Exchange Rate Volatility and International Trade:

The Role of Financial Development

By

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Abstract

There is no clear answer on how exchange rate volatility affects trade. Moreover, it might be that in countries with low levels of financial development costs of exchange rate volatility are higher. This paper examines whether the effect of exchange rate volatility on trade depends on the level of financial development of trading partners. To answer the research question I use a panel data of 1560 country pairs over the period of 1996-2010. I divide country pairs into three subsamples based on their level of financial development measured by stock and private bond market capitalization per GDP and private credit per GDP. For the whole sample as well as for each of the subsamples an augmented gravity model with exchange rate volatility as one of the explanatory variables is estimated. The results suggest that while short-term exchange rate volatility does not influence trade, the effect of long-term exchange rate volatility on trade is positive for country pairs with a high level of financial development and it is negative for country pairs with a low level of financial development. In addition, extreme long-term exchange rate volatility negatively affects trade for country pairs where at least one trading partner has a low level of financial development. These findings argue that development of financial sector should be one of the priorities in economic policy for countries lagging behind. In addition, from the prospects of trade growth, flexible exchange rate regimes are beneficial for countries with high levels of financial development. At the same time, choice of exchange rate regimes for trade promotion with or between countries with low levels of financial development requires further investigation.

Key words: exchange rate volatility, financial development, gravity model, trade.

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List of abbreviations

CU – Currency Union

ECM – Error-correction model

FD – Financial development

FE – Fixed effects

GARCH – Generalized Autoregressive Conditional Heteroskedasticity

GMM – Generalized Method of Moments

IMF – International Monetary Fund

IV – Instrumental variables

OECD – Organization for Economic Co-operation and Development

OLS – Ordinary Least Squares

PCR – Private credit ratio

RE – Random effects

RTA – Regional Trade Agreement

SBM – Stock and bond markets

Chapter 1: Introduction

The breakdown of the Bretton Woods system in 1971 marked the point of collapse of fixed exchange rate regimes. In 1973 all major currencies started floating. At these times the question of influence of exchange rate volatility on trade appeared to be of a great academic interest and wide policy debates. As it is commonly stated, an increase in exchange rate volatility increases risks that, in turn, can lead firms to reduce their trade with international agents. Numerous studies have been held exploring the problem stated above. Among the most influential are Clark (1973), Krugman (1986), Dell'Ariccia (1998), and Rose (1999). However, the studies give mixed results ranging from negative to positive or no influence of exchange rate volatility on trade.

In recent times some relatively new developments have affected exchange rate fluctuations. Such processes as liberalization of capital flows and increase in the number of cross border transactions, currency crises in emerging markets as a special case of extreme exchange rate volatility, and transition periods in Central and Eastern European countries lead exchange rates to exhibit high volatility. At the same time, emergence of new hedging mechanisms, increase in the number of multinational firms and the creation of Currency unions can possibly reduce firms' exposure to exchange rate risks (IMF, 2004). Thus, there is no clear answer on how changes in the world economies affect the degree of firms' exposure to exchange rate risks.

In my study, I take the role of financial development of trading partners as one of the factors that can influence the effect of exchange rate volatility on trade. I assume that a high degree of financial sector development can decrease firms' exposure to and costs of exchange rate volatility. First of all, well-developed financial sector provides firms with an opportunity to hedge the risks using different financial instruments. Secondly, countries with better

financial development provide firms with greater access to private credits, thus, helping them to survive during periods of high exchange rate volatility. There are only a few studies such as Wei (1998), Chit and Judge (2011), and Caglayan et al. (2012) that explore the similar problem. Most of them claim that trade of countries with low levels of financial development is more affected by exchange rate fluctuations.

Therefore, the main goal of my study is to determine whether the effect of exchange rate volatility on trade depends on the level of financial development of trading partners. My initial hypothesis is that the effect of exchange rate volatility on trade is negative for country pairs where at least one trading partner has a low level of financial development, while there is positive or no effect of exchange rate volatility on trade for countries with high levels of financial development. I check the hypothesis stated above using a sample of 1560 country pairs for the period of 1996-2010 and estimating an augmented gravity model with exchange rate volatility as one of the explanatory variables. The contribution of this paper to the existing literature is in division of countries into groups based on measures of their level of financial development which are different from the previous research. Moreover, the models are estimated using fixed effects technique allowing for correlation between country pairs-specific effects and explanatory variables. In addition, I distinguish the effect on trade of short-term and long-term exchange rate volatilities as well as moderate and extreme exchange rate fluctuations.

The results of the paper suggest that short-term exchange rate volatility does not affect trade. At the same time, the effect of long-term exchange rate volatility on trade is positive for country pairs with a high level of financial development, while it is negative for country pairs with a low level of financial development. Moreover, extreme long-term exchange rate volatility affects trade negatively for country pairs where at least one trading partner has a low level of financial development.

After the Introduction, Chapter 2 observes the relevant academic literature that models and estimates the impact of exchange rate volatility on trade flows. In addition, I discuss a special case of the role of financial sector development on the impact of exchange rate volatility on trade. Chapter 3 describes the main variables of interest, that is exchange rate volatility, trade and level of financial development. In this Chapter I classify country pairs based on their level of financial development. In addition, I discuss different methods of measuring exchange rate volatility. Finally, I explore the relationship between exchange rate volatilities and trade for different subsamples formed based on the level of financial development of trading partners. In Chapter 4 I provide empirical evidence on the role of financial development on the effect of exchange rate volatility on trade by estimating different specifications of the augmented gravity model. Next, I discuss some limitations of my study and suggest ideas for further research. Chapter 5 concludes and proposes policy recommendations.

Chapter 2: Literature review

After the collapse of the Bretton Woods system and adoption of floating exchange rate regimes by many countries the relationship between exchange rate volatility and trade has been started being the subject of wide policy debates. Numerous studies have been conducted questioning whether trade is influenced by exchange rate volatility or not. In this chapter I review the relevant literature that models and estimates the relationship between exchange rate fluctuations and international trade. Firstly, I observe the main theoretical papers on the given topic. Secondly, the empirical evidence is provided distinguishing between negative, positive and no effect of exchange rate volatility on trade. Finally, I discuss the special case of the role of financial sector development on the impact of exchange rate volatility on trade.

2.1 Theoretical aspects

One of the first papers that describe the impact of exchange rates on firm's behavior is a paper by Clark (1973). Clark considers the case of a hypothetical firm that operates under certain conditions. Firstly, the firm functions in a perfectly competitive market and produces a single good for export markets using no imported inputs. Secondly, the firm pays for its exports in foreign currency, thus, its revenues and profits highly depend on exchange rates. Thirdly, the firm is small and has no access to hedging opportunities. Finally, firm adjusts its production only to the levels of demand. Thus, the firm doesn't change its output based on profitability of its export which can vary because of changes in exchange rates. Clark assumes that the firm is a profit maximizer and it is risk averse. Therefore, the firm will produce until its marginal revenue exceeds marginal costs in order to compensate for exchange rate risks. The more risk averse the firm is, the less it produces. As so, higher exchange rate volatility transfers into lower output and export volumes.

Later this model was developed by Hooper and Kohlhagen (1978). They include export supply and import demand functions in their model. Their study supports the idea that higher exchange rate volatility leads to higher costs and lower trade for risk adverse firms. As the trade contracts are agreed today but actual payments are usually made in the future, changes in exchange rates can affect firms' profits. At the same time, effect of exchange rate volatility on prices is ambiguous and depends on the risk taker, i.e. if importers bear the risk, the prices will fall as import demand falls; if exporters bear the risk, the prices will rise because of a risk premium.

It is worth mentioning that studies by both Hooper and Kohlhagen (1978) and Clark (1973) rely on very strong assumptions that were relaxed later by other authors. Clark himself accepts that when the firm uses imported inputs in its production process the effect of exchange rate volatility can be not so drastic. It can be explained by the fact that revenue losses can be offset by input cost gains. Thus, the profits remain unchanged or do not fall significantly. In a similar manner, as it is observed by Cushman (1986) that exchange rates tend to adjust to inflation rates differences quickly. Thus, if a foreign currency depreciates, the loss of an exporting firm will be partially offset by an increase in export prices. In addition, if a firm trades with many countries and exchange rates move in different directions, the firm will be protected from the overall currency risk. Moreover, firms can diversify their trade between different international markets and/or between international and domestic market, thus, diversifying exchange rate risks. Thus, the effect of exchange rate volatility on trade can be not as big as it is supposed by Clark.

Some researchers relax the assumption of no hedging opportunities. Based on Auboin and Ruta (2011) firms can hedge against exchange rate risks which can lead to the absence of the effect of exchange rate volatility on volumes of trade. However, hedging is not accessible to all trading companies in all countries and its costs can be significant for

small firms. Caporale and Doroodian (1994) claim that hedging imposes high costs for companies and it is difficult to implement because of problems in exchange rate forecasting. As so, hedging of exchange risks benefits big firms, rather than small ones.

In addition, in his paper Clark assumes that a hypothetical firm is risk averse. However, the firms can have different attitude towards risk as it is explained by De Grauwe (1988). For example, risk-neutral firms can be not affected by exchange rate volatility and risk seeking firms can, on the other hand, increase their level of production to compensate for decrease in revenues. The De Grauwe's model assumes that when income effects exceed substitution effects firms tend to export more in response to high exchange rate volatility. Another theoretical model by Broll et al. (2006) is based on studies of optimum production decision using portfolio theory. It finds that increased exchange rate volatility can have positive, neutral or negative effect on trade depending on elasticity of risk aversion with respect to the standard deviation of firm's profit.

One more assumption that can be relaxed is an inability of firms to adjust their factors of production to exchange rate volatility. However, if firms can do so, then increased variability can even bring profits. For example, Broll and Eckwert (1999) assume that firms can easily reallocate their products among the markets as a response to changes in exchange rates. Such type of behavior allows firms to bear gains from uncertainty while relying on a domestic market as a safe one.

Another approach in theoretical modeling of exchange rate variability and trade is models of hysteresis in international trade. These models show that high exchange rate volatility can influence firm's decision on whether to enter or exit a particular market or not (Krugman, 1986). In the presence of sunk costs, firms will tend not to react to short-term exchange rate fluctuations. However, if fluctuations are deep and last for a long period of time firms will incline to stay away from such markets if they are not in them and stay in

the market if they have already entered them. As so, exchange rate volatility will increase firm's inertia in entry and exit decisions.

Next, as it is noted by the IMF (2004), the factors that affect exchange rate volatility can also influence other aspects of the economy that will in turn affect trade. Bacchetta and Van Wincoop (2000) develop a general equilibrium model for two countries. In this model monetary, fiscal and technological shocks create uncertainty. Their effect on trade is analyzed for fixed and floating regimes. They suggest that the level of trade does not depend on the type of exchange rate arrangements. In addition, relationship between exchange rates and trade flows can be ambiguous depending on changes in other macroeconomic variables. For example, monetary expansion in a foreign country will lead to exchange rate depreciation and imports drop. However, the exchange rate effect can be offset by increased demand generated by monetary expansion.

Finally, while most of the literature explores the effect of exchange rates volatility on trade it is noted by Mundell (1961) that there can be a reverse causality, i.e. trade flows stabilize real exchange rate fluctuations. Broda and Romalis (2011) show that greater distance between two trading partners significantly increases exchange rate volatility through the effect on intensity of trade relations. Their paper suggests that strong trade links dampen exchange rate volatility and can possibly lead to the creation of a currency union.

