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ROMAN HORVÁTH

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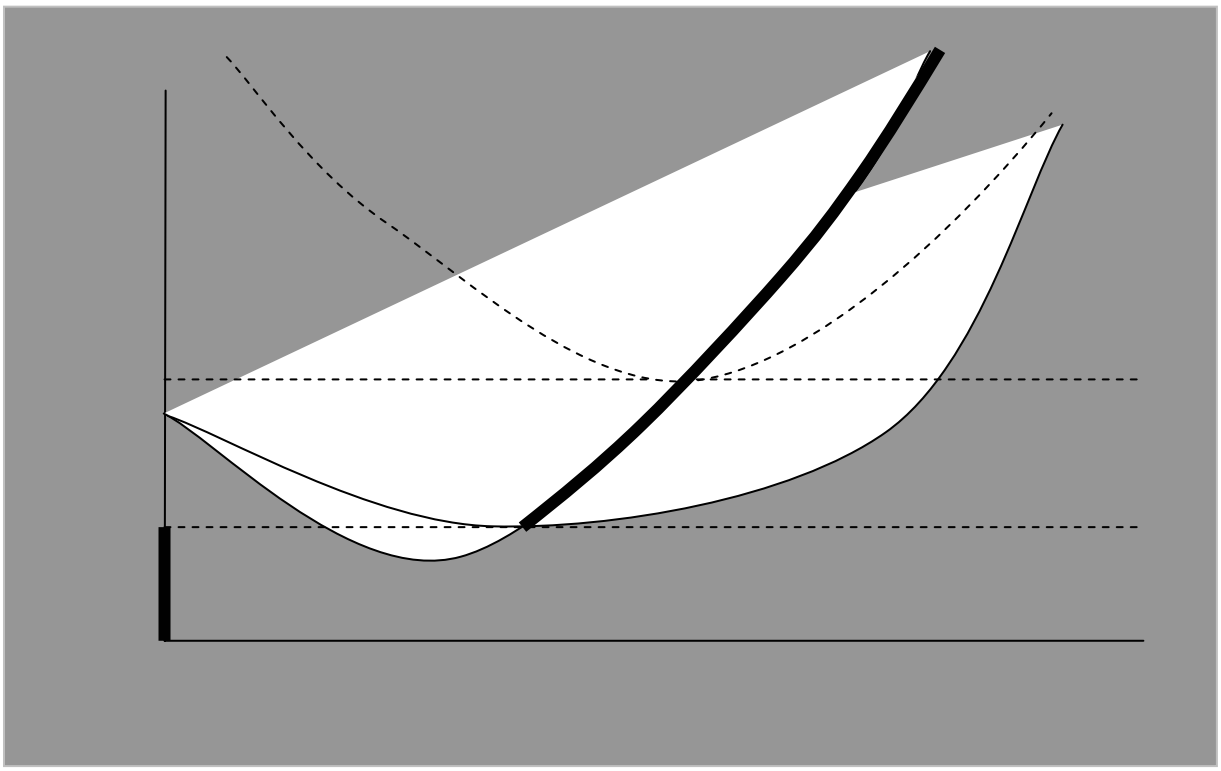

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Exchange Rate Variability, Pressures and Optimum Currency Area Criteria: Implications for the Central and Eastern European Countries

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 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 CEECs encounter exchange rate pressures approximately at the level of Euro area countries before their euro adoption.

Keywords: Exchange Rates, Optimum Currency Area, Euro Adoption, GMM.
JEL Classification: F15, F31, E58

* Monetary and Statistics Department, Czech National Bank and Institute of Economic Studies, Faculty of Social Sciences, Charles University, Prague. E-mail: Roman.Horvath@cnb.cz. The author thanks Martin Cincibuch, Fabrizio Coricelli, Jarko Fidrmuc, Dana Hájková, Luboš Komárek, Michal Skořepa and the seminar participants at the ČNB for helpful comments. The views expressed in this paper are not necessarily those of the Czech National Bank. This paper has been supported by the Czech National Bank Research Project No. A2/2003.

I. Introduction

There are numerous papers dealing with the first moment of exchange rate, e.g. focused on finding equilibrium exchange rate. In this paper we take different approach concentrating on the second moment of exchange rate, e.g. attempting to identify the determinants of exchange rate variability by the use of 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 or business cycles synchronization to address the issue.[1] Namely, we examine the hypothesis whether the 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, other factors 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 at limiting the pressures at the foreign exchange market. Therefore, we investigate whether OCA conditions belong among the culprits of exchange rate pressures.

