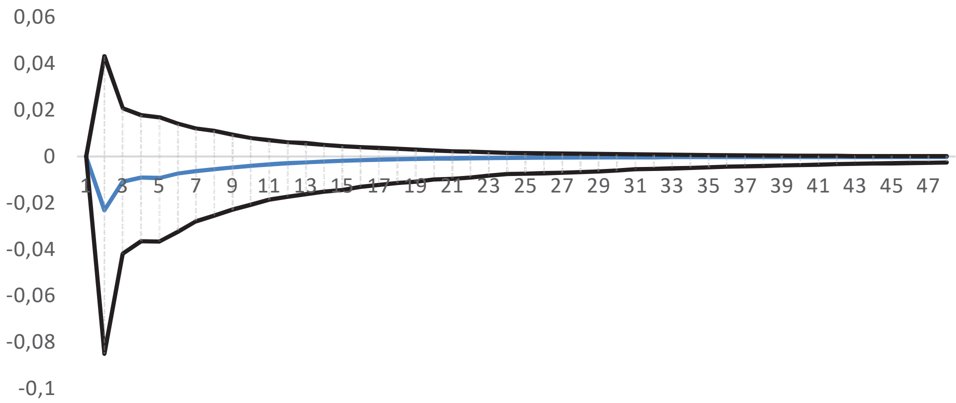
Source: own

Figure 7A.23 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 2, Exchange rate



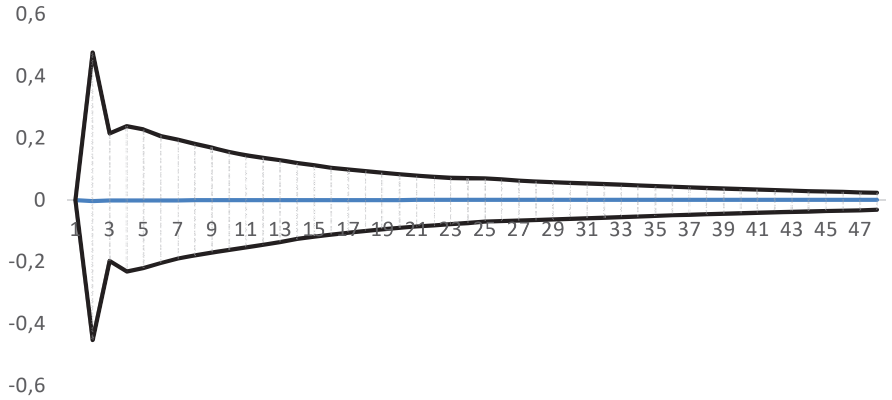
Source: own

Figure 7A.24 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 3, Exchange rate



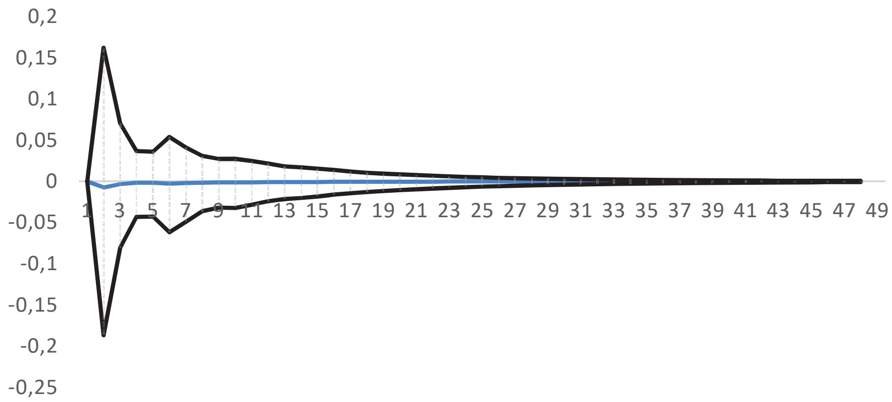
Source: own

Figure 7A.25 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 4, Exchange rate



Source: own

Figure 7A.26 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 5, Exchange rate



Source: own

Figure 7A.27 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 6, Exchange rate

