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TRADE OPENNESS AND EXCHANGE RATE VOLATILITY

Paper within MATER THESIS IN ECONOMICS

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Abstract

The present thesis tries to argue the importance of non monetary factors in explaining real exchange rate volatility. The main interest is on the effect of trade openness on real effective exchange rate (REER) volatility. Based on theoretical studies I test the existence of a negative relationship between total trade share of an economy and the volatility of REER. Empirical evidence on a panel of 11 CEE and Baltic Countries for the 1995-2006 period confirms the relationship. The conclusion is that for these specific countries a large part of variation of the real exchange rate can be explained by openness of the respective economy to trade.

Definitions

Trade openness is a measure is determining how open an economy is to world trade and income growth benefits that results from trade (Squalli, Wilson 2006).

Real effective exchange rate (REER) is the weighted average of a country's currency relative to an index or basket of other major currencies adjusted for the effects of inflation. The weights are determined by comparing the relative trade balances, in terms of one country's currency (Hau, 2000).

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1 Introduction

In the 1990's when all Central and Eastern European countries became independent they started to move towards free market economies through liberalization and integration into the world economy by means of international trade, capital transfers and exchange of information and/or knowledge. At the same time all major industrial and transition countries were encountering severe trade imbalances, accompanied by extremely volatile exchange rates. These cases of trade liberalization provided excellent data for testing the effect of trade on real exchange rate. A healthy economy is often considered a precondition for a stable (i.e. less volatile) real exchange rate that is correctly aligned. Greater volatility implies lower foreign direct investments because of the greater probability for occurrence of a monetary crisis in a developing country. Thus, a country's more intense trade activity decreases the exchange rate fluctuations and aligns it so as not to cause large welfare losses (Li, 2003).

A worldwide phenomenon i.e. globalization is a result of integration of economies in the world market achieved by means of opening of the economies. The complete integration in the global economy follows after an increase in the degree of financial and trade openness. Moreover, economies with higher levels of openness can more easily be integrated into the global goods and capital market, contributing to the growth and welfare of the country. Nevertheless, a higher degree of openness might serve as a source of higher exposure towards external monetary and real shocks (Calderon, Loyaza, Schmidt-Hebbel, 2004).

In 1983 Meese and Rogoff rejected the hypothesis that monetary instability is the only driving force behind the exchange rate volatility, and came to the conclusion that monetary models are unable to replicate and forecast exchange rate fluctuations. Monetary instability is only one of several factors driving exchange rate instability. There are other non-monetary factors that have gained importance in explaining exchange rate volatility like productivity shocks, government spending, terms of trade shocks, trade or economic openness (Calderon, 2004). In my paper I will focus on the effect of trade openness on exchange rate volatility.

The general interest for exchange rate volatility arouse from the following fact: for many years researchers were asserting that under floating exchange regime for developed countries real exchange rate follows a random walk. The main reason is that in the short run nominal prices are sticky (financial and monetary shocks affect nominal exchange rate in the short run thus real exchange rate also fluctuates) hence it is extremely difficult to prove the convergence of real exchange rate to PPP. At the same time many researchers failed to reject the hypothesis of random walk of real exchange rate (and its convergence to PPP) even in the long run, which is supposed to be easier to prove (Rogoff, 1996). The other interesting fact is that many studies stress the existence of a puzzle in the correlation of trade and volatility of real exchange rates. Empirical investigations show a negative correlation between exchange rate volatility and openness to trade. But current account sustainability condition (i.e. healthy development of trade activities) implies a less volatile exchange rate in economies, which are less open to international trade (Bleaney, 2006).

The aim of this paper is to test the hypothesis that the real exchange rate is less volatile in more open economies. Hence for the same nominal exchange rate volatility, countries with more open economies have less volatile real exchange rate due to the fact that prices

adjust more to exchange rates fluctuations (Bleaney, 2006). More closed economies need higher variation of the exchange rate to obtain the same relative price level adjustment, and in consequence real exchange rate effect is larger. At the same time, economies with higher degree of openness should have more stable real exchange rate, for the same nominal exchange rate shocks (Hau, 2002).

The theoretical predictions have been recently demonstrated by Obstfeld (1995), Rogoff (1996), Hau (2002) and Calderon (2004). The present paper is the first study to provide evidence on the link between trade openness and exchange rate fluctuations based on a sample of 11 Central and Eastern European transitional countries for time period 1995-2006.

I will use pooled OLS for panel data to test the following hypothesis: real exchange rate fluctuations are negatively correlated with the degree of openness of the economy. The following variables will be used as additional control variables: government expenditures, interest rate, change in per capita GDP and different exchange arrangements. The study will be based on Obstfeld-Rogoff model of exchange rate determination.

The following section will describe previous studies on the relationship between trade openness and exchange rate volatility. Special attention will be paid to the non-monetary fundamentals of real exchange rate. In section 3 the regression model and the variables are described. Then in section 4 I look at the results of the empirical analysis are to present and make a discussion of the results. The final section 5 looks at conclusions of my study.

2 Theoretical background

In this section I will present some of the previous theoretical studies on the relationship between openness of the economy and exchange rate. Afterwards, I will examine factors affecting the movement of real exchange rate. First, there is a need to analyze the most important non-monetary determinant i.e. trade openness and then the others: productivity differentials, capital mobility, government expenditures and interest rate differentials.

2.1 Previous studies

Real exchange rate volatility is an important issue for a country's economy as real exchange rate stands for the price level in general and more specifically for relative competitiveness. Even though, there are few studies on the determinants of real exchange rate volatility and specifically on the effect on trade on real exchange rate volatility, while there are many studies on the impact of exchange rate volatility on trade (Hau, 2000). There are several studies in the area of exchange rate volatility and trade openness which I will present further.

Holden, Holden and Suss (1979) were among the first to identify that the exchange rate variation is negatively depending on openness of the economy. They study the overall determinants of exchange rate volatility and the overall effect of variables on the exchange rate policy. The result of their model regarding openness is that a better measure is probably needed (because of the relatively low significance) and probably the effect of openness on the exchange rate may not be as strong as predicted by Mundell's optimum currency area theory.