The methodology applied in this paper originates in Bayoumi and Eichengreen (1998) (BE thereafter)[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 instrumental variables relevance.[3] Therefore, it also allows us to assess the robustness of the findings by BE.

In addition, we also provide simple "out-of-sample approach" forecasting, in a spirit of real equilibrium exchange rate literature (see e.g. Halpern and Wyplosz, 1997 or Maeso-Fernandez *et al.*, 2004), for predicting exchange rate volatility and pressures for several Central and Eastern European countries (CEECs) based on OCA criteria. This allows us to identify the part of exchange rate volatility and exchange rate pressures explicitly connected to fundamentals (or OCA criteria in our case). Obviously, if the volatility and pressures remained high and persisted in future (whatever the difficulty with finding the right

[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 the data from 1980s, while we work with the data from 1990s.

benchmark for comparison), it would then indicate that euro adoption for these countries may not be beneficial. On the other hand, favourable OCA conditions imply for small open economies that necessary condition for joining monetary union is met (sustainability of union in the long run) and policy makers may choose such timing and scenario of euro adoption that maximize medium term net benefits for the economy.

The paper is organized as follows: We discuss some basics on OCA and a fear of floating in section II. Empirical methodology is laid out in the section III. We provide the instrumental variables 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. Appendix with some descriptive statistics follows.

II. 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 benefits stemming from common currency (Mundell, 1961). Theoretically, usefulness of having own currency decreases when countries are subject to common shocks. Originally, OCA theory puts forward a number of criteria under which it is more likely that idiosyncratic shocks occur rarely. Next, OCA theory emphasize that in case idiosyncratic shocks nonetheless occur after forming the currency union, the union is likely to be more sustainable, if the economy reacts to shocks with low welfare loss. On the other hand, Mundell (1973) notes that countries even subject to idiosyncratic shocks may form a currency union, if they are able to diversify sufficiently the risks. This, however, requires well-functioning and integrated financial markets.

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

Notably, the OCA and fear of floating literature emphasize different factors for the exchange rate regime choice. Traditional OCA theory focuses much more on a real sector, while fear of floating literature stresses merely 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 having own currency by the exchange rate variability or pressures. Our supposition is that if exchange rate volatility is substantial or exchange rate pressures high, it indicates that 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 OCA and fear of floating literature implies that more open country will incline to limit their exchange rate volatility. In a similar manner, the utility from maintaining own currency decreases when the economic size of a given 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 economic structure of EU core countries (such as Austria or Germany) is substantially more similar in comparison to remaining EU countries (Fidrmuc and Korhonen, 2003).

III. Empirical Methodology

A growing body of literature (see e.g. Calvo and Reinhart, 2002 or von Hagen and Zhou, 2005) suggests 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 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 the1990s. 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, a combination of 20 countries leads to 190 observations.

We estimate the following equation:

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

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

We measure bilateral exchange rate variability as

$$VOL_{ij} = SD\left[\Delta\left(\log e_{ij}\right)\right] \quad (2)$$

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

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

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

[5] Weimann (2003) argues that 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 fluctuation margins in ERM, while free elsewhere. This is right in bilateral target zone. In fact, it does not have to be in the multilateral target zone. Indeed, Serrat (2000) shows that the exchange rate volatility in multilateral target zones may increase under some conditions, as compared to free float.

[6] We collected data underlying variables VOL_{ij}, $DOLVAR_{ij}$ and FIN_{ij} from 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 Directions of Trade – IMF and the World Bank databases and variable $DISSIM_{ij}$ from the Monthly Statistics of Foreign Trade-OECD.

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

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

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

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

$$\mathrm{Pr}\, essure_{ij} = SD\left[\lambda\Delta\left(\log(e_{ij})\right) + \eta\left(Intervention_i - Intervention_j\right) + \mu\Delta r_{ij}\right], \qquad (4)$$

Δr_{ij} represents the difference between short-term interest rates between i-th and j-th country (data collected from IMF's IFS). The 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 a series with greater volatility), as opposed to BE original methodology that has simply assumed $\lambda = \eta = \mu = 1$. This choice is motivated to provide sensitivity analysis in the measurement of exchange rate pressures.