2.2 Empirical evidence

All empirical evidence regarding influence of exchange rate volatility on trade produces rather ambiguous results. An IMF (2004) study explores the problem from different prospective, i.e. by type of exchange rate volatility (real vs. nominal, short- vs. long-term etc.), by country group and by type of trade (disaggregation by products). As it is noted by the authors, the effect of exchange rate volatility on trade can be because of a

correlation not causality. For example, during the Asian crises (1997-1998) imports dropped significantly and exchange rates were highly volatile. However, the main reason for a reduction in imports was a decline in domestic demand not the exchange rate movements. To address this problem the study uses a gravity model. The general conclusion of the paper is that "when we turn to bilateral trade, we do find evidence that exchange rate volatility tends to reduce trade. However, this negative effect is not robust to alternative ways of controlling for factors that could affect trade" (p. 41). The other findings are that exchange rates volatility affects trade in differentiated goods more than trade in homogeneous goods, members of a currency union tend to trade more, and the explored effect is ambiguous for different country groups.

Most of the other studies find a negative influence of exchange rate uncertainty on trade. For example, Rose (1999) and Dell'Ariccia (1998) find a negative relationship between trade and exchange rates volatility as well as strong effect of currency union on trade. Wang and Barrett (2007) explore the effect of exchange rate uncertainty on trade in eight sectors between the U.S. and Chinese Taipei for the period of 1989-1998. They find that volatility affects flows only in the agricultural sector. Cho et. al (2002) come to the same conclusion using panel data for ten OECD countries for the period of 1974-1995.

Many recent studies are concentrated on developing countries. For example, Chit et al. (2010) find strong evidence of a negative relationship between exchange rate volatility and real export of five emerging East Asian economies to each other and to the rest of the world. Oztruck and Kalyoncu (2009) find evidence of a negative effect of exchange rate uncertainty on trade for the Republic of Korea, Pakistan, Poland and South Africa, but a positive effect for Hungary and Turkey. Arize et al. (2001) focuses on least developed countries and finds out a negative impact of exchange rate volatility on exports both in the short and long run. The conclusion is that least developed countries having no developed

financial markets and ability to hedge exchange rate risks feel the impact of exchange rate instability on trade more severely.

At the same time, other studies do not find any significant effect of exchange rate volatility on trade. For instance, Hondroyiannis et al. (2008) do not discover any significant effect for a sample of twelve industrialized countries over the period 1977-2003. Tenreyro (2007) in her model addresses all biases and the problem of reverse causality indentified in the previous literature. She uses the probability of pegging home currency to the same anchor by two countries as an instrument for exchange rate volatility. As a result, no effect of exchange rate volatility on trade is found. Eicher and Henn (2009) incorporate exchange rate volatility in a gravity model and also do not find significant effects of volatility on trade. The studies mentioned above as well as further researches that report negative and positive or no relationship between exchange rate volatility and trade are presented in Appendix 1.

All in all, Coric and Pugh (2010) review forty nine studies on the given topic and declare that twenty nine studies claim negative relationship between exchange rate volatility and trade, eight studies find out no relationship, four studies find out positive effect and eight studies are inconclusive about the results. The authors report: "on average, exchange rate variability exerts a negative effect on international trade. […] our results suggest a regime effect, whereby the trade effect of exchange rate variability is conditioned by the institutional environment". Therefore, the theoretical and empirical results confirm that effects of exchange rate volatility on trade exist, but its size and significance is not consistent across the studies. The evidence is mixed as the results are sensitive to the choice of a sample period, data frequency, countries included in the sample, measurement of exchange rate volatility, model specification, etc.

2.3 The role of financial development

Some of the researchers argue that negative relationship between exchange rate volatility and trade flows are more common for countries with low levels of financial development as firms at emerging markets do not have access to forward exchange markets and cannot hedge their exchange rate risks. At the same time, developed financial markets allow firms operating at advanced economies markets to reduce their exposure to exchange rate fluctuations (IMF, 2004). While short-term risks can be easily hedged at forward exchange markets, long-term risks are more difficult to hedge as contracts usually cover only short-term horizons. At the same time, hedging instruments and their management incur additional costs (Cote, 1994).

Ethier (1973) conclude that exchange rate volatility does not affect trade in the presence of perfect forward market and the absence of any other kind of uncertainty. Viaene and Vries (1992) show that increase in exchange rate volatility can have opposite effect on exporters and importers as these two are on the opposite sides of the forward market. Thus, exporters lose and importers benefit when the trade balance is positive or the forward risk premium is positive, and otherwise. Wei (1998) employs data on over 1,000 country pairs and uses an endogenous regime-switching regression to estimate the probability of hedging availability. His paper does not support the idea that availability of hedging instruments reduces the effect of exchange rate volatility on trade.

Some studies find out that exchange rate volatility affects trade more in the case of developing countries. In their paper, Grier and Smallwood (2007) find that the effect of exchange volatility on trade is more negative for developing countries. They study a sample of nine developed and nine developing countries employing the GARCH model. As it turns out, real exchange rate uncertainty has a negative impact on export growth for six of the

nine developing countries, a positive impact for two developed countries and an insignificant effect for the developed countries. Caglayan et al. (2012) investigate the effect of real exchange rate volatility on manufactures export controlling for the level of financial development (i.e. private credit per GDP) of the exporting country for twenty eight emerging countries for the period of 1978-2005. The authors find that while better financial development positively affects trade exchange rate shocks can negate this impact. Negative effect of exchange rate volatility on trade can even be enhanced at intermediate levels of financial development.

Chit and Judge (2011) examine the role of financial sector development, measured by Financial Sector Development Index, on the effect of exchange rate fluctuations on export of East Asian countries for the period of 1990-2006. They conclude that the less developed the financial sector of the country is, the more exchange rate volatility affects trade. The rationale for this conclusion is that firms can protect themselves from exchange rate uncertainty if financial markets are developed even if there are no perfect hedging opportunities. For example, an exporting firm can borrow relatively stable foreign currency to finance its activities and, thus, avoid the foreign exchange risk. In addition, developed financial markets transfer exchange rate risk more efficiently and provide better access to finance opportunities, thus, mitigating risks.

On a micro level, Hericourt and Poncet (2012) use panel data of 100,000 Chinese exporters for the period of 2000-2006 to test the financial development hypothesis. Their main finding is that firms tend to export less to countries with high exchange rate volatility. However, the effect depends on the degree of firms' financial vulnerability defined by credit constraints, i.e. the effect is higher for highly financially vulnerable firms. Thus, the authors argue that development of credit markets is necessary in order to help firms to overcome

export sunk costs related to exchange rate fluctuations. In addition, they claim that floating exchange rate regimes can be harmful for emerging economies.

From the studies above, the evidence of the influence of financial development on effect of exchange rate volatility on trade is inconclusive. While most of the authors theoretically and empirically prove that countries with low levels of financial development are more exposed to impact of exchange rate fluctuations on trade, some of them, for example, Wei (1998), come to different results. My paper contributes to the existing research by differentiating the effect of long-term and short-term as well as moderate and extreme exchange rate volatilities on trade. In addition, I divide countries into groups based on such measures of financial development as private credit per GDP and stock and bond market capitalization per GDP while the observed papers usually use combination of other measures.

To conclude, the observed literature on the effect of exchange rate volatility on trade provides different results which depend on the sample period, countries, model specification, and other factors. Even though most of the studies support the hypothesis of a negative relationship between exchange rate volatility and trade, there are still many researches that claim no or positive relationship. In addition, most of the studies support an idea that trade of the countries with low financial development suffers from exchange rate volatility more. Thus, even if the effect of exchange rate volatility on trade exists it is rather small and there are many other factors that affect trade more.

Chapter 3: Developments in trade, exchange rate volatility and financial development

In my study I would like to explore whether the influence of exchange rate volatility on trade depends on the level of financial development of trading partners. For this purpose I use an augmented gravity model where exchange rate volatility as one of the independent variables is regressed on imports. I run the regressions for different subsamples which are generated based on financial development of trading partners. As a sample I use 1560 country pairs for the period of 1996-2010. These country pairs are formed out of the forty countries with the highest GDP in 2010. These countries accounted for about sixty nine per cent of total trade in 2010. Hong Kong, Iran, Saudi Arabia and United Arab Emirates are excluded from the sample because of the rudimentary data and specificity of their economies. The list of countries used in the study is presented in Appendix 2. In this chapter I discuss the main variables of interest for the given sample, that is trade, exchange rate volatility and level of financial development.

3.1 Measures of financial development

Beck et al. (1999) present a set of measures of financial development across countries and over time. In my study I employ three measures of financial sector development indicators form Beck's database, that is private credit to GDP, stock market capitalization to GDP and private bond market capitalization to GDP.

The first measure of the activity of financial intermediaries is the ratio of private credit by deposit banks and other financial institutions to GDP (PCR). This measure isolates credit issued to the private sector by financial intermediaries as opposed to credit issued to governments and public enterprises. The lack of a developed financial intermediation

increases transaction costs and can serve as a barrier for international trade. In addition, exchange rate uncertainty becomes more harmful for firms that have high external finance dependency but are located in countries with a low level of financial development (Caglayan et al., 2012). As Levine et al. (2000) claims the higher level of PCR the greater financial intermediation development. Figure 1 shows PCR across countries computed as an average over 1996-2010. From a sample of forty countries exactly half performs above average.

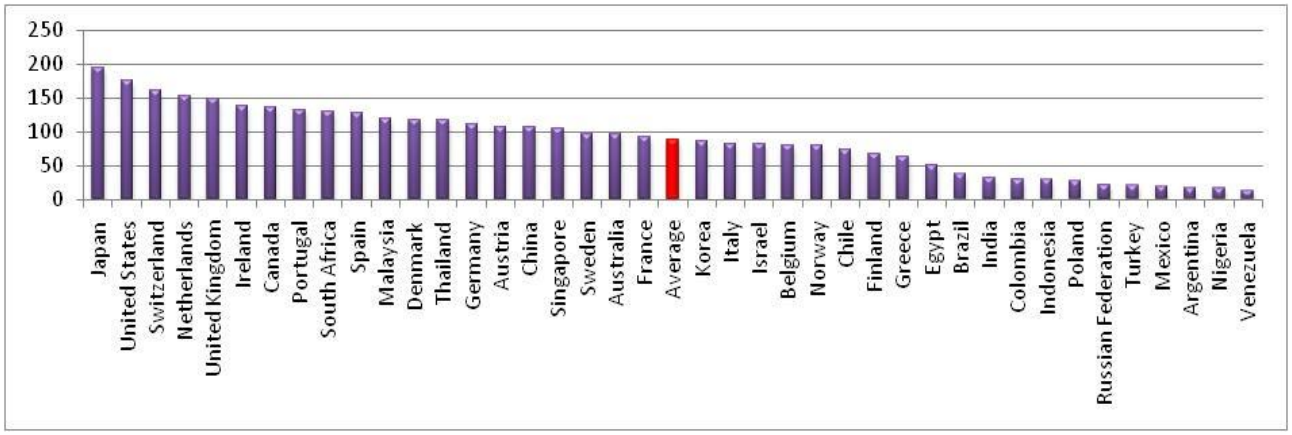

Figure 1. PCR across countries

The second and the third measures of financial development describe stock and bond markets. As an indicator of the size of the stock market I use the stock market capitalization to GDP where stock market capitalization is defined as total shares traded on the stock market exchange. I use private bond market capitalization to GDP as an indicator of the size of the domestic bond market. This measure equals to the total amount of outstanding domestic debt securities issued by private domestic entities divided by GDP. Consequently, the size of stock and bond markets (SBM) is defined as a sum of the two indicators. Apart from providing external financing for firms, I assume that well-developed stock and bond markets can serve as an indicator of the development of financial markets in the country. Figure 2 shows SBM across countries calculated as an average over 1996-2010. Nineteen out of forty countries have SBM higher than average.

