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# Real Exchange Rates and Optimum Currency Areas: Evidence from Developed Economies

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## 1. Introduction

In this paper we investigate the link between the variability of real exchange rate and various optimum currency area (OCA) criteria such as trade integration, openness, commodity export structure and correlation of output. Real exchange rate is more volatile because of asymmetric shocks that are more common when countries form an optimum currency area only to a limited degree.

We use data from developed economies to examine this link, but in our opinion the results are equally relevant to accession countries. Therefore we provide some discussion on their optimal timing of euro adoption from the point of view of the methodology applied here.

Traditional approaches estimate equilibrium real exchange rates and consider factors such as terms of trade, foreign direct investment or trade structure. Here we follow a different methodology focusing on the second moment of real exchange rate. This approach is relevant for policy analysis, too. Countries should look at their optimum currency area criteria to assess costs and benefits when considering joining the monetary union as it *inter alia* affects variations in real exchange rates. Nowadays, this is especially important for policy makers in new EU member countries and other EU accession countries.

We find that the criteria pointed out by the literature on optimum currency areas indeed explain a considerable part of real exchange rate variation. These criteria include the correlation of output movements, degree of trade integration, similarities in commodity structure of exports and openness. In addition, we find that financial development and economic size affect the volatility of real exchange rates. We control for participation in Exchange Rate Mechanism (ERM) and also for some other institutional settings. Interestingly, the results indicate that ERM participation limits the real exchange rate variation.

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The paper is organised as follows. The next section is a short survey of the OCA theory and its criteria. Section 3 offers some empirical research of the OCA theory. In section 4 we explain the real exchange rate approach we use in our paper. Section 5 describes the data and the methodology used in our analysis. In section 6 and 7 we provide empirical results from the OLS and the IV estimation, respectively. Finally, in section 8 we summarise our results and offer some concluding remarks.

## 2. The OCA Theory and its Criteria

The OCA theory started with the seminal contributions by Mundell (1961), McKinnon (1963), and Kenen (1969). Three main *OCA criteria for monetary integration* arose from this debate. Mundell (1961) defined *the mobility of factors of production including labor* as the first criterion. High factor market integration and sufficient factor mobility within a group of partner countries can reduce the need to alter real factor prices, and the nominal exchange rate, between countries in response to disturbances. If one country suffers a depression due to a negative shock, factors of production may move from this country to another which is hit by a positive shock. Hence, prices of these factors do not need to fall so sharply in the depressed country and rise in the booming country. The factor mobility is then able to compensate for the exchange rate changes.

The second criterion, designated by McKinnon (1963), is the *degree of economic openness*. The higher the degree of openness the more changes in international prices of tradables are likely to be transmitted to the domestic cost of living. Also devaluation would be more rapidly transmitted to the price of tradables and the cost of living, negating its intended effects. Hence, the nominal exchange rate would be less useful as an adjustment instrument for small open economies.

Kenen (1969) outlined the third criterion: the *diversification in production and consumption*. A high diversification in production and consumption diminishes the possible impact of shocks specific to any particular sector. Therefore diversification reduces the need for changes in the terms of trade via the nominal exchange rate and provides "insulation" against a variety of disturbances. More diversified partner countries are more likely to endure small costs from forsaking nominal exchange rate changes amongst them and find a common currency beneficial.

Other criteria include *price and wage flexibility*. When nominal prices and wages are flexible between and within countries contemplating a common currency, the transition towards adjustment following a shock is less likely to be associated with sustained unemployment in one country and/or inflation in another. This will lessen the need for nominal exchange rate adjustment. In this case the loss of direct control over the nominal exchange rate instrument need not represent a cost. Price and wage flexibility are particularly important in the very short run, when the factor mobility is partly restricted, to facilitate the adjustment process following a shock. Permanent shocks will entail permanent changes in real prices and wages.

One very important criterion is the *similarity of supply and demand*

*shocks and business cycles* in countries using a common currency (or having their exchange rates fixed). Monetary and exchange rate policy cannot be used as a stabilisation tool if a member country is, for example, hit by an asymmetric shock. Hence, business cycles of countries considering creation of a currency area must be correlated to a large extent.

*Fiscal transfers* are part of a non-market based adjustment process. The aim is the redistribution of financial transfers from relatively richer to relatively poorer countries or from countries hit by a positive shock to countries hit by a negative shock. However, these two aims could be inconsistent: a country hit by a positive shock could be at the same time a relatively poorer country. Moreover, the system of fiscal transfers requires a certain degree of political integration.