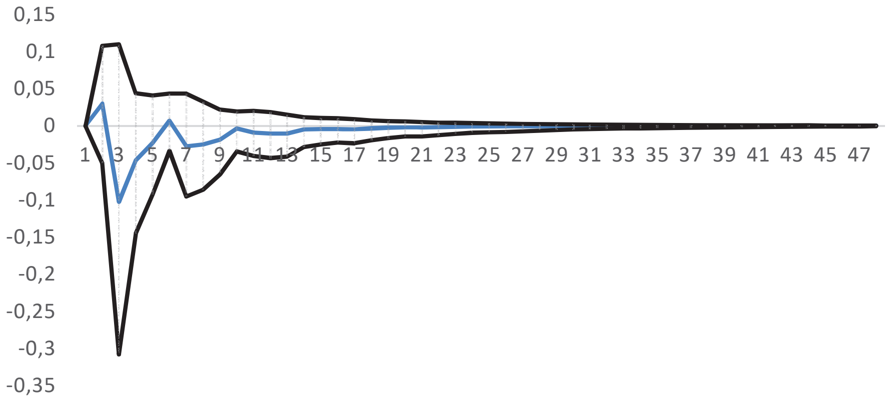


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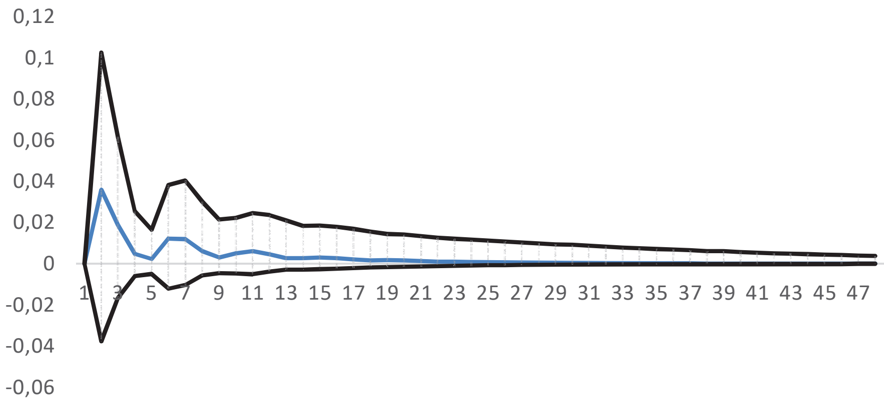
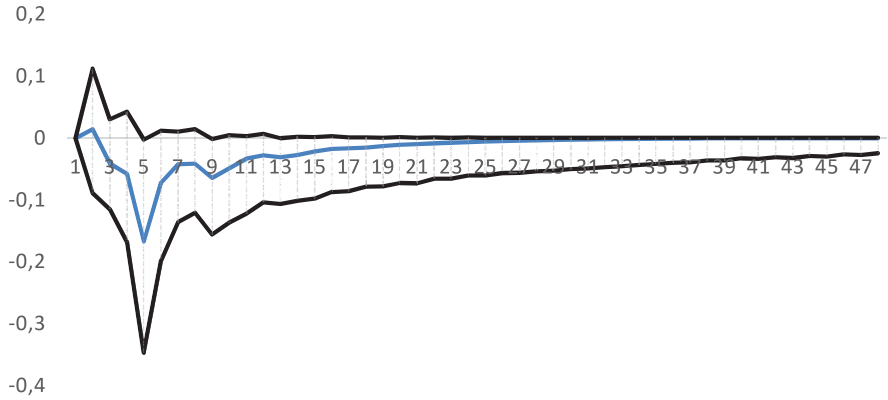
Figure 7A.28 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 7, Exchange rate



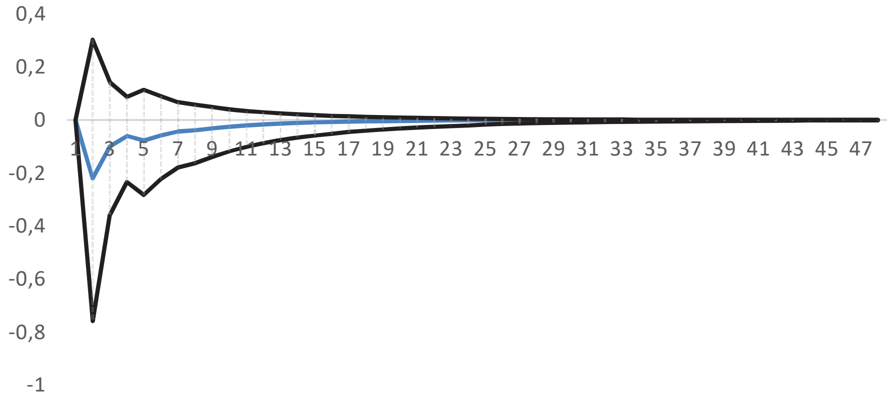
Source: own

Figure 7A.29 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 8, Exchange rate



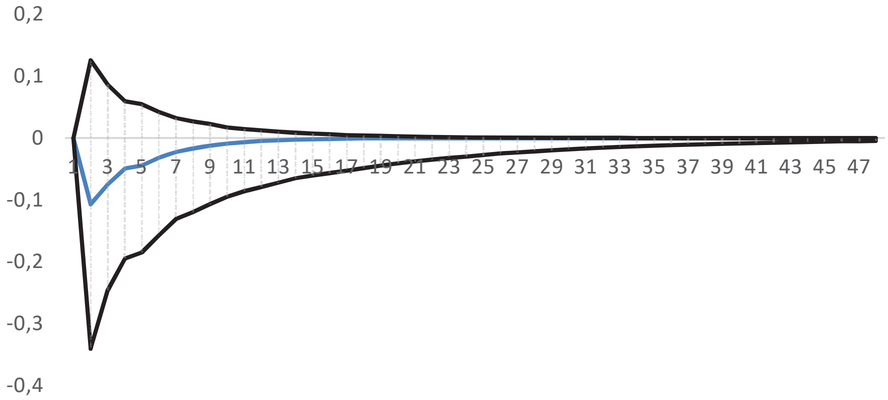
Source: own

Figure 7A.30 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 9, Exchange rate



Source: own

Figure 7A.31 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 0, Exchange rate



Source: own

Figure 7A.32 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 1, Exchange rate