We estimate each cross-sectional equation by the generalized method of moments (GMM), as the results of Hausmann-Wu test indicate that some explanatory variables are endogenous. In addition, it is noteworthy that even if the instruments are 'exogenous', they may be weak. Consequently, this would increase the asymptotic standard errors and reduce the power of hypothesis tests. Therefore, we examine the presence of weak instruments by Shea's test, which is particularly suited when there are multiple endogenous regressors.[9] For the sake of space, we omit ordinary least squares (OLS) results. Besides, OLS results are inconsistent.

[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 of reserves stands at 0.72 for the Czech Republic in 1999-2004 (we were unable to obtain these data for other countries in our sample).

[9] We use only Shea's measure of relevance of instruments, despite this test lacks distributional theory. All other tests rely on the assumptions not met in this paper. Hahn and Hausman (2002) provide the test only for one or two endogenous regressors and we identified 5 endogenous regressors. Yet, the test by Stock and Yogo (2004) assumes homoskedastic disturbances, which is also not the case in this paper.

IV. Results – Instrumental Variable Estimation

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

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 the website of Andy Rose: 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 the economies, USA dummy and exogenous variables.[10] Additionally, we provide the detailed descriptive statistics on all 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 relevance of instrumental variables in case of multiple endogenous variables. Thus, it can pinpoint the possible presence of weak instruments, if 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. R-squared for remaining endogenous variables is much higher. Generally, it takes values between 0.4-0.8 (with an average of 0.4 for openness, 0.6 for trade links and 0.8 for the variability of dollar). Detailed results are available in Table 13 in the Appendix. Finally, we decide to exclude the variability of output and inflation differential from the estimation, as their inclusion causes most 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 various equations together to give some insights of the sensitivity of the estimates. The first two columns present the results with respect to only 'traditional' OCA criteria, while the remaining columns include additional factors.

[10] The use of central bank independence index as the 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 1000. Financial development coefficient multiplied by 10^8. *, **, *** - denotes the significance at 10%, 5% and 1%, respectively.

Generally, explanatory variables are typically significant with expected signs in all the specifications. Besides, the value of coefficients is stable across the specifications, to a large extent. Greater trade linkages robustly decrease bilateral exchange rate variability, while dissimilarity in commodity structure of bilateral exports tends to increase it. This dissimilarity reflects industry-specific shocks. These shocks are more similar, if countries reveal a comparative advantage in the same export industries. Greater openness is associated with smaller exchange rate variability as well as 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 a volatility of other currencies. Exchange rate volatility is substantially lower in European countries reflecting the existence of ERM. EU-core countries dummy is not positively associated with the exchange rate variability, which is in line with Fidrmuc and Korhonen (2003), who also do not find significant difference between EU-core and periphery countries in this respect.[11]

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

As aforementioned, there are reasons to examine the determinants of exchange rate pressures as well. Authorities may limit the exchange rate volatility, if they believe that it undermines country's stability and growth prospects. Nevertheless, they may only hardly limit exchange rate pressures, which arise, if the current exchange rate is not optimal.

Results for the exchange rate pressures, as depicted in Table 2, show similar and consistent pattern. Trade links as opposed to the results of BE are important in limiting the pressures. Industry-specific shocks do not seem to affect the pressures. The reason behind might be that policy makers typically do not react to industry-specific shocks. Openness is negatively associated to the pressures. It seems that more open countries are concerned with large exchange rate pressures, to a greater extent. In contrast to the results in Table 1, financial development is positively associated to exchange rate pressures. A likely explanation put forward by Devereux and Lane (2003) is that more financially developed countries are able to tolerate greater exchange rate pressures.

Table 2 – Variability of exchange rates 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 1000. Financial development coefficient multiplied by 10^8. *, **, *** - denotes the significance at 10%, 5% and 1%, respectively. Dependent variable in columns (1) - (4) is calculated as stated in the equation (4), while by the principal component method in columns (5) - (8).

Interestingly, the variability of dollar does not influence the extent of pressures. On the other hand, Europe dummy is significant with the negative sign suggesting that lower pressures were prevailing among these countries on a bilateral basis. The EU core dummy is not robustly associated with the pressures either.

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

V. 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 Eurozone. We predict the exchange rate volatility and pressures by what is called '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 (and pressures alternatively) and fundamentals is estimated for the developed countries (which is done is section III). In the second step, we calculate predicted exchange rate variability and pressures for CEECs on the basis of estimated structural relationship from the step one.