Another criterion, *financial market integration*, can reduce the need for exchange rate adjustment. It allows, among other things, to cushion temporary adverse disturbances through capital inflows (by borrowing from surplus areas or decumulating net foreign assets that can be reverted when the shock is over). Under a high degree of financial integration even modest changes in interest rates would elicit equilibrating capital movements across partner countries. This would reduce differences in long-term interest rates, easing the financing of external imbalances but also fostering an efficient allocation of resources.

*Similarities of inflation rates* are also needed to create an OCA. External imbalances can arise from persistent differences in national inflation rates resulting, *inter alia*, from: disparities in structural developments, diversities in labor market institutions, differences in economic policies, and diverse social preferences. When inflation rates between countries are similar over time, terms of trade will also remain fairly stable. This will foster more equilibrated current account transactions and trade, and reduce the need of nominal exchange rate adjustment.[1]

The OCA theory provides a set of criteria that countries willing to proceed with monetary unification should satisfy in order to minimize the costs of joining a monetary union, i.e. the cost of losing the independent monetary policy and the exchange rate tool.

## 3. Eastern Eurozone Enlargement in the Context of the OCA Theory

Soon before the final introduction of the European currency there were negotiations on a further enlargement of the Eurozone to the Eastern and Central European Countries (CEECs). The accession of ten CEECs to the Eurozone is likely to happen within the next ten years and it is an important issue to assess whether these candidates are better or worse suitable for Eurozone membership than current participants.

Many of the empirical papers are focused on the correlation of economic activity across current and potential monetary union members. Countries

[1] On the other hand, not all inflation differentials are necessarily problematic. A "catching up" process by less developed candidate countries could lead to the Balassa-Samuelson effect until the process is completed.

that enter a monetary union are likely to experience dramatically different business cycles than before. In part this will necessarily reflect the adoption of a common monetary policy, but it will also be a result of closer international trade with other members of the union. Closer international trade could result in either tighter or looser correlations of national business cycles.

In the field of empirical research, one of the most important contributions is the paper of Frankel and Rose (1998). The authors argue that some of the OCA criteria are endogenous and are likely to converge once the countries join the monetary union. These criteria are international trade and business cycles. Frankel and Rose (1998, p. 1024) state, that: "[...] some countries may appear, on the basis of historical data, to be poor candidates for EMU entry. But EMU entry per se, for whatever reason, may provide a substantial impetus for trade expansion; this in turn may result in more highly correlated business cycles. That is, a country is more likely to satisfy the criteria for entry into a currency union ex post than ex ante."[2] This hypothesis is sometimes called the "*endogeneity hypothesis*". Additionally, Fidrmuc (2004) enriches the endogeneity hypothesis by showing empirically that it is the degree of intra-industry trade rather than trade itself that induces business cycle synchronization.

There is also another hypothesis which states that closer international trade could result in looser correlations of national business cycles. Krugman (1993) argues that business cycles could become more idiosyncratic. As countries become more integrated they will also specialize in the production of those goods and services for which they have a comparative advantage. Members of a currency area would become less diversified and more vulnerable to supply shocks. Correspondingly their incomes will become less correlated, resulting in more idiosyncratic business cycles. Therefore, if membership in a currency area does not appear optimal *ex ante*, it will be even less optimal *ex post*. This is the well-known "*Krugman specialization hypothesis*".

Moreover, there could exist other problems concerning joining the Eurozone. As a result of the convergence criteria, each EU member country will have to peg its currency to the euro at least two years before joining the Eurozone and be able to keep the exchange rate fluctuations within a maximum band of $\pm 15$ % or preferably $\pm 2.25$ % (i.e. participation in the ERM2). During this period, national macroeconomic policy will be restricted only to the extent that requires meeting the convergence criteria. However, after joining the Eurozone a common monetary policy is entrusted to the European Central Bank and member countries consequently lose their independence concerning this important stabilization tool including the exchange rate. In addition, due to the Stability and Growth Pact, there are also limits on the extent to which fiscal policy can be used for macroeconomic stabilization. Moreover, if prices and wages are not flexible, national labor and financial markets are not sufficiently integrated in order to ensure good factor mobility, and system of fiscal transfers does not exist, the only absorption mechanism is a similarity of supply and demand shocks

[2] The paper of Frankel and Rose (1998) is thus an application of the well-known Lucas Critique.

and business cycles of currency union member countries. Countries that are exposed to symmetric shocks tend to have more synchronized business cycles and thus similar policy preferences.