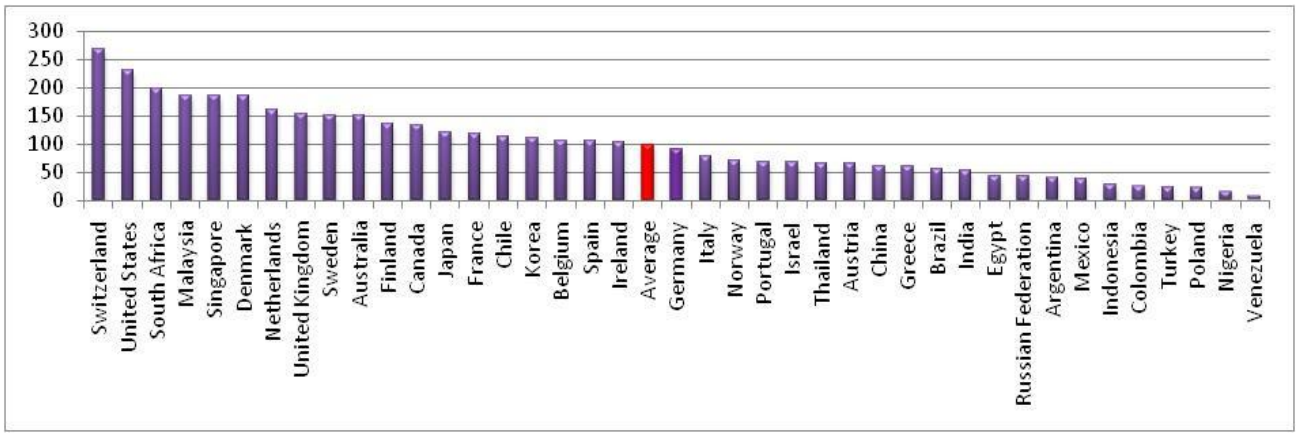

Figure 2. SBM across countries

Based on the indicators mentioned above I define a country as the one with a high level of financial development if this country has financial intermediation development level and size of bond and stock markets above average. Thus, a new dummy variable *HighFD* is determined as

$$HighFD = \begin{cases} 1, if\ PCR > \overline{PCR}\ and\ SBM > \overline{SBM}; \\ 0, otherwise. \end{cases}$$

In total, fifteen countries out of forty qualify to have a high level of financial development according to the definition used in this study. Table 1 divides the countries based on their level of financial development.

Table 1. List of countries based on their level of financial development

Countries with high level of financial development (15 countries):	Other countries (25 countries):
Australia, Canada, Denmark, France, Ireland, Japan, Malaysia, Netherlands, Singapore, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States.	*Argentina, Austria, Belgium, Brazil, Chile, China, Colombia, Egypt, Finland, Germany, Greece, India, Indonesia, Israel, Italy, Korea, Mexico, Nigeria, Norway, Poland, Portugal, Russian Federation, Thailand, Turkey, Venezuela.*

As this study explores bilateral relationship between countries, I classify country pairs based on their level of financial development. Therefore, three groups are determined:

- both countries have a high level of financial development – *FD_HH* (210 country pairs);
- only one trading partner either importer or exporter has a low level of financial development – *FD_HL* (750 country pairs);
- both countries have a low level of financial development – *FD_LL* (600 country pairs).

3.2 Measures of exchange rate volatility

There is no general method of measuring exchange rate volatility. As there is no one accepted model of a firm's reaction to changes in exchange rates, then different measures of volatility can be employed depending on researcher's assumptions and scope of analysis. Based on the literature review, the main methods used for measuring exchange rate variability are average absolute difference between the previous forward rate and the current spot rate (Hooper and Kohlhagen, 1978; Dell'Ariccia, 1998), within period standard deviation (Dell'Ariccia, 1998; Chit and Judge, 2011), (G)ARCH modeling of exchange rate volatility (Doyle, 2001; Huchet-Bourdon and Korinek, 2011) and a moving average of the standard deviation of the exchange rate (Arize et al., 2000; Huchet-Bourdon and Korinek, 2011).

In this study, a within period standard deviation and a moving average of the standard deviation of the exchange rate approaches are employed. Several methods of exchange rate volatility measurement are used for a robustness check of the results. All methods define current volatility as the one calculated on the movements of exchange rate during the previous periods. It means that firms are backward looking as they consider past volatility to predict present risk.

A within period standard deviation method measures the standard deviation of the first difference of the logarithm of the exchange rate. According to Dell'Ariccia (1998) this method gives larger weight to large exchange rate changes. In addition, exchange rate volatility is equal to zero if exchange rate follows a constant trend. According to this approach exchange rate volatility is expressed as:

$$V_t = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(\Delta E_i - \overline{\Delta E})^2} \quad (1)$$

where V_t – exchange rate volatility at year t,

ΔE_i – the first difference of the logarithm of exchange rate at month i year (t-1), and n=12[1].

The two other methods are based on a moving standard deviation of exchange rate. They capture movements of exchange rate volatility over time. I divide exchange rate volatility on a long-term and a short-term. A short-term volatility is calculated over twelve months, while a long-term volatility is measured over a 60-month period. For each year this indicator is expressed as:

$$V_t = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(\Delta E_i)^2} \quad (2)$$

[1] For 1999 I use a different formula to account for an introduction of euro:

$$V_t = \sqrt{\frac{1}{n-2}\sum_{i=2}^{n}(\Delta E_i - \overline{\Delta E})^2}.$$

The same formula is used for country pairs where one of the trading partners is Greece (for the year of 2001).

where ΔE_1 – the first difference of the logarithm of exchange rate at month one year (t-1), and n=12 (for a short-term volatility)[2];

ΔE_1 – first difference of the logarithm of exchange rate at month one year (t-6), and n=60 (for a long-term volatility)[3].

It is interesting to note that nominal exchange rate volatility is very close to real exchange rate volatility, i.e. correlation between two is equal to 0.97. The same outcome is obtained by Dell'Ariccia (1998) and it is explained by stickiness of prices. The relationship between nominal and real exchange rate volatilities is presented in Figure 3. As nominal and real exchange rate volatilities are very similar, only the results for nominal exchange rate volatilities are reported in the study.

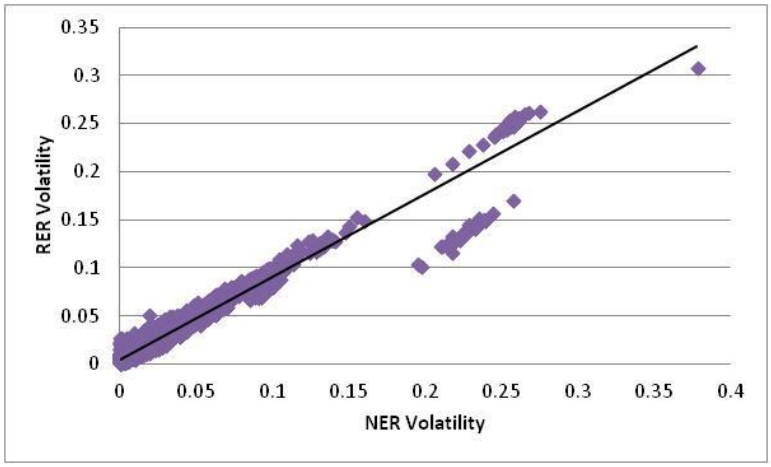

Figure 3. Real and Nominal Exchange rate volatilities (based on Method 1 calculations)

Next, three measures of exchange rate volatilities are illustrated in Figures 4-5 for two country pairs USA – Belgium and USA – Argentina[4].

[2] For 1999 I use a different formula to account for an introduction of euro:

$$V_t = \sqrt{\frac{1}{n-2}\sum_{i=2}^{n}(\Delta E_i)^2},$$

The same formula is used for country pairs where one of the trading partners is Greece (for the year of 2001).

[3] Observations of January, 1999 (for all country pairs) and January, 2001 (for country pairs where one of the trading partners is Greece) are not used in calculations.

[4] The results for other country pairs exhibit similar patterns and are not reported in the study.

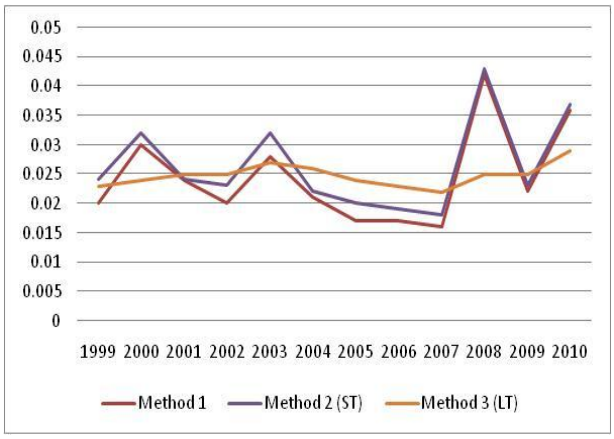

Figure 4. Exchange rate volatility USA-BEL

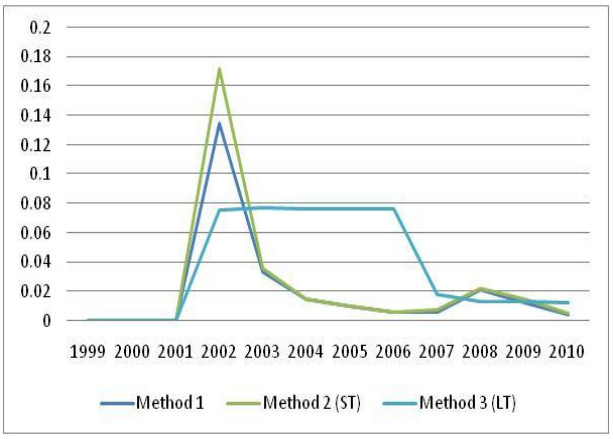

Figure 5. Exchange rate volatility USA-ARG

According to these examples the 12-months moving standard deviation measure is quite close to the one measured by a within period standard deviation method. However, the long-run moving standard deviation is more stable what indicating persistence of exchange rate shocks. As expected, all three methods show zero volatility under fixed exchange rate arrangements. Therefore, because of a similarity in performance of exchange rate volatilities this study only reports the results with nominal exchange rate volatility measured by Methods 2 and 3.

3.3 Exchange rate volatility and imports

Most of the studies employ several measures of exchange rate volatility for robustness check of the results. In my study, I use short-term and long-term exchange rate volatilities assuming that firms are more exposed to long-term exchange rate fluctuations. This assumption is in line with Krugman (1986) according to which in the presence of sunk costs, firms will tend not to react to short-term exchange rate fluctuations. Figures 6a and 6b show the relationship between imports and short-term and long-term volatilities respectively for the whole sample. Based on the figures below both volatilities are negatively correlated with imports. However, correlation of long-term volatility with trade variable is higher in absolute terms.

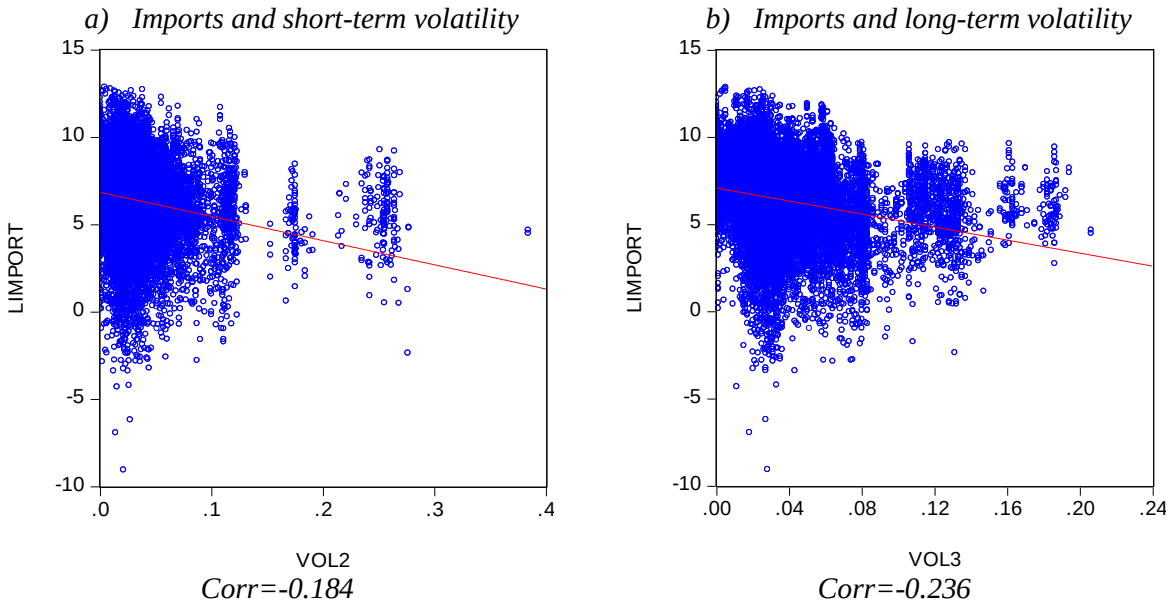

Figure 6. Exchange Rate Volatility and imports , 1996-2010

Next, I observe the relationship between short-term and long-term exchange rate volatilities and imports for different groups of countries. Figure 7 reports the results. The upper graphs a-b consider these relationship for countries with high levels of financial development, graphs c-d for countries with low levels of financial development and graphs e-f for countries where one partner has a low level of financial development while another has a high level of financial development.