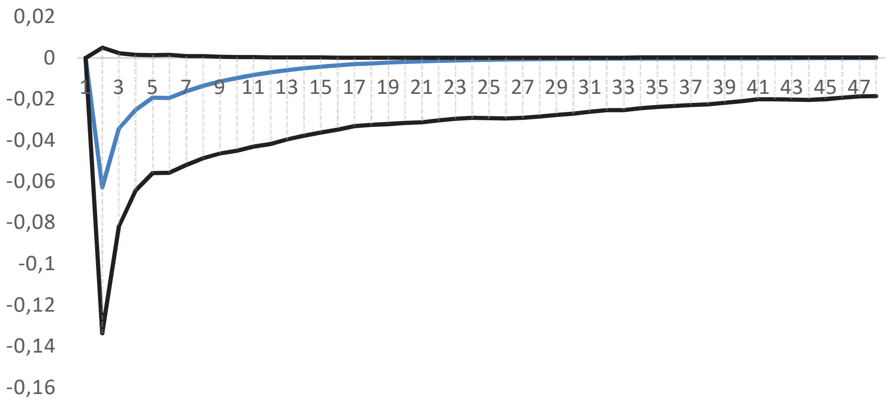


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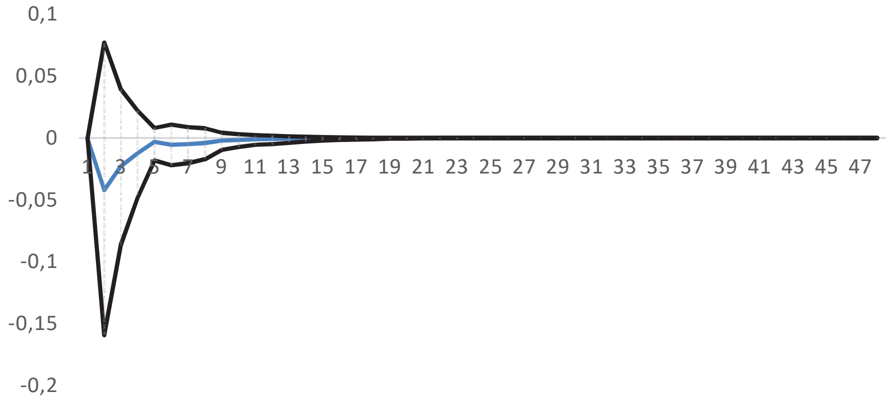
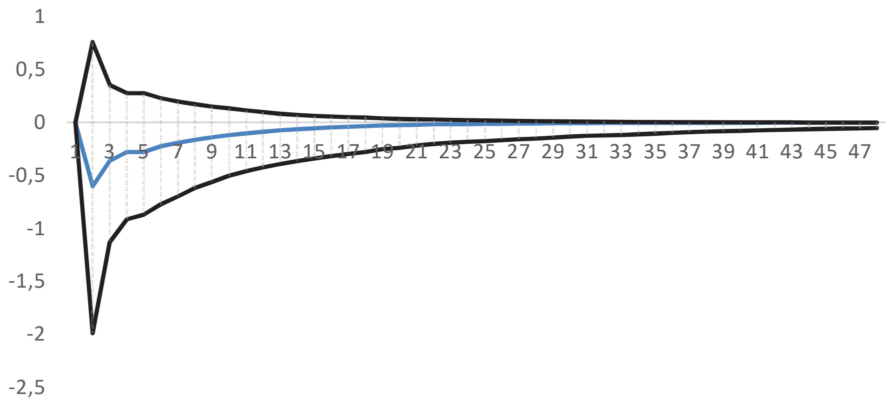
Figure 7A.33 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 2, Exchange rate



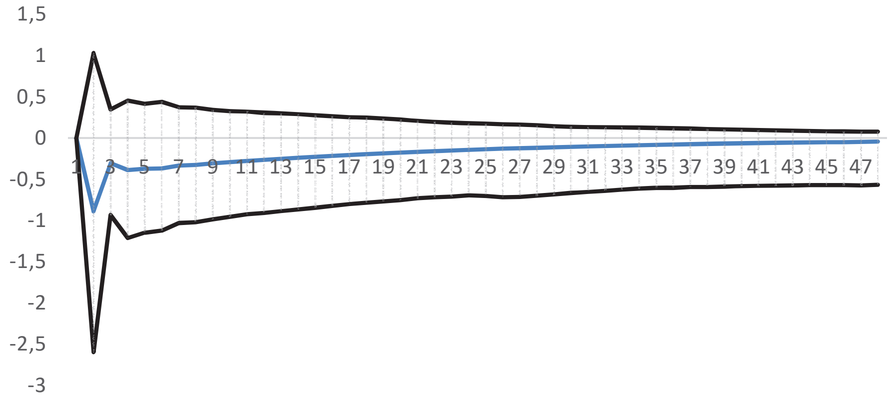
Source: own

Figure 7A.34 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 3, Exchange rate



Source: own

Figure 7A.35 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 4, Exchange rate



Source: own

Figure 7A.36 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 5, Exchange rate

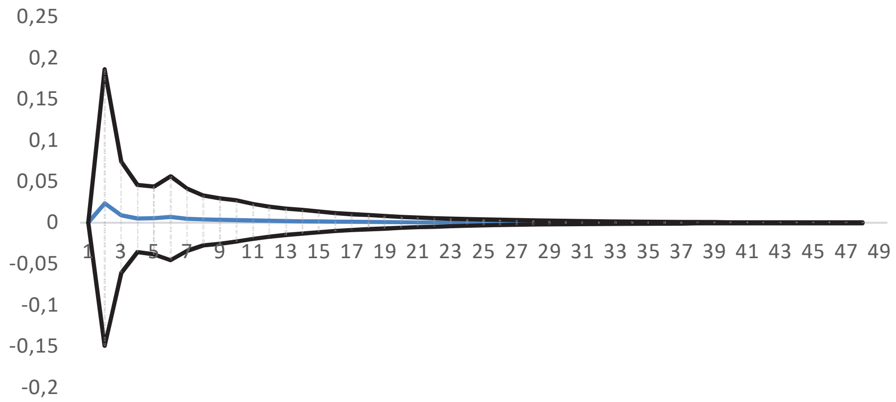


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Figure 7A.37 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 6, Exchange rate

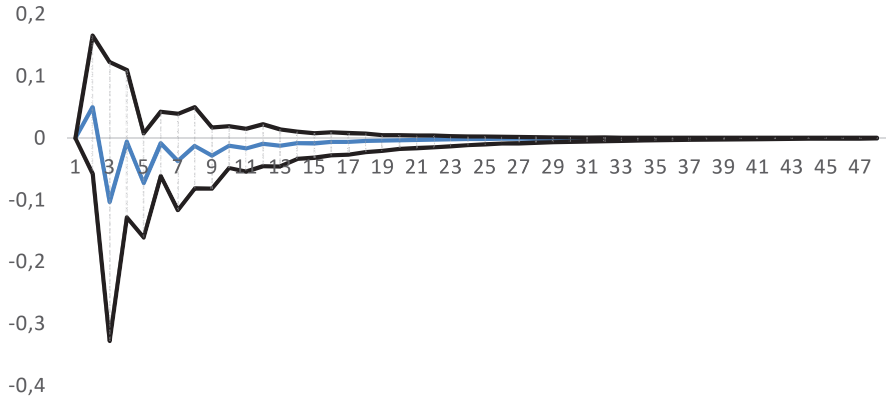

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Figure 7A.38 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 7, Exchange rate