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

It is noteworthy that our approach is rather conservative estimate of readiness to adopt euro for two reasons. First, OCA criteria may be endogenous (Frankel and Rose, 1998). Frankel and Rose argue that common currency spurs the trade integration and, as a result, also the

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

synchronization of business cycles. In other words, post-accession patterns of the shocks may differ from those of pre-accession, as a result of the adoption of common currency. On the other hand, "the OCA endogeneity" effect may be rather small for highly open CEECs, which trade is already largely oriented towards Eurozone. Second, exchange rate itself may generate rather than absorb shocks. Borghuis and Kuijs (2004) find for the Czech Republic, Hungary, Poland, Slovakia and Slovenia that exchange rate have served "as unhelpful propagator of monetary and financial shocks than as a useful absorber of real shocks". In such case, net benefits from maintaining own currency decrease.

The list of CEECs in this paper is as follows: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic, Slovenia and Romania. To examine the aforementioned hypothesis, we first compute the descriptive statistics of 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 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 data prior this period are only partially informative in connection to euro adoption.

First, we examine OCA conditions in the CEECs. Namely, we focus on the 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 a quarterly data).[15]

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

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

[15] Dissimilarity of export commodity structure data ends in 2002, as we were unable to collect more recent figures. Also for some countries, the data were not available on a quarterly basis. Nevertheless, generally the commodity structure of exports tends to be quite stable over time, see Chart 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.

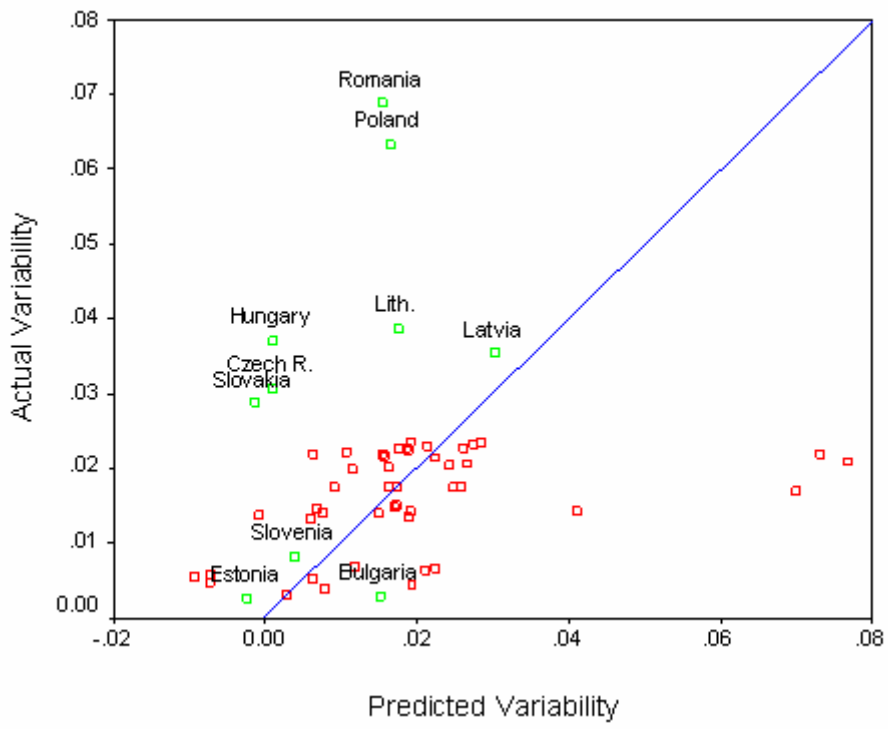
Table 3 – OCA conditions in the CEECs, 1999-2004

	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 II – Empirical methodology for the explanation how the variables have been calculated. The data are from 1999-2004 for the CEECs. OCA conditions for the CEECs are calculated with the EMU. In the last two rows, Eurozone values are the averages respectively GDP-weighted averages of all its current members OCA conditions in 1989-1998. CEECs trade intensity results based to the EU.

