THE ENDOGENEITY OF THE OPTIMUM CURRENCY AREA CRITERIA AND KENEN′S CRITERION OF DIVERSIFICATION

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Abstract

This article tries to give additional insights on the endogeneity hypothesis of optimum currency area criteria introduced by Frankel and Rose (1996). It investigates the effects of Kenen′s (1969) criterion of diversification on business cycles synchronization for samples of industrial and transition countries over the periods 1991-1998 and 1995-2004. Following Kenen, higher diversified economies should lead to more coordinated business cycles because they would be more affected by symmetric industry-specific shocks. The results of the empirical analysis are quite paradoxical and do not support theoretically argument. They indicate that diversified economic structures are irrelevant in case when industry-specific shocks dominate business cycle synchronization. Moreover, the evidence seems to suggest that the effect of diversification is negatively associated with the bilateral correlations of business cycles. On the contrary, the effect of diversification is positive and stronger in case when country-specific shocks are the dominant force in explaining business cycle synchronization.

The article also investigates the differences in the impact of the type of shocks and trade structure and trade intensity on business cycle correlation among industrial countries and among industrial-transition (the EMU and the CEEC-EU-8) country pairs. The results show that industry-specific shocks actually cause the convergence of business cycle among industrial countries, while for the transition countries country-specific shocks are more important in explaining business cycles synchronization. The results also suggest that in case of the industry-specific shocks domination, increased intra-industry trade actually induce higher business cycle correlation while in case when the country-specific shocks dominate business cycle synchronization, the trade intensity, inter-industry trade and diversified trade are the main determinant of the synchronicity of the business cycles correlation. These contradict conclusions could support Kenen’s (2000) hypothesis that the impact of trade integration (as well as the trade structure) on shocks synchronization depends on the type of shocks. And finally, from the view point of classic theory of OCA, only Mundell′s (1961) criterion of similarity in production structures dilutes the asymmetric effects of industry-specific shocks.

1. Introduction

Kenen (1969) argue that well-diversified economy will be a better candidate for membership in a currency union than country that is more specialized in production, as it will not have much need to change its real exchange rate. In well-diversified economies, the importance of asymmetric industry-specific shocks would be of lesser significance than in less-diversified economies. The law of large numbers will come into play and positive changes with respect to some sector will be offset by negative changes with respect to others; as demand for some increases, the demand for others fall.

Frankel and Rose (1996) find that trade integration leads to an increase in business cycle harmonization between two countries and claim that currency area optimality is endogenous. The intuition is that monetary integration reduces trading costs by removing exchange rate risk, cost of currency hedging, reducing information and transportation costs. Moreover, it reduces trading costs beyond the elimination of the costs from exchange rate volatility, since sharing a common currency is a much more serious and durable commitment than a fixed rate (McCallum, 1995). Therefore, having even a very stable exchange rate may not be the same as being a member of a common currency area. Monetary integration precludes future competitive devaluation, facilitates foreign direct investment and is likely to encourage forms of political integration. This will promote trade, economic and financial integration and foster business cycle synchronization among the countries sharing a single currency. Frankel and Rose show that historically closer international trade (trade intensity) between countries has been associated with more synchronized business cycles. Thus, an increase in trade intensity among member of a common currency area could make monetary union itself more sustainable by increasing the synchronization of business cycles. Therefore, countries that join currency union may satisfy OCA properties ex-post even if they do not ex-ante.

The Frankel and Rose endogeneity hypothesis of optimum currency area criteria is supported with many studies by estimations of the relation between trade and currency union. Rose (2000) finds a large positive effect of a currency union on international trade and argues that monetary integration increases bilateral trade by a factor 3. The obtained result has been widely debated, and the survey by Rose and Stanley (2004) of thirty-four studies show that currency union increases bilateral trade by between 30 % and 90 %. Fidrmuc (2001) and Gruben, Koo, Millis (2002) test the Frankel and Rose endogeneity hypothesis of optimum currency area criteria and they extend the research by introducing intra-industry trade. Fidrmuc shows that the convergence of business cycles actually relates to intra-industry trade, while the trade intensity is less important in explaining business cycle synchronization. Gruben et al. add intra- and inter-industry trade to the model and find that specialization generally does not significantly asynchronize business cycles between two countries. Furthermore, the high share of intra-industry trade in total trade between two countries increase synchronicity between their business cycles.