There are many approaches for assessing a country's readiness to join a currency union: for example, correlation of supply and demand shocks, correlation of business cycles, convergence of monetary policy and the OCA index (structural convergence). These four approaches are interesting especially in the context of the above-mentioned endogeneity hypothesis and correlation of economic activity. For a detailed survey of these studies see (Kučerová, 2005). There are other suitable approaches as well, for example approaches that include labor mobility surveys, production diversification analyses, portfolio diversification analyses or nominal and real convergence.

## 4. The Real Exchange Rate Variability Approach

According to Mundell (1973), the currency unions are beneficial for the member countries as regards dealing with the volatility of real exchange rate. However, he also stresses that the possibility of future relative price changes (appreciation/depreciation) brings uncertainty into the world economy. Therefore, Mundell also emphasizes that the benefits from the common currency may be limited if the adoption creates large movements in prices. Thus, it seems reasonable that ideal candidates for the common currency should form an optimum currency area to a high degree.

According to Vaubel (1976, p. 40), the crucial criterion is the variability of the real exchange rate since "real exchange rate changes are clearly measurable and automatically give the appropriate weights to the economic forces of which they are the result". Gros and Hobza (2003) also measure the real exchange rate flexibility and find it an informative OCA criterion: "[...] when we observe that the real exchange rate between two currencies is stable, it could be argued that in these two countries there were not many (asymmetric) shocks that required real exchange rate changes" (p. 10).

In addition, a growing body of literature also shows it may not be appropriate to look at putative official exchange rate regimes as they differ from *de facto* regimes. Von Hagen and Zhou (2002) examine the choice of the exchange rate regimes in 25 transition economies and find discrepancies between official and actual (*de facto*) exchange rate regimes. This gives further support for the methodology applied here.

In our paper, we follow this line of distinction between *de jure* and *de facto* and apply methodology introduced by Bayoumi and Eichengreen (1997). This methodology fully accounts for two essential issues: It models the actual exchange rate regimes and the multiple interdependencies among countries. Nevertheless, while Bayoumi and Eichengreen present only estimates with nominal exchange rates, we work with real exchange rates.

## 5. Data

We examine the determinants of bilateral real exchange rate variability for 20 developed countries. These are 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.[3] The data sample contains twenty countries for the period from 1989 to 1998, which we label for convenience as representing the 1990s.

The regression equation we estimate is as follows:

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

The regressand in equation (1) stands for the bilateral exchange rate variability. $X_{ij}$ represents a vector of optimum currency area (OCA) variables, namely the asymmetry of business cycles [$SD(\Delta y_i - \Delta y_j)$], trade linkages ($TRADE_{ij}$), dissimilarity of export commodity structure ($DISSIM_{ij}$), openness ($OPEN_{ij}$) and economic size ($SIZE_{ij}$), all between country $i$ and $j$. $FIN_{ij}$ assesses the level of financial development and $ERM_{ij}$ is a dummy variable that takes on the value 1, if both country $i$ and $j$ participate in ERM.[4] $DOLVAR_{ij}$ captures the effect of the variability of the U.S. dollar. The $EUcore_{ij}$ dummy assesses the hypothesis of significantly higher economic convergence among the following countries: Austria, Belgium, Germany, Netherlands and Switzerland.

We calculate bilateral real exchange rate variability as:

$$VOL_{ij} = STDEV\left[d\left(\log(e_{ij}\frac{p_i^*}{p_j})\right)\right] \quad (2)$$

$VOL_{ij}$ is the standard deviation of the change ($d$) from the month $t$ to $t$+1 in the logarithm of nominal exchange rate ($e_{ij}$) between countries $i$ and $j$. $P_i^*$ stands for foreign price level, while $P_i$ is domestic price level.[5] Optimum currency area variables are constructed as follows: $SD(\Delta y_i - \Delta y_j)$ is the standard deviation of the difference in the logarithm of real output between $i$ and $j$, $DISSIM_{ij}$ is the sum of the absolute differences in the shares of agricultural, mineral, and manufacturing trade in total merchandise trade, $TRADE_{ij}$ is the average of the ratio of bilateral exports to domestic GDP for the given two countries, $SIZE_{ij}$ is the mean of the logarithm of the two GDPs measured in U.S. dollars and $OPEN_{ij}$ is an arithmetic mean of the $i$-th and $j$-th country ratio of trade (export + import) to its GDP. $FIN_{ij}$ is constructed as an average of the ratio of broad money to corresponding GDP again bilate-

[3] We exclude Greece due to the lack of data.