We find trade integration in the CEECs vis-à-vis Euro area topped by the Czech Republic, Estonia, Hungary and Slovakia. At the bottom, there is Bulgaria, Latvia and Poland. Nevertheless, the trade integration generally is very high reaching levels typical for Eurozone members. As regards dissimilarity in export commodity structure, there is a greater variety within the Eurozone countries in comparison to the CEECs exports to Eurozone. So, CEECs reveal their comparative advantage in the export sectors typical for Euro area. Next, most of CEECs perhaps except Poland and Romania are highly opened. 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 Eurozone presented in Table 3 are based on averaging over the bilateral relations among the countries. If we used weights (1998 GDP taken in our case), the results for Eurozone are more favorable in terms of their OCA conditions. Bilateral trade links within the Euro area countries increases considerably. The commodity structure of bilateral exports within the Euro area are 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 OCA conditions are favorable for most CEECs, they remain rather stable for a long period and do not change abruptly (see Chart 3-6 in Appendix) despite the pattern of shocks may change after joining Eurozone.

Chart 1 – Actual and Predicted Exchange Rate Volatility: Comparison of CEECs and 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 euro for the CEECs). The results in Chart 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, predicted exchange rate variability is roughly at the Eurozone levels. The obvious discrepancy in terms of the degree of exchange rate volatility between Euro area countries and the CEECs arises from a fact that while several CEECs maintain flexible exchange rates all Euro area countries participated in the ERM in the sample period and thus bounded their exchange rate fluctuations. This discrepancy disappears in case of exchange rate pressures, as shown below. It is also noteworthy that Latvia and Lithuania exhibit relatively large exchange rate volatility despite these countries maintained currency board arrangement thorough the sample period. This is because both countries did not anchor their currencies vis-à-vis euro during the whole sample period.

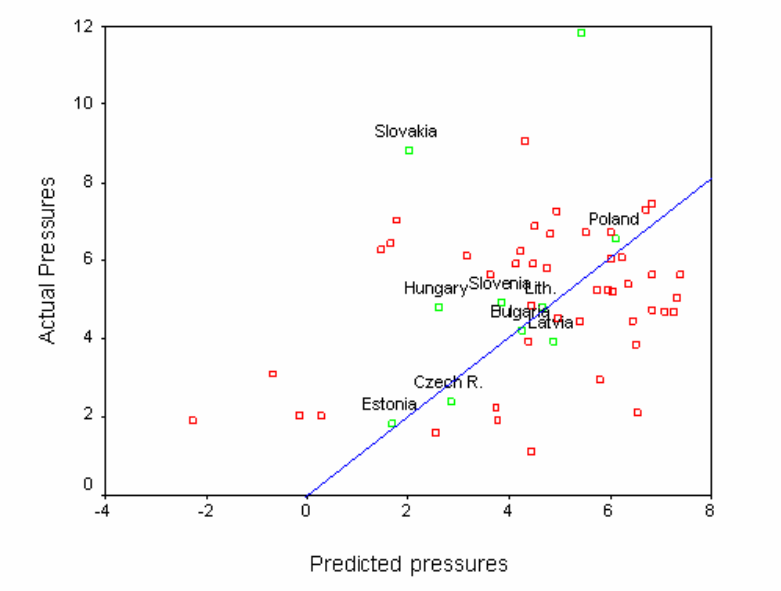
Table 5 – Actual and Predicted Exchange Rate Volatility: the CEECs, 1999-2004

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

Chart 2 – Actual and Predicted Exchange Rate Pressures: CEECs and Eurozone



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

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

Next, we examine exchange rate pressures for the CEECs. The results in Chart 2 suggest that CEECs experience exchange rate pressures at the level typical for Euro area countries. Estonia, Czech Republic, Slovakia and Hungary have the smallest pressures predicted 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 explaining the underlying reasons for this difference. This difference may be a reason of several factors such as credibility of economic policies, rigidity of labor markets, or speculative attacks (for example, speculative attack on the Hungarian forint in January 2003). Alternatively, the difference between 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 actual and predicted pressures is large, would in comparison to other countries benefit the most from adopting euro.

We present detailed results on actual and predicted exchange rate pressures in Table 7. Interestingly, pressures seem to be lowest in Estonia and the Czech Republic among the CEECs. On the other hand, Slovakia and Romania experience quite large pressures in 1999-2004. Predicted pressures are largely correlated with those 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 based on Table 2, column 2.

Overall, the results suggest that most of the CEECs fulfill the necessary condition for joining monetary union, e.g. are relatively well aligned with the Euro area. Nevertheless, it would be hasty to advise the countries to join the Euro area as soon as possible, even if one believes that the CEECs may benefit from large currency union in the long-term (as OCA conditions

suggest).[17] This is so, because it is necessary to consider a number of additional economic policy issues (e.g. nominal convergence) over the medium-term to ensure the smooth adoption of common currency.