Since 1979 there were almost no studies on this issue until 2000 when Hau published his first article on real effective exchange rate volatility and economic openness, which provided the most thorough research on the effect of trade openness on exchange rate volatility (which served as a core theoretical study for this thesis). By this time globalization and trade liberalization became a very important economic issue related with exchange rate. At the same time many countries worldwide have chosen exchange rates with different degrees of flexibility which basically provide a reason for studying exchange rate volatility. Here we will mention some of the most interesting studies related to our thesis.

Calderon was one of the few who used new open macroeconomics theory to explain exchange rate volatility. Thus, he emphasizes that non-monetary factors are important in explaining the exchange rate volatility. Calderon (2004) tests the hypothesis that real exchange rate fluctuations are less volatile in more open countries. He conjectures a structural relationship between real exchange rate volatility and the volatility of its fundamentals. The main findings of Calderon's study are: real exchange rate fluctuations and shifts in the fundamentals are more volatile in developing countries. Real exchange rate fluctuations in developing countries are four times as volatile as in industrial economies. Then, the more flexible is the exchange rate regime the more volatile are the real exchange rate fluctuations. Real exchange rates among developing countries with flexible regimes are more than 3 times as volatile as those in developing countries with either hard pegs or fixed regimes. Interesting finding is that there is a weak negative correlation between financial openness and real exchange rate volatility.

A much focused study on identifying the relationship between trade and exchange rate volatility was provided by Broda and Romalis (2003). They developed a model according to which international trade depresses exchange rate volatility. They wanted to prove that an increase in trade by 1 percent of GDP from the median trade relationship implies a decrease in the volatility of the bilateral real exchange rate by 12 per cent. But the result shows that an increase in bilateral trade volume by 10 per cent reduces the volatility of the associated exchange rate by only 0.3 per cent. The results of their study differ from the predictions because usually a bilateral trading relationship is rather small, which implies a smaller variation of the bilateral real exchange rate while typical exchange rate is quite volatile (11 per cent from its trend).

Hau (2000) relates the volatility of the (trade-weighted) effective real exchange rate to the degree of trade openness of an economy. He examines if economic integration through the expansion of world trade decreases real exchange rate volatility even in the absence of monetary integration. As a theoretical base Hau uses inter-temporal monetary model with nominal labor market rigidities and examines how different degrees of trade integration affect the real exchange changes in presence of asymmetric monetary and real shocks for the two countries. The main conclusion of the model is that both monetary and real shocks have a smaller effect on the real exchange rate if the two countries import larger percentage of their consumption basket, hence trade integration promotes real exchange rate stability. Hau is studying the real effective exchange rate volatility for 54 countries from 1980 and finds strong empirical support for negative correlation between openness (measured by import share of GDP) and the real exchange rate volatility. Hau finds that the impact of economic openness on exchange rate volatility is statistically significant (in most of the cases at 1 per cent significance level) and openness explains up to 52 per cent of exchange rate variations (Stancik, 2006).

Bleaney (2006) states that fundamentals like gross domestic product, money supply, employment level do not help too much to determine exchange rates within their observed range of fluctuations, they are important only for setting of the width of the range. Even though he totally agrees with the Hau's study that more open economies experience less exchange rate volatility. Bleaney is arguing that a better measure of openness is current account balance to GDP and it sets the limits to real exchange rate volatility. Bleaney is pointing out that according to theory real exchange rates follow a near-random walk movement, but only within some bounds. The bounds are much wider for less open economies and thus less open economies will encounter higher real exchange rate volatility. Analyzing a sample of 22 OECD countries over the period 1980-2005 he finds a statistically significant and robust correlation between exchange rate volatility and trade openness, so that countries with higher trade to GDP ratio have lower volatility of real effective exchange rate.

Tseng, Chen & Lin (2005) provide more evidence on whether international trade may help to stabilize exchange rate movements, as in Mundell (1961). Their finding is that an increased trade volume (relative to domestic aggregate demand) tends to reduce exchange rate volatility when a domestic absorption shock disturbs the economy. They suggest that whether trade imbalances have aggravated exchange rate volatility in many industrial countries is an open question, which needs to be solved through more empirical investigations.

Our thesis will be in line with the above mentioned scholars' studies, having the goal to test the hypothesis that an increased economic openness (i.e. trade openness) decreases volatility of exchange rate based on a sample of transitional countries one more time.

2.2 Determinants of exchange rate volatility

Dornbusch (1976) in his famous theoretical model brings evidence supporting the hypothesis that unanticipated monetary policy shocks might generate disproportionately large fluctuations in the exchange rate. Thus the overshooting effect is caused by the low speed of adjustment in the goods market through which the exchange rate disproportionately absorbed the unanticipated monetary shock in the short run. Consequently, we come to the idea that monetary stability is not the only one factor influencing the exchange rate instability but just one of several factors. According to the New Open Economy Macroeconomics there are also non-monetary factors like productivity shocks, terms of trade shocks, and government spending which are important in explaining exchange rate volatility (Calederon, 2004). Other factors affecting real exchange rate are openness of the economy, interest rate, and exchange rate regime, level of output, income, inflation and unpredictable circumstances. Transitional countries are mostly affected by these factors (Stancik, 2006).

I shall emphasize more on trade openness as we consider that it has the biggest impact on volatility of exchange rate among non-monetary factors.

Empirical studies suggest using Obstfeld-Rogoff (1995, 1996) model of exchange rate determination, which presents theoretical foundations for volatility of real exchange rate fluctuations (the volatility of real exchange rate fundamentals and trade openness).

In the following sections the incentives for choosing the particular determinant as well as their validity are explained. First, mentioning our main factor of interest which is openness and then the other factors.

