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Exchange Rate Variability, Pressures and Optimum Currency Area Criteria: Implications for the Central and Eastern European Countries

Roman Horváth [*]

Abstract

This paper estimates the medium-term determinants of the bilateral exchange rate variability and exchange rate pressures for 20 developed countries in the 1990s. The results suggest that the optimum currency area criteria explain the dynamics of bilateral exchange rate variability and pressures to a large extent. Next, we predict exchange rate volatility and pressures for the Central and Eastern European Countries (CEECs). We find that the CEECs encounter exchange rate pressures at approximately the same level as the euro area countries did before they adopted the euro.

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Nontechnical Summary

In this paper, we analyze the determinants of bilateral exchange rate volatility and pressures for 20 developed countries. We employ standard optimum currency area (OCA) criteria such as trade linkages and business cycle synchronization to address the issue. Specifically, we examine the hypothesis of whether countries fulfilling the OCA criteria to a lesser degree encounter greater exchange rate variability and pressures. In other words, countries experiencing similar shocks should have stable exchange rates.

We start by estimating whether exchange rate volatility is explicable by the set of optimum currency area criteria. Next, similarly we study whether the OCA conditions rank among the culprits of exchange rate pressures. This is so, as policy makers may regard excessive exchange rate volatility as undesirable for the economy and thus attempt to limit the variation of the exchange rate. Nevertheless, this strategy might not be successful in limiting the pressures on the foreign exchange market.

We find that the variables indicated by the optimum currency area theory explain the dynamics of exchange rates and exchange rate pressures to a large extent. There is also some evidence that more open and less financially developed economies fear letting their exchange rates float freely (fear of floating). Greater variability of the US dollar increases exchange rate variability, but not exchange rate pressures. The results also do not support any significant difference between the EU core and EU periphery. European economies bilaterally face both weaker exchange rate variability and weaker exchange rate pressures as compared to other developed countries.

Next, we also predict exchange rate variability and pressures for the Central and Eastern European countries (CEECs). The results suggest some heterogeneity among the CEECs in terms of their exchange rate volatility and pressures. Notably, Estonia has experienced both low variability and low pressures. Overall, our model implies that the current levels of exchange rate variability and pressures are at the same level as the euro area countries before they adopted the euro. This is because the CEECs seem to be relatively well aligned with the euro area countries, especially in terms of their trade integration, openness and similar export commodity structure.

1. Introduction

There are numerous papers that deal with the first moment of the exchange rate, i.e., that focus on finding the equilibrium exchange rate. In this paper we take a different approach that concentrates on the second moment of the exchange rate, i.e., that attempts to identify the determinants of exchange rate variability, using a quarterly data set for 20 developed economies over the period 1989–1998. In this respect, we employ standard optimum currency area (OCA) criteria such as trade linkages and business cycle synchronization to address the issue.[1] Specifically, we examine the hypothesis of whether countries fulfilling the OCA criteria to a lesser degree encounter greater exchange rate variability. In other words, countries experiencing similar shocks should have stable exchange rates. In addition, factors other than the standard set of OCA criteria, such as financial development or inflation differentials, may matter as well, and we make use of these, too.

In this regard, policy makers may regard excessive exchange rate volatility as undesirable for the economy and thus attempt to limit the variation of the exchange rate. Nevertheless, this strategy might not be successful in limiting the pressures on the foreign exchange market. Therefore, we investigate whether the OCA conditions rank among the culprits of exchange rate pressures.

The methodology applied in this paper originates in Bayoumi and Eichengreen (1998) (hereinafter "BE")[2], but we elaborate on a series of issues, especially in the estimation of the extent of exchange rate pressures, the inclusion of additional relevant factors and the evaluation of the relevance of instrumental variables.[3] Therefore, our approach also allows us to assess the robustness of the findings of BE.

In addition, we provide simple "out-of-sample approach" forecasting, in the spirit of the real equilibrium exchange rate literature (see e.g. Halpern and Wyplosz, 1997, or Maeso-Fernandez *et al.*, 2004), to predict exchange rate volatility and pressures for several Central and Eastern European countries (CEECs) based on the OCA criteria. This allows us to identify the part of exchange rate volatility and exchange rate pressures explicitly connected with fundamentals (or the OCA criteria in our case). Obviously, if the volatility and pressures were to remain high and persist in the future (whatever the difficulty with finding the right benchmark for comparison), it would indicate that euro adoption may not be beneficial for these countries. On the other hand, favorable OCA conditions imply, for small open economies, that the necessary condition for joining the monetary union is met (sustainability of the union in the long run) and policy makers may choose the timing and scenario of euro adoption that maximizes the medium-term net benefits for the economy.

The paper is organized as follows: We discuss some basics on OCAs and the fear of floating in section II. The empirical methodology is laid out in section III. We provide an instrumental variable estimation of bilateral exchange rate variability and exchange rate pressures in section IV. The application to the CEECs is presented in section V. Section VI concludes. An appendix with some descriptive statistics follows.

[1] See Mongelli (2002) for a recent survey of the OCA literature.

[2] Devereux and Lane (2003) also apply this methodology to examine the external sustainability of developing countries.

[3] In addition, BE apply their methodology to data from the 1980s, while we work with data from the 1990s.

2. Optimum Currency Areas and Fear of Floating

Traditionally, optimum currency area theory focuses on the choice of the optimal exchange rate regime and discusses the conditions that countries should fulfill in order to maximize the benefits stemming from a common currency (Mundell, 1961). Theoretically, the usefulness of a country having its own currency decreases when countries are subject to common shocks. To begin with, the OCA theory puts forward a number of criteria under which it is more likely that idiosyncratic shocks will occur rarely. Next, the OCA theory emphasizes that in the event of idiosyncratic shocks nonetheless occurring after the formation of the currency union, the union is likely to be more sustainable if the economy reacts to such shocks with low welfare loss. On the other hand, Mundell (1973) notes that even countries subject to idiosyncratic shocks may form a currency union if they are able to diversify the risks sufficiently. This, however, requires well-functioning and integrated financial markets.

Recently, there have been additional advances in the literature on the optimal exchange rate choice. Calvo and Reinhart (2002) point out that countries will have a tendency to limit the fluctuations of their exchange rate due to financial imperfections. Typically, if a country is highly indebted and cannot borrow in its own currency, exchange rate fluctuations expose it to currency and interest rate mismatches. Hausmann, Panizza and Stein (2002) discuss the reasons behind the fear of floating in greater detail. Often, researchers associate the fear of floating with the developing economies. However, Calvo and Reinhart (2002) present evidence that even some of the developed countries fear floating.

The OCA theory and fear of floating literature emphasize different factors for the exchange rate regime choice. Traditional OCA theory focuses much more on the real sector, while the fear of floating literature stresses only the financial aspects of the regime choice. While our primary focus is on the OCA criteria, we also study financial development as one of the factors behind the choice of exchange rate regime.

In this paper, we approximate the usefulness of a country having its own currency using exchange rate variability or pressures. Our supposition is that substantial exchange rate volatility or high exchange rate pressures indicate that the nominal exchange rate remains an important adjustment mechanism. Next, trade integration and synchronization of business cycles stand as a proxy for the extent of idiosyncratic shocks at the national level. As such, we expect that greater trade integration and more synchronized business cycles will be associated with greater exchange rate stability. Analogously, dissimilarity of export commodity structure might be a useful proxy for capturing the extent of idiosyncratic shocks at the sectoral level. Both the OCA and fear of floating literature imply that a more open country will tend to limit its exchange rate volatility. In a similar manner, the utility from a country maintaining its own currency decreases when the economic size of that country is small.

Next, we control for several factors to assess the robustness of the set of standard OCA criteria in explaining exchange rate volatility and pressures. First, financially developed countries are likely to exhibit stable exchange rates, as their FX markets are more liquid. Second, greater inflation differentials are likely to be associated with less stable exchange rates (on a bilateral basis). Finally, we introduce two dummies capturing the potential difference in terms of exchange rate volatility and pressures between EU core vs. EU periphery countries and European vs. non-

European countries. It is sometimes disputed whether the economic structure of the EU core countries (such as Austria or Germany) is substantially more similar in comparison with the remaining EU countries (Fidrmuc and Korhonen, 2003).

3. Empirical Methodology

A growing body of literature (see e.g. Calvo and Reinhart, 2002, or von Hagen and Zhou, 2005) suggests that it may not be appropriate to study *de iure* exchange rate regimes, as *de facto* regimes may actually be different. We follow this line and apply a methodology that fully accounts for two crucial issues identified in the literature. It models the actual exchange rate regimes as well as the multiple interdependencies among economies.