Firstly, both short-term and long-term exchange rate volatilities are negatively correlated with imports for all three sub-samples. However, the correlations are higher in absolute terms for country groups where at least one partner has a low level of financial development. Secondly, the coefficients of correlation are higher in absolute terms for long-term exchange rate volatility than for short-term one for all sub-samples. These observations can reflect the fact that trade between countries is more affected by long-term exchange rate fluctuations and country pairs where at least one partner has a low level of financial development are more vulnerable to this effect.

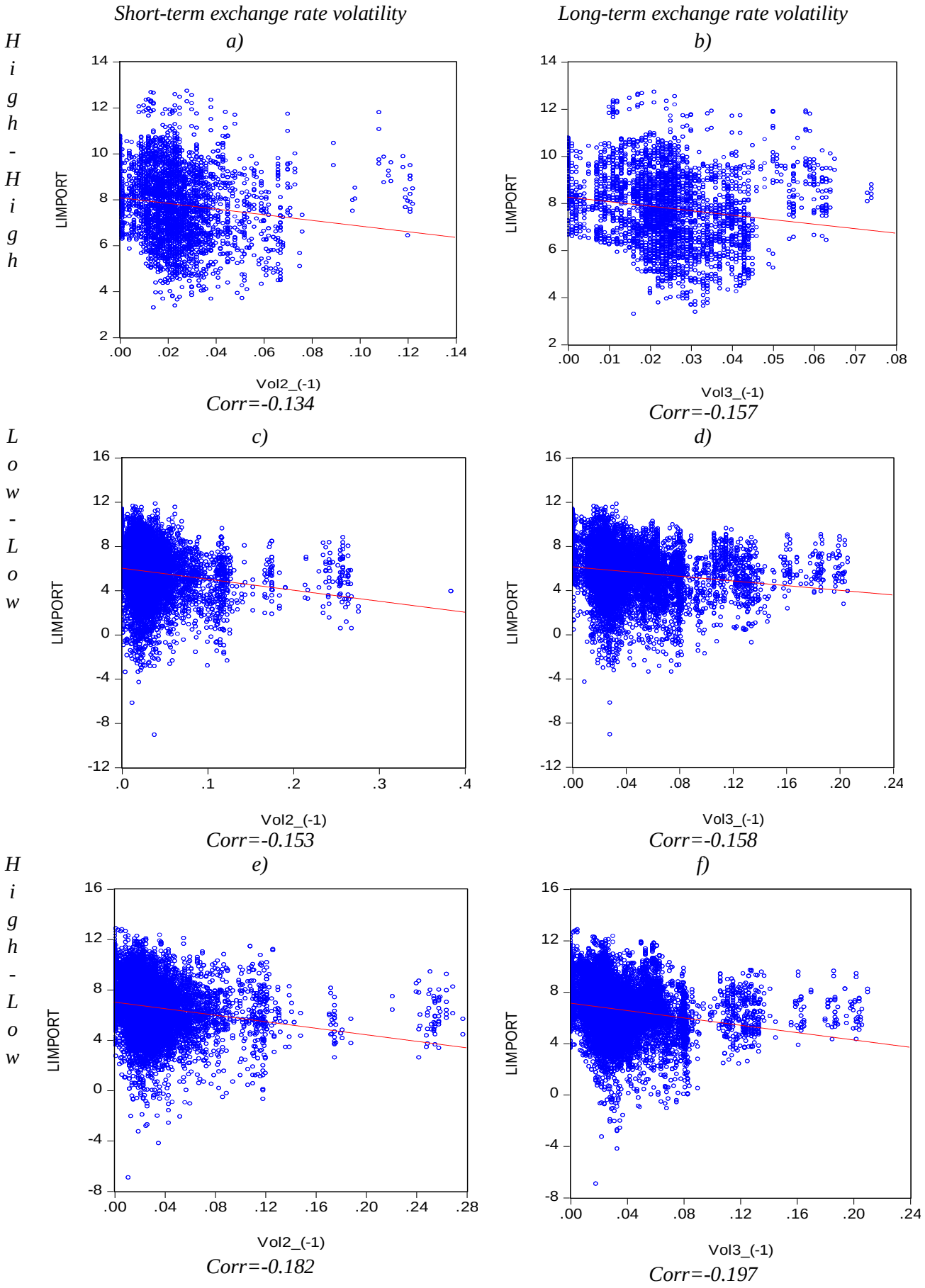

Figure 7. Exchange Rate Volatility and imports for different country groups, 1996-2010

To conclude, this Chapter has shown that real exchange rate volatility is very close to nominal exchange rate volatility because of stickiness of the prices. In addition, long-term exchange rate volatility is more stable than the short-term one. As expected, trade is more correlated with long-term exchange rate volatility and correlation is higher in absolute terms for countries where at least one trading partner has a low level of financial development.

Chapter 4: Model: econometric approach

In this chapter I check the hypothesis that effect of exchange volatility on trade depends on the level of financial development of trading partners. For this purpose different models of the effect of exchange rate volatility on trade for country pairs with different levels of financial development are estimated. I use the gravity model as a baseline specification. All models are estimated for both short-term and long-term exchange rate volatilities.

4.1 Basic model specification

Most of the empirical studies that focus on the relationship between exchange rate volatility and bilateral trade employ the gravity model. A simple gravity model assumes that the volume of trade between two countries increases with higher GDPs and decreases with the geographical distance which serves as a proxy for transportation costs. The empirical studies usually augment the gravity model with other factors that can potentially influence trade flows such as common border, common language, membership in the same currency union or trade agreement, etc. (see, for example, Clark et al., 2004, Dell'Ariccia, 1999, Rose 2000, Tenreyro, 2007).

In this study I implement the model that differs from the gravity model in the way that the dependent variable is not a bilateral trade, but imports from one country to another. Thus, the empirical model is specified as follows:

$$Imp=f\,(Y^*, Y, Vol, Dist, Border, ComLang, RTA) \quad (3)$$

where imports (*Imp*) are a function of reporting country's GDP (Y), partner country's GDP(Y^*), exchange rate volatility (*Vol*), and a number of gravity variables – the distance between two countries (*Dist*), sharing of a common border (*Border*) or common language (*ComLang*) and membership in Regional Trade Agreement (*RTA*).

Firstly, dummy variables for level of financial development (*FD_LL*, *FD_HL*) and their interaction with exchange rate volatility are added in order to examine the effect of financial development on the relationship between exchange rate volatility and imports. All variables except dummies are in logarithms. As a result, the following model is estimated:

$$\ln(Imp_{ijt}) = \beta_0 + \beta_1 \ln(Y_{ijt}) + \beta_2 \ln(Y^*_{ijt}) + \beta_3 \ln(Dist_{ij}) + \beta_4 Border_{ij} + \beta_5 ComLang_{ij}$$

$$+\beta_6 RTA_{ijt} + \beta_7 Vol_{ijt} + \beta_8 FD\_LL_{ij} + \beta_9 FD\_HL_{ij} + \beta_{10} FD\_LL_{ij} * Vol_{ijt} +$$

$$+\beta_{11} FD\_HL_{ij} * Vol_{ijt} + v_{ij} + \delta_t + w_{ijt} \quad (4)$$

where *i* – index for a reporter country, *i=1,2,…,40;*

j – index for a partner country, *j=1,2,…,40* for $\forall i \neq j;$

t – index for time periods, *t*=1,2,...,*15*;

v_{ij} – unobserved country pair-specific effects;

δ_t – unobserved time-specific effects;

w_{ijt} – an error term which is, by assumption, independently and identically distributed with N(0,σ^2).

According to this model, the net marginal effect of volatility on imports depends on the level of financial development of country pairs, i.e.

$\frac{\partial \ln(\mathrm{Imp}_{ijt})}{\partial \mathrm{Vol}_{ijt}} = \beta_7,$ - for country pairs where both partners have high levels of financial development;

$\frac{\partial \ln(\mathrm{Imp}_{ijt})}{\partial \mathrm{Vol}_{ijt}} = \beta_7 + \beta_{11},$ - for country pairs where one partner has a high level of financial development, while another has a low level of financial development;

$\frac{\partial \ln(\mathrm{Imp}_{ijt})}{\partial \mathrm{Vol}_{ijt}} = \beta_7 + \beta_{10},$ - for country pairs where both partners have low levels of financial development.

Thus, other things equal, net marginal effect of exchange rate volatility on imports is not constant across country pairs and it depends on the level of financial development of both trading partners. I expect both β_{10} and β_{11} to have a negative sign. In addition, coefficients β_1, β_2, β_4, β_5 and β_6 are expected to be positive, while β_3, β_8 and β_9 are supposed to be negative.

Unobserved country pair-specific effects v_{ij} control for cultural, economic, and institutional country-pair specific factors that are constant over time and are not explicitly represented in the model. In baseline models I assume that v_{ij} is uncorrelated with explanatory variables. In addition, in order to account for unobserved time specific effects δ_t a set of time dummies is introduced in each model specification. Finally, I assume that idiosyncratic errors w_{ijt} are uncorrelated with the explanatory variables in each time period *t*.

Next, I relax the assumption of independence between explanatory variables and country pair-specific effects and estimate fixed effect regressions. In this case all variables that do not vary over time are dropped out. Finally, I estimate some extensions of the model with fixed effects.

4.2 Data

The sample consists of 23,400 observations, including annual data for 1560 country pairs for the period of 1996-2010. All variables, except dummies, are in logarithms. The choice of the time period is constrained by the data availability. In addition, rapid development of financial markets started in 20th century. Thus, in terms of financial development the "time was different" before the analyzed period.

I carry out empirical investigation using imports as a dependent variable. The data on imports is obtained from the UN Commodity Trade Statistics Database (COMTRADE) and it

is expressed in millions of current U.S. dollars. For some country pairs, data on imports is unavailable and is considered to be a missing value.

The independent variables are GDP of trading partners, exchange rate volatility, distance between two countries and a set of gravity dummies. The nominal GDP is collected from the World Bank and it is expressed in millions of U.S. dollars. Monthly exchange rate data is obtained from International Financial Statistics (IFS) and it is defined as a number of units of national currency per one U.S. dollar. Assuming no arbitrage opportunities exchange rates for other country pairs are computed as

$$ER_{currency1/currency2} = \frac{ER_{currency1/US\$}}{ER_{currency2/US\$}} \quad (5)$$

Next, exchange rate volatility is calculated as stated in Section 3.2.

A set of gravity variables includes such items as common border, common language and distance. All the variables are collected from CEPII GeoDist[5]. The distance is expressed in kilometers and it is calculated following the great circle formula, which uses latitudes and longitudes of the most important cities/agglomerations in terms of population. The common language dummy is equal to one if a common language is spoken by at least nine per cent of the population in both countries, and it is zero otherwise. The common border dummy is equal to one if two countries have a common border, and it is equal to zero if not. In addition, regional trade agreement (RTA) dummy is introduced. It is equal to one if two countries are members of the same trade agreement, and it is zero otherwise. This variable is constructed by the author based on the information available at the web-site of the World Trade Organization[6].