Focusing on the endogeneity hypothesis of optimum currency area criteria introduced by Frankel and Rose, this article investigates the effects of Kenen′s criterion of diversification on business cycles synchronization for samples of industrial and transition countries. Namely, Ricci (1995) show that the criterion of diversification is endogenous and the creation of a currency area will make member countries more diversified and, thus, less vulnerable to asymmetric shocks. On the other hand, Krugman (1991) argues that closer economic integration enhances specialization in production and would result in more asymmetric business cycles.

To test effect of diversification, the Fidrmuc (2001) and Gruben et al. (2002) models are extended. The results demonstrate that diversification is relevant in explaining transfers of country-specific shocks and irrelevant in case when industry-specific shocks dominate business cycle synchronization. Moreover, the evidence seems to suggest that the effect of diversification is negative in case when industry-specific shocks dominate business cycle synchronization. The results obtained are quite paradoxical, because diversified economies should be more affected by symmetric industry-specific shocks and their business cycles correlation should be more symmetric.

The article also investigates the differences in the impact of trade structure, trade intensity and type of shocks on business cycle correlation among industrial countries and among industrial-transition (the EMU and the Central and Eastern European Countries, new EU countries; CEEC-EU-8) country pairs. The important differences in the pattern of trade structures among industrial countries and »mixed« country pairs suggest that industry-specific shocks and intra-industry trade are more important in explaining business cycles synchronization for industrial countries, while for the transition countries country-specific shocks dominate business cycle synchronization. In the latter case, the trade intensity, inter-industry trade and diversified trade are the main determinant of the synchronicity of the business cycles correlation.

The remainder of this article is organized as follows. Section 2 introduces the relationship between classical OCA properties and business cycles synchronization. Section 3 provides some empirical and theoretical insights on the subject of shocks, business cycles synchronization, trade integration and specialization. Section 4 describes the data and empirical methodology. Section 5 discusses the main empirical results and Section 6 concludes the article.

2. Mundell, McKinnon, Kenen and Business Cycles Synchronization

During the 1970s, the OCA theory provided an important advancement as brought a new “meta-property,” the similarity of shocks, which capturing the interaction between several OCA properties (Mongelli, 2002).[1] The basic assumption behind this hypothesis is that if the shocks and the speed with which the economy adjusts (including also the policy responses to shocks) are similar across partner countries, then each member of a currency area might feel a smaller cost from the loss of the direct control over its nominal exchange rate and national monetary policy and the net benefits from adopting a single currency might be higher. We could also claim that if country′s vulnerability of output depends on the shocks, and if the countries would be more affected by symmetric shocks than their correlation of outputs would be more symmetric. In other words, only countries whose business cycles are perfectly synchronized with others' could benefit from a monetary union. The loss of a national monetary policy instrument is more costly as the degree of asymmetry (as correlation of economic activity) increases.

Moreover, we could also show that the OCA contributions in the 1970s have been widely influenced by ever since Mundell′s model (1961), where exogenous shocks display "mirror-image" asymmetry (Kenen, 2000). Hence, to understand the notion of the similarity of shocks or the business cycle synchronization, the role of trade integration and the trade structure, we must go back to Mundell. He show that the potential disadvantages of adopting a common currency would come from the elimination of the exchange rate between members of a currency area, when no longer would it be possible to let the exchange rate absorb idiosyncratic shocks. If we assume two countries (or regions) and two products, this shock is asymmetrical to the extent that it creates a surplus demand for products from the first country and a surplus supply of products from the second country. The shift of demand from the second country to the first country causes unemployment in the second country and inflationary pressure in the first country. The price of product from the first country will tend to increase and conversely, the price of product from the second country will tend to decline. Therefore, the terms of trade between both countries deteriorate. In language used by Kenen (2000), Mundell ask, how can these countries cope with an expenditure-switching shock when they undertake to keep their exchange rate fixed?[2] To answer this question, Mundell show that optimum currency areas are identical with economic regions (or countries) and defines region in terms of similar production structures since they would