In this regard, we examine the variables influencing bilateral exchange rate variability in 20 industrial countries in the period 1989–1998. Later in the text, we refer for convenience to the period 1989–1998 as the 1990s. The countries in the sample are as follows: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Great Britain, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, and the USA.[4] As our setting is bilateral, the combination of 20 countries leads to 190 observations.

We estimate the following equation:

$$VOL_{ij} = \alpha + \beta X_{ij} + \chi FIN_{ij} + \delta EUROPE_{ij} + \phi DOLVAR_{ij} + \varphi EUcore_{ij} + \gamma INFL_{ij} + e_{ij} \quad (1)$$

The dependent variable in equation (1) stands for the bilateral exchange rate variability.5 Xij is a vector of OCA variables (focused on both the probability of an asymmetric shock and the ability to withstand the shock), specifically asymmetry of business cycles, trade linkages, dissimilarity of export commodity structure, openness and economic size, all between country i and country j. FINij captures the level of financial development and EUROPEij is a dummy variable that takes a value of 1 if countries i and j are both European. DOLVARij captures the variability of the U.S. dollar. The EUcoreij dummy assesses the hypothesis of significantly higher real convergence among the following countries: Germany, Austria, Belgium, the Netherlands and Switzerland. $INFL_{ij}$ represents the inflation rate differential.[6]

[4] We exclude Greece due to a lack of data.

[5] Weimann (2003) argues that the BE methodology may entail some econometric difficulties. He claims that there are censored as well as uncensored dependent variables. Nominal exchange rates are bounded by the fluctuation margins in the ERM, but are free elsewhere. This is right in a bilateral target zone, but, in fact, need not be the case in a multilateral target zone. Indeed, Serrat (2000) shows that the exchange rate volatility in multilateral target zones may increase under some conditions, as compared to a free float.

[6] We obtained the data underlying the variables VOL_{ij}, $DOLVAR_{ij}$ and FIN_{ij} from the IMF's International Financial Statistics (IFS). BCS_{ij}, $SIZE_{ij}$ and $OPEN_{ij}$ were computed from the World Bank databases. $TRADE_{ij}$ was calculated using the IMF Directions of Trade and World Bank databases, and variable $DISSIM_{ij}$ was sourced from the OECD's Monthly Statistics of Foreign Trade.

We measure bilateral exchange rate variability as

$$VOL_{ij} = SD\left\lfloor \Delta\left(\log e_{ij}\right)\right\rfloor \tag{2}$$

where $STDEV[\Delta(\log e_{ij})]$ is the standard deviation of the change (Δ) from quarter t to quarter $t+1$ in the logarithm of the nominal exchange rate (e_{ij}) between countries i and j.[7] The formal derivation of all the explanatory variables is presented in Appendix 1.

Next, we estimate the equation with exchange rate pressures as the dependent variable, analogously to that of variability. To do this, we first construct the proxy for the extent of intervention as

$$Intervention_i = -\frac{\Delta\left(\mathrm{Re}\, s_i\right)}{M0_i}, \tag{3}$$

where $\Delta(Res_i)$ is the quarterly change in reserves in country i and $M0_i$ is a measure of narrow money (both obtained from the IMF's IFS dataset). We are aware that the correlation between FX intervention volume and change in reserves need not be close to unity.[8] Nevertheless, the change in reserves is the closest proxy available for actual FX intervention volumes.

To construct the estimate of exchange rate pressures, we adjust the bilateral exchange rate variability for the effect of interventions and the interest rate differential in countries i and j:

$$\Pr essure_{ij} = SD\left\lfloor \lambda\Delta\left(\log(e_{ij})\right) + \eta\left(Intervention_i - Intervention_j\right) + \mu\Delta r_{ij}\right\rfloor, \tag{4}$$

where Δr_{ij} represents the difference between short-term interest rates between country i and country j (data obtained from the IMF's IFS). Parameters λ, η and μ are determined as the inverse of the variance of each variable over the sample period and alternatively by the principal components method (thus giving a greater weight to series with greater volatility), as opposed to the original BE methodology, which simply assumed $\lambda = \eta = \mu = 1$. This choice is motivated to provide a sensitivity analysis for the measurement of exchange rate pressures.

We estimate each cross-sectional equation by the generalized method of moments (GMM), as the results of the Hausmann-Wu test indicate that some of the explanatory variables are endogenous. In addition, it is worth noting that even if the instruments are "exogenous", they may be weak. Consequently, this would increase the asymptotic standard errors and reduce the power of the hypothesis tests. Therefore, we examine the presence of weak instruments by Shea's test, which is

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[7] The results are largely the same if we use monthly changes.

[8] Neely (2000) provides some evidence for several developed countries. It is interesting to note that the correlation of quarterly FX intervention volumes and the change in reserves stands at 0.72 for the Czech Republic in 1999–2004 (we were unable to obtain the analogous data for the other countries in our sample).

particularly appropriate when there are multiple endogenous regressors.[9] For the sake of space, we omit the ordinary least squares (OLS) results. Besides, the OLS results are inconsistent.

4. Results – Instrumental Variable Estimation

In this section, we provide an instrumental variable estimation of the determinants of the variability of bilateral exchange rate changes and the variability of exchange rate pressures.

The Hausman-Wu test indicates that five variables (BCS_{ij}, $TRADE_{ij}$, $DOLVAR_{ij}$, $INFL_{ij}$ and $OPEN_{ij}$) are endogenous. As a result, we instrument these variables. We downloaded these instruments from Andy Rose's website: www.haas.berkeley.edu/~arose. The set of instruments is as follows: log (distance) and its square, regional trade agreement dummy, common language dummy, common border dummy, size of economies, USA dummy and exogenous variables.[10] Additionally, we provide detailed descriptive statistics on all the variables, including the instruments, in Table 8-12 in the Appendix.

First, we estimate the Shea's partial R-squared. Shea's partial R-squared is a measure of the relevance of instrumental variables in the case of multiple endogenous variables. Thus, it can pinpoint the possible presence of weak instruments if the partial R-squared is sufficiently small. In this case, we generally find poor instruments for the variability of output and inflation (see also Table 9 for the relevant correlation matrix). We calculate Shea's statistic based on a number of different specifications to assess the robustness of the results. The partial R-squared for the variability of output and inflation is relatively small and ranges from 0.1 to 0.2. The R-squared for the remaining endogenous variables is much higher. Generally, it takes values between 0.4 and 0.8 (with an average of 0.4 for openness, 0.6 for trade links and 0.8 for the variability of the dollar). Detailed results are available in Table 13 in the Appendix. Finally, we decide to exclude the variability of output and the inflation differential from the estimation, as their inclusion causes most of the explanatory variables to be insignificant, while this is not true in the OLS estimation. In this context, this clearly shows the importance of assessing the relevance of instruments.

Table 1 gives the results for the determinants of bilateral exchange rate variability. We report the results for four different equations together to give some insights into the sensitivity of the estimates. The first two columns present the results with respect to the "traditional" OCA criteria only, while the remaining columns include additional factors.

[9] We only use Shea's measure of relevance of instruments, although this test lacks a distributional theory. All other tests rely on assumptions not satisfied in this paper. Hahn and Hausman (2002) provide the test for only one or two endogenous regressors, and we identified five endogenous regressors. However, the test by Stock and Yogo (2004) assumes homoskedastic disturbances, which is also not the case in this paper.

[10] The use of the central bank independence index as an additional potential instrument is left for further research.

Table 1: Variability of Actual Exchange Rates, IV Estimation

	(1)	(2)	(3)	(4)
Trade linkages	-0.027	-0.031	-0.023	-0.023
	(-2.39)**	(-2.31)**	(-5.13)***	(-5.57)***
Dissimilarity of exports	0.037	0.054	0.001	0.001
	(2.62)***	(2.97)***	(1.73)*	(1.66)*
Size of economy		0.006	0.001	
		(4.19)***	(2.41)**	
Openness	-0.296			-0.085
	(-5.47)***			(-2.88)***
Financial development	-0.222	-0.260	0.020	-0.035
	(-2.24)**	(-2.05)**	(-1.30)	(-2.87)***
Variability of dollar			0.040	0.038
			(3.53)***	(3.32)***
EU core dummy			-0.001	0.0003
			(-0.36)	(-0.13)
Europe dummy			-0.015	-0.015
			(-14.45)***	(-14.8)***
Sargan test	5.66	3.49	8.78	6.75
p-value	0.34	0.48	0.07	0.15

Note: t-statistic based on robust standard errors reported in parenthesis. P-value is reported for Sargan test. Openness coefficients multiplied by 1,000. Financial development coefficient multiplied by 10^8. *, **, *** - denotes significance at 10%, 5% and 1% level respectively.