[5] The database is available at (http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=6).
[6] The interactive chart is available at (http://www.wto.org/english/tratop_e/region_e/rta_participation_map_e.htm?country_selected=HKG&sense=b).

The summary statistics for the main variables are represented in Table 2. On average countries where both partners have high levels of financial development have higher GDP, trade more and exhibit lower exchange rate volatility comparing to the other country pairs.

Table 2. Summary statistics

Variable	The whole sample	FD_HH	FD_HL	FD_LL
# of observations	23400	3150	11250	9000
Ln(Imports)	6.44 (2.16)	7.79 (1.58)	6.65 (2.00)	5.69 (2.23)
Ln(GDP)	12.90 (1.19)	13.3 (1.34)	12.98 (1.23)	12.66 (1.02)
Exchange rate volatility, Method 2	0.031 (0.030)	0.024 (0.017)	0.030 (0.028)	0.034 (0.034)
Exchange rate volatility, Method 3	0.037 (0.029)	0.025 (0.013)	0.035 (0.027)	0.043 (0.034)

Note: Standard deviations are reported in parenthesis.

4.3 Empirical results

In this section I discuss some important empirical results on the impact of short-term and long-term exchange rate volatilities on imports depending on the level of financial development of the trading partners. Firstly, I estimate "naïve" regressions using dummy variables for groups of countries. Secondly, I estimate models for different country groups separately using fixed effects and pooled OLS techniques. Thirdly, I discuss the results for some extensions of the fixed effects models. Finally, I check the sensitivity of the results, indicate potential drawbacks in the models and propose ideas for further research.

4.3.1 "Naive" regressions

Table 3 presents estimation results of the impact of short-term and long-term volatilities on imports of the countries included in the sample. The models contain dummy variables for different levels of financial development of trading partners and their

interactions with exchange rate volatilities. Each model includes time fixed effects and standard errors are corrected for heteroskedasticity.

Table 3. Estimation results of the "naive" regressions

Dependent variable: Ln(Imports)		
	(1)	(2)
Ln(GDP_reporter)	0.892***	0.892***
	(0.012)	(0.012)
Ln(GDP_partner)	0.909***	0.910***
	(0.007)	(0.007)
Long-term exchange rate volatility	-	10.463***
		(3.813)
Short-term exchange rate volatility	4.634	-
	(3.639)	
FD_LL	-0.674***	-0.493***
	(0.046)	(0.039)
FD_HL	-0.317***	-0.137***
	(0.036)	(0.051)
FD_LL*Volatility	-5.444**	-11.862**
	(2.296)	(2.870)
FD_HL*Volatility	-5.432***	-12.037***
	(1.992)	(2.795)
Common border	0.568***	0.573***
	(0.026)	(0.023)
Common language	0.410***	0.407***
	(0.019)	(0.016)
RTA	0.295***	0.295***
	(0.029)	(0.027)
Ln(Distance)	-0.652***	-0.652***
	(0.020)	(0.022)
Constant	-10.993***	-11.143***
	(0.335)	(0.327)
# of observations	23236	23236
R-squared	0.695	0.695

Note: Numbers in parenthesis are White standard errors.
Estimated coefficients of time dummies are not included in the Table 3.
** - significance at the 10% level; ** - significance at the 5% level; *** - significance at the 1% level.*

All gravity dummies as well as distance and GDPs of the trading partners are statistically significant and have expected signs. GDPs of trading partners representing supply and demand sides for imports have almost the same positive effect on trade. Dummy variables on the level of financial development suggest that countries where at least one

partner has a low level of financial development trade less than the countries where both partners have high levels of financial development.

The main variable of interest is exchange rate volatility. The results provide evidence that short-term volatility has no statistically significant impact on imports of countries with high levels of financial development, while it negatively affects trade of countries where at least one partner has a low level of financial development. As so, one per cent increase in short-term exchange rate volatility dampens imports by approximately 0.8 per cent for countries where at least one partner has a low level of financial development, other things being equal. At the same time, the results for long-term exchange rate volatility are different. The model suggests that long-term exchange rate volatility increases trade between countries with high levels of financial development significantly. However, one per cent increase in long-term exchange rate volatility decreases imports for *FD_LL* and *FD_HL* country pairs by 1.4 per cent and 1.6 per cent respectively, other things being equal.

Thus, trade between countries with high levels of financial development is unaffected by short-term exchange rate volatility and it is intensified by higher long-term exchange rate fluctuations. At the same time, both long-term and short-term exchange rate volatilities harm trade between countries where at least one trading partner has a low level of financial development.

The main problem with the models discussed above is that we do not include fixed effects for country pairs assuming that they are exogenous. However, if this assumption is not justified the coefficient from the models above are inconsistent and biased.

4.3.2 Models with fixed effects

In this subsection I run and compare models estimated by pooled OLS and fixed and random effects techniques for the whole sample as well as for different country groups. It is done in order to check if country pair effects are exogenous or not. Firstly, I estimate the models for the whole sample. The results are presented in Table 4.

Table 4. Estimation results: the whole sample

Dependent variable: Ln(Imports)						
	Pooled	RE	FE	Pooled	RE	FE
Ln(GDP_reporter)	0.933*** (0.009)	0.804*** (0.022)	0.909*** (0.046)	0.933*** (0.009)	0.799*** (0.025)	0.883*** (0.046)
Ln(GDP_partner)	0.951*** (0.005)	0.501*** (0.028)	0.425*** (0.062)	0.951*** (0.006)	0.495*** (0.024)	0.400*** (0.060)
Long-term exchange rate volatility	-	-	-	-3.135*** (1.031)	-0.385 (0.442)	-0.498 (0.412)
Short-term exchange rate volatility	-1.491 (1.881)	0.071 (0.321)	0.480 (0.292)	-	-	-
Common border	0.479*** (0.030)	0.581*** (0.183)	-	0.507*** (0.024)	0.589*** (0.174)	-
Common language	0.528*** (0.023)	0.544*** (0.149)	-	0.511*** (0.016)	0.541*** (0.144)	-
RTA	0.231*** (0.033)	0.057** (0.028)	0.075** (0.030)	0.230*** (0.033)	0.060** (0.027)	0.080*** (0.028)
Ln(Distance)	-0.673*** (0.020)	-0.743*** (0.054)	-	-0.653*** (0.020)	-0.738*** (0.053)	-
Constant	-12.237*** (0.271)	-4.138*** (0.622)	-10.821*** (1.144)	-12.337*** (0.278)	-4.030*** (0.587)	-10.135*** (1.114)
Cross-section fixed[7]	No	No	Yes	No	No	Yes
Period fixed	Yes	No	Yes	Yes	No	Yes
# of observations	23236	23236	23236	23236	23236	23236
R-squared	0.681	0.502	0.951	0.682	0.502	0.951

Note: Numbers in parenthesis are White standard errors.
** - significance at the 10% level; ** - significance at the 5% level; *** - significance at the 1% level.*

Based on fixed effects estimators for the whole sample neither short-term nor long-term volatilities have statistically significant effect on imports. The numbers from fixed effect

[7] Cross-section assumes a country pair.

models differ from the results I get by pooled OLS method. I suppose that exchange rate volatility mostly varies across countries and highly volatile countries can also suffer in other dimensions. For example, countries with high exchange rate fluctuations can have irresponsible policymakers and/or bad institutions as a matter of history. As exchange rate volatility is, most probably, negatively correlated with unobserved country-pair specific effects, coefficients I get by pooled OLS method overestimate in absolute terms the effect of exchange rate volatility on trade. In addition, according to a Hausman test (see Appendix 3) the null hypothesis of independence of explanatory variables from country-pair effects is rejected. Thus, random effects estimators are inconsistent while fixed effects technique should produce consistent estimates.

Next, I estimate the same models for different country groups which are formed based on the level of financial development of the countries[8]. Table 5 reports empirical results for the group of countries where both members have high levels of financial development.

The results suggest that short-term exchange rate volatility has no statistically significant impact on imports. It can be explained by the fact that short term exchange rate risks can be fully hedged and hedging instruments are widely available in countries with high level of financial development. At the same time, long-term exchange rate volatility positively affects trade based on the results from the fixed effects model. As so, one per cent increase in exchange rate volatility causes 2.1 per cent increase in imports, other things being equal.

[8] As the Hausman test indicates inconsistency of random effects estimators the results for this technique are not reported and are available upon request.

Table 5. Estimation results: high-high sample

Dependent variable: Ln(Imports)				
	Pooled	FE	Pooled	FE
Ln(GDP_reporter)	0.699*** (0.006)	0.519*** (0.043)	0.667*** (0.005)	0.551*** (0.040)
Ln(GDP_partner)	0.575*** (0.008)	0.561*** (0.038)	0.572*** (0.009)	0.593*** (0.039)
Long-term exchange rate volatility	-	-	2.302 (1.909)	2.141*** (0.742)
Short-term exchange rate volatility	-0.433 (1.937)	0.279 (0.370)	-	-
Common border	1.105*** (0.032)	-	1.088*** (0.038)	-
Common language	0.256*** (0.010)	-	0.266*** (0.013)	-
RTA	0.131** (0.065)	0.134*** (0.028)	0.130** (0.063)	0.123*** (0.030)
Ln(Distance)	-0.416*** (0.030)	-	-0.436*** (0.034)	-
Constant	-5.390*** (0.283)	-6.630*** (0.708)	-5.231*** (0.303)	-7.515*** (0.685)
Cross-section fixed	No	Yes	No	Yes
Period fixed	Yes	Yes	Yes	Yes
# of observations	3150	3150	3150	3150
R-squared	0.722	0.979	0.723	0.979

Note: Numbers in parenthesis are White standard errors.
** - significance at the 10% level; ** - significance at the 5% level; *** - significance at the 1% level.*

One of the explanations for this finding is that flexible exchange rate regimes are supposed to be more credible as they partially absorb economic shocks. Thus, firms prefer to trade with countries where exchange rates are flexible and more volatile. Another explanation is in line with De Grauwe's (1988) paper in which he claims that risk seeking firms can increase their level of production in response to high exchange rate volatility in order to compensate for decrease in revenues. As so, countries with high levels of financial development have bigger companies which can increase their production possibilities in return to higher risks. Finally, firms can decrease the amount of debt denominated in foreign currency or can match their assets and liabilities more carefully in order to reduce vulnerability to exchange rate shocks. According to Eichengreen et al. (2002) the problem of "original sin" exists mostly for developing countries. Thus, countries with high levels of

financial development can easily start using their national currencies in invoicing and, therefore, avoid the problem of exchange rate volatility. Moreover, if firms trade with many trading partners all over the world, they will be protected from the overall currency risk. As multinational companies are mainly presented in countries with high levels of financial development, it can explain the positive impact of exchange rate volatility on trade.

Further I estimate the models for the countries where both partners have low levels of financial development. The results are presented in Table 6.

Table 6. Estimation results: low-low sample

Dependent variable: Ln(Imports)				
	Pooled	FE	Pooled	FE
Ln(GDP_reporter)	1.074*** (0.018)	0.962*** (0.072)	1.072*** (0.018)	0.939*** (0.071)
Ln(GDP_partner)	1.259*** (0.012)	0.283*** (0.065)	1.257*** (0.014)	0.259*** (0.058)
Long-term exchange rate volatility	-	-	-0.220 (1.228)	-0.123 (0.547)
Short-term exchange rate volatility	0.921 (1.462)	0.619** (0.294)	-	-
Common border	0.198*** (0.036)	-	0.211*** (0.026)	-
Common language	0.556*** (0.029)	-	0.553*** (0.028)	-
RTA	0.282*** (0.035)	0.035 (0.035)	0.281*** (0.035)	0.039 (0.032)
Ln(Distance)	-0.757*** (0.019)	-	-0.748*** (0.021)	-
Constant	-17.537*** (0.473)	-10.111*** (1.438)	-17.526*** (0.494)	-9.495*** (1.322)
Cross-section fixed	No	Yes	No	Yes
Period fixed	Yes	Yes	Yes	Yes
# of observations	8905	8905	8905	8905
R-squared	0.655	0.931	0.654	0.931

Note: Numbers in parenthesis are White standard errors.
** - significance at the 10% level; ** - significance at the 5% level; *** - significance at the 1% level.*

According to the model with fixed effects long-term exchange rate volatility does not have statistically significant effect on imports for countries with low levels of financial development. At the same time, the coefficient on short-term exchange rate volatility is

significant at five per cent significance level and suggests that higher exchange rate volatility increases imports. However, the effect is rather small. One more interesting finding is that membership in RTA does not influence trade for these sample of country pairs as the coefficients on RTA are statistically insignificant for fixed effects models.