[1] It is also possible that a high similarity of shocks among members of a currency union is not prerequisite. For example, Mundell (1973) argue that if members of a currency union are financially integrated, a common currency could be shared by countries subject to idiosyncratic shocks and hence a lower correlations of economic activity as long as they insure one another through private financial markets.

[2] Mundell assume that an increase in sector productivity in the second country causes an excess demand for products from the first country and an excess supply of products from second country. Therefore, these shocks could be also the same as the industry-specific shocks.

be more affected by symmetric industry-specific shocks. Factor mobility, particularly labor mobility, both geographical and industrial can compensate for regional (production) differences (or asymmetric industry-specific shocks) and as such can replace a system of individual regional currencies. In brief, we could also claim that the more similar economies are to each other the less asynchronous would be their output fluctuations arising from industry-specific shocks. If the industry-specific shocks, and policy responses to shocks, are similar across partner countries then the need for policy autonomy is reduced and the net benefits from a monetary union would be higher.

Following Mundell, McKinnon (1963) point out that where economy is relatively open, the more it will be inclined to use fixed exchange rates since variable exchange rate have large effects on the domestic price level. In highly open economy, the less tenable is the Keynesian assumption of sticky domestic prices and wages in response to exchange rate fluctuations. This would in turn also reduce the potential for money illusion by wage earners. The changes in international prices would be more rapidly transmitted to the price of tradable and non-tradable prices, negating its intended effects. Therefore, in small open economies flexible exchange rates become both less effective as a control device for external balance and more damaging to internal price stability. Economies should rely more on fiscal and monetary policies than on exchange rates to improve the trade balance disequilibria. In short, the nominal exchange rate would be less useful as an adjustment instrument to neutralize industry-specific shocks. Hence, countries that are highly integrated with each other, especially with respect to international trade, are more likely to constitute an optimum currency area since they have less to lose from moving from variable exchange rates to a single currency. In highly open economies flexible exchange rates become less need to maintain external stability and the industry-specific shocks are becoming more symmetric. Frankel and Rose (1996) hypothesize that the degree of integration between potential members of a common currency area cannot be considered independently of income correlation since the correlation of business cycles across countries depends on trade integration. Also McKinnon (2004) point out that McKinnon (1963) should have made the case that the more open economies are to each other, the less asynchronous would be their output fluctuations arising from demand (or industry-specific) shocks.

Kenen (1969) considers the arguments put forward by Mundell and McKinnon and hypothesizes that a more diversified economy would be a better candidate to have fixed exchange rates since dilutes the impact on the economy of industry-specific shocks (due to changes in external demand or in technology) affecting a narrow category of products.[3] Diversification, particularly in the exports sector reduces the effect of negative asymmetric shocks through offsetting positive changes in other sectors. From the standpoint of external balance, economic diversification (reflected in export diversification) reduces the need for changes in the terms of trade and therefore, for changes in national exchange rates. In more diversified economies flexible exchange rates become less need to maintain external stability. Furthermore, diversification also reduces the size of the change in the real exchange rate needed to offset an exogenous shock to a single industry. Therefore, more diversified countries might feel a smaller cost from the loss of the direct control over its nominal exchange rate and national monetary policy and the net benefits from a monetary union might be higher. But, if diversification decreases country′s vulnerability to industry-specific shocks and the need for changes in the terms of trade, than we could also claim that the more diversified economies are to each other the less asynchronous would be their output fluctuations arising from industry-specific shocks. Furthermore, more diversified partner countries would be more affected by symmetric industry-specific shocks and their correlation of outputs would be more symmetric.