Generally, the explanatory variables are typically significant with the expected signs in all the specifications. Moreover, the value of the coefficients is stable across the specifications to a large extent. Greater trade linkages robustly decrease bilateral exchange rate variability, while dissimilarity in the commodity structure of bilateral exports tends to increase it. This dissimilarity reflects industry-specific shocks. These shocks are more similar if countries display a comparative advantage in the same export industries. Greater openness is associated with smaller exchange rate variability, as is financial deepening. The relationship between openness and exchange rate fluctuations may suggest that more open economies fear floating (Calvo and Reinhart, 2002). Understandably, USD fluctuations spread to volatility of other currencies. Exchange rate volatility is substantially lower in European countries, reflecting the existence of the ERM. The EU core countries dummy is not positively associated with exchange rate variability, which is in line with Fidrmuc and Korhonen (2003), who also find no significant difference between EU core and periphery countries in this respect.[11]

As mentioned above, there are reasons for examining the determinants of exchange rate pressures as well. The authorities may limit exchange rate volatility if they believe that it undermines the country's stability and growth prospects. Nevertheless, they may hardly limit the exchange rate pressures that arise if the current exchange rate is not optimal.

The results for exchange rate pressures, as depicted in Table 2, show a similar and consistent pattern. Contrary to the results of BE, trade links are important in limiting the pressures. Industry-

[11] The results with the ERM participation dummy are largely similar to those with the Europe dummy and, for the sake of brevity, are not presented.

specific shocks do not seem to affect the pressures. This may be because policy makers typically do not react to industry-specific shocks. Openness is negatively associated with pressures. It seems that more open countries are affected by large exchange rate pressures to a greater extent. In contrast to the results in Table 1, financial development is positively associated with exchange rate pressures. A likely explanation put forward by Devereux and Lane (2003) is that financially more developed countries are able to tolerate greater exchange rate pressures. Interestingly, variability of the dollar does not influence the extent of pressures. On the other hand, the Europe dummy is significant with a negative sign, suggesting that lower pressures were prevailing among these countries on a bilateral basis. The EU core dummy is not robustly associated with pressures either.

Table 2: Variability of Exchange Rate Pressures, IV Estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade linkages	-11.11	-8.49	-8.22	-6.50	-4.88	-3.73	-3.47	-2.74
	(-6.10)***	(-4.57)***	(-3.99)***	(-4.54)***	(6.22)***	(4.62)***	(-4.10)***	(-4.67)***
Dissimilarity of exports	-0.32	-0.217	0.06	0.25	0.12	-0.06	0.03	0.12
	(-0.51)	(-0.34)	(0.11)	(0.6)	(0.45)	(-0.22)	(0.17)	(0.70)
Size of economy	1.14		0.61		0.52		0.26	
	(6.26)***		(1.83)*		(6.76)***		(1.94)*	
Openness		-0.062		-0.02		-0.03		-0.01
		(-6.48)***		(-1.65)*		(-6.90)***		(-1.69)*
Financial development	83.1	59.8	56.9	37.2	35.6	24.8	23.0	14.5
	(4.86)***	(4.24)***	(2.68)***	(3.05)***	(4.89)***	(4.12)***	(2.64)***	(2.91)***
Variability of dollar			-3.12	-3.79			-0.61	-0.87
			(-0.63)	(-0.86)			(-0.30)	(-0.49)
EU core dummy			-1.26	-0.93			-0.52	-0.37
			(-1.68)*	(-1.15)			(-1.64)	(-1.09)
Europe dummy			-1.19	-1.64			-0.60	-0.79
			(-1.87)*	(-3.63)***			(-2.31)**	(-4.24)***
Sargan test	2.94	2.79	4.37	6.27	2.43	2.37	4.18	5.93
p-value	0.56	0.59	0.36	0.18	0.66	0.67	0.38	0.20

Note: t-statistic based on robust standard errors reported in parenthesis. P-value is reported for Sargan test. Openness coefficients multiplied by 1,000. Financial development coefficient multiplied by 10^8. *, **, *** - denotes significance at 10%, 5% and 1% level respectively. In columns (1)–(4) the dependent variable is calculated as stated in equation (4), while in columns (5)–(8) it is calculated by the principal component method.

Overall, the variables indicated by the OCA theory provide a sufficient role for the determination of bilateral exchange rate variability and pressures in the 1990s. This largely supports the previous findings of BE for the 1960s–1980s. Nevertheless, our approach seems to generate more robust results in terms of the sign and size of the estimated parameters. In addition, the robustness of the results allows us, in our opinion, to apply it to the Central and Eastern European countries.

5. Implications for Central and Eastern European Countries

In this section we provide an application to the CEECs and predict their exchange rate volatility and pressures based on the OCA criteria. As argued below, the motivation for carrying out such analysis is to assess the degree of alignment of the CEECs with the Eurozone. We predict the exchange rate volatility and pressures using what is called the "out-of-sample approach" in the equilibrium exchange rate literature (see Halpern and Wyplosz, 1997, or Maeso-Fernandez *et al.*, 2004). This approach is based on a two-step procedure. In the first step, the relationship between exchange rate volatility (or pressures) and fundamentals is estimated for the developed countries (as done in section III). In the second step, we calculate the predicted exchange rate variability and pressures for the CEECs on the basis of the estimated structural relationship from step one.

As a result, we obtain a prediction of medium-term exchange rate volatility and pressures for the CEECs adjusted for exchange rate volatility based on the OCA criteria. We interpret this result as a measure of the readiness for euro adoption. This is in line with Vaubel (1976), who argues that countries fulfilling the OCA criteria should largely have stable real exchange rates.[12] On the other hand, if a country's OCA conditions imply substantial variation in exchange rates (or exchange rate pressures, if the country fixes its exchange rate), then the adoption of a common currency may not be a good choice.

It is worth noting that our approach is a rather conservative estimate of readiness to adopt the euro, for two reasons. First, the OCA criteria may be endogenous (Frankel and Rose, 1998). Frankel and Rose argue that a common currency spurs trade integration and, as a result, also synchronization of business cycles. In other words, the post-accession shock patterns may differ from the pre-accession ones as a result of the adoption of the common currency. On the other hand, the "OCA endogeneity" effect may be quite small for the highly open CEECs, whose trade is already largely oriented to the Eurozone. Second, the exchange rate itself may generate rather than absorb shocks. Borghuis and Kuijs (2004) find for the Czech Republic, Hungary, Poland, Slovakia and Slovenia that the exchange rate has served "as much or more as an unhelpful propagator of monetary and financial shocks than as a useful absorber of real shocks". In such case, the net benefits of a country maintaining its own currency decrease.

The list of CEECs in this paper is as follows: Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic, Slovenia and Romania. To examine the aforementioned hypothesis, we first compute the descriptive statistics of the selected OCA criteria, exchange rate variability and pressures for these countries. Second, we predict the exchange rate volatility and pressures based on the OCA criteria vis-à-vis the euro area and compare the results with the corresponding actual values.[13] In this regard, we use the quarterly data from 1999:1 to 2004:4, as we believe that the data prior this period are only partially informative with regard to euro adoption.

[12] Horváth and Kučerová (2005) find that the OCA criteria also largely explain the real exchange rate variability.

[13] The data in this section were obtained from the IMF's online IFS, the EIU, the OECD's Monthly Statistics of Foreign Trade and, exceptionally, various central bank websites.

Table 3: OCA Conditions in the CEECs, 1999–2004

	Trade links	Dissimilarity of exports	Openness	Financial Development
Bulgaria	0.105	0.287	114.1	1.53
Czech Republic	0.223	0.053	129.9	2.69
Estonia	0.237	0.106	163.1	1.42
Hungary	0.224	0.084	137.2	1.75
Latvia	0.099	0.617	94.4	1.19
Lithuania	0.121	0.317	103.4	1.00
Poland	0.087	0.093	64.9	1.62
Romania	0.112	0.147	76.0	0.87
Slovakia	0.256	0.085	147.7	2.44
Slovenia	0.160	0.023	114.1	1.96
Eurozone	0.177	0.314	70.3	2.71
Eurozone – GDP weighted	0.246	0.259	67.8	3.72

Note: See section III – Empirical Methodology for an explanation of how the variables have been calculated. The data are from 1999–2004 for the CEECs. The OCA conditions for the CEECs are calculated with the EMU. In the last two rows, the Eurozone values are the averages, or GDP-weighted averages, of all its current members' OCA conditions in 1989–1998. The CEEC trade intensity results are based on the EU.