Next, I estimate the models for a country group where one trading partner has a low level of financial development, while the other has a high level of financial development. The estimation outputs are presented in Table 7.

Table 7. Estimation results: high-low sample

Dependent variable: Ln(Imports)				
	Pooled	FE	Pooled	FE
Ln(GDP_reporter)	0.878*** (0.011)	0.805*** (0.040)	0.879*** (0.011)	0.788*** (0.038)
Ln(GDP_partner)	0.853*** (0.005)	0.453*** (0.059)	0.853*** (0.006)	0.435*** (0.058)
Long-term exchange rate volatility	-	-	-1.266 (1.066)	-0.157 (0.295)
Short-term exchange rate volatility	-0.531 (1.834)	0.491 (0.328)	-	-
Common border	0.643*** (0.030)	-	0.644*** (0.030)	-
Common language	0.429*** (0.022)	-	0.423*** (0.018)	-
RTA	0.409*** (0.026)	0.080** (0.032)	0.409*** (0.026)	0.082*** (0.031)
Ln(Distance)	-0.640*** (0.014)	-	-0.634*** (0.016)	-
Constant	-10.550*** (0.246)	-9.730*** (1.003)	-10.586*** (0.264)	-9.258*** (0.965)
Cross-section fixed	No	Yes	No	Yes
Period fixed	Yes	Yes	Yes	Yes
# of observations	11181	11181	11181	11181
R-squared	0.707	0.957	0.707	0.957

Note: Numbers in parenthesis are White standard errors.
** - significance at the 10% level; ** - significance at the 5% level; *** - significance at the 1% level.*

The results for country pairs where only one partner has a low level of financial development suggest that both short-term and long-term exchange rate volatilities have no

statistically significant impact on trade. These findings are pretty similar to the ones I get for the country pairs where both partners have low levels of financial development.

Finally, I estimate regressions with fixed effects including interaction terms of exchange rate volatilities with dummy variables for levels of financial development of trading partners. The results are presented in Table 8.

Table 8. Estimation results: the whole sample

Dependent variable: Ln(Imports)		
	(1)	(2)
Ln(GDP_reporter)	0.908***	0.883***
	(0.046)	(0.045)
Ln(GDP_partner)	0.424***	0.399***
	(0.063)	(0.059)
Long-term exchange rate volatility	-	3.923***
		(1.246)
Short-term exchange rate volatility	0.670	-
	(1.164)	
FD_LL*Volatility	-0.391	-5.108***
	(1.330)	(1.232)
FD_HL*Volatility	0.062	-3.626***
	(1.169)	(1.141)
RTA	0.075**	0.077***
	(0.030)	(0.027)
Constant	-10.802***	-10.132***
	(1.160)	(1.078)
Cross-section fixed	Yes	Yes
Period fixed	Yes	Yes
# of observations	23236	23236
R-squared	0.951	0.952

Note: Numbers in parenthesis are White standard errors.
** - significance at the 10% level; ** - significance at the 5% level; *** - significance at the 1% level.*

The results confirm that short-term exchange rate volatility does not affect trade. Coefficients on short-term exchange rate volatility and interaction terms are statistically insignificant. The Wald test (see Appendix 4a) accepts the null hypothesis and suggests that coefficients on short-term exchange rate volatility are equal for all subsamples. At the same time, coefficients on long-term exchange rate volatility and interaction terms are statistically significant at one per cent significance level. The Wald test (see Appendix 4b) rejects the null

hypothesis at one per cent significance level what indicates that coefficients on exchange rate volatility for different subsamples are not equal. The findings suggest that influence of long-term exchange rate volatility on trade depends on the level of financial development of trading partners. For country pairs with a high level of financial development the effect of long-term exchange rate volatility on trade is positive, that is one per cent increase in exchange rate volatility increases trade by 3.9 per cent, other things being equal. For country pairs where one trading partner has a high level of financial development and the other has a low level of financial development: one per cent increase in exchange rate volatility increases trade by 0.3 per cent *ceteris paribus.* Finally, for country pairs with a low level of financial development one per cent increase in long-term exchange rate volatility dampens trade by 1.2 per cent, other things being equal.

To conclude, based on fixed effects models I find that short-term exchange rate volatility does not influence trade between any country pairs. This finding is in line with De Grauwe (1988) who argues that short-run variability is irrelevant to trade. It can be explained by the fact that in the presence of sunk costs firms will tend not to react to short-term exchange rate fluctuations (Krugman, 1986). Another explanation is that trade contracts are signed pretty much ahead and/or for a long period of time. Moreover, short-term exchange rate risks can easily be hedged.

At the same time, influence of long-term exchange rate volatility on trade is positive for country pairs with a high level of financial development while it is negative for country pairs with a low level of financial development. For country pairs where only one partner has a low level of financial development the results are inconclusive as I get a small statistically significant positive effect by one method and negative, but statistically insignificant effect by the other. These findings confirm my initial hypothesis that high degree of financial sector development can decrease firms' exposure to and costs of exchange rate volatility.

4.3.3 Models with threshold

As it is noted in Chapter 2, on average, exchange rate volatility has little or no impact on trade. However, extremely high exchange rate volatility, especially in times of financial crisis or collapse of fixed exchange rate regimes, can have disastrous effects on trade. As private markets are usually not able to anchor their behavior to large swings in exchange rates, the costs of extreme exchange rate volatility can be disproportionally high. Thus, highly volatile exchange rates can prevent companies from entering the market or force the firms that are already in to move away (Engel and Hakkio, 1993).

For the reasons mentioned above I check if the effect of extremely high volatilities on trade differs from the effect of moderate volatilities. To account for this I introduce a new *Threshold* dummy variable. For both short-term and long-term volatilities,

$$Threshold = \begin{cases} 1, if\ Volatility > 0.1; \\ 0, otherwise. \end{cases}$$

The choice of the threshold to be equal to 0.1 is based on the observation of histograms of the exchange rate volatilities. Figure 8 shows a histogram for short-term exchange rate volatility.

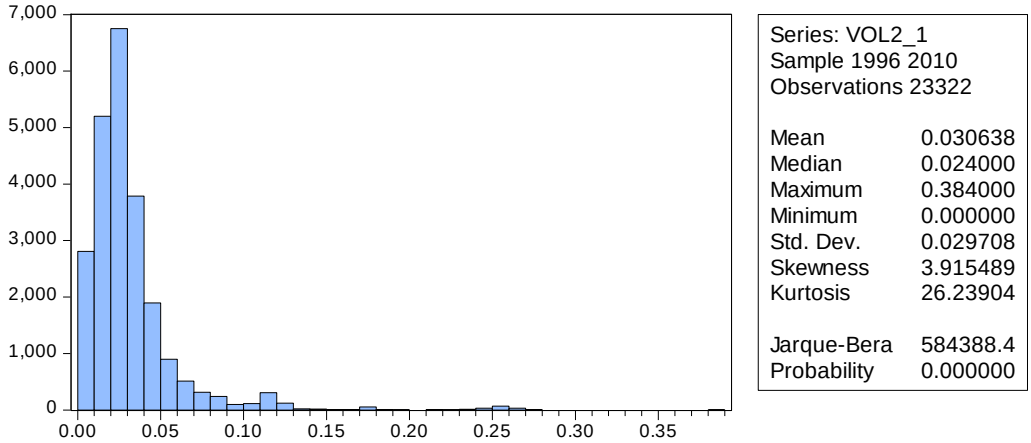

Figure 8. Histogram: short-term exchange rate volatility

Mean is equal to 0.031, minimum value is 0.000 and maximum is 0.384. The histogram is positively skewed and most of the observations are concentrated around the mean plus/minus two standard deviations. At the same time, only 3.4 per cent of observations are higher than 0.1. Thus, I assume that the value of 0.1 is a reasonable threshold for short-term exchange rate volatility.

Figure 9 shows a histogram for long-term exchange rate volatility. Mean is equal to 0.037, minimum value is 0.000 and maximum is 0.21. The histogram shows similar patterns as the one above. Around 4.6 per cent of observations are higher than 0.1 representing a rational threshold for a long-term exchange rate volatility.

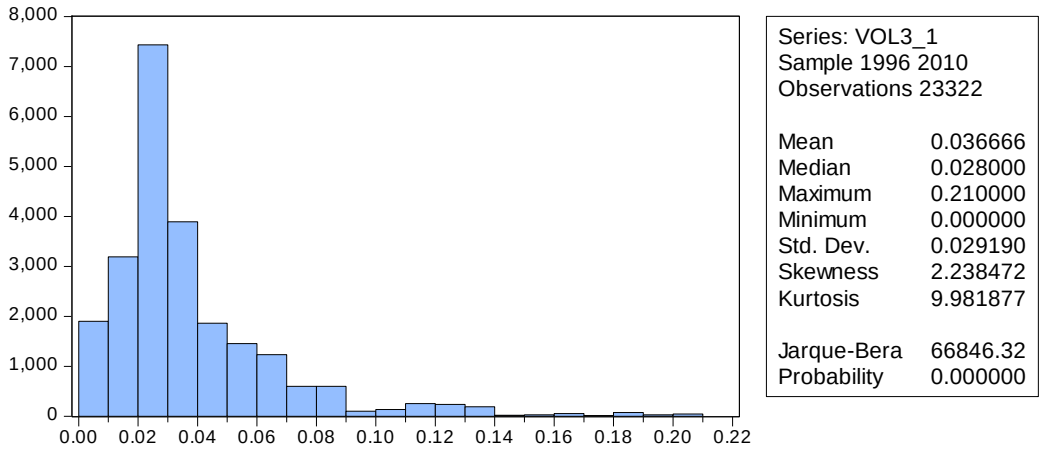

Figure 9. Histogram: Long-term exchange rate volatility

The results for the models with short-term volatility are represented in Table 9. From the table below the coefficients on exchange rate volatility, threshold and an interaction term are statistically insignificant for all subsamples. At the same time the coefficients on volatility themselves have the same positive sign as in regressions without threshold dummies. These results suggest that not only moderate but also extreme short-term volatility has no impact on trade.

Table 9. Estimation results: short-term exchange rate volatility

Dependent variable: Ln(Imports)				
	The whole sample	FD_HH	FD_HL	FD_LL
Ln(GDP_reporter)	0.910*** (0.045)	0.519*** (0.042)	0.808*** (0.039)	0.964*** (0.070)
Ln(GDP_partner)	0.426*** (0.062)	0.561*** (0.038)	0.455*** (0.059)	0.284*** (0.065)
Short-term exchange rate volatility	0.522 (0.518)	0.410 (0.574)	0.243 (0.699)	0.553 (0.663)
Threshold (Volatility>0.1)	0.059 (0.098)	-0.373 (0.307)	0.128 (0.116)	0.055 (0.088)
Threshold*Volatility	-0.378 (0.524)	2.960 (2.640)	-0.474 (0.773)	-0.234 (0.503)
RTA	0.075** (0.029)	0.133*** (0.028)	0.082*** (0.031)	0.035 (0.035)
Constant	-10.842*** (0.138)	-6.629*** (0.707)	-9.790*** (0.997)	-10.144*** (1.427)
Cross-section fixed	Yes	Yes	Yes	Yes
Period fixed	Yes	Yes	Yes	Yes
# of observations	23236	3150	11181	8905
R-squared	0.952	0.979	0.957	0.931

Note: Numbers in parenthesis are White standard errors.
** - significance at the 10% level; ** - significance at the 5% level; *** - significance at the 1% level.*

Next, I estimate the models using long-term exchange rate volatilities. The results are presented in Table 10. The estimates for a sample of countries with high levels of financial development cannot be obtained as there are no country pairs with exchange rate volatility higher than 0.1.