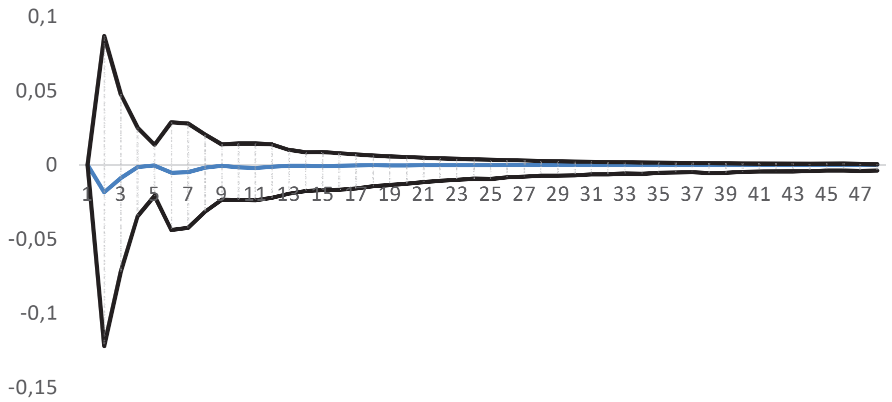

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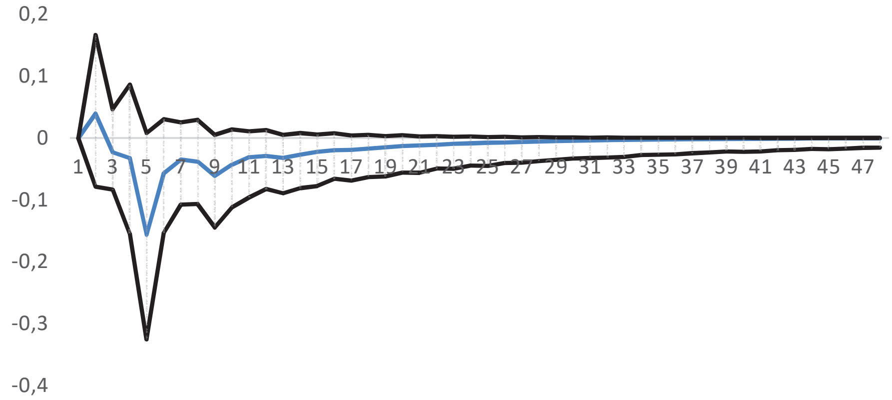
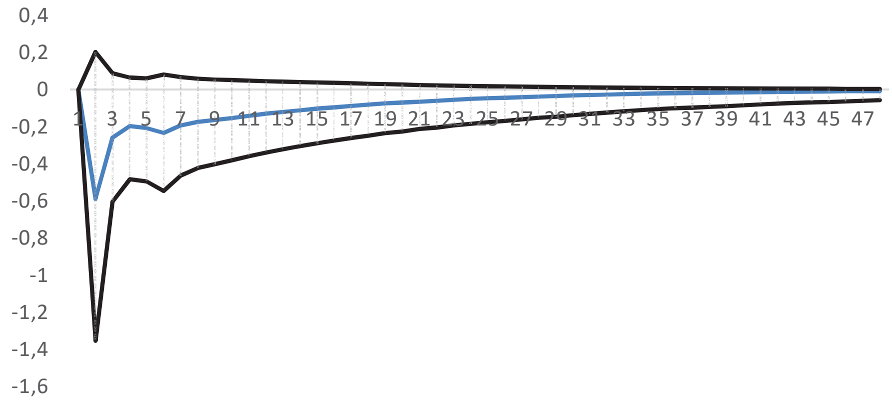
Figure 7A.39 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 8, Exchange rate



Source: own

Figure 7A.40 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 9, Exchange rate



Source: own

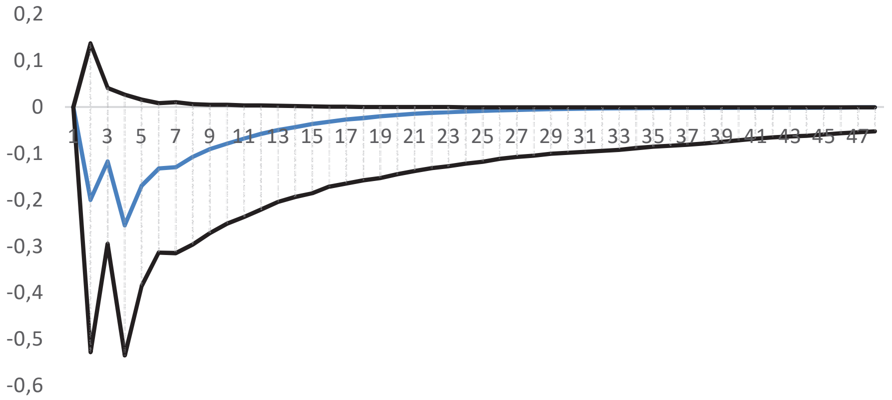
Table 7A.3 Cointegrating vectors (long run coefficients): panel estimation for each SITC section, EU and EA as partner countries, aggregate exports included

	Variable	0	1	2	3	4	5	6	7	8	9
EA	P _SITC	-0.18	0.32	-0.08	-0.39	-0.07	0.17	-0.10	0.06	-0.25	0.04
		(0.00)	(0.01)	(0.11)	(0.00)	(0.22)	(0.00)	(0.12)	(0.14)	(0.00)	(0.16)
	INPR	0.60	-0.16	0.79	-0.38	-0.21	0.67	-0.14	0.22	-0.11	1.23
		(0.00)	(0.76)	(0.00)	(0.13)	(0.73)	(0.00)	(0.24)	(0.05)	(0.55)	(0.00)
	PF_SITC	0.08	0.01	-0.48	0.22	-0.73	-0.16	0.27	0.04	0.43	0.02
		(0.51)	(0.41)	(0.00)	(0.17)	(0.00)	(0.08)	(0.18)	(0.70)	(0.00)	(0.03)
	EA_INPR	-0.71	1.64	-0.93	-0.12	1.19	-1.51	-0.11	0.19	0.84	2.56
		(0.06)	(0.02)	(0.00)	(0.80)	(0.16)	(0.00)	(0.59)	(0.27)	(0.02)	(0.00)
	GARCH	0.00	-0.02	0.03	-0.02	0.55	-0.03	0.01	0.00	0.00	0.06
		(0.86)	(0.85)	(0.00)	(0.28)	(0.25)	(0.22)	(0.26)	(0.48)	(0.53)	(0.14)
	AGGR	0.50	0.99	0.77	0.44	1.49	0.64	0.69	0.70	0.69	-0.05
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.36)
EU	P_SITC	-0.04	0.20	-0.11	-0.66	-0.12	0.02	-0.22	0.10	-0.20	-0.10
		(0.46)	(0.14)	(0.04)	(0.00)	(0.10)	(0.74)	(0.00)	(0.09)	(0.01)	(0.04)
	INPR	0.21	-0.12	0.95	-0.08	-1.32	0.66	-0.17	-0.03	-0.44	3.24
		(0.18)	(0.84)	(0.00)	(0.79)	(0.10)	(0.00)	(0.12)	(0.81)	(0.00)	(0.00)
	PF _SITC	-0.64	-0.03	-0.58	0.19	-0.77	-0.31	0.39	0.13	0.49	0.01
		(0.00)	(0.13)	(0.00)	(0.24)	(0.00)	(0.00)	(0.04)	(0.26)	(0.00)	(0.45)
	EU_INPR	-0.08	0.76	-0.91	-0.37	2.37	-1.16	0.02	0.02	1.03	-0.70
		(0.71)	(0.26)	(0.00)	(0.39)	(0.02)	(0.00)	(0.91)	(0.92)	(0.00)	(0.65)
	GARCH	0.00	0.03	0.03	-0.05	0.62	-0.05	0.01	-0.01	0.01	0.04
		(0.98)	(0.65)	(0.00)	(0.36)	(0.23)	(0.14)	(0.43)	(0.15)	(0.22)	(0.20)
	AGGR	0.94	1.18	0.76	0.51	1.62	0.73	0.58	0.68	0.63	-0.22
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Note: p-values in parentheses