First, we examine the OCA conditions in the CEECs. Specifically, we focus on trade links, dissimilarity of export commodity structure, openness and financial development.[14] Table 3 depicts the OCA conditions for the CEECs averaged from 1999 to 2004 (based on quarterly data).[15]

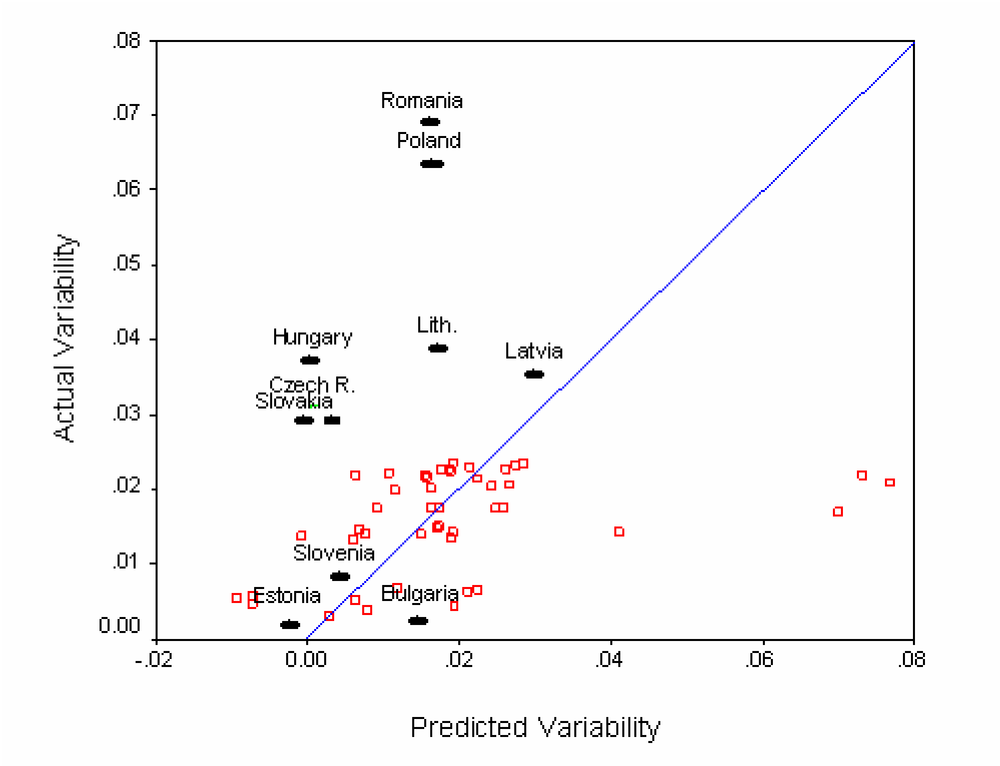
We find that trade integration in the CEECs vis-à-vis the euro area is topped by the Czech Republic, Estonia, Hungary and Slovakia. At the bottom are Bulgaria, Latvia and Poland. Nevertheless, trade integration is generally very high, reaching levels typical for the Eurozone members. As regards dissimilarity in export commodity structure, there is a greater variety within the Eurozone countries in comparison with the CEECs' exports to the Eurozone. So, the CEECs reveal their comparative advantage in export sectors typical for the euro area. Next, most of the CEECs, except perhaps Poland and Romania, are highly open. On the other hand, the degree of financial intermediation is generally much weaker as compared to the Eurozone (before its creation). It is important to note that the results for the Eurozone presented in Table 3 are based on averaging over bilateral relations between countries. If we use weights (1998 GDP in our case), the results for the Eurozone are more favorable in terms of their OCA conditions. Bilateral trade links within the euro area countries increase considerably. The commodity structure of bilateral exports within the euro area is less diversified as compared to no GDP weighting. While the results for openness remain largely the same, financial intermediation is much stronger. Another point here is that while the OCA conditions are favorable for most CEECs, they remain quite

[14] We also examined other variables from equation (1), in particular the size of the economy. The results are largely unchanged and, for the sake of space, we do not present them.

[15] The data on dissimilarity of export commodity structure end in 2002, as we were unable to obtain more recent figures. Also, for some countries the data were not available on a quarterly basis. Nevertheless, the commodity structure of exports generally tends to be quite stable over time (see Figure 4 in the Appendix). It is also important to note that this variable is calculated vis-à-vis Germany, as figures for the euro area as a whole simply do not exist.

stable over the long term and do not change abruptly (see Figure 3-6 in Appendix), although the pattern of shocks may change after joining the Eurozone.

Figure 1: Actual and Predicted Exchange Rate Volatility: Comparison of CEECs and the Eurozone



Note: The predictions are based on Table 1, column 1.

The next step is to compare the actual and predicted exchange rate variability between the euro area countries and the CEECs (vis-à-vis the euro for the CEECs). The results in Figure 1 clearly suggest that while actual exchange rate variability is larger in the CEECs than it used to be in the euro area before its creation, the predicted exchange rate variability is roughly at Eurozone levels. The obvious discrepancy in terms of the degree of exchange rate volatility between the euro area countries and the CEECs arises from the fact that while several CEECs maintain flexible exchange rates, all the euro area countries participated in the ERM in the sample period and thus bounded their exchange rate fluctuations. This discrepancy disappears in the case of exchange rate pressures, as shown below. It is also worth noting that Latvia and Lithuania exhibit relatively large exchange rate volatility despite the fact that these countries maintained currency board arrangements throughout the sample period. This is because neither country anchored its currency vis-à-vis the euro at any time during the sample period.

Table 5: Actual and Predicted Exchange Rate Volatility: the CEECs, 1999–2004

	Exchange Rate Variability	
	Actual	**Predicted**
Bulgaria	0.014	0.015
Czech Republic	0.026	0.001
Estonia	0.005	-0.002
Hungary	0.037	0.001
Latvia	0.036	0.030
Lithuania	0.036	0.017
Poland	0.063	0.016
Romania	0.051	0.015
Slovakia	0.030	-0.001
Slovenia	0.010	0.004

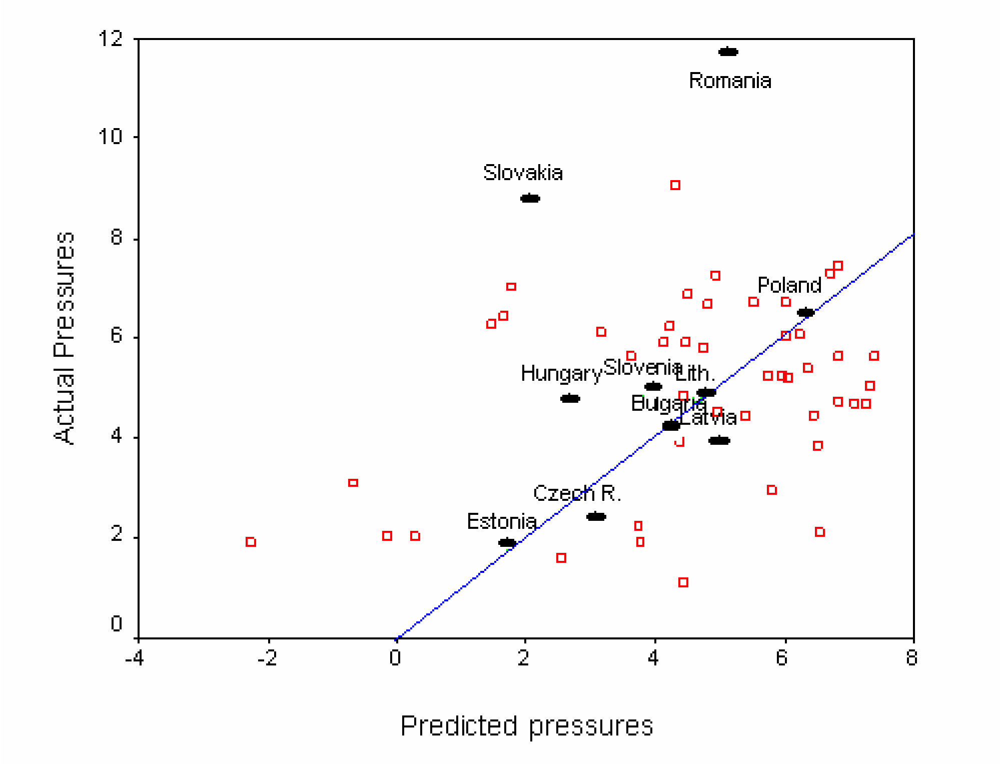
Note: The predictions are based on Table 1, column 1.