The results for country pairs with low levels of financial development suggest that exchange rate volatility by itself does not have statistically significant influence on trade. However, extreme exchange rate fluctuations affect imports negatively, i.e. one per cent increase in extreme exchange rate volatility decreases trade by 4.4 per cent, other things being equal.

The results for country pairs where one country has a low level of financial development while the other has a high level of financial development provide some

evidence that moderate long-term exchange rate volatility positively affects trade as the coefficient on volatility is positive and significant at five per cent significance level. These results are similar to those I get for country pairs with a high level of financial development and suggest that one per cent increase in exchange rate volatility increases imports by 1.4 per cent, other things being equal. However, extreme exchange rate fluctuations work in other direction. According to the model, one per cent increase in extreme exchange rate volatility dampens trade by 1.3 per cent *ceteris paribus*.

Table 10. Estimation results: long-term exchange rate volatility

Dependent variable: Ln(Imports)			
	The whole sample	FD_HL	FD_LL
Ln(GDP_reporter)	0.904*** (0.053)	0.818*** (0.038)	0.954*** (0.082)
Ln(GDP_partner)	0.420*** (0.061)	0.465*** (0.055)	0.275*** (0.062)
Long-term exchange rate volatility	-0.065 (0.694)	1.368** (0.607)	-0.741 (0.986)
Threshold (Volatility>0.1)	0.445*** (0.098)	0.164** (0.078)	0.620*** (0.139)
Threshold*Volatility	-3.477*** (0.927)	-2.708*** (0.686)	-3.637*** (1.242)
RTA	0.082*** (0.027)	0.083*** (0.030)	0.041 (0.032)
Constant	-10.683*** (1.238)	-10.082*** (0.922)	-9.864*** (1.582)
Cross-section fixed	Yes	Yes	Yes
Period fixed	Yes	Yes	Yes
# of observations	23236	11181	8905
R-squared	0.952	0.957	0.931

Note: Numbers in parenthesis are White standard errors.
** - significance at the 10% level; ** - significance at the 5% level; *** - significance at the 1% level.*

To conclude, the overall results suggest that short-term exchange rate volatility has no statistically significant influence on trade. However, moderate long-term exchange rate volatility supports trade growth for country pairs where at least one trading partner has a high level of financial development. At the same time, extreme long-term exchange rate volatility

dampens trade for country pairs where at least one partner has a low level of financial development. It is worth mentioning that the results for extreme long-term exchange rate volatility for a sample of country pairs with a high level of financial development are unavailable as such countries did not face such exchange rate fluctuations for the period observed.

4.4 Endogeneity issues

Mundell (1961), Broda and Romalis (2011), and others indicate the problem of reverse causality between exchange rate volatility and trade. They assume that the more countries trade with each other the narrower the band within which exchange rate fluctuates. If this is the case, exchange rate volatility is an endogenous variable and the results I get are biased.

As it is stated by Dell'Ariccia (1999), the problem of reverse causality can arise if central banks try to stabilize the exchange rates with country's main trading partners. In this case, exchange rate volatility and trade are negatively correlated, that is the more countries trade with each other the lower exchange rate volatility is. If the problem of reverse causality is not properly addressed the results can arise because of correlation, not causality.

The usual way to address the problem of reverse causality is to use instrumental variables. The literature review suggests that three main instruments have been used in such type of studies. Firstly, the standard deviation of the relative money supply is used as an instrumental variable for exchange rate volatility (Clark et al., 2004; Frankel and Weil, 1993; Chit and Judge, 2011). The rationale is that money supply is correlated with exchange rates, but not with trade flows as monetary policy does not take trade policy into account. However, as it is noted by Dell'Ariccia (1999), these arguments are not true for European countries for which one of the monetary policy goals is exchange rate stability. The second widely used

instrument is the sum of the squares of forward errors. The forward errors are defined as the difference between forward and spot exchange rates (Dell'Ariccia, 1999). This instrument is correlated with exchange rate, but it is not a target of central banks and it is not used for exchange rate stabilization. Thus, it should be a valid instrument for exchange rate volatility. The main problem for this instrument is data availability of forward rates for a large number of currencies over a long period of time. The third instrument is dummies for exchange rate regimes. Exchange rate regimes are correlated with exchange rate volatility. However, adoption of one or another exchange rate regime can be influenced by trade considerations. Thus, I find this instrument to be invalid.

Another solution for panel data models is proposed by Dell'Ariccia (1999). He claims that models with fixed effects can capture the behavior of central banks if this behavior does not change over time. In this case, the central banks' stabilizing strategies are assumed to be country-pair specific effects which are eliminated by fixed effects estimation. Dell'Ariccia supposes that central banks form their stabilizing strategies based on relative importance of trading partners and not on the exact values of the trade flows. That is the case for my study. Even though trade flows are not constant over time, the main trading partners remain almost the same for each country for the period observed. Therefore, I conclude that regressions with fixed effects should produce unbiased estimates. However, if central banks' stabilizing strategies are not constant over time the models I use can suffer from the endogeneity problem. Thus, I want to acknowledge that search of valid instruments for exchange rate volatility can be an important topic for further research.

4.5 Robustness tests

In this section I check if the coefficients of interest in the models with fixed effects are sensitive to different measures of financial development. I do this for robustness check of

the results. In the Tables below I summarize the coefficients on exchange rate volatilities and do not report the other coefficients. It is worth mentioning that for regressions with alternative measures of financial development, the other coefficients have the same signs and almost the same magnitude as for initial regressions.

Table 11 represents the coefficients on short-term exchange rate volatility and its interactions with level of financial development. First, I use combination of PCR and SBM to define the level of financial development. Next, I use each of the measures of financial development separately. From the Table below, all the coefficients are statistically insignificant and pretty similar in magnitude. The Wald tests suggest that the coefficients on short-term exchange rate volatility are equal for all subsamples (see Appendix 5a and 5b).

Table 11. Short-term exchange rate volatility: alternative measures of financial development

	PCR+SBM	PCR	SBM
Exchange rate volatility	0.670 (1.164)	0.550 (0.482)	0.689 (0.795)
FD_LL*Volatility	-0.391 (1.330)	-0.045 (0.682)	-0.433 (0.986)
FD_HL*Volatility	0.062 (1.169)	-0.097 (0.630)	-0.034 (0.818)

Note: Numbers in parenthesis are White standard errors.
** - significance at the 10% level; ** - significance at the 5% level; *** - significance at the 1% level.*

Next, I run the same regressions for long-term exchange rate volatility. The results are presented in Table 12. While the coefficients for country groups which are defined based on PCR and SBM together and SBM separately are almost the same, they differ for PCR division. The Wald test for SBM division suggests that the coefficients on long-term exchange rate volatility are different for all subsamples at one per cent significance level (see Appendix 6a). At the same time, the Wald test for PCR division claims that coefficients on exchange rate volatility are the same for all subsamples (see Appendix 6b).

Table 12. Long-term exchange rate volatility: alternative measures of financial development

	PCR+SBM	PCR	SBM
Exchange rate volatility	3.923***	-1.492	2.566***
	(1.246)	(1.535)	(0.802)
FD_LL*Volatility	-5.108***	1.203	-3.831***
	(1.232)	(1.286)	(0.9385)
FD_HL*Volatility	-3.626***	0.886	-2.554***
	(1.141)	(1.256)	(0.706)

Note: Numbers in parenthesis are White standard errors.
** - significance at the 10% level; ** - significance at the 5% level; *** - significance at the 1% level.*

Thus, I conclude that short-term exchange rate volatility is not sensitive and long-term exchange rate volatility is sensitive to different measures of the level of financial development. A possible explanation of this finding is that PCR and SBM are highly correlated (correlation is equal to 0.799 for raw data and 0.551 for dummies). Thus, it is hard to distinguish the influence of each on the effect of exchange rate volatility on trade. In addition, the results are mostly driven by stock and bond market capitalization per GDP. However, I suppose that the level of financial development is more carefully defined by combination of PCR and SBM as these measures allow accounting for development of financial intermediation and financial markets at the same time.

4.6 Limitations of the models and suggestions for further research

The results I get by modeling the relationship between trade and exchange rate volatility are based on the analysis of the sample of the forty countries with the highest GDP. These countries are the richest ones and have more developed financial systems compared to the other countries in the world. Therefore, the countries I treat as countries with a low level of financial development amongst the sample, are not so undeveloped compared to the rest of the world. At the same time, there are a lot of countries where availability of private credits is low and stock exchanges do not exist. I suppose that replicating of the same modeling techniques for the most undeveloped countries can give different results. Most probably, the

coefficients on exchange rate volatility will be higher in absolute value. Thus, modeling of trade relationships for undeveloped countries can be a good topic for further research.

Further, the research is based on several strong assumptions for exchange rate volatilities. First of all, I assume that firms are backward looking and they make their decisions in time t based on exchange rate volatilities in time (t-1). Secondly, following Keynesians approach I take prices as sticky, thus, assuming that nominal and real exchange rate volatilities are approximately the same. Thirdly, I assume no arbitrage opportunities and calculate exchange rates based on this assumption. Finally, there is no common pattern on how to calculate exchange rate volatility and I replicate the results using only two of possible methodologies, i.e. long-term and short-term moving averages. Therefore, relaxing of the assumptions mentioned above can give further insights into the same problem.

In addition, I look only at aggregated data. However, as noted, for example, by Wang and Barrett (2007), exchange rate volatility affects trade in agricultural sector, while has no effect on trade in the other sectors. Thus, disaggregation of data by sectors can be one of the topics for further research. I assume that the effect of exchange rate volatility on trade can be different across sectors as sectors differ in size of firms, production technologies, usage of inputs, availability of private credits, presence at stock exchanges, etc.

Finally, I assume exchange rate volatility to be exogenous. Many scholars point out that there is a reverse causality between trade and exchange rate volatility and use instrumental variables to treat this problem. Therefore, searching for valid instruments for short-term and long-term exchange rate volatilities is left for further research. Moreover, many researchers as Rogoff et al. (2006), Chit and Judge (2011) and Oztruck and Kalyoncu (2009) use alternative methods of estimation such as GMM method, dynamic panel and some other. I acknowledge that more sophisticated techniques can possibly give further insight into the problem.

Chapter 5: Conclusion and policy recommendations

The main purpose of this study was to determine whether the effect of exchange rate volatility on trade depends on the level of financial development of trading partners. To explore this problem I used a gravity model as a baseline and estimated a number of econometric models using panel data for the sample of 1560 country pairs for the period of 1996-2010. In the models I used short-term and long-term exchange rate volatilities. Moreover, all the models were estimated for the whole sample as well as for different subsamples which were formed based on the level of financial development of trading partners.

The main results of this study suggest that short-term exchange rate volatility does not have statistically significant effect on trade for any country groups. At the same time, influence of long-term exchange rate volatility on trade is negative for country pairs with a low level of financial development and it is positive for country pairs with a high level of financial development. Moreover, extreme long-term exchange rate volatility dampens trade for country pairs where at least one trading partner has a low level of financial development. Thus, the extreme long-term exchange rate volatility is harmful for trade.

The results I find in this study are in line with most of the researches that claim that the effect of exchange rate volatility on trade depends on the level of financial development of the countries and it is negative for country pairs with a low level of financial development. However, there are several differences. Firstly, I find that extreme long-term exchange rate volatility affects trade most severely. Secondly, I do not discover any significant effect of short-term exchange rate volatility on trade. Thirdly, I find positive effect of long-term exchange rate volatility on trade for country pairs with a high level of financial development.