2.2.1 Trade openness

As we have seen in the section of previous studies, there are several studies which theoretically and empirically find evidence that greater openness of economies and higher exchange rate stability cannot be achieved one without achieving the other; hence there is a certain relationship between them. Hau (2000) is among the first to study this relationship, particularly he analyzes the impact of openness of an economy on exchange rate movements. Hau claims the existence of a link between trade integration and real exchange rate volatility, and they are negatively correlated.

The study made by Hau is based on the Obstfeld-Rogoff model of exchange rate determination (1995), the only difference being that he includes supply shocks in his analysis. The model is based on small open economies with tradable and non-tradable sector. Solving the model one receives the solution stating that more open economies have more flexible aggregate price levels. Then it is proved that flexibility decreases the unanticipated money supply and real shocks, and following Dornbuch it results that higher openness of the economy leads to lower real exchange rate volatility.

We will present just the last part of the solution of the model as it is most interesting for finding the conclusion regarding trade openness. Hau is considering the variation of exchange rate as a result of two shocks - monetary and supply shocks.

Solving the model, one can conclude that an unanticipated monetary shock has only transitory effect on real price of non-tradables, while the real price of tradables is constant. More open economies have generally more receptive aggregate price levels. Due to higher flexibility of aggregate price level the effect of money supply shock on short-term consumption and real exchange rate changes decreases. Therefore, a higher aggregate price level flexibility implies lower real exchange rate volatility for a more open economy. At the same time, an unanticipated real (supply) shock generates the same negative relationship between real exchange rate volatility and economic openness as the monetary shock does (Hau, 2002).

The percentage change of real exchange rate is given by the following relationship

$$E - P = P_T - P = (1 - \gamma)\, P_T = (1 - \text{Openness})\, M^S$$

where, $P = \gamma\, P_T = \gamma\, E$ and $P_T = M^S = E$

E – steady-state nominal exchange rate, P – the price index in percentage, M^S – money supply, P_T – price of tradable goods, γ – coefficient of openness.

It follows directly that more open economies have smaller changes in the real exchange rate. Thus, real exchange rate decreases in the openness of the economy.

Then the model is generalized by Hau to a dynamic setting of repeated monetary and supply shocks it is found that money supply and labor supply shocks generate the same negative relationship between real exchange rate volatility and openness.

Calderon (2004) also made an empirical study to determinate the impact of trade openness on real exchange rate volatility, using the same Obstfeld-Rogoff model. The measure of openness of the economy is the same as in Hau (2002) based on two-sector model economy (traded and non-traded sector). Calderon finds some testable implications of the effect of trade openness on exchange rate volatility. The greater the trade openness, the smaller is the impact of the productivity, monetary and fiscal shocks on real exchange rate fluctuations. Hence, the relationship between degree of openness and real exchange rate volatility is a negative one (Calderon, 2004).

2.2.2 Productivity growth

Based on the well-known Balassa–Samuelson consumer price level in wealthier countries is systematically higher than in poorer ones (Penn effect) and productivity growth rate vary more in traded sectors than in other sectors. Interesting about Penn effect is that REER deviations usually take place in the same direction. At the same time if productivity growth is concentrated in tradable sector, the price for non-tradables will increase also and the REER will appreciates. As the productivity gains are mostly in traded sectors, high productivity will be correlated with high REER (Maeso-Fernandez, Osbat, Schnatz, 2001).

There are two expressions of productivity: the relative price differential between traded and non-traded goods in home and foreign economies, and the total labor productivity differential. In the empirical analysis we will use the second one because the first one is an indirect proxy as it is capturing only the effect of productivity growth in tradables, while the second one measure the total labor productivity growth between two countries for example and is measured as change in real GDP per capita (Li, 2003). It is assumed that productivity differentials (i.e. growth in real GDP per capita) have a positive impact on real exchange rate (Maeso-Fernandez, Osbat, Schnatz, 2001).

2.2.3 Capital mobility

Starting with the 1990s, large capital flows came in the transitional countries in Europe as they opened their capital markets. As a result of the increase in capital inflows the demand for non-tradable goods increases which leads to appreciation of real exchange rate. Therefore, it is difficult to draw a clear-cut conclusion on the effect of capital mobility on the variation of the real exchange rate (Li, 2003).

2.2.4 Government expenditures

Real exchange rate movements are affected by changes in the level of government expenditures. Government expenditures (or fiscal balance) are one of the key elements of national savings. According to Frenkel and Mussa (1985) a permanent increase in government spending leads to an appreciation of the equilibrium real exchange rate in longer run, as a result, of a permanent increase in net foreign assets. At the same time, government spending has a positive impact on real exchange rate in short run based on the demand side effects. However, in longer terms, higher government spending most probably destabilizes the currency, since it could be accompanied (or followed) by excessive-burdening taxes, which would has a negative impact on real exchange rate. The effect of government spending is ambiguous due to its effect on real interest rate (Maeso-Fernandez, Osbat, Schnatz 2001). But at the same time Mankiw (1987) shows that in a flexible-price model

higher government spending may temporally lower the real interest rate, which lowers volatility of the exchange rate.

2.2.5 Interest rate differentials

Interest rate differentials are frequently used as an auxiliary determinant of real exchange rate based on uncovered interest rate parity.

Interest rates, inflation and exchange rate are highly correlated. Interest rate is determined in most of the cases by the central bank and serves as a monetary policy instrument. Influencing interest rates leads to changes in inflation rates and exchange rates, and variations in interest rate leads to variation of inflation and exchange rate. Higher interest rates will attract foreign capital inflows and will depreciate the currency (increase the exchange rate) and vice versa holds as well.

The relationship between interest rate differential and the real exchange rate is tested by Chortareas and Driver (2001) for 18 OECD countries. The test was divided between G7 economies and eleven small open economies (like in present research). For the eleven small OECD countries they found a positive relationship between the exchange rate and interest rate differential, but for G7 counties they failed to show the existence of a positive relationship, probably because they tested the relationship only for G7 economies.

3 Data and method

In this section I will present data, model and variables as well as use cross country data analysis to test the model and the patterns that links exchange rate volatility and economic openness. In the end the findings of our empirical investigation are presented.