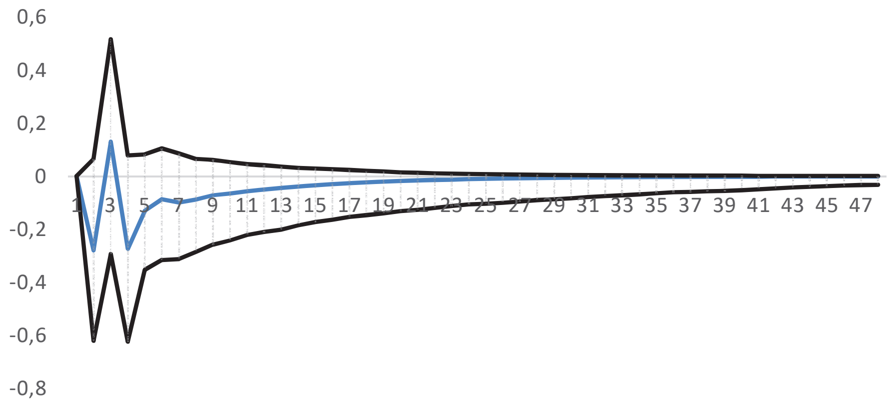
Source: own

Figure 7A.41 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 0, Aggregate exports



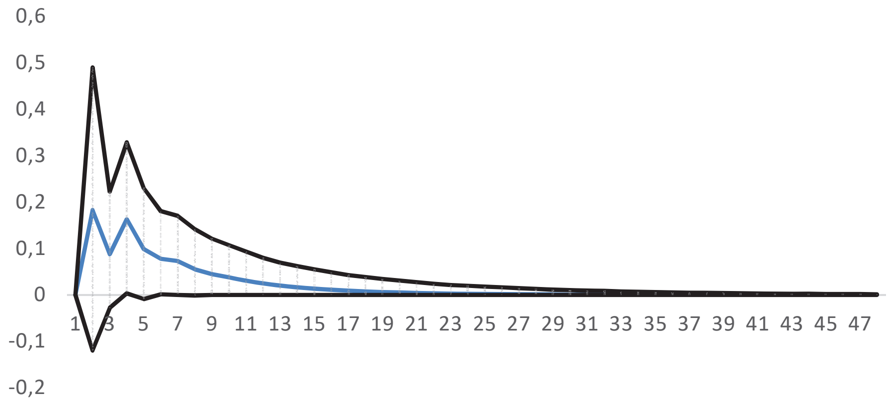
Source: own

Figure 7A.42 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 1, Aggregate exports



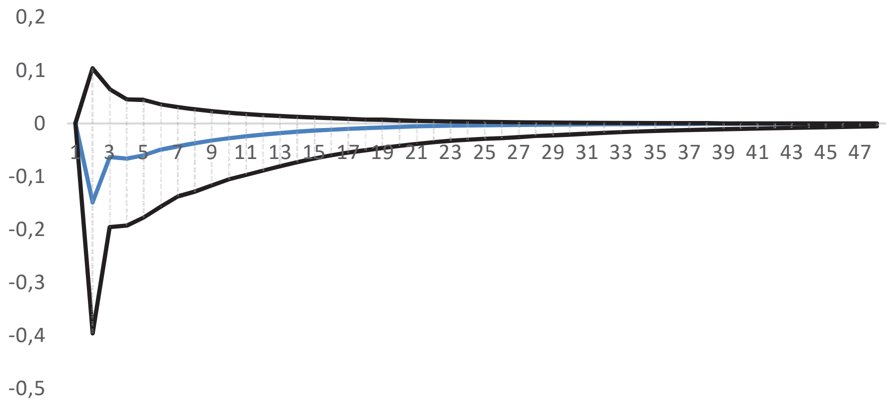
Source: own

Figure 7A.43 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 2, Aggregate exports



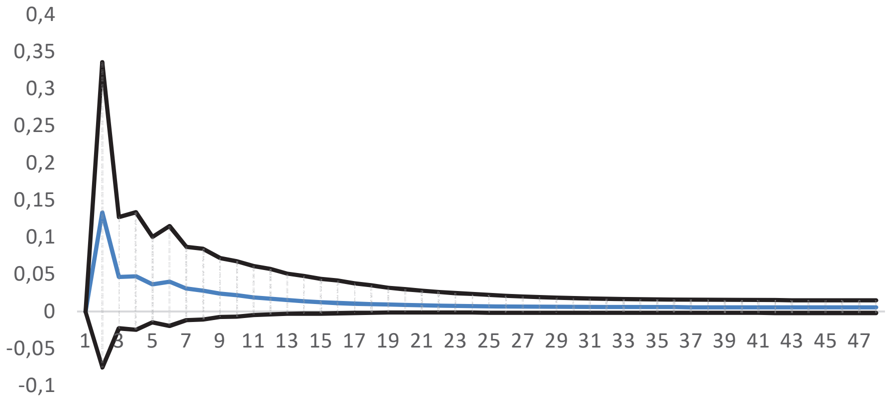
Source: own

Figure 7A.44 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 3, Aggregate exports