To sum up the argument, we could ask in the same way as Frankel and Rose (1996): Can the degree of integration between potential members of a common currency area be considered independently of income correlation? Surely not, since the correlation of business cycles across countries depend on trade integration or openness to trade. But why could we not claim that it depends also on trade similarity or intra-industry trade and trade diversification? Furthermore, why trade is so important? Some countries could have a more diversified and more similar economic structure with partner countries, but their trade could be more specialized.[4] Nevertheless, as we have just shown, asymmetrical shocks could be transmitted only through trade channel. Only in this case, the industry-specific shocks affect country′s external equilibrium and the terms of trade. But it is also important to keep in minds that if economies are relatively more open, than their internal stability would be also more affected.

[3] Kenen (2002) also claims that diversification criterion is a test of a country's vulnerability to industry-specific shocks.

[4] On the other hand, some countries could also have the higher degree of openness to trade, but a small external sector. In this case, McKinnon′s criterion of openness is not valid. But in contrast, in extremely (relatively) open economies the share of bilateral trade to total trade could be very small.

3. Trade, Specialization, Industry- and Country-Specific Shocks and Business Cycles Synchronization

Following Kenen (1969), product diversification decreases the likelihood of asymmetric shocks and alleviates their negative effects. More diversified partner countries would be more affected by symmetric industry-specific shocks and their correlation of outputs would be more symmetric. In contrast, if industry-specific shocks are the dominant force in explaining business cycle correlation, the impact of specialization on business cycle correlation would be negative, since most trade will be inter-industry. Furthermore, the effect of specialization and diversification could be also endogenous. According to Krugman (1991), closer economic integration enhances specialization in production and, thus, would result in less symmetric business cycles. On the other hand, Ricci (1995) points out, as countries become integrated to a higher degree, they diversify more.

The intensity of trade has an ambiguous effect on business cycle correlation. Standard trade theory predicts that openness to trade will lead to increased specialization in production and asymmetric effects of industry-specific shocks. Namely, increased specialization generates less similarity in production structures, and to the extent that when industry-specific shocks are dominate drivers of the business cycle, increased specialization could reduce output correlation. However, the importance of this effect depends on the degree of specialization induced by integration. According to Frankel and Rose (1996), if trade integration is dominated by intra-industry trade, the effect of specialization may not be large, since the pattern of specialization occurs mainly within industries. On the other hand, if country-specific shocks dominate business cycle correlation, trade integration is expected to increase business cycle correlation regardless of the pattern of specialization. The impact of this shock on business cycle correlation should depend on the depth of the trade links between countries. In summary, the net effect on business cycle synchronization depends on the relative variance of country-specific and industry-specific shocks. If the former dominate, the impact of trade intensity on business cycle correlation would be positive. In other case, the impact on business cycle correlation depends on the pattern of specialization.

A number of studies focus on interaction between trade, specialization and business cycle synchronization. Krugman (1993) finds that European countries are less specialized than U.S. regions and, thus, less vulnerable to industry-specific shocks. But as pointed Peri (1998), the comparison is not valid because Krugman′s U.S. data are for 1977, while the EU data are for 1985. He finds that in 1986 the degree of specialization in the U.S. was about the same as the one in Europe because in Europe the extent of specialization has not changed much since the mid-1970s and as Kim (1995) finds the

U.S. regions have become less specialized over the second half of twentieth century. Clark and Wincoop (1999) find the opposite results that U.S. regions are less specialized and have higher business cycle synchronization than EU countries. Furthermore, the results confirm the presence of a European border effect which can be explained with the lower level of trade between European countries and the higher degree of sectoral specialization.