[4] Even if one of the countries did not participate in ERM over the whole sample period (such as Finland or Italy), the value of dummy is one. We collected data on variable $VOL_{ij}$ and $FIN_{ij}$ from IMF's IFS online, $SD(\Delta_{yi} - \Delta_{yj})$ was computed from the World Bank databases, $TRADE_{ij}$ was calculated using the Directions of Trade – IMF and the World Bank databases, variable $DISSIM_{ij}$ from the Monthly Statistics of Foreign Trade – OECD and $SIZE_{ij}$ and $OPEN_{ij}$ from the World Bank data.

[5] Alternatively, internal real exchange rate (the ratio of tradable to non-tradable prices) could be used. In the case of "catching-up" countries, modeling the tradable and non-tradable price dynamics might be of special importance – see (Coricelli – Jazbec, 2004) due to the presence of the Balassa-Samuelson effect. Nevertheless, the results of Alberola and Tyrvainen (1998) indicate that for developed European countries this effect is weak and thus we opt for equation (2) as the preferable specification in our paper.

rally for country $i$ and $j$. $DOLVAR_{ij}$ is simply an arithmetic average of the variability of the U.S. dollar exchange rates for each country pair. $DOLVAR_{ij}$ takes on a zero value when USA is one of the pair of the countries.

All original data are of quarterly frequency (end of period data are used). However, we take average or standard deviation of all the variables over time (as apparent from the above description). As a result, our final data matrix is cross-sectional. Given that the data are bilateral, the mathematical combination of bilateral relationships among 20 countries leads to 190 observations in our data matrix.

We estimate all our cross-sectional equations by OLS at first. However, it is reasonable to suspect some of the explanatory variables in the analyzed equations to be endogenous. For example, more volatile exchange rate changes may affect the trade integration as well as asymmetry of shocks. As a result, standard OLS estimates are inconsistent. Hence we instrument the equations in the attempt to eliminate this inconsistency. We draw our set of instruments from the gravity models.[6] Nevertheless, this is not the whole story. Even if the instruments are exogenous, they may be weak. Consequently, this increases the asymptotic standard errors and reduces the power of hypothesis tests.

Recently, there have been enormous advancements in the understanding of validity of instruments when there is more than one endogenous regressor. Several papers address the issue and propose how to test formally for the extent of correlation between the instruments and the included endogenous variables in the linear instrumental variable (IV) regressions. Horvath (2005) discusses these issues in greater detail.

Because our data does not fulfil the requirements for the other test such as those proposed by Hahn and Hausmann (2002) or Stock and Yogo (2003), we provide Shea's measure of relevance of instruments.

Shea (1997) proposes to compute the sample partial $R^2$ for each endogenous regressor. Unfortunately his approach lacks any distributional theory, but may serve as a rule of thumb. E.g. there is a finding by Devereux and Lane (2003) that partial $R^2$ for some of their endogenous regressors is close to zero, suggesting the presence of weak instruments.

In this regard, it is interesting to note the following. Weimann (2003) argues that this 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. However, Serrat (2000) shows that the volatility in multilateral target zones may increase as compared to free float. Hence, one may argue that this issue does not necessitate a problem.

## 6. Results – OLS Estimation

In this section we provide an estimation of determinants of real exchange rate variability by the OLS method. First, we present the results in *Table 1*.

[6] Most of these instruments we downloaded from the website of Andy Rose: www.haas.berkeley.edu/~arose.