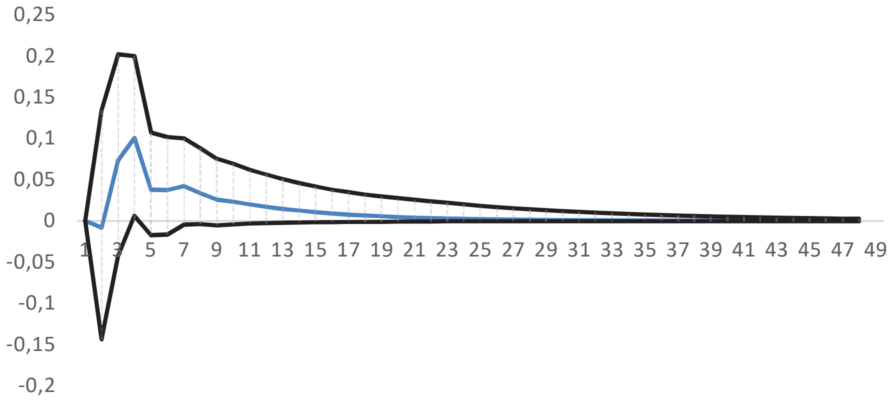
Source: own

Figure 7A.45 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 4, Aggregate exports



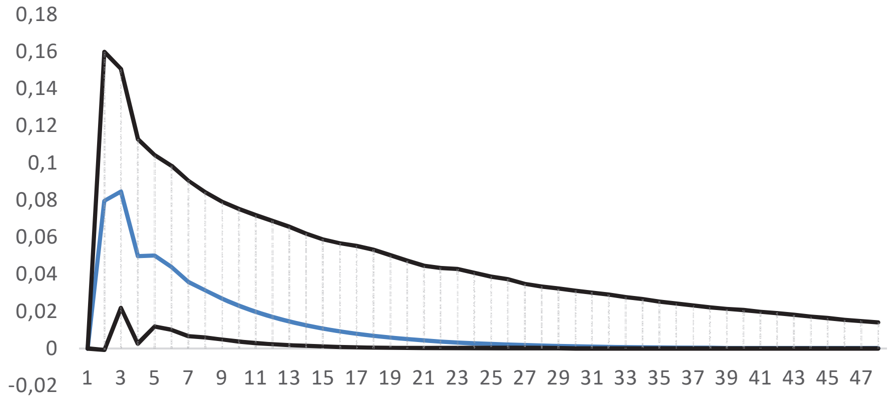
Source: own

Figure 7A.46 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 5, Aggregate exports



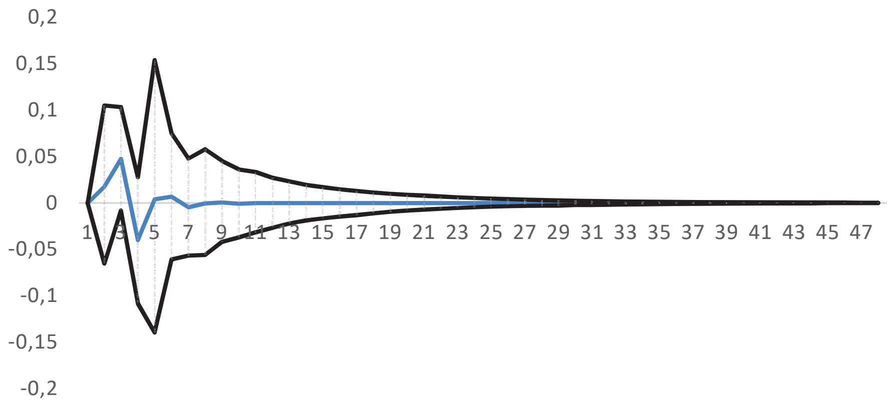
Source: own

Figure 7A.47 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 6, Aggregate exports



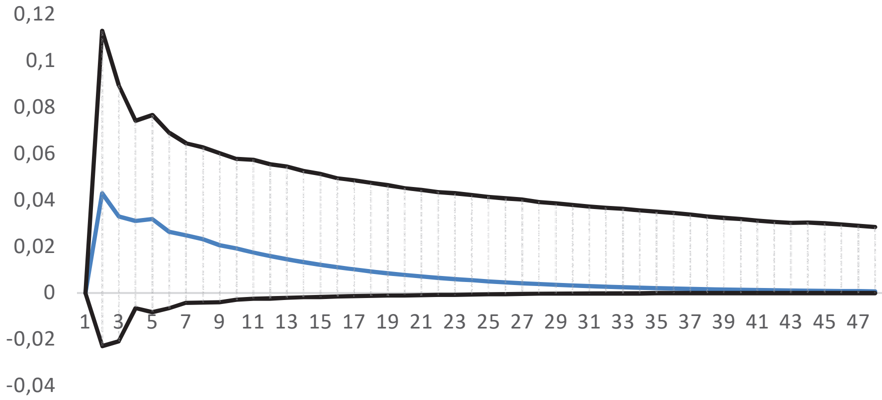
Source: own

Figure 7A.48 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 7, Aggregate exports



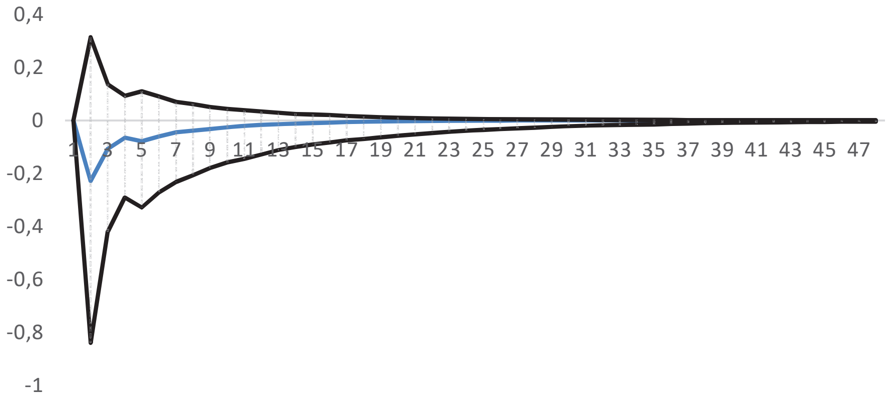
Source: own

Figure 7A.49 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 8, Aggregate exports



Source: own

Figure 7A.50 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EU, SITC section 9, Aggregate exports



Source: own

Figure 7A.51 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 0, Aggregate exports