In the majority of previous study the focus was on the bilateral dollar exchange rate (which is not representative of the trade flows for some countries) and only Hau (2000) used aggregate different bilateral exchange rates in one trade-weighted effective real exchange rate, and in analysis is used the same measure. Hau uses 36 months frequency arguing that monetary models perform better at low frequencies and they outperform random-walk hypothesis. In my analysis I find significant result for high frequency – 12 months which in fact are the only one which gives satisfactory results compared to higher (3, 6, 9 months) or lower frequency (18, 24, 36 months).

The volatility of the exchange rate is measured as standard deviation of the percentage changes of the real effective exchange rate (REER) on 12 months intervals and we use the same formula as in Hau (2000). Volatility for monthly data is defined as follows:

$$\text{Volatility}_i = \left[\frac{1}{T} \sum_t \left(\frac{\text{REER}_{t+12,\,i} - \text{REER}_{t,\,i}}{\text{REER}_{t,\,i}} \right)^2 \right]^{\frac{1}{2}}$$

Unlike Hau, as a measure of trade openness we do not use the inverse of import share in GDP, but the ratio of trade (imports plus exports) to GDP like Calderon. As a matter of fact there is no consensus on what constitutes the best measure of openness. Calderon's measure of trade openness is more complex since it can be influenced by structural characteristics of the economy as well as by external factors. Hau's measure of trade openness in-

dicates only restrictive trade policy on imports, which is more reliable measure for developing countries, as imports of consumption goods are most stringently restricted. But the countries from our sample have a stable economic development and are rather small, at the same time being active actors in international trade. Thus, if one wants to capture the entire effect of trade openness on volatility one needs to use the ratio of imports plus exports to GDP.

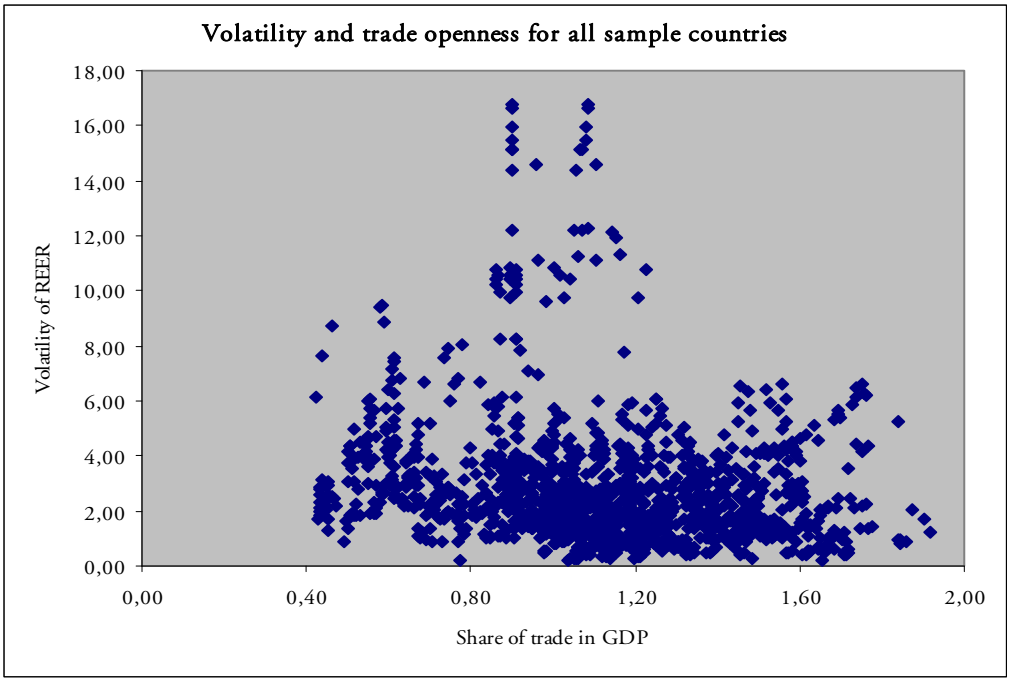
3.1 Data

The analysis is based on a sample 11 transitional countries from Central and Eastern Europe i.e. Bulgaria, Croatia, Romania, Czech Republic, Hungary, Estonia, Latvia, Lithuania, Poland, Slovakia, Slovenia which are all now members of the EU (except Croatia), based on monthly data for the time period 1995-2006.

Data on trade weighted effective real exchange rate and other control variables are found in IMF International Financial Statistics data base and Ecowin. The measure of volatility is performed based on the above mentioned formula as well as on the economic openness. I add a set of dummy variables as all analyzed countries have exchange rate commitment according to International Financial Statistics (IMF 2006).

Figure 1 present the scatter plot of 12 months volatility of real effective exchange rate and share of total trade in GDP for all sample countries.

Figure 3.1



Source (IMF Financial Statistics)

Based on the above scatter plot we obtain the first evidence of the negative relationship between trade openness and volatility of REER, i.e. unless some exceptions (which we see in case of Bulgaria) I can strongly affirm that for our data sample the higher the trade openness results in lower volatility of REER. More specifically, countries with the higher trade openness like Czech Republic, Hungary, Estonia, Latvia, Lithuania, Slovak Republic

and Slovenia (on average higher than 1) have lower volatility (bounded by the interval 0.4 - 4), and at the same time countries with relatively lower trade openness like Bulgaria, Romania, and Croatia have higher volatility of REER.

3.2 Method and Variables

In the regression analysis is used pooled OLS for panel of countries and then a dummy is introduced. It is expected the variables to take the sign that is in line with the theoretical background. Furthermore, it is important to see how the variables are defined in Table 3.2.

Table 3.2 Definition of variable and the expected sign

Variable:	Expected sign:	Definition:
Volatility	Dependent variable	Volatility of real effective exchange rate calculated as a standard deviation over 12 months REER index (2000 year =100) for all countries in percentage.
Trade openness	Negative	The share of total trade (imports plus exports) in GDP.
Δ GDP per capita	Positive	Is an indicator of change in the level of productivity, regarded as monthly change of GDP per capita in PPS per inhabitant in euros.
Government expenses	Negative	The share of final government consumption in GDP.
Interest rate	Positive	Inter-banking 3-months interest rate.
Dummy variable	Negative	1-pegged exchange rate arrangement, 0- otherwise.