VI. 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 variables pointed by the optimum currency area theory explain the dynamics of exchange rates and exchange rate pressures, to a large extent. There is also certain evidence that more open economies fear floating. Greater variability of US dollar increases exchange rate variability, but not pressures. Results are also not in support of significant difference between the EU core and EU periphery. European economies face bilaterally both weaker exchange rate variability and 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 experience both low exchange rate variability and pressures. However, overall our model implies that the current levels of exchange rate variability and pressures are at the level of Euro area countries before their euro adoption. This is so, 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.

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Appendix 1 – Measurement of Explanatory Variables

Appendix 1 lists the formal derivation of all explanatory variables.

Business cycles synchronization:

$BCS_{ij} = SD\left(\Delta y_{it} - \Delta y_{jt}\right)$, where SD denotes sample standard deviation, Δy_i stands for the year-on-year real GDP growth of country *i* (analogously for country *j*). *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*, 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 export in current prices from country *i* to country *j* at time *t* (analogously for country *j*). y_{it} is GDP in current prices country *i* at time *t*.

Economic size:

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

USD Variability:

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

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 $\bar{X}_1$.

Note:
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
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 the economies and USA dummy.
It is noteworthy that as the dependent variable is irrelevant for the results of Shea test, it is adequate to report the above four specifications.