The results for the individual CEECs are also presented in Table 5. Clearly, countries maintaining a currency board, such as Estonia or Bulgaria, experience the smallest exchange rate variability. The Polish zloty and Romanian leu are particularly volatile in the sample period. The predicted exchange rate variability is generally at the Eurozone level; however, there is also heterogeneity within the CEECs. We find that the predicted variability is topped by Estonia and the Visegrad countries (except Poland). Surprisingly, we find Lithuania and Latvia at the bottom. A study in a similar vein by Boreiko (2003), while using different methodology (a fuzzy cluster algorithm), identifies the same group of CEECs as being most aligned with the euro area. The only exception here is Latvia.[16]

Next, we examine the exchange rate pressures for the CEECs. The results in Figure 2 suggest that the CEECs experience exchange rate pressures at the level typical for the euro area countries. Estonia, the Czech Republic, Slovakia and Hungary have the smallest predicted pressures among the CEECs. Nevertheless, it is interesting to note that the actual pressures for Slovakia and Hungary are much greater than those implied by our model. Unfortunately, our analysis does not allow for an explanation of the underlying reasons for this difference. It may be due to several factors, such as credibility of economic policies, rigidity of labor markets, or speculative attacks (for example, the speculative attack on the Hungarian forint in January 2003). Alternatively, the difference between the actual and predicted pressures might be interpreted as "excessive non-fundamental volatility". According to Mundell (1973), this non-fundamental volatility vanishes after joining the monetary union. In such case, the countries for which the difference between the actual and predicted pressures is large would, in comparison with other countries, benefit the most from adopting the euro.

[16] Boreiko (2003) also examines the nominal convergence of the CEECs and the group of best performers, then narrows down to Estonia and Slovenia.

Figure 2: Actual and Predicted Exchange Rate Pressures: Comparison of CEECs and the Eurozone



Note: The results are based on Table 2, column 2.

We present detailed results for the actual and predicted exchange rate pressures in Table 7. Interestingly, among the CEECs the pressures seem to be lowest in Estonia and the Czech Republic. On the other hand, Slovakia and Romania experienced quite large pressures in 1999–2004. The predicted pressures are largely correlated with the actual ones. We predict that Estonia should experience the smallest exchange rate pressures in this region, while Poland may face pressures three times larger than Estonia.

Table 7: Actual and Predicted Exchange Rate Pressures: the CEECs, 1999–2004

	Exchange Rate Pressures	
	Actual	**Predicted**
Bulgaria	4.70	4.27
Czech Republic	2.37	2.84
Estonia	1.84	1.68
Hungary	4.82	2.60
Latvia	3.93	4.86
Lithuania	4.81	4.46
Poland	6.57	6.10
Romania	11.83	5.42
Slovakia	8.83	2.00
Slovenia	4.94	3.86

Note: The results are based on Table 2, column 2.

Overall, the results suggest that most of the CEECs fulfill the necessary condition for joining the monetary union, i.e., they are relatively well aligned with the euro area. Nevertheless, it would be hasty to advise them to join the euro area as soon as possible, even if one believes that they may benefit from a large currency union in the long term (as the OCA conditions suggest).[17] This is because it is necessary to consider a number of additional economic policy issues (e.g. nominal convergence) over the medium term to ensure smooth adoption of the common currency.

6. Conclusions

In this article we study the determinants of bilateral exchange rate variability and exchange rate pressures. The results are as follows. We find that the variables indicated by the optimum currency area theory explain the dynamics of exchange rates and exchange rate pressures to a large extent. There is also some evidence that more open economies fear floating. Greater variability of the US dollar increases exchange rate variability, but not exchange rate pressures. The results also do not support any significant difference between the EU core and EU periphery. European economies bilaterally face both weaker exchange rate variability and weaker exchange rate pressures as compared to other developed countries.

Next, we also predict exchange rate variability and pressures for the CEECs. The results suggest some heterogeneity among the CEECs in terms of their exchange rate volatility and pressures. Notably, Estonia experiences both low variability and low pressures. Overall, however, our model implies that the current levels of exchange rate variability and pressures are at the same level as the euro area countries before they adopted the euro. This is because the CEECs seem to be relatively well aligned with the euro area countries, especially in terms of their trade integration, openness and similar export commodity structure.

[17] This statement is conditional on the extent to which the euro area forms an OCA. Obviously, this is beyond the scope of this paper.

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Appendix 1 Measurement of Explanatory Variables

This appendix lists the formal derivation of all the explanatory variables.

Business cycle synchronization:

$BCS_{ij} = SD(\Delta y_{it} - \Delta y_{jt})$, where SD denotes sample standard deviation, Δy_i stands for the year-on-year real GDP growth of country *i* (analogously for country *j*), and *t* represents time.

Dissimilarity of export commodity structure:

$DISSIM_{ij} = \frac{1}{T}\sum_{t=1}^{T}\left[\left(ABS\left(A_{it} - A_{jt}\right)\right) + \left(ABS\left(B_{it} - B_{jt}\right)\right) + \left(ABS\left(C_{it} - C_{jt}\right)\right)\right]$, where ABS denotes the absolute value, A_{it} is the share of agricultural trade in total merchandise trade of country *i* at time *t*, B_{it} is the share of mineral trade in total merchandise trade of country *i* at time *t*, and C_{it} is the share of manufacturing trade in total merchandise trade of country *i* at time *t* (analogously for country *j*).

Trade intensity:

$TRADE_{ij} = \frac{1}{T}\sum_{t=1}^{T}\left(\frac{ex_{ijt}}{y_{it}} + \frac{ex_{jit}}{y_{jt}}\right)$, where ex_{ijt} is the volume of exports at current prices from country *i* to country *j* at time *t*, and y_{it} is GDP at current prices for country *i* at time *t* (analogously for country *j*).

Economic size:

$SIZE_{ij} = \frac{1}{T}\sum_{t=1}^{T}\left(\log y_{it} + \log y_{jt}\right)$, where y_{it} is GDP in USD for country *i* at time *t* (analogously for country *j*).

Openness:

$OPENNESS_{ij} = \frac{1}{T}\sum_{t=1}^{T}\left(\frac{ex_{it} + im_{ti}}{y_{it}} + \frac{ex_{jt} + im_{jt}}{y_{jt}}\right)$, where ex_{it} and im_{ti} are exports and imports of country *i*, and y_{it} is *i*-th country GDP at time *t*, all at current prices (analogously for country *j*).

Financial development:

$FIN_{ij} = \frac{1}{T}\sum_{t=1}^{T}\left(\frac{M2_{it}}{y_{it}} + \frac{M2_{jt}}{y_{jt}}\right)$, where $M2_{it}$ is monetary aggregate M2 in country *i* at time *t*, and y_{it} denotes *i-th* country GDP at time *t* (analogously for country *j*).

USD variability:

$DOLVAR_{ij} = \begin{cases} \psi \ \textit{if} \ i \vee j \neq USA \\ 0 \quad \textit{otherwise} \end{cases}$, where $\psi = \frac{1}{2}\left(SD[\Delta(\log e_{it})] + SD[\Delta(\log e_{jt})]\right)$. SD denotes sample standard deviation, e_{it} represents the exchange rate of country *i* against the USD, and Δ is the change in the given variable from time *t* to *t+1* (analogously for country *j*).

Inflation differential:

$INFL_{ij} = \frac{1}{T}\sum_{t=1}^{T}\left(\pi_{it} - \pi_{jt}\right)$, where π_{it} is year-on-year CPI inflation in country *i* at time *t* (analogously for country *j*).