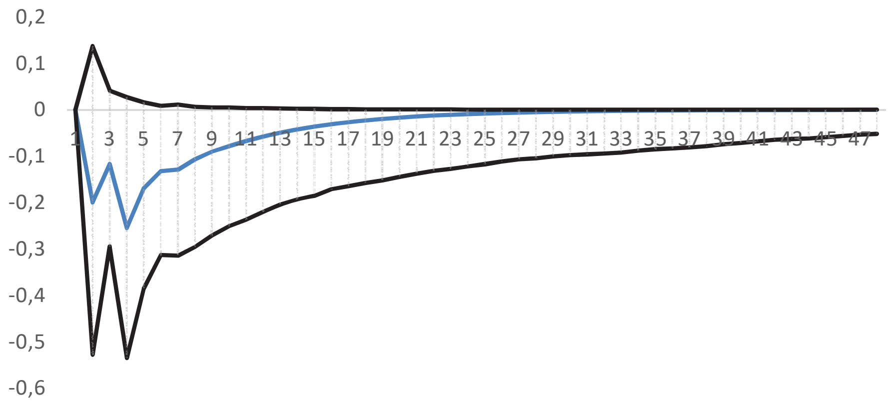


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Figure 7A.52 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 1, Aggregate exports

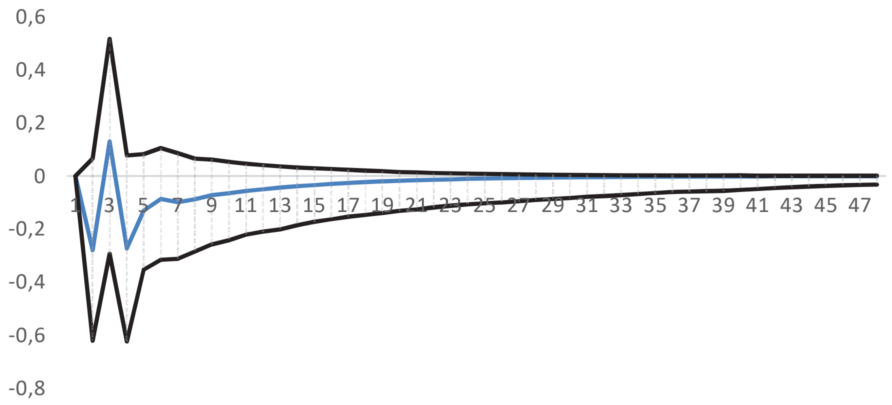

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Figure 7A.53 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 2, Aggregate exports

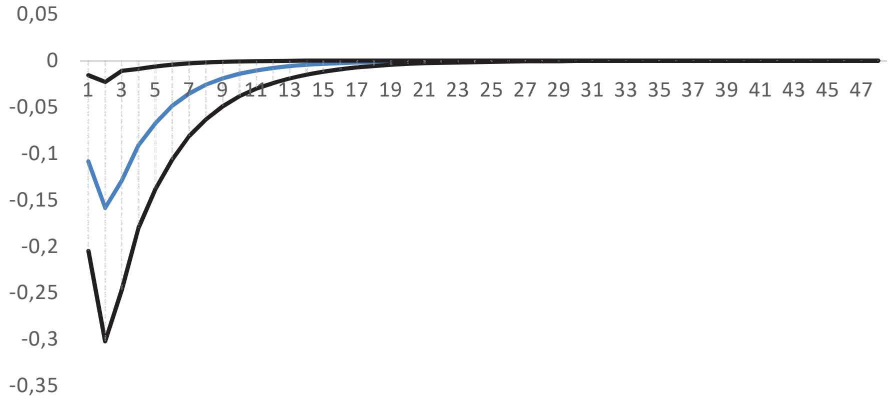

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Figure 7A.54 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 3, Aggregate exports

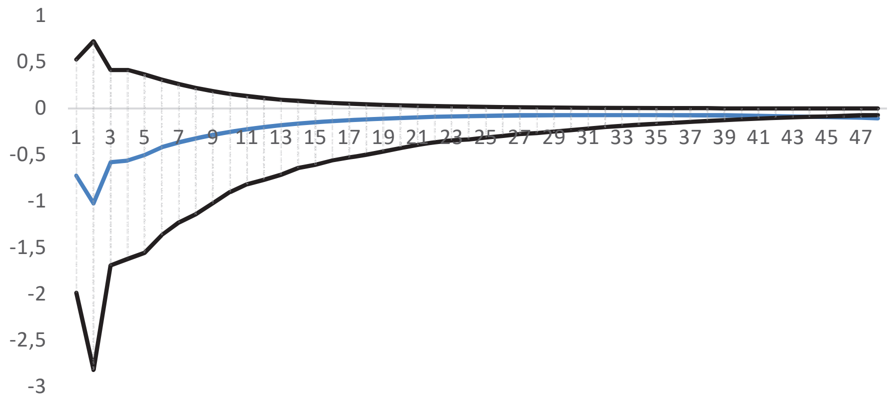

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Figure 7A.55 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 4, Aggregate exports

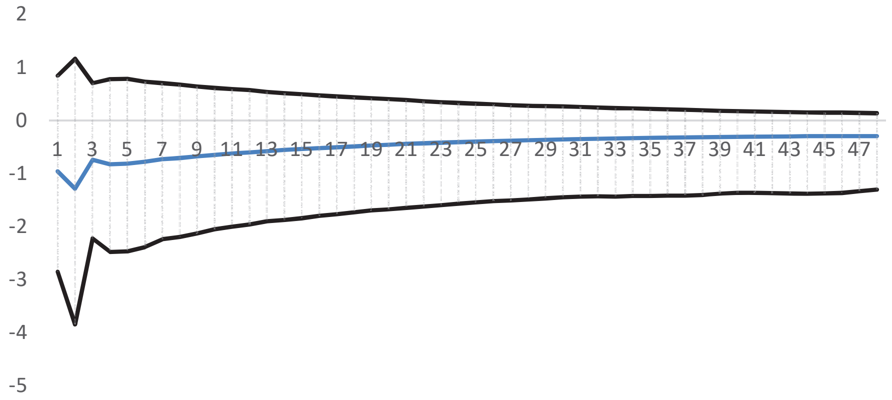

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Figure 7A.56 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 5, Aggregate exports