Kalemli-Ozcan, Sorensen, Yosha (2001) and Imbs (2001) show that country with a less specialized production structure exhibit more correlated business cycles and find a significantly positive role for an index of similarity in production structures. Imbs (2004) estimates a simultaneous equation model to find a link between trade, financial integration, industrial specialization and output co-movements. He also finds that business cycles of two economies with a similar economic structure are significantly more synchronized. Furthermore, he finds that the convergence of business cycles relates to intra-industry trade. Baxter and Kouparitsas (2004) apply extreme-bounds analysis to check the robustness of the determinants of business cycle synchronization. They also find that trade intensity is robustly related to business-cycle correlation, but an index of similarity in production structures is found not to be robust when bilateral trade intensity and other variables are considered. Calderon, Chong and Stein (2002) are focused on industrial and also developing countries. They find those countries with higher trade integration and more symmetric structures of production exhibit higher business cycle synchronization. Furthermore, the impact of trade intensity on business cycles is higher for industrial countries from both developing and the industrial-developing country pairs. Traistaru (2004) uses a similar procedure to investigate the degree of business cycles synchronization for samples of current and future (CEEC-EU-8) euro area member countries over the period 1990-2003. She finds that business cycles between the CEEC-EU-8 countries and euro area members are less correlated in comparison to the current euro area members. The results also show that similarity of economic structures and bilateral trade intensity leads to an increase of business cycles synchronicity.

Fontagne and Freudenberg (1999) find a negative relation between intra-industry trade in vertical and horizontal differentiation and exchange rate volatility. Consequently, both types of intra-industry trade will grow by a similar amount due to EMU. They also predict that only a share of greater intra-industry trade in horizontal differentiation leads to more symmetric shocks and, on the other hand, a share of greater vertical intra-industry trade is not necessarily associated with more synchronized business cycles. Garnier (2005) shows the opposite results that business cycles synchronization is more strongly positively linked to vertical than horizontal intra-industry trade.

Bayoumi and Prasad (1997) find that the relative contributions of industry- and country (or region)-specific shocks to be roughly similar in Europe and the U.S. In fact, region-specific shocks in the U.S are more important in nontraded goods sectors, while in the EU country-specific shocks are more prevalent in traded goods sectors. Funke, Hall, and Ruhwedel (1999) find that country-specific shocks have been far more important in explaining business cycles synchronization for 19 OECD countries than industry-specific shocks. They show that the country-specific shocks have declined over the period 1971-1993.

In summary, a large body of empirical research suggests that increasing trade intensity and symmetric structures of production tends to be associated with higher business cycles synchronization. In contrast, Kenen (2000) uses a simple Keynesian model and notes that the correlation of business cycles may increase with the intensity of trade links between these countries, but not necessarily due to higher symmetry of shocks. Consequently, the impact of trade integration on shock asymmetry depends on the type of shocks.[5] At this point, Kose, Prasad and Terrones (2003) observe empirically that trade intensity has a weak negative effect on output correlations. Fidrmuc (2001) finds that intra-industry trade is more important than trade intensity in driving business cycles synchronization. Gruben et al. (2002) also find a positive relation between intra-industry trade and business cycles correlations and do not find any significantly negative relations between specialization and business cycles synchronization.

4. Econometric Methodology

Kenen argues that product diversification reduces probability of asymmetric shocks and dilutes their negative effects. The core of this argument rests on the idea that positive changes with respect to some exports will be offset by negative changes with respect to others. As a result of higher diversification country's aggregate exports will be more stable than those with less thoroughly diversified economy. McKinnon (1969) criticizes Kenen in pointing that the more diversified an economy, the larger it is, and, because it is diversified, the foreign trade sector is smaller and so is the export sector. Melitz (1995) makes another point. According to him, a poorly diversified economy could be an

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[5] Kenen also shows that an increase in the correlation between country-specific expenditure shocks raises the correlation between two countries′ incomes. By contrast, the expenditure-switching shocks work to offset the positive influence of the expenditure-changing shocks. He also argues that Mundell (1961) analyzed the problem with the expenditure-switching shocks and in his model only expenditure-switching shocks are important in defining an optimum currency area. These theoretically arguments suggest that the expenditure-switching shocks could be the same as the industry-specific shocks and the expenditure-changing shocks could be the same as the country-specific shocks.

open one and, thus, more diversified since it imports a large share of goods and factors required in consumption and production. Therefore, to examine the patterns of diversification exhibited by countries only diversified export may not be enough important, but rather both export and import. As we have also shown, from the view point of classic theory of OCA, the asymmetrical shocks could be transmitted only through trade channel affecting country′s external equilibrium and the terms of trade. For these reasons, diversification has to imply diversification in imports and exports and has to be measured through bilateral total trade.