Appendix 2 – Additional Results

Table 8: Correlation Matrix of Explanatory and Dependent Variables

	Diss. of export	Var. of USD	ERM dummy	EU core dummy	Fin. develop.	Europe dummy	Open.	Ex. Rate Var.	Var. of output	Size of econ.	Trade links
Dissimilarity of exports	1.00										
Variability of USD	0.03	1.00									
ERM dummy	**-0.22**	**0.26**	1.00								
EU core dummy	-0.11	-0.08	0.09	1.00							
Financial development	**0.47**	0.01	**-0.28**	-0.08	1.00						
Europe dummy	**-0.32**	**0.31**	**0.75**	**0.21**	**-0.37**	1.00					
Openness	-0.04	0.07	**0.34**	**0.29**	-0.05	**0.43**	1.00				
Exchange Rate Variability	**0.30**	0.01	**-0.63**	**-0.23**	**0.24**	**-0.83**	**-0.48**	1.00			
Variability of output	**0.20**	**0.23**	-0.04	**-0.27**	-0.05	-0.00	0.02	**0.15**	1.00		
Size of economy	**-0.22**	**-0.39**	-0.14	-0.03	**-0.35**	**-0.27**	**-0.60**	**0.19**	**-0.31**	1.00	
Trade links	**-0.17**	**-0.22**	**0.29**	0.11	**-0.14**	**0.28**	0.13	**-0.46**	-0.12	**0.23**	1.00
Inflation differential	-0.03	0.04	**0.19**	-0.08	-0.04	0.14	-0.09	-0.12	**0.17**	**0.17**	**0.21**

Note: Correlation coefficients significant at 5% level in bold. Data for developed countries only.

Table 9: Correlation Matrix of Endogenous Variables and Instruments

	Adjacency	Distance	Dist.-sqr.	Language	USA	WTO
Adjacency	1.00					
Distance	**-0.46**	1.00				
Distance - squared	**-0.42**	**1.00**	1.00			
Common language	**0.28**	-0.07	-0.05	1.00		
USA dummy	-0.06	**0.25**	**0.25**	0.11	1.00	
WTO	**0.20**	**-0.65**	**-0.66**	-0.12	**-0.26**	1.00
USD variability	-0.02	**-0.14**	**-0.14**	**-0.23**	**-0.84**	**0.23**
Openness	0.04	**-0.43**	**-0.42**	0.11	**-0.32**	**0.33**
Trade links	**0.54**	**-0.47**	**-0.45**	**0.35**	0.12	**0.37**
Var. of output	**-0.19**	**0.14**	**0.14**	**-0.15**	**-0.14**	-0.02
Inflation differential	**0.15**	-0.12	-0.12	-0.07	-0.13	**0.16**

Note: Correlation coefficients significant at 5% level in bold. Data for developed countries only.

Table 10: Descriptive Statistics

	Trade links	Size of economy	Variability of output	Exchange rate variability	Openness	Europe dummy
Mean	0.11	6.06	0.03	0.02	64.77	0.45
Median	0.06	5.97	0.03	0.02	61.15	0.00
Maximum	1.20	8.70	0.07	0.04	134.06	1.00
Minimum	0.00	4.08	0.01	0.00	20.42	0.00
Std. Dev.	0.15	0.91	0.02	0.01	21.03	0.50
Skewness	3.66	0.34	0.37	-0.17	0.62	0.21
Kurtosis	20.56	2.64	1.84	2.10	3.00	1.04
Jarque-Bera	2866.12	4.63	14.97	7.34	12.25	31.68
Probability	0.00	0.10	0.00	0.03	0.00	0.00
Observations	190	190	190	190	190	190

Note: Data for developed countries only.

Table 11: Descriptive Statistics (Continued)

	Financial development	EU core dummy	ERM dummy	USD variability	Inflation differential	Dissimilarity of exports	Exchange rate pressures
Mean	887605.30	0.05	0.41	0.09	2.31	0.41	0.05
Median	2.44	0.00	0.00	0.09	1.67	0.25	0.06
Maximum	8875957.00	1.00	1.00	0.15	8.72	1.94	0.11
Minimum	0.00	0.00	0.00	0.00	0.45	0.03	0.00
Std. Dev.	2669651.00	0.22	0.49	0.04	1.78	0.41	0.02
Skewness	2.67	4.01	0.36	-1.26	1.98	1.82	0.14
Kurtosis	8.11	17.06	1.13	4.55	6.12	5.78	2.54
Jarque-Bera	432.00	2072.43	31.81	69.28	200.9	165.45	8.14
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Observations	190	190	190	190	190	190	153

Note: Data for developed countries only.

Table 12: Descriptive Statistics on Instruments

	Adjacency	Distance	Distance-squared	Language	WTO	USA
Mean	0.11	7.56	58.55	0.15	0.43	0.10
Median	0.00	7.25	52.58	0.00	0.00	0.00
Maximum	1.00	9.42	88.68	1.00	1.00	1.00
Minimum	0.00	4.92	24.22	0.00	0.00	0.00
Std. Dev.	0.31	1.20	18.18	0.36	0.50	0.30
Skewness	2.48	-0.01	0.16	1.99	0.28	2.67
Kurtosis	7.17	1.75	1.68	4.96	1.08	8.11
Jarque-Bera	333.23	12.29	14.60	155.72	31.71	432.00
Probability	0.00	0.00	0.00	0.00	0.00	0.00
Observations	190	190	190	190	190	190

Note: Data for developed countries only.

Table 13: Relevance of Instrumental Variables: Shea's Partial R-squared

	TRADE	BCS	OPEN	INFL	DOLVAR
Specification 1	0.64	0.23	0.55	0.20	---
Specification 2	0.68	0.18	---	0.23	---
Specification 3	0.53	0.15	---	0.15	0.77
Specification 4	0.52	0.12	0.29	0.15	0.77

Note: For abbreviations, see Appendix 1. Following Shea (1997), the test is implemented as follows: I regress each endogenous regressor, X , on the set of instruments. I save the fitted values, $\hat{X}$. Next, I regress one of the endogenous regressors, X_1 , on the remaining regressors and save the residuals, $\tilde{X}_1$. Next, I regress $\tilde{X}_1$ on the remaining $\tilde{X}$ and save $\bar{X}_1$. Finally, I compute the sample squared correlation between $\tilde{X}_1$ and $\bar{X}_1$.

Specification 1: Explanatory variables: TRADE, BCS, INFLATION, OPEN, DISSIM, FIN.

Specification 2: Explanatory variables: TRADE, BCS, INFLATION, SIZE, DISSIM, FIN.

Specification 3: Explanatory variables: TRADE, BCS, INFLATION, OPEN, DISSIM, FIN, DOLVAR, EUROPE, EUCORE.

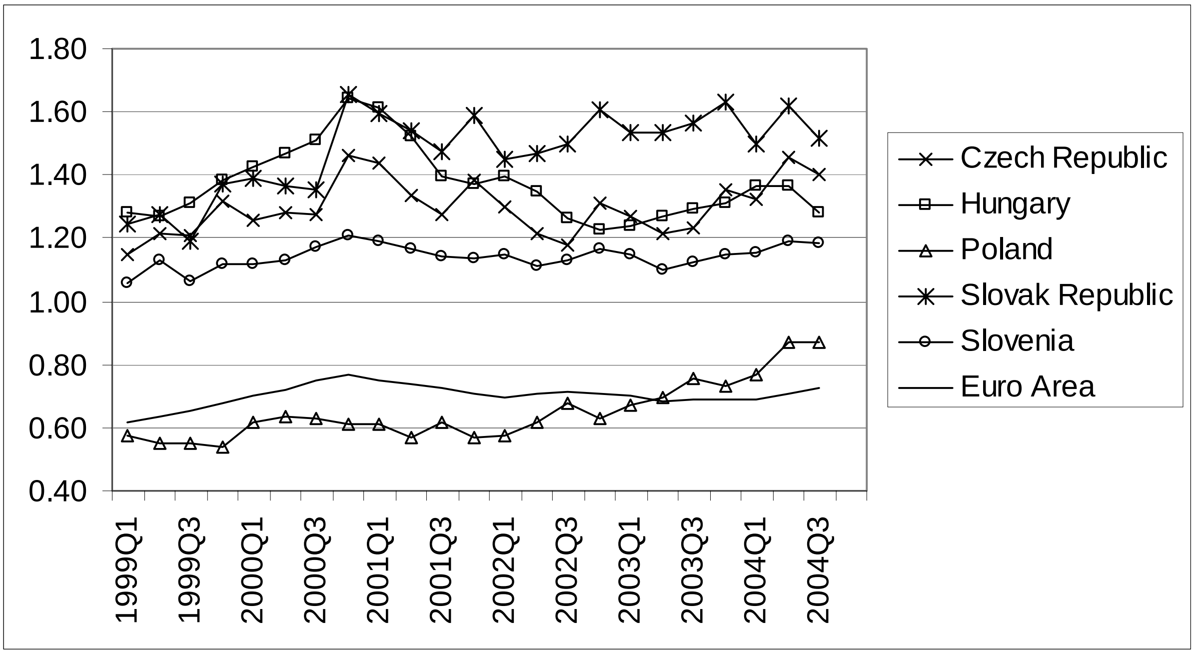
Specification 4: Explanatory variables: TRADE, BCS, INFLATION, SIZE, DISSIM, FIN, DOLVAR, EUROPE, EUCORE.