TABLE 1 Determinants of Real Exchange Rate Variation

| Variable | (1) | | (2) | |
|---|---|---|---|---|
| | Coefficient | *t*-Statistic | Coefficient | *t*-Statistic |
| Variability of output | 0.17 | 3.57 | 0.22 | 4.38 |
| Trade linkages | –0.02 | –3.29 | –0.02 | –3.79 |
| Dissimilarity of exports | 0.01 | 2.83 | 0.01 | 2.76 |
| Openness | –0.0002 | –4.32 | | |
| Size of economy | | | 0.005 | 4.22 |
| Financial development | 2E-09 | 4.46 | 2E-09 | 5.6 |
| Variability of dollar | 0.03 | 1.52 | 0.06 | 2.94 |
| ERM | 0.002 | 0.45 | –7E-05 | –0.02 |
| EU core | –0.01 | –7.03 | –0.01 | –7.1 |
| *R*-squared | 0.63 | | 0.63 | |

*Note*: White Heteroskedasticity-Consistent Standard Errors and Covariance

*R*-squared is high, all coefficients yield the expected signs and almost all variables are significant (measured by *t*-Statistic).

According to our results from Table 1, *variability of output* has a strong and significant effect on real exchange rate variability. Thus, the cyclical fluctuations of output had an adverse impact on real exchange rate movements in the 1990s. Therefore, economic cooperation between the countries (especially monetary union member countries) is of high importance to precede large real exchange rate fluctuations. This finding is relevant also for accession countries which intend to join the Eurozone as soon as possible, because premature adoption of the euro could cause high real exchange rate volatility and subsequently, bring higher uncertainty in development of relative prices.

Other significant variables are *trade linkages* and *dissimilarity of exports*. The positive role of international trade in the process of monetary integration and its impact on business cycle correlation has been *inter alia* emphasized by Frankel and Rose (1998b). Our results verify that higher bilateral trade together with high similarity of exports led to lower real exchange rate volatility in selected developed countries in the 1990s. According to this, high trade integration with EU (especially Eurozone) member countries could help accession countries to reduce exchange rate fluctuations during and after the process of Eurozone integration.

Both *openness* and *size of economy* have a significant effect on real exchange rate variability. With increasing openness of the economy the real exchange rate variability decreases. Open economies are cautious about their competitiveness, and central banks sometimes implicitly target real exchange rates. In the case of *size of economy* the dependence was positive: relatively large economies faced higher real exchange rate volatility than relatively small economies. This is understandable. Small economies influence terms of trade only to a limited extent. The independence of their monetary policy is limited as well.

In this regard, these results look favorable for accession countries because the majority of them are small and open economies. According to these

TABLE 2 Determinants of Real Exchange Rate Variation with dummy Europe

| Variable | (1) | | (2) | |
|---|---|---|---|---|
| | Coefficient | *t*-Statistic | Coefficient | *t*-Statistic |
| Variability of output | 0.19 | 5.21 | 0.19 | 4.78 |
| Trade linkages | –9E-03 | –2.14 | –0.01 | –2.11 |
| Dissimilarity of exports | 0.006 | 3.13 | 0.006 | 2.99 |
| Size of economy | | | 3.1E-04 | 0.30 |
| Openness | –7E-05 | –2.01 | | |
| Financial development | 1.3E-09 | 4.67 | 1.4E-09 | 3.97 |
| Variability of dollar | 0.09 | 4.42 | 0.1 | 4.54 |
| EU core | 0.007 | 2.26 | 0.006 | 1.85 |
| Europe dummy | –0.03 | –13.8 | –0.03 | –13.7 |
| *R*-squared | 0.78 | | 0.77 | |

*Note*: White Heteroskedasticity-Consistent Standard Errors and Covariance

OCA criteria, adoption of the euro single currency will thus be beneficial for accession countries in the long run, as measured by real exchange rate variability.

As regards *financial development* the coefficient is significantly positive albeit very low. (However, one has to be cautious about the value of regression coefficients, as OLS may in fact be inconsistent. We tackle this issue in the next section). In the world of unrestricted capital movements and global financial markets this finding is somewhat surprising. It suggests that higher level of financial development is accompanied by greater variations in real exchange rates, but it may be a consequence of using the ratio of M2 to GDP as a proxy.

*ERM* membership does not seem to have an effect on real exchange rate variability. When accounting for endogeneity of explanatory variables, we find that ERM limits the real exchange rate variation (see the next section). On the contrary, *variability of dollar* seems to be significant in OLS estimation and its significance varies when estimated by GMM. Naturally, larger movements in USD generate more variation in bilateral real exchange rates.

Results in the case of dummy *EU core* confirm that higher economic convergence between the EU core countries reduced the exchange rate fluctuations among these countries in the 1990s.