In order to capture the degree of trade diversification exhibited by countries engaging in international trade, two separate indicators are calculated: the equivalent number of sectors and the spread. Such an approach allows one to distinguish between product diversification and symmetric structures of production. Namely, the greater number of studies focuses on the link between symmetric structures of production and business cycle synchronization, but, to my knowledge, there is a lack of estimates of the effects of diversification patterns manifest in international trade on business cycle synchronization.

4. a. Empirical Models

To test the endogeneity hypothesis of OCA criteria, I first estimate the following regression:

(1) $$Cor(\Delta y_i, \Delta y_j) = \alpha + \beta \bullet \ln(TI_{i,j}) + \gamma \bullet IIT_{i,j} + \varphi \bullet DIV_{i,j} + \varepsilon$$

where *i* and *j* denotes countries and the variables are defined as:

- $Cor(\Delta y_i, \Delta y_j)$ denotes the business cycle correlation between country *i* and country *j*
- $TI_{i,j}$ represents the average bilateral trade intensity between country *i* and country *j*
- $IIT_{i,j}$ stands for intra-industry trade between country *i* and country *j*
- $DIV_{i,j}$ denotes the product diversification between country *i* and country *j*

All the variables are measured through bilateral total trade, since the asymmetrical shocks could be transmitted only through trade channel. But the idea behind this measuring is also that the structure of trade and the openness to trade can be seen as a proxy for the output structure of a country and the openness of economy. The specification of the model implies that positive β would confirm the endogeneity hypothesis of Frankel and Rose, since more trade intensity (openness to trade) leads to an increase of business cycle synchronization. On the other hand, negative β would imply that specialization effect dominates business cycle synchronization as well as that the effects of the industry-specific shocks dominate. However, in case of positive β it would not be possible to conclude whether industry-specific (or country-specific) shocks dominate business cycle correlation since the degree of specialization induced by integration may not be large if most trade is intra-industry. Therefore, the coefficient β is expected to be positive, if industry-specific shocks are the dominant source of business cycles correlation and openness to trade leads to vertical specialization, or if country-specific shocks dominate business cycle synchronization. Namely, country-specific shocks will have positive effects on business cycle correlation as overall trade intensity increases regardless of its composition. The coefficient γ is expected to be positive, since the intra-industry trade reflects the similarity of trade structures. A more similar structure of trade should lead to more coordinated business cycles because they would be more affected by common country- or industry-specific shocks.

Our main interest lies on the sign of the coefficient φ. It is expected to be positive, since the higher diversification in production lead to more synchronous business cycles. According to Kenen, positive industry-specific shocks with respect to some sectors will be offset by negative industry-specific shocks with respect to others. The net effect of positive and negative industry-specific shocks would result in more symmetric industry-specific shocks and, thus, more symmetric business cycles. Therefore, if diversification criterion is a test of a country's vulnerability to industry-specific shocks than the effect of diversification should be positive in case of industry-specific shocks domination. Furthermore, although intuitive, it is also expected to be positive in case when country-specific shocks dominate business cycle synchronization, since the country-specific shocks have positive effects on business cycle correlation regardless the trade′s structure.