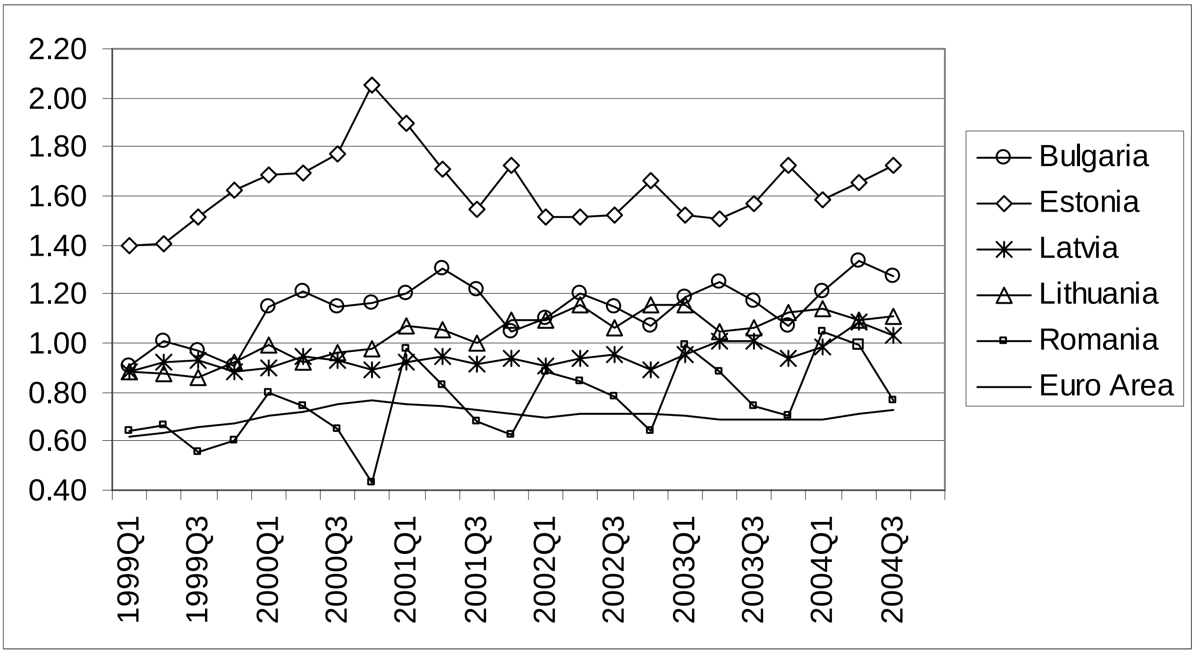
Endogenous variables: TRADE, BCS, INFLATION, OPEN, DOLVAR .

The instrument list is the same for all four specifications: log (distance) and its square, regional trade agreement dummy, common language dummy, common border dummy, size of economies and USA dummy.

It is worth noting that as the dependent variable is irrelevant for the results of Shea test, it is enough to report the above four specifications.

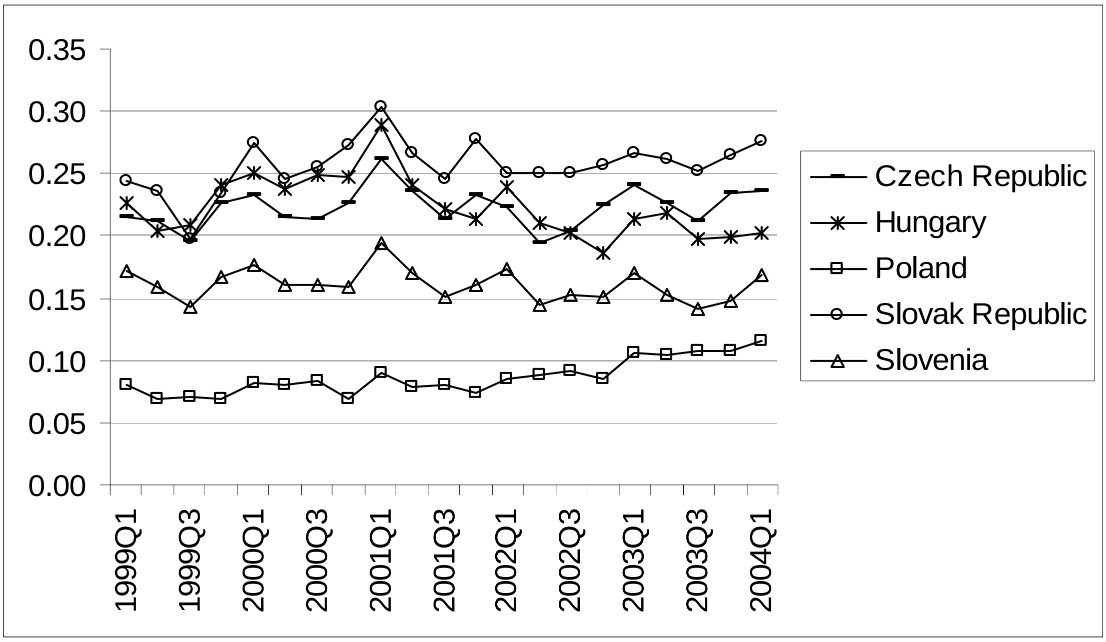
Figure 3: Openness

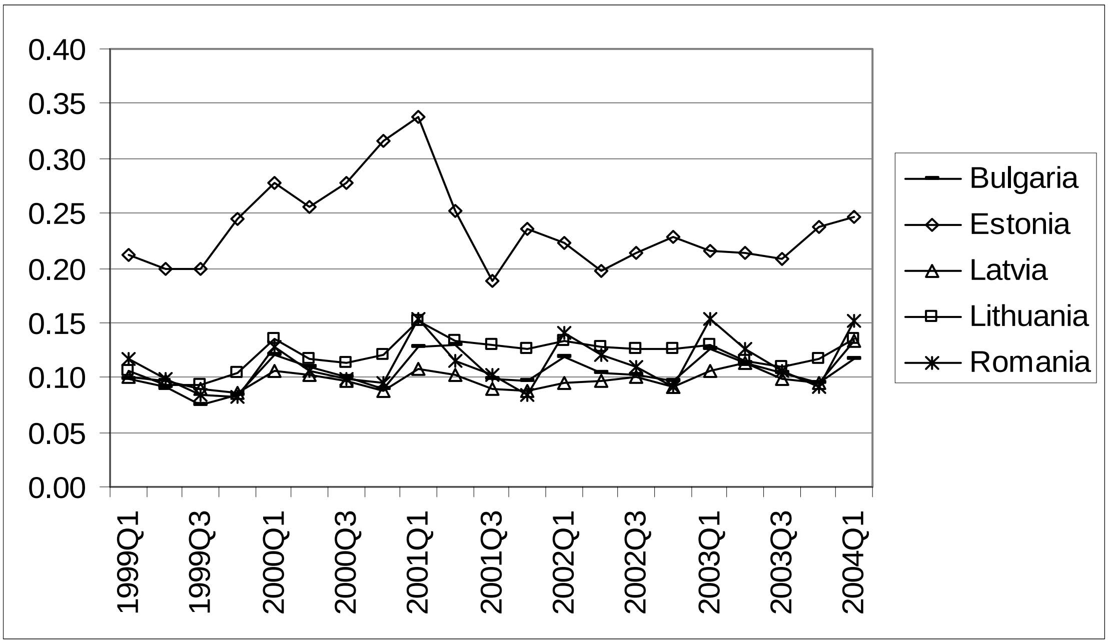




Note: Openness, as is shown in Figures, is measured by the average of given CEEC and Eurozone openness. A country's openness is estimated as the sum of exports and imports over GDP. Eurozone openness is an average of its member states openness. See Appendix 1 for details.