We have further estimated regressions, in which we have excluded dummy *ERM* and included dummy *Europe* instead. The results are given in *Table 2*. *R*-squared increased and all variables, except for *size of economy*, are significant. Hence this model seems to explain real exchange rate variability even better.

The new *dummy Europe* is significant and explains real exchange rate variability in the analyzed countries in the 1990s better than dummy ERM when estimated by OLS. According to our results, European countries experienced lower bilateral real exchange rate fluctuations than non-European countries. So the "economic" borders of the EU contain also non-EU Western European countries included in our sample. This is appealing as Switzerland and Norway value the stability of their currencies, because they are highly integrated by trade with EU economies. Lastly, *variability*

*of output*, *dissimilarity of exports*, and *variability of dollar* remain significant.

As regards the effect of *trade linkages*, *openness*, and *EU core* variables, the coefficients are all significant albeit relatively small in size. Nevertheless, these variables help to explain real exchange rate fluctuations in selected developed countries in the 1990s. Notice that dummy *EU core* has an opposite sign. This further suggests that instrumenting the equation may be a good idea. Indeed, we find that the EU core variable does not help in explaining bilateral real exchange rate variations in line with Fidrmuc and Korhonen (2003). Fidrmuc and Korhonen argue that it is difficult to find substantial differences between so-called EU core and EU periphery countries. In contrast to the previous results the *size of economy* does not seem to play an important role in explaining real exchange rate variability.

Nevertheless, if explanatory variables are correlated with the error term, OLS estimates are biased and inconsistent. That is why we apply an instrumental variables estimation in the next section.

## 7. Results – IV Estimation

In this section we provide an estimation of the determinants of real exchange rate variation by the generalized method of moments (GMM). This is because there is good reason to believe that movements in real exchange rates influence the degree of trade integration, openness, correlation of output movements and variability of USD.

For this reason we perform a Hausman specification test and indeed find that these four variables are endogenous ($p$-value of the test was 0.0002). We instrument the exogenous variables by the following set of instruments: log (distance) and its square, regional trade agreement dummy, common language dummy, common border dummy, size of the economies, USA dummy and exogenous variables.

First of all, we assess the relevance of the instruments. When instruments are not informative for endogenous variables, the estimated regression coefficients, while consistent, may be severely biased. We document this issue below. We apply Shea's measure of relevance of instruments. This approach lacks any distributional theory, but still may locate the presence of weak instruments.[7] *Table 3* indicates that the instruments for variability of output are not very informative, as the corresponding $R$-squared is considerably low. Indeed, when we include the variability of output in our instrumental variables estimation, the results do not look convincing. Some regression coefficients have the "wrong sign" and the fit is poor. As a result, we exclude variability of output movements in our GMM estimation.

Next, we perform a test for overidentifying restrictions (Sargan's test). In any case we cannot reject the null hypothesis at any reasonable level of sig-

[7] Unfortunately, any other existing test for the presence of weak instruments is not applicable for our data.

TABLE 3 Relevance of Instrumental Variables

| Table 1-2 | Trade links | Variability of output | Openness | USD variability |
|---|---|---|---|---|
| Equation (1) | 0.41 | 0.08 | 0.23 | 0.64 |
| Equation (2) | 0.44 | 0.05 | – | 0.67 |

*Note*: Shea's partial *R*-squared. Columns (1) and (2) from tables 1-5 are not reported.

TABLE 4 GMM Estimation of Determinants of Real Exchange Rates Variation

| Variable | Coefficient | *t*-Statistic | Coefficient | *t*-Statistic |
|---|---|---|---|---|
| Trade linkages | -0.03 | -3.8 | -0.04 | -5.21 |
| Dissimilarity of exports | 0.005 | 1.80 | 0.002 | 0.97 |
| Openness | -0.0003 | -5.64 | | |
| Size | | | 0.006 | 5.63 |
| Financial development | 3E-09 | 7.28 | 4E-09 | 12.5 |
| Variability of dollar | 0.01 | 0.41 | 0.015 | 0.53 |
| EU core | 0.0001 | 0.03 | -0.003 | -1.09 |
| ERM | -0.006 | -3.18 | -0.005 | -3.12 |
| *J*-statistic | 0.021 | | 0.014 | |

*Note*: White Heteroskedasticity-Consistent Standard Errors and Covariance

nificance and thus instruments are possibly uncorrelated with the estimated error term.[8]

We report the result for IV estimation in *Table 4* and *5*.