Chart 3 – Openness

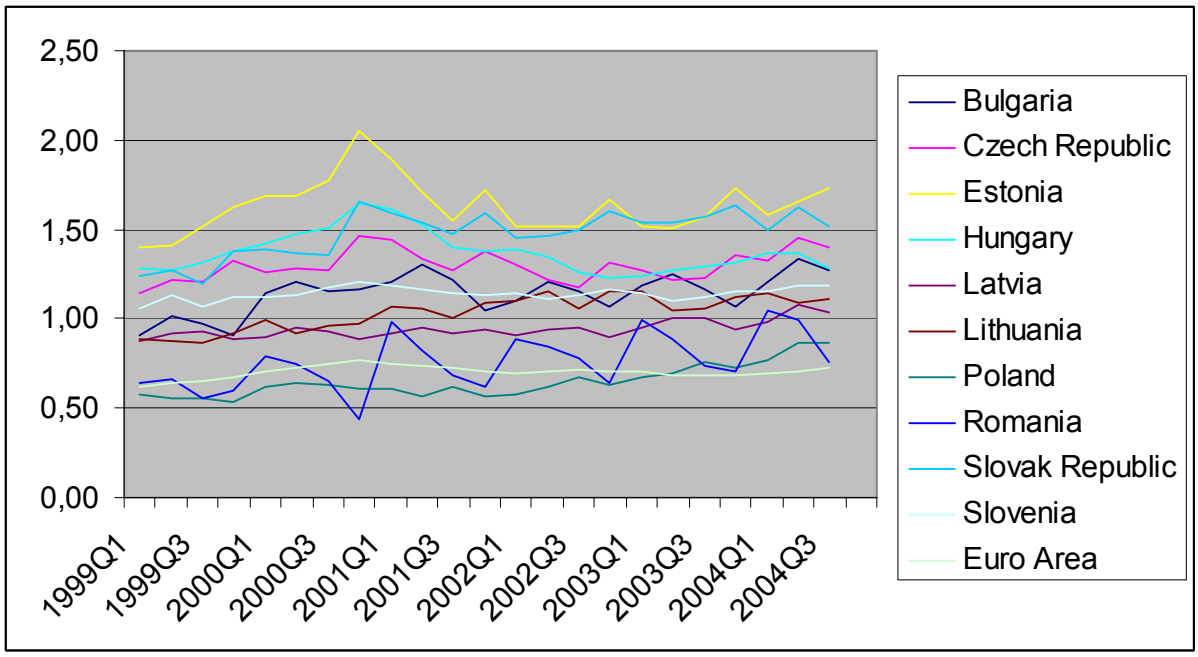


Chart 4 – Trade Links

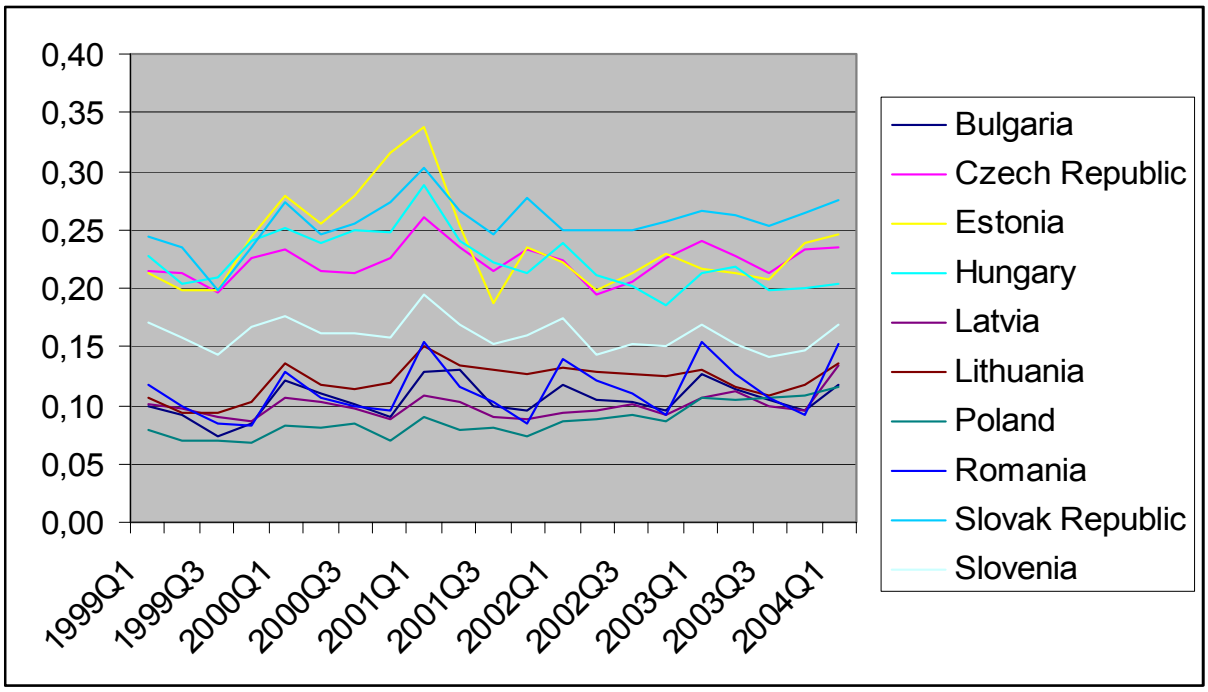


Chart 5 – Financial Development (M2/GDP)