To test the endogeneity hypothesis of OCA criteria, I also estimate the following regression:

(2) $$Cor(\Delta y_i, \Delta y_j) = \alpha + \beta_1 \bullet IntraTrade_{i,j} + \beta_2 \bullet InterTrade_{i,j} + \varphi \bullet DIV_{i,j} + \varepsilon$$

(3) $$IntraTrade_{i,j} = \ln\left(\frac{IIT_{i,j} \bullet TI_{i,j}}{100}\right)$$

(4) $$InterTrade_{i,j} = \ln\left[\left(1 - \frac{IIT_{i,j}}{100}\right) \bullet TI_{i,j}\right]$$

where all the terms are defined in the same way as in the preceding model (1), and $IntraTrade_{i,j}$ stands for intra-industry trade intensity between country *i* and country *j* and $InterTrade_{i,j}$ stands for inter-industry trade intensity between country *i* and country *j*.

The coefficient β_1 is expected to be positive, since the intra-industry trade intensity reflects the similarity of economic structures. The sign of β_2 depends on the relative variances of country- and industry-specific shocks. If industry-specific shocks dominate business cycle synchronization, β_2 will be negative, since more asymmetries in production structures lead to more asynchronous business cycles. And, in case of country-specific shocks domination, β_2 will be positive, since more intense trading relations lead to an increase in business cycle harmonization. As in the preceding model, the coefficient φ is expected to be positive, since the higher diversification in production would be expect to lead to more synchronous business cycles.

4. b. Measuring Variables

The bilateral trade intensity is computed with the following measure:

(5) $$TI_{i,j} = \frac{X_{i,j} + M_{i,j}}{X_i + M_i + X_j + M_j}$$

where $X_{i,j}$ denotes total merchandise exports from country *i* to *j* during period *t*, $M_{i,j}$ denotes imports to *i* from *j*, X_i denotes total exports from country *i*, and M denotes imports.[6]

I use an index of intra-industry trade developed by Grubel and Lloyd to measure the intra-trade intensity or the similarity in the structure of trade:

[6] This variable is specified easily also in the following way:

$$T_{i,j} = \frac{1}{T}\sum_t \frac{X_{i,j,t} + M_{i,j,t}}{X_{i,t} + M_{i,t} + X_{j,t} + M_{j,t}}$$

The tests are performed also with such defined variable, but the results stay unchanged.

(6) $$IIT_{i,j}=\left[1-\frac{\sum_k \left|X_{i,j}-M_{i,j}\right|}{\sum_k \left(X_{i,j}+M_{i,j}\right)}\right]\bullet 100$$

where $X_{i,j}$ and $M_{i,j}$ denote the sector k exports and imports from country *i* to country *j* by three-digit SITC commodity groups.

Methodology for the measuring product diversification is taken from the International Trade Centre (Market Analysis Section). However, the diversification is measured through bilateral total trade instead through the exports. To measure this variable, two indexes are calculated, the equivalent number of products and the spread. The equivalent number of products or Herfindahl index is defined as:

(7) $$H_{i,j}=\sum_k \left[\frac{\left(X_{i,j}+M_{i,j}\right)}{\sum_k \left(X_{i,j}+M_{i,j}\right)}\right]^2$$

where all the terms are defined in the same way as in the preceding equation (6). The equivalent number is a theoretical value which represents the number of sector k of identical size. However, the equivalent number ignores the differences in each industry's share to the total bilateral trade and only focuses on the number of industries a country is active in. The spread index complements the equivalent number, since has not take into the account the number of industries in which a country is active, but only the share of each industry in total trade. It measures the dispersion between the highest and lowest value in a given statistical series, and it is calculated using a weighted standard error:

(8) $$S_{i,j}=\frac{STDEV_{i,j}}{\sum_k \left(X_{i,j}+M_{i,j}\right)}$$

(9) $$STDEV_{i,j}=\sqrt{\frac{\sum_k \left[\left(X_{i,j}+M_{i,j}\right)-\left(\overline{X_{i,j}+M_{i,j}}\right)\right]^2}{k-1}}$$

Both indices are weighted by the same share:

(10) $$DIV_{i,j} = \frac{1}{0{,}5 \cdot H_{i,j} + 0{,}5 \cdot S_{i,j}}$$

The real economic activity is measured by real GDP and industrial production index. The series of real GDP (at 1995 prices) and indices of industrial production (at 2000 base year) are quarterly and seasonally adjusted. I take natural logarithms of each variable and employ two different de-trending methodologies to obtain the cyclical component. The de-trending methodologies included taking the fourth-differences of the variables which can be interpreted as a simple growth rate and using a Hodrick-Prescott filter using the traditional smoothing parameter of 1600 for quarterly series. Once I obtain the cyclical component of economic activity, I compute the correlation between the cyclical components of economic activity.[7]

4. c. Sensitivity Analysis

However, the estimates obtained with OLS regression might be inappropriate, since the trade indicators may be endogenous. Namely, the association between trade links and business cycles synchronization could be the result of the adoption of a common exchange rate policy, rather than the aspect of trade structure or openness to trade. In order to account for this effect, the models have to be extended by using the conventional gravity model variables. In other words, the regressions have to be instrumented by exogenous determinants of bilateral trade flows. Furthermore, Gruben et al. (2002) find that instrumental variables method is inappropriate, since business cycles synchronization can be affected not only by trade, but also by common monetary policy and by factor mobility. Instead of that they suggest to take OLS estimation and to integrate instruments into the equation. Hence, the sensitivity analysis introduces the effect of gravity model variables directly in the model. Following Frankel (1997), the gravity model variables are including the log of distance between the two countries, the log of the product of the two countries′ GDPs and per capita GDPs, a dummy for geographic adjacency, a dummy for the euro area country pairs, a dummy for the CEEC-EU-8 country pairs and a dummy for the member states of the CEFTA.

[7] I also use the Jarque-Bera statistic to test the null of whether the observed series (variables) are normally distributed. I reject the hypothesis of normal distribution at the 5 % level. For fulfillment of this criterion, the samples are corrected.

4. d. Data

First I test the endogeneity hypothesis of OCA criteria for sample of industrial countries for the periods 1991-1998 and 1995-2004. The sample periods for the real economic activity are the same. The trade indicators are measured as an average for 1995-1998 and 1995-2004, the years for which economic activity is calculated. The sample covers 14 EU countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden and the UK) and Norway, Japan and the US. Luxembourg is excluded from the sample due to its specific trade structure.

The endogeneity hypothesis of OCA criteria is also tested for sample of the CEEC-EU-8 countries: Slovenia, Slovakia, Hungary, Poland, the Czech Republic, Estonia, Lithuania and Latvia. The sample includes the CEEC-EU-8 country pairs and »mixed« (the EMU and the CEEC-EU-8) country pairs. Namely, such approach is allowed to analyze the impact of the trade structure and trade intensity on business cycle correlation between the CEEC-EU-8 and the EMU countries. In other words, we are interested in how business cycles synchronization is transmitted across these countries or if the trade structure causes the convergence of business cycles between the CEEC-EU-8 and the EMU countries in the same way as between industrial countries. The series of real GDP are calculated for the period 1995-2004, the series of indices of industrial production are calculated for the period 1999-2004. The trade indicators are measured as an average for 1999-2004.

The data are taken from the Eurostat data set.

5. Results

5. a. Industrial Countries

Table 1 shows the results of both models testing the endogeneity hypothesis of OCA criteria.[8] In the specifications for the period 1991-1998 where the business cycle correlation is measured by real GDP, the coefficients β and β_2 are positive in some specifications and insignificant (the basic models show a positive and partly significant association). The estimated coefficients for the similarity in the structure of trade (the coefficients γ and β_1) are negative and insignificant. The results could suggest that the country-specific shocks dominate the sample, but they have no direct effect on the correlation of business cycles. By contrast, in the specifications where the business

[8] The results are taken from the sensitivity analysis.

cycle correlation is measured by industrial production, almost all the coefficients have the opposite signs. The coefficients γ and β_1 are positive and significant in some specifications, and the coefficients β_2 are negative. This indicates that the industry-specific shocks dominate business cycle synchronization, since the higher asymmetries in production structures lead to more asynchronous business cycles. The evidence also seems to