It is worth mentioning that the study has some limitations. As it is stated in section 4.6 the sample is limited to the countries with the highest GDP, the data is aggregated, and treatment of the reverse causality problem and exchange rate volatility calculations are based on strong assumptions. Thus, search of valid instruments for exchange rate volatility, relaxation of assumptions for exchange rates as well as broadening of the research to disaggregated data and/or other countries can provide further insights into the same problem.

Based on the results described above some **policy recommendations** can be proposed. First of all, as financial sector development provides the mechanism for firms to mitigate the negative effects of exchange rate volatility on trade, development of financial sector should be one of the priorities in economic policy for countries lagging behind.

Secondly, even though fixed exchange rate regimes offer the private sector an implicit guarantee against short-term exchange rate movements these regimes lead to moral hazard and excessive foreign currency borrowing. Thus, introduction of floating exchange rate regimes provides incentives for more cautious risk management and more careful matching of assets and liabilities in foreign currency. In addition, in countries with high levels of financial development firms can start making and accepting payments in their national currencies, thus, reducing exposure to exchange rate risks (Kamil, 2012). Moreover, risk seeking firms even can increase their sales in response to high exchange rate volatility (De Grauwe, 1988). Therefore, in countries with high availability of private credits and well-developed stock exchanges, firms operate in an environment which protects them from exposure to exchange rates risks. As so, floating exchange rate regimes are beneficial for trade and are recommendable for countries with high levels of financial development.

Thirdly, bilateral trade between countries where at least one partner has a low level of financial development can be dampened with extreme long-term exchange rate volatility. These countries cannot fully rely on the market in determining exchange rates and, thus,

should be cautious about the introduction of floating exchange rate regimes. One of the solutions is to follow managed floating where the Central Bank should intervene in the market whenever extreme exchange rate fluctuations last for a long period of time and can, potentially, harm trade. In addition, the Central Bank should have some degree of credibility so that market participants can form positive expectations and be sure that the Central Bank will take actions at "bad times". Another solution is to peg the national currency to the basket of currencies of major trading partners. However, in this case a country should ensure that its Central Bank is able to manage the peg and that currencies of major trading partners are stable enough (Velasco, 2000).

Finally, short-term exchange rate fluctuations do not affect trade. However, it does not mean that they are not taken into account by market participants. Short-term exchange rate volatility forms expectations and, thus, may grow into long-term exchange rate fluctuations. It can be not a problem for countries with floating exchange rate regimes as exchange rate volatility is considered to be a natural process. However, even insignificant short-term exchange rate fluctuations for countries with fixed exchange rate regimes may create panic as it indicates inability of the Central Bank to keep exchange rate fixed. Thus, only countries with disciplined policymakers can rely on fixed exchange rate regimes.

To conclude, the results of this paper suggest that flexible exchange rate regimes are beneficial for trade growth between countries with high levels of financial development. At the same time, choice of exchange rate regimes from the prospects of trade growth with or between countries with low levels of financial development requires further investigation.

Appendixes

Appendix 1

Table A1.1. Exchange rate volatility and trade: literature review

Study	Sample period	Countries	Estimation technique	Main results
Caporale and Doroodian (1994)	1974-1992, quarterly	U.S., Canada	GARCH	Negative and statistically significant effect of real exchange rate volatility on trade flows
Dell'Ariccia (1998)	1975-1994	15 EU countries	Pooled OLS, IV, RE and FE	Small negative effect of exchange rate volatility on trade, positive effect of a currency union on trade
Rose (1999)	1970, 1975, 1980, 1985, 1990	186 countries	OLS, cross-sections and pooled, IV	Small negative effect of exchange rate volatility on trade, positive effect of a currency union on trade
Arize et al. (2000)	1973-1996, quarterly	13 countries	Johansen's multivariate procedure	Significant negative effect of real exchange rate volatility on trade
Doganlar (2002)	1980-1996, quarterly	5 Asian countries	Engle-Granger residual-based cointegrating technique	Negative effect of real exchange rate volatility on export
Wang and Barrett (2007)	1989-1998, monthly	U.S. and Chinese Taipei	GARCH-M	Volatility negatively affects only trade in agricultural sector
Oztruck and Kalyoncu (2009)	1980–2005, quarterly	6 countries	Engle-Granger residual-based cointegrating technique	The volatility of real exchange rate exert a significant negative/positive effect on trade depending on the market
Chit et al. (2010)	1982-2006, quarterly	5 East Asian countries	OLS, FE, GMM-IV, G2SLS-IV	Real exchange rate volatility has a negative impact on exports
Bailey, Tavlas and Ulan (1986)	1973-1984, quarterly	7 OECD countries	OLS	No significant effect of nominal and real exchange rate volatility on trade, mixed results
McKenzie and Brooks (1997)	1973-1992, monthly	German, U.S.	OLS	Positive effect of nominal exchange rate volatility on trade

Aristotelous (2001)	1889-1999	UK and U.S.	OLS, gravity model	Neither real exchange rate volatility nor different exchange rate regimes have an effect on export volume
Kasman&Kasman (2005)	1982-2001, quarterly	Turkey	ECM	Significant positive effect of real exchange rate volatility on export
Tenreyro (2007)	1970-1997	87 countries	PML-IV	Nominal exchange rate variability has no effect on trade
Hondroyiannis et al. (2008)	1977-2003, quarterly	12 industrialized countries	OLS, FE, RE, GMM	No significant effect of real exchange rate variability on exports
Eicher and Henn (2009)	1950-2000	177 countries	Gravity model, FE	No significant effect, lower impact of CU on trade than was found by Rose (2000)

Source: part of the Table is taken from Ozturk (2006), the rest is added by the author.

Appendix 2

List of countries:

Australia
Canada
Denmark
France
Ireland
Japan
Malaysia
Netherlands
Singapore
South Africa
Spain
Sweden
Switzerland
United Kingdom
United States
Argentina
Austria
Belgium
Brazil
Chile
China
Colombia
Egypt
Finland
Germany
Greece
India
Indonesia
Israel
Italy
Korea
Mexico
Nigeria
Norway
Poland
Portugal
Russian Federation
Thailand
Turkey
Venezuela

Appendix 3

a) Hausman test for a model with short-term volatility:

Correlated Random Effects - Hausman Test
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	788.785025	4	0.0000

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
LGDP_REPORTER	0.873949	0.808095	0.000053	0.0000
LGDP_PARTNER	0.389662	0.483693	0.000052	0.0000
VOL2_1	-0.016548	-0.041266	0.000110	0.0185
RTA	0.083479	0.129939	0.000033	0.0000

Cross-section random effects test equation:
Dependent Variable: LIMPORT
Method: Panel Least Squares
Sample: 1996 2010
Periods included: 15
Cross-sections included: 1560
Total panel (unbalanced) observations: 23236

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-9.902000	0.122295	-80.96805	0.0000
LGDP_REPORTER	0.873949	0.013683	63.87019	0.0000
LGDP_PARTNER	0.389662	0.013681	28.48265	0.0000
VOL2_1	-0.016548	0.127702	-0.129583	0.8969
RTA	0.083479	0.019527	4.275043	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.951040	Mean dependent var	6.437552
Adjusted R-squared	0.947509	S.D. dependent var	2.158309
S.E. of regression	0.494491	Akaike info criterion	1.494360
Sum squared resid	5299.259	Schwarz criterion	2.036433
Log likelihood	-15797.47	Hannan-Quinn criter.	1.670430
F-statistic	269.3354	Durbin-Watson stat	0.957871
Prob(F-statistic)	0.000000		

b) Hausman test for a model with a long-term volatility:

Correlated Random Effects - Hausman Test
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	756.086703	4	0.0000

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
LGDP_REPORTER	0.866043	0.801541	0.000052	0.0000
LGDP_PARTNER	0.381766	0.475495	0.000052	0.0000
VOL3_1	-0.622744	-0.620200	0.000589	0.9165
RTA	0.089188	0.133104	0.000033	0.0000

Cross-section random effects test equation:
Dependent Variable: LIMPORT
Method: Panel Least Squares
Sample: 1996 2010
Periods included: 15
Cross-sections included: 1560
Total panel (unbalanced) observations: 23236

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-9.678113	0.131803	-73.42889	0.0000
LGDP_REPORTER	0.866043	0.013791	62.79918	0.0000
LGDP_PARTNER	0.381766	0.013788	27.68869	0.0000
VOL3_1	-0.622744	0.162848	-3.824095	0.0001
RTA	0.089188	0.019565	4.558483	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.951073	Mean dependent var	6.437552
Adjusted R-squared	0.947544	S.D. dependent var	2.158309
S.E. of regression	0.494324	Akaike info criterion	1.493686
Sum squared resid	5295.689	Schwarz criterion	2.035759
Log likelihood	-15789.65	Hannan-Quinn criter.	1.669756
F-statistic	269.5263	Durbin-Watson stat	0.958602
Prob(F-statistic)	0.000000		

Appendix 4

a) Wald test for a model with short-term exchange rate volatility:

Wald Test:

Test Statistic	Value	df	Probability
F-statistic	1.452172	(2, 21656)	0.2341
Chi-square	2.904345	2	0.2341

Null Hypothesis: C(4)=C(5)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	-0.390840	1.330068
C(5)	0.062417	1.168519

Restrictions are linear in coefficients.
*Note: C(4) is FD_LL*Volatility; C(5) is FD_HL*Volatility from Table 8, column 1.*

b) Wald test for a model with long-term exchange rate volatility:

Wald Test:

Test Statistic	Value	df	Probability
F-statistic	9.698565	(2, 21656)	0.0001
Chi-square	19.39713	2	0.0001

Null Hypothesis: C(4)=C(5)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	-5.108065	1.231611
C(5)	-3.626244	1.140723

Restrictions are linear in coefficients.
*Note: C(4) is FD_LL*Volatility; C(5) is FD_HL*Volatility from Table 8, column 2.*

Appendix 5

a) Wald test for a model with short-term exchange rate volatility, SBM division :

Wald Test:

Test Statistic	Value	df	Probability
F-statistic	1.164142	(2, 21656)	0.3122
Chi-square	2.328283	2	0.3122

Null Hypothesis: C(4)=C(5)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	-0.432363	0.986268
C(5)	-0.034363	0.818395

Restrictions are linear in coefficients.
*Note: C(4) is FD_LL*Volatility; C(5) is FD_HL*Volatility from Table 8, column 2.*

b) Wald test for a model with short-term exchange rate volatility, PCR division:

Wald Test:

Test Statistic	Value	df	Probability
F-statistic	0.034223	(2, 21656)	0.9664
Chi-square	0.068446	2	0.9664

Null Hypothesis: C(4)=C(5)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	-0.044591	0.682051
C(5)	-0.097454	0.629710

Restrictions are linear in coefficients.
*Note: C(4) is FD_LL*Volatility; C(5) is FD_HL*Volatility from Table 8, column 1.*

Appendix 6

a) Wald test for a model with long-term exchange rate volatility, SBM division:

Wald Test:

Test Statistic	Value	df	Probability
F-statistic	8.444674	(2, 21656)	0.0002
Chi-square	16.88935	2	0.0002

Null Hypothesis: C(4)=C(5)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	-3.831140	0.938026
C(5)	-2.554463	0.706247

Restrictions are linear in coefficients.
*Note: C(4) is FD_LL*Volatility; C(5) is FD_HL*Volatility from Table 8, column 1.*

b) Wald test for a model with long-term exchange rate volatility, PCR division :

Wald Test:

Test Statistic	Value	df	Probability
F-statistic	0.873408	(2, 21656)	0.4175
Chi-square	1.746815	2	0.4175

Null Hypothesis: C(4)=C(5)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	1.202965	1.285734
C(5)	0.886177	1.256242

Restrictions are linear in coefficients.
*Note: C(4) is FD_LL*Volatility; C(5) is FD_HL*Volatility from Table 8, column 2.*

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