The regression will look like:

$$Volatility_{i,t} = b_0 + b_1 Openness_{i,t} + b_2 \Delta GDP_{i,t} + b_3 G_{i,t} + b_4 i_{i,t} + b_5 D_{i,t} + u_{i,t}$$

The control variables in regression are productivity growth (change in GDP per capita), share of government expenditures in GDP and interest rate. As REER is deflated with the price index, i.e. it depends only on nominal exchange rate and price level the choice of exchange rate agreement does not influence too much the volatility of exchange rate, because it does not affect the price level. In order to show this, I will use a dummy variable for pegged exchange arrangements. As all the other countries have different degree of exchange rate flexibility they will not be included in the test for dummies, and even introducing additional dummies for them does not influence the final result of the regression.

4 Empirical analysis

In this section will be presented present the main empirical findings taking into consideration the simple model and the model with dummies for exchange rate arrangements based on de facto classification of exchange rate regimes and monetary policy issued by IMF as of 31st July 2006.

Looking in Table 6.1 (Correlations) in appendix one can observe the existence of a significantly negative relationship between openness and volatility, thus the correlation is not that strong (which is normal) but the sign is as expected. There is a quite low and insignificant correlation of volatility of REER and change in GDP per capita, which is in line with the theory, but we expected a higher coefficient for correlation. The correlation between volatility and interest rate is quite high 0.476 (the larger the differentials in interest rate result in larger the difference between initial exchange rate and PPP value i.e. higher variation). Interesting to notice is that the highest significant correlation among our variables is between changes in GDP per capita and government expenditures -0.600. After introducing the government expenditures into the regression it decreases the coefficient of GDP per capita by almost double (see in table 4.1).

Table 4.1 Effective Real Exchange Rate Volatility for all sample

	1	2	3	4
Constant	3.300***	3.589***	3.305***	3.469***
	(17.791)	(10.018)	(17.848)	(9.593)
Trade openness	-0.830***	-0.807***	-0.916***	-0.901***
	(-5.259)	(-4.929)	(-5.676)	(-5.346)
Change in GDP per capita	0.483	0.253	0.428	0.172
	(0.593)	(0.242)	(0.526)	(0.165)
Interest rate	0.02***	0.02***	0.02***	0.02***
	(19.145)	(18.317)	(18.963)	(18.274)
Government expenditures	-	-0.016	-	-0.009
		(-0.895)		(-0.483)
Pegged exchange arrangement	-	-	0.249*	0.234*
			(2.486)	(2.285)
Adjusted R^2	0.232	0.231	0.235	0.233
Sample size	1396	1386	1396	1386
Number of countries	11	11	11	11

We state the t-value in the parentheses and indicate significance level on a 10 percent (*), 5 percent (**), and 1 percent (***).

Table 4.1 shows the regression results for our sample of 11 countries from Central and Eastern Europe. Starting with the first regression it can be noticed a strong negative impact of trade openness on volatility significant at 1 per cent level. The fitness of the first model is 0.232. Inclusion of government expenditures in the second regression does not improve the fit of the regression, but it shows indeed the robustness of trade openness. Interest rate proves to be a quite important control variable with a significant but low coefficient of 0.02 (relatively as it is a scale-dependant variable). At the same time looking in appendix table 6.4, interest rate seems to have an extremely important explanatory power for the entire model as it explains up to 22.6 per cent of volatility of REER. The explanatory power of interest rate remains robust but drops for Baltic countries it explains up to 11.6 per cent of volatility and for increases for CEE countries as 27.1 per cent of volatility (see tables 6.5 and 6.6). The importance of interest rate in our regression is explained by the fact that all analyzed countries in that period of time where in full transition as all of them had the goal EU accession. Therefore they used strict and common monetary policies and at the same time as one of the most powerful tool to lower inflation (which was also was a condition for acceding to EMU). Trade openness explains only 3.7 per cent of the volatility for all sample countries (see table 6.4). For Baltic countries trade openness alone explains up to 11.9 per cent of the volatility, whereas for CEE countries only 1.8 per cent of volatility.

Unlike Hau's study, change in GDP per capita is statistically insignificant in explaining volatility of exchange rate. Part of the explanation is that I do not use the log of per capita GDP (as we wanted to capture the increase, not just the level of GDP per capita) and the other is that Hau is using log of per capita GDP for countries with quite different levels of development. But in present analysis countries have quite similar level of economic development that is why even though it is statistically significant it has little influence on volatility.

From the table 4.1 is seen that all the regressions have the same level of adjusted R^2 so that all our models have same explanatory power. Hence a quarter of the volatility of REER for our sample data is explained by economic openness, which is generally a very good result as we have mentioned above that monetary models tend to perform worse at higher frequencies but the fit of the model is rather good for our chosen method. If we divide the analyzed countries into two groups: Baltic countries and Central and Eastern European countries we obtain the following results (see tables 6.5 and 6.6). For the same frequency of exchange rate in case of Baltic States the adjusted R^2 increases up to 0.28 with openness significant at 1 per cent, and in case we take log of the regression openness explains almost half of the volatility of exchange as adjusted R^2 increases up to 0.461 per cent. For CEE countries the fit of the regression did not improve drastically as the adjusted R^2 increased only slightly up to 0.271 with openness still significant at 1 per cent but the coefficient dropped almost six times (compared to Baltic countries), the log of regression does not show any valuable results that is why we do not even include it.