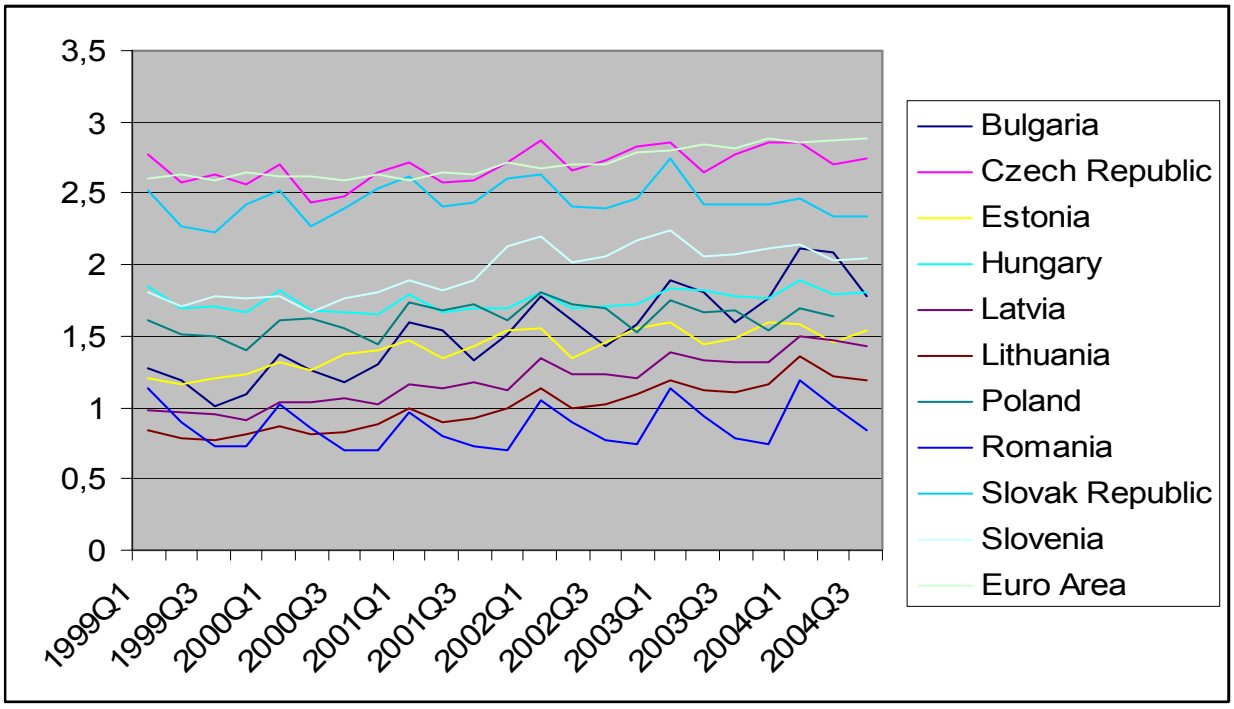
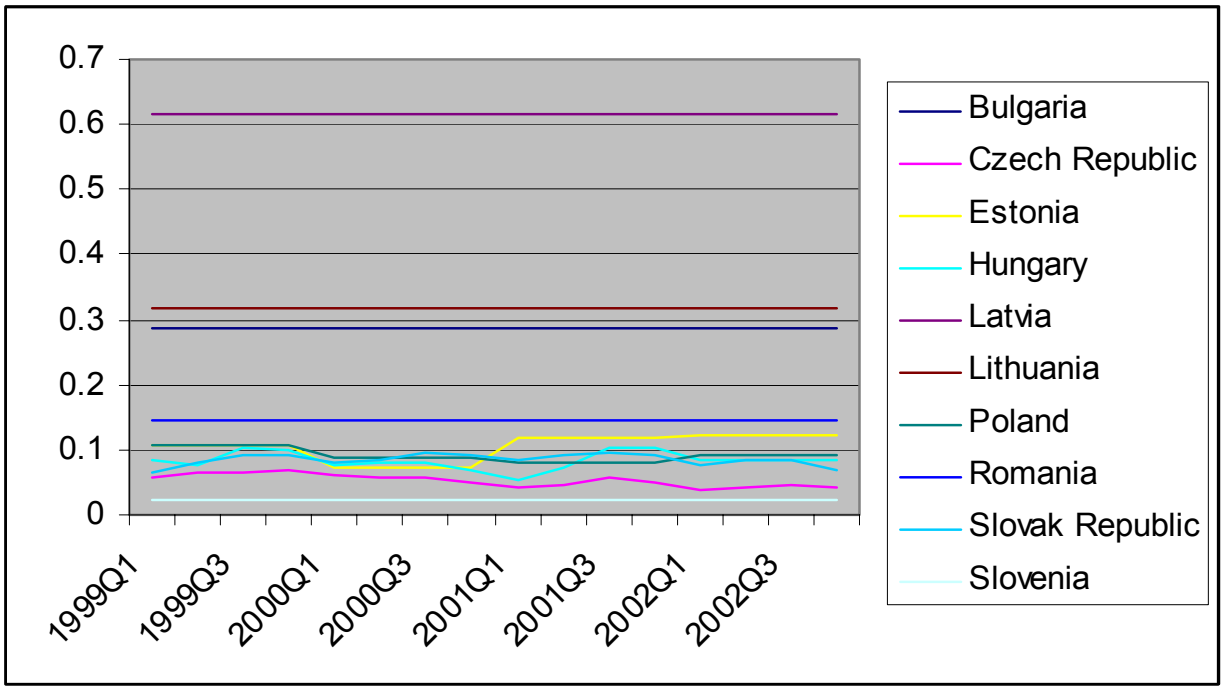
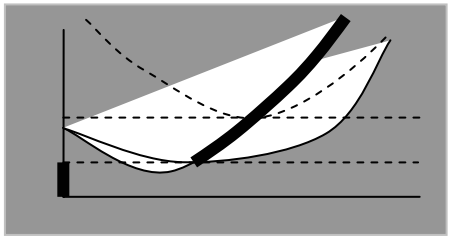


Chart 6 – Dissimilarity in Export Commodity Structure





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