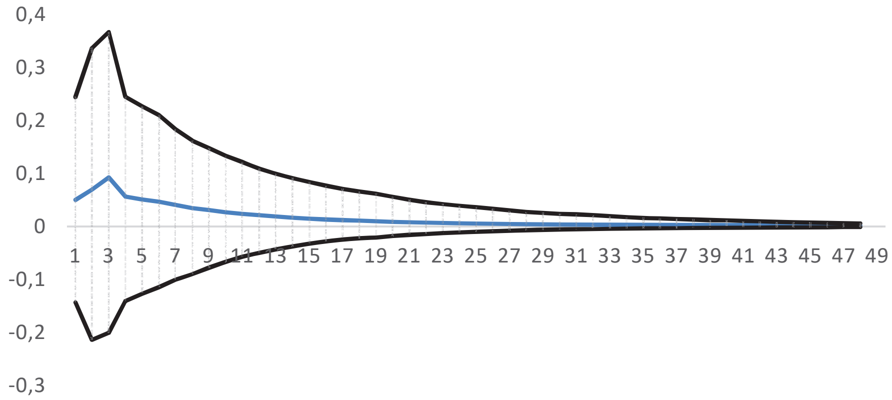

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Figure 7A.57 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 6, Aggregate exports

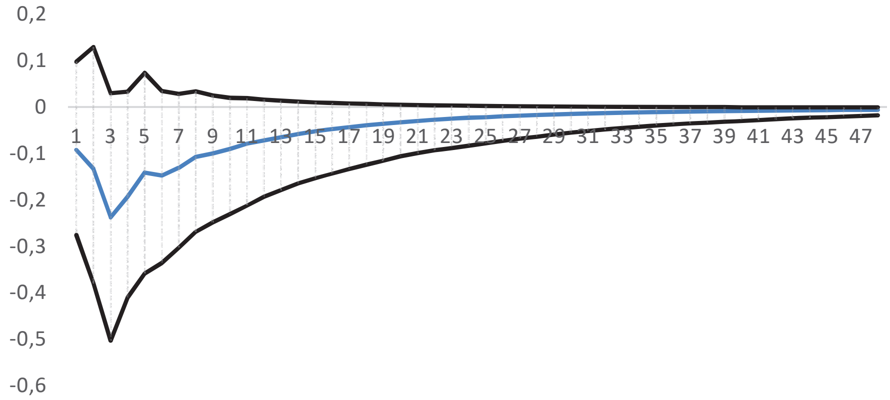

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Figure 7A.58 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 7, Aggregate exports

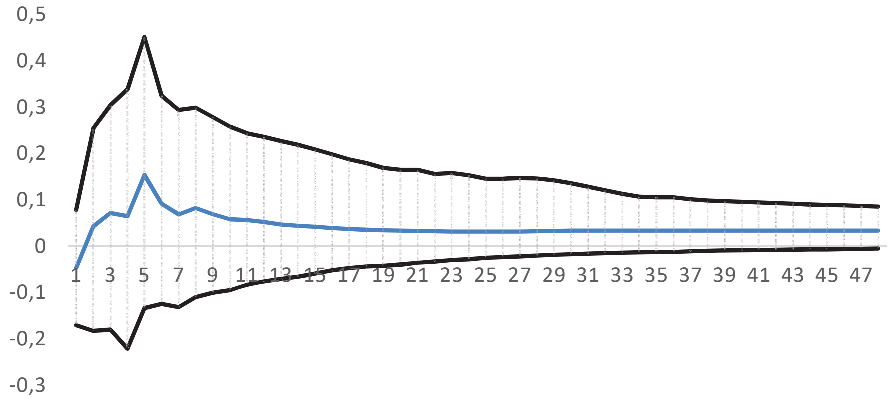

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Figure 7A.59 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 8, Aggregate exports

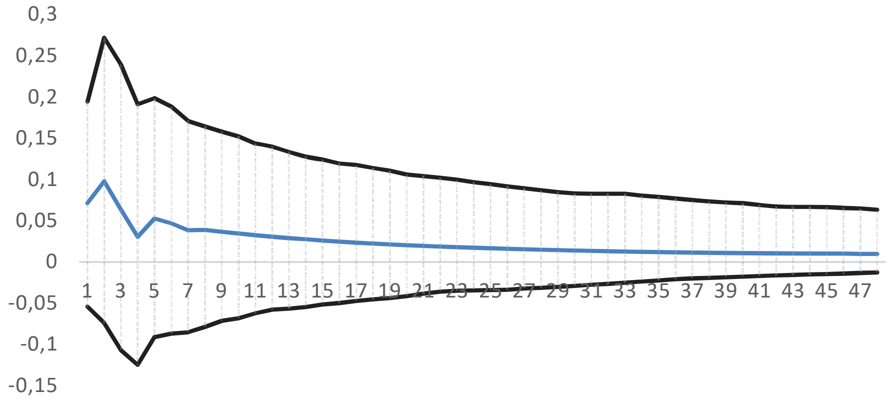

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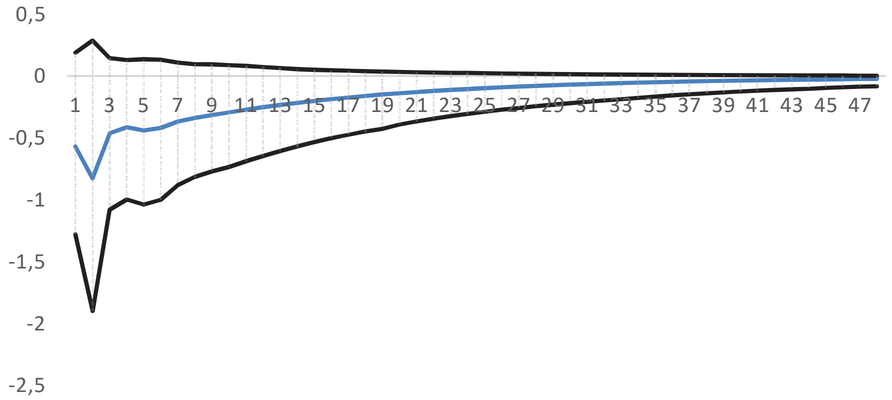
Figure 7A.60 Impulse responses of exports volume to one standard deviation shock in exchange rate volatility (GARCH) with 0.95 confidence band, trade partner: EA, SITC section 9, Aggregate exports



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