Then dummy variables are introduced to distinguish the countries according to IMF exchange rate commitments as of 2006. I have grouped all the countries with different levels of flexibility of exchange rate in one group and with pegged exchange rate in another group. Thus, we can consider regressions 1 and 2 testing for countries with flexible exchange rate. Regressions 3 and 4 test the model with dummy and actually introducing the dummy for pegged exchange arrangements the result does not improve too much due to the fact that the sample of countries is not that large. The coefficient of openness increases slightly and remains significant at 1 per cent level. Based on the results of regressions 3 and 4 the following conclusion arises: the importance of trade openness on volatility increases under fixed exchange rates arrangements, having a stronger negative effect on the volatility of the exchange rate. Thus, the positive coefficient for peg dummy in regressions 3 and 4 shows that as the peg becomes tighter the volatility within the boundaries is higher. In all analyzed regressions openness is highly significant and robust, with strong influence on volatility compared to other factors so that we can conclude that the present model is quite good in explaining the volatility of the REER at our chosen frequency. But as it was previously mentioned the model explains only a quarter of the volatility, which is very good due to the number of observations and the fact that we have monthly data. The disadvantage of monthly data is that they mostly capture small changes in the variables, compared to yearly data which are more volatile. At the same time we assume that the biggest part of volatility of exchange rate is explained by money supply.

Comparing the results with Hau's study we see that the models used in present research have adjusted R^2 around 0.24, while Hau's has around 0.48 (twice more), but it should be taken into account that Hau is testing for low frequency volatility (which usually perform better at lower frequencies). Even though, the models from my study have a lower explanatory power, at the same time, the coefficients of openness are on average 0.83 when in Hau's study is only 0.001. Therefore we were right in choosing as a measure of open-

ness the ratio of trade on GDP, as it captures the entire influence of trade on volatility. Furthermore, we have tried to use average inflation as a control variable as in Hau's study, although REER is already deflated with CPI. Although, the coefficient of inflation was significant at 1 per cent level, it had a low value of only 0.002, unlike Hau, which has a higher coefficient for inflation than for openness. Hence, although the coefficients are lower for the regression in Hau (2002), the fitness of the model is higher.

In conclusion, I can strongly affirm that a rather high percentage of volatility among our sample countries is explained by economic openness. Thus, openness is as I have expected a very important non-monetary determinant explaining the volatility of exchange rate, and basically the only significant one among all the others. At the same time, interest rate proved to be a very important monetary factor with important influence on volatility (see tables 4.1 and 6.1) as it shows constant values of the coefficient and significance at 1 per-cent level for all regressions. Moreover, the results of the analysis are in accordance with the theoretical framework.

5 Conclusions

In this thesis I test the hypothesis that higher economic or trade openness decreases the volatility of real effective exchange rate. According to monetary theory there is an inverse relationship between real exchange rate volatility and economic openness. As we have seen non-tradables increase the degree of aggregate price rigidity (and reduce openness) while tradables facilitate openness (Hau, 2002). Therefore, more closed economies need larger changes in real exchange rate to achieve the same level of relative prices to seize the result of monetary or real shocks. In contrast, economies with higher degree of openness behave like flexible price economies which are less affected by real shocks (we suppose monetary as well).

The empirical evidence on pooled data for eleven CEE countries supports the link between openness and volatility. The negative relationship between openness and volatility becomes stronger with the inclusion of interest rate which is the only control variable with high significance and explanatory power at the same time. The initial model can explain up to 24 per cent of the variation of the exchange rate through openness for our sample of countries. The dummy variables do not improve the fit of the model but only confirm theoretical insight that if the exchange rate is pegged it does not necessarily mean that the volatility of the exchange rate is smaller, it will actually be higher but within some boundaries and the narrower the boundaries are the higher the volatility is. Quite different to my results is the empirical result of Calderon (2004) who found that real exchange rate volatility is on average 4 to 7.5% less volatile under fixed exchange rate arrangements than under flexible ones. At the same time, grouping the countries into Baltic and CEE countries gives us some improvements as the fit of the regression for both groups increase up to 27 per cent. Furthermore, taking the log of the model for Baltic Countries economic openness can explain almost half of the variation in the exchange rate, as for CEE countries the log of the model do not bring any good result, possibly due to the fact that Baltic countries have all pegged exchange rate, while CEE countries have more flexibility in the exchange rate.

Hence, we can say that Latvia, Lithuania and Estonia can rely on openness as a tool to lower the volatility of real exchange rate. On average Baltic countries have rather low

openness of 1.09, which results in high, around 3.28 variations of the real exchange. Also here we can mention that countries like Croatia, Romania and Poland are the ones which also can, to some extent, use openness as a tool of decreasing volatility of exchange rate as it has the highest value for our analyzed sample of countries. Because for CEE countries openness is just the non-monetary tool to be used to lower volatility along with other monetary tools, we have countries like Slovenia which has the same average value for openness as Bulgaria, but volatility is 4 times lower. Thus, for CEE countries most of the volatility is the result of the fluctuations in interest rate and money supply.

5.1 Further studies

First suggestion would be to analyze a longer period of time for more countries from different continents, as due to availability of data I made an analysis based on 11 CEE countries, and not as planned in the beginning with 25 CEE and CSI countries. At the same time by including more countries it would be possible to group countries according to their level of economic development and to analyze the results, as for our sample data some countries are relatively the same. It would be interesting to see the results for higher and lower frequency volatility. As well as to use country's land area as an instrumental variable which shows that coefficient for openness is more negative than OLS counterpart. Furthermore, an additional control variable, which would possibly improve the precision of the model is capital mobility which due to lack of data was not used. The last suggestion would be to use different measurement for openness and different statistical models.