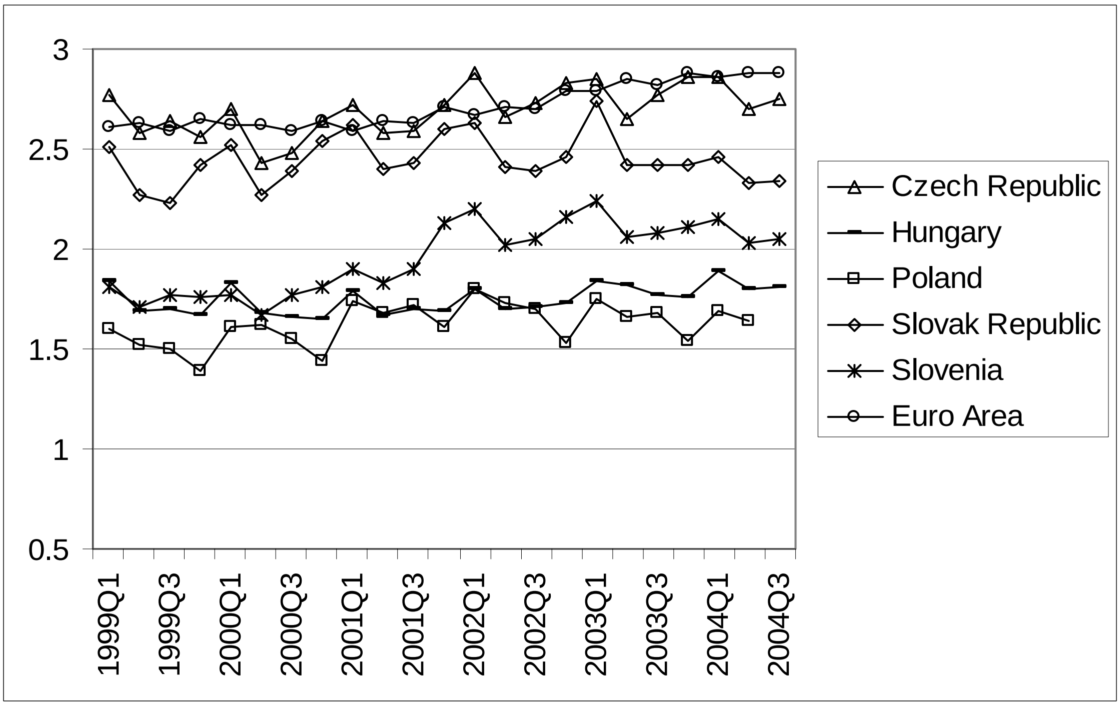
Figure 4: Trade Links





Note: Trade links assess the degree of trade integration of a given country with Euro area countries. See Appendix 1 for details.

Figure 5: Financial Development (M2/GDP)



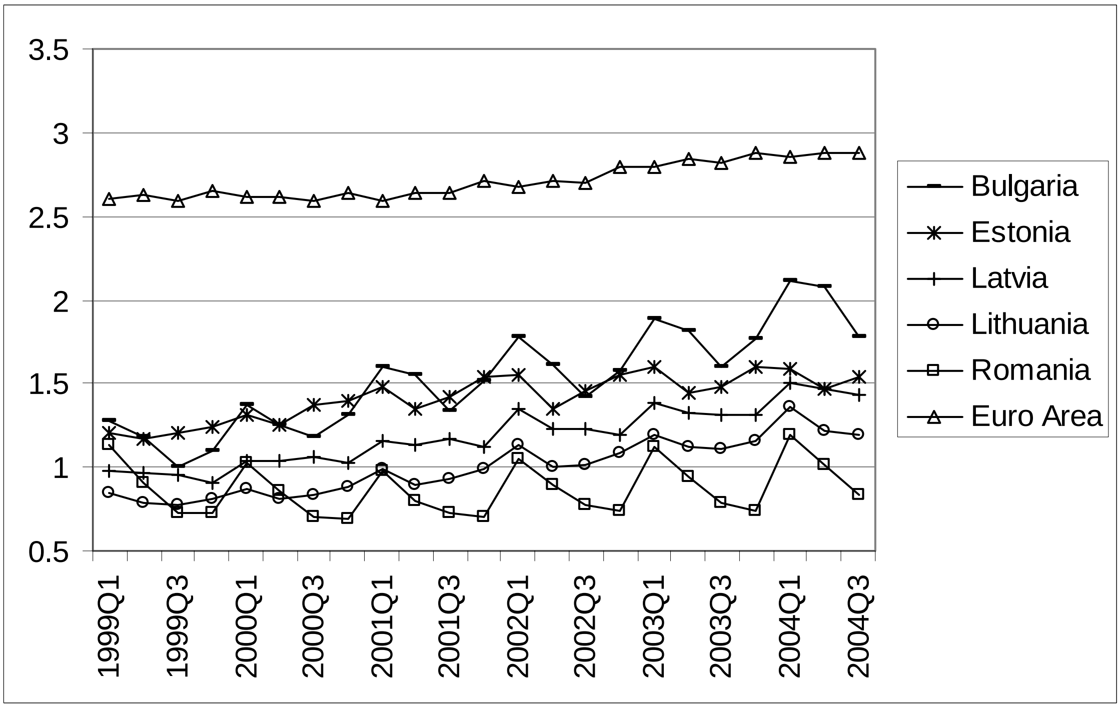
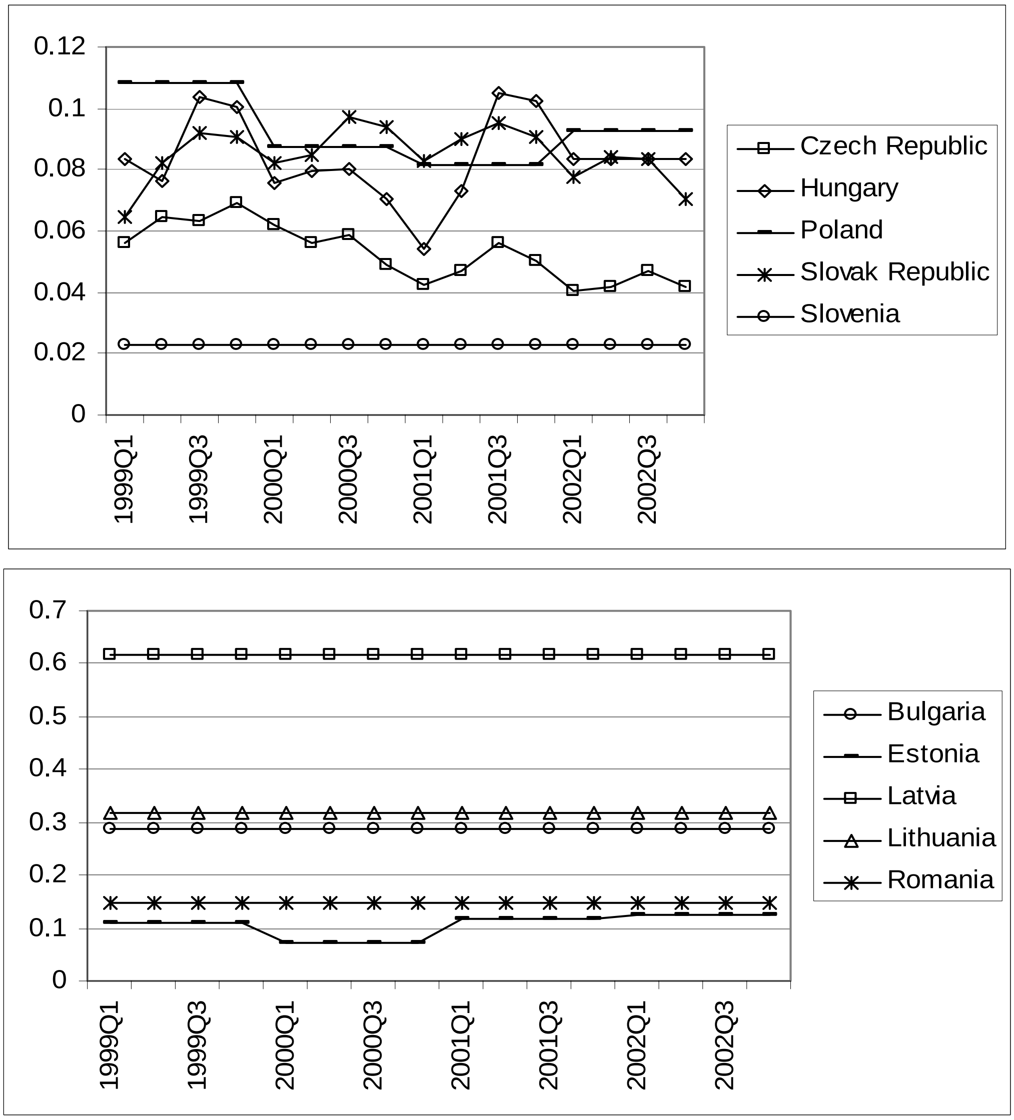


Figure 6: Dissimilarity in Export Commodity Structure



Note: Dissimilarity on the level of SITC – 10. See Appendix 1 for details.

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