Beginning with the estimates from Table 4, the importance of *openness*, *size of economy*, *trade linkages*, and *financial development* also slightly increased as measured by the value of regression coefficients. Our results confirm some of the conclusions of the OCA theory. According to McKinnon (1963), for small and open economies it is preferable to fix their exchange rate. Interestingly, the level of financial development increases the real exchange rate variability.

With the GMM estimation the effect from participation in *ERM* becomes negative and significant. Thus, GMM estimation reveals a positive role played by ERM membership in reducing the real exchange rate fluctuations during the 1990s.

There are three variables that are not significant in the specification in Table 4: *dissimilarity of exports*, *variability of dollar*, and dummy *EU core*. It is noteworthy that Horvath (2005) finds that the variability of the dollar influences bilateral nominal exchange rate variability. This would suggest that price movements offset the effect of USD on local currency. Using the second specification (in Table 5) the issue is less clear, as the variability of the dollar becomes significant. Also, dissimilarity of export commodity structure seems to be significant at a 10% significance level in *Table 5*.

Table 5 reports our results again after dropping dummy *ERM* from the estimated equations and including *dummy Europe* using the GMM estima-

[8] We present the *J*-statistic in Table 4 and 5. Multiplying this statistic by the number of observations and comparing with the $\chi$-square distribution is Sargan's test. The degrees of freedom are equal to the overidentifying restrictions, i.e. the difference between the number of instruments and parameters.

TABLE 5 GMM Estimation of Determinants of Real Exchange Rates Variation with dummy Europe

| Variable | Coefficient | *t*-Statistic | Coefficient | *t*-Statistic |
|---|---|---|---|---|
| Trade linkages | –0.02 | –4.46 | –0.021 | –4.29 |
| Dissimilarity of exports | 0.004 | 1.95 | 0.003 | 1.80 |
| Openness | –0.0001 | –2.31 | | |
| Size | | | 0.002 | 1.96 |
| Financial development | 2E-09 | 8.27 | 2.84E-09 | 8.46 |
| Variability of dollar | 0.064 | 2.74 | 0.065 | 2.67 |
| EU core | 0.003 | 1.08 | 0.001 | 0.22 |
| Europe dummy | –0.016 | –7.36 | –0.016 | –6.91 |
| *J*-statistic | 0.006 | | 0.006 | |

*Note*: White Heteroskedasticity-Consistent Standard Errors and Covariance

tion. The *Europe dummy* remains significant in our GMM estimation though the value of the coefficient is lower than in our OLS estimation. Still it has a large impact on the real exchange rate fluctuations measured by the value of the regression coefficient. European countries thus experienced lower real exchange rate fluctuations than non-European countries.

## 8. Conclusions

This paper contributes to the discussion concerning the applicability of the OCA theory. We link OCA criteria with bilateral real exchange rate variation. We find that OCA criteria such as trade linkages, openness and size of economy or financial development explain a substantial part of real exchange variability. We do not find clear evidence that variability of the dollar had an effect on the real exchange variability in the analyzed countries in the 1990s. Also, the significance of the dissimilarity in export commodity structure varies, but still it seems that larger export similarities limit real exchange rate volatility. ERM participation is associated with lower real exchange rate variation either due to credibility effect of target zones or convergence of the participating economies. The observation holds even if we include the other European countries in the ERM variable. On the contrary, we find no evidence that the countries of the so-called EU core would significantly differ from the remaining economies in terms of their real exchange rate variation.

We conclude that there is clear evidence that countries fulfilling optimum currency area criteria tend less to have a bilaterally more volatile real exchange rate. Fulfilling OCA criteria to a lesser degree may increase the difficulties in the conduct of monetary policy, as different inflation rates are likely to occur across the monetary union. Therefore, there is a role for OCA criteria in the timing and scenario of the forthcoming Eurozone enlargement process and the monetary integration process in general.

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## SUMMARY

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# Real Exchange Rates and Optimum Currency Areas: Evidence from Developed Economies

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In this paper, the authors link real exchange rates and optimum currency area criteria. The authors examine the hypothesis that countries not fulfilling optimum currency area criteria in full will tend to have volatile bilateral real exchange rate. The authors find that, based on a study of data from developed economies from the 1990s, optimum currency criteria (such as trade integration, asymmetry of shocks, openness) help explain bilateral real exchange-rate variation.