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Appendix

Table 6.1 Correlations

	Volatility	Openness	G	Δ GDP/capita	Int. Rate
Volatility	1				
Openness	-0.193**	1			
G	-0.012	0.205**	1		
Δ GDP/capita	0.001	0.021	-0.600*	1	
Int. Rate	0.476**	-0.118**	-0.251**	-0.003	1

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed)

Table 6.2 Descriptive statistics

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Volatility	1573	0.1979	16.7492	2.8515	2.3503
Openness	1548	0.4245	1.9192	1.1147	0,.954
G	1525	11.7727	30.0617	19.984	3.0501
Δ GDP/capita	1572	70.8623	1286.42	424.9363	238.7641
Interest rate	1434	0.71	1070.26	14.8531	45.08

Table 6.3 Exchange rate arrangements as of 31.07.2006

Pegged arrangement	Independent floating	Managed floating	Limited flexibility
Bulgaria	Poland	Czech Republic	Hungary
Estonia		Romania	Slovak Republic
Lithuania		Croatia	Slovenia
Latvia			

(Source IMF)

Table 6.4 Effective Real Exchange Rate Volatility for all sample

	1	2
Constant	4.426***	2.408***
	(19.868)	(46.152)
Trade openness	-1.489***	-
	(-7.697)	
Interest rate	-	0.022***
		(20.435)
Adjusted R^2	0.037	0.226
Sample size	1536	1425
Number of countries	11	11

We state the t-value in the parentheses and indicate significance level on a 10 percent (*), 5 percent (**), and 1 percent (***).

Table 6.5 Effective Real Exchange Rate Volatility for Baltic Countries

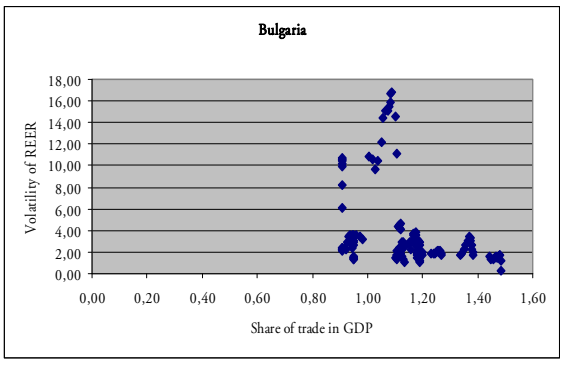
	1	2	3	4
Constant	5.213***	1.661***	0.233	-3.375***
	(13.906)	(11.919)	(0.285)	(-5.051)
Trade openness	-2.252***	-	-1.826***	-1.213***
	(7.746)		(-6.098)	(-10.242)
Interest rate	-	0.123***	0.081***	0.334***
		(7.176)	(4.597)	(6.895)
Government expenditures	-	-	0.193***	1.237***
			(5.715)	(5.288)
Adjusted R^2	0.114	0.116	0.283	0.461
Sample size	426	382	378	378
Number of countries	3	3	3	3

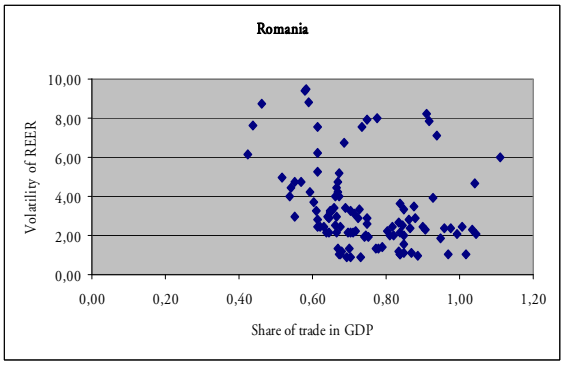
Note: regression 4 is a log normal regression.

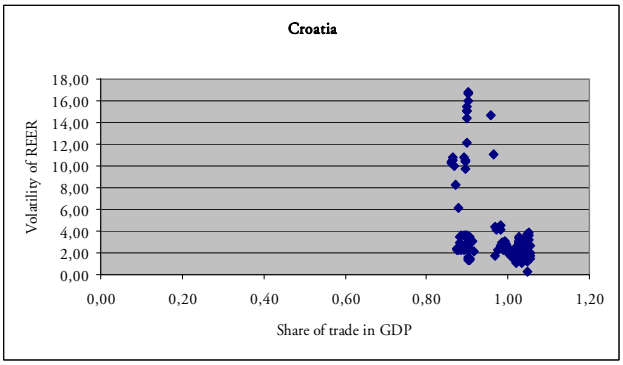
Table 6.6 Effective Real Exchange Rate Volatility for CEE Countries

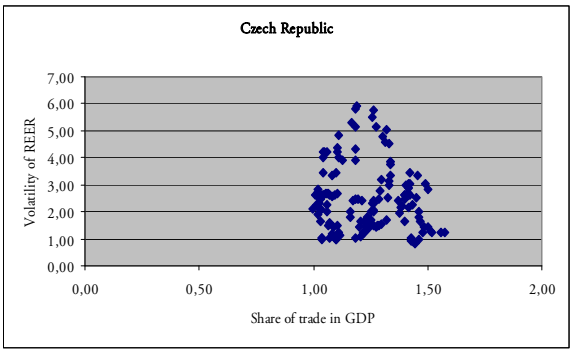
	1	2	3	4
Constant	4.098***	2.465***	2.798***	2.792***
	(14.936)	(40.055)	(13.310)	(13.283)
Trade openness	-1.134***	-	-0.368***	-0.360**
	(-4.602)		(-1.989)	(-1.946)
Interest rate	-	0.022***	0.020***	0.020***
		(19.669)	(19.033)	(18.993)
Change in GDP per capita	-	-	0.647	-
			(0.603)	
Adjusted R^2	0.018	0.271	0.272	0.271
Sample size	1106	1040	1008	1010
Number of countries	8	8	8	8

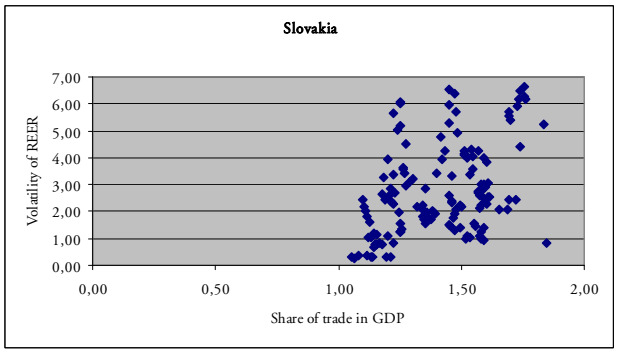
6.7 Scatter plots of the volatility of REER and trade for each sample country

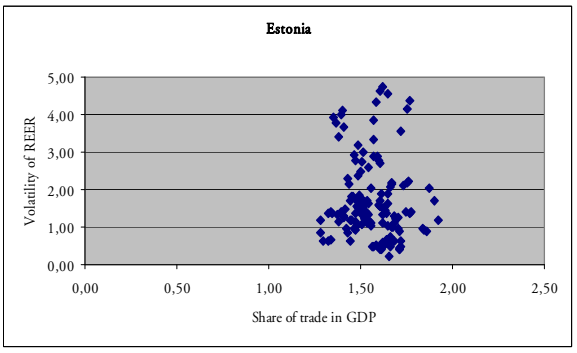


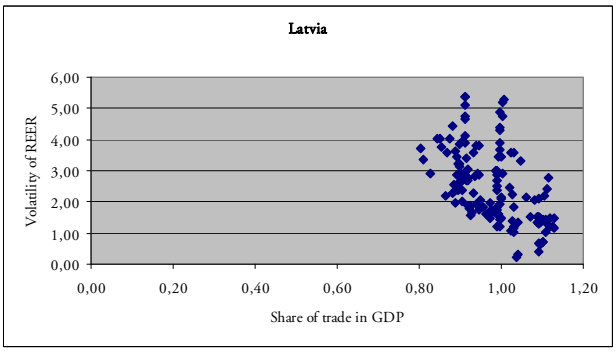


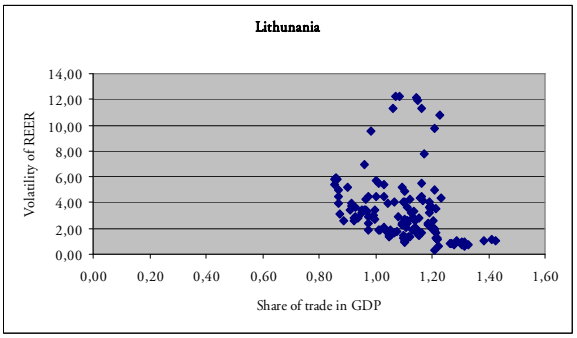


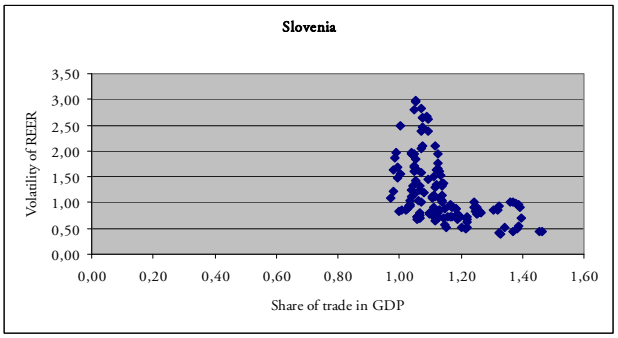

Czech Republic
Volatility of REER
7,00
6,00
5,00
4,00
3,00
2,00
1,00
0,00
0,00
0,50
1,00
1,50
2,00
Share of trade in GDP

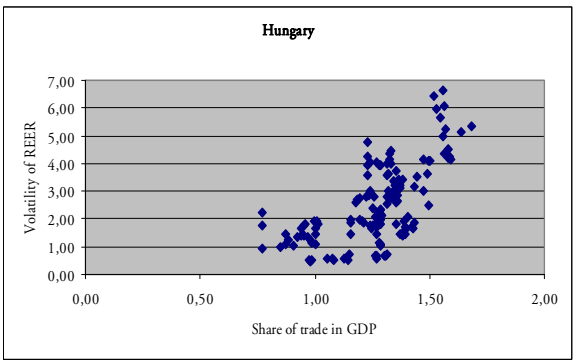

Slovakia
Volatility of REER
7,00
6,00
5,00
4,00
3,00
2,00
1,00
0,00
0,00
0,50
1,00
1,50
2,00
Share of trade in GDP

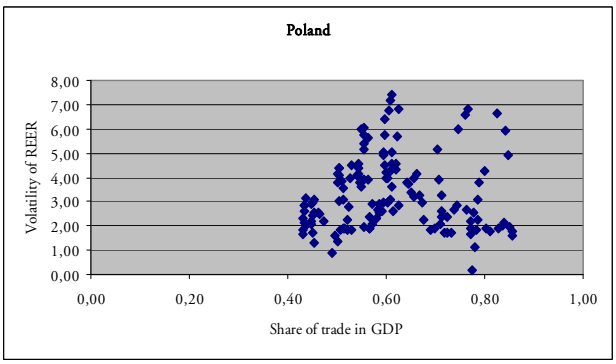

Estonia
Volatility of REER
5,00
4,00
3,00
2,00
1,00
0,00
0,00
0,50
1,00
1,50
2,00
2,50
Share of trade in GDP


Latvia
Volatility of REER
6,00
5,00
4,00
3,00
2,00
1,00
0,00
0,00
0,20
0,40
0,60
0,80
1,00
1,20
Share of trade in GDP


Lithunania
Volatility of REER
14,00
12,00
10,00
8,00
6,00
4,00
2,00
0,00
0,00
0,20
0,40
0,60
0,80
1,00
1,20
1,40
1,60
Share of trade in GDP


Slovenia
Volatility of REER
3,50
3,00
2,50
2,00
1,50
1,00
0,50
0,00
0,00
0,20
0,40
0,60
0,80
1,00
1,20
1,40
1,60
Share of trade in GDP


Hungary
Volatility of REER
7,00
6,00
5,00
4,00
3,00
2,00
1,00
0,00
0,00
0,50
1,00
1,50
2,00
Share of trade in GDP


Poland
Volatility of REER
8,00
7,00
6,00
5,00
4,00
3,00
2,00
1,00
0,00
0,00
0,20
0,40
0,60
0,80
1,00
Share of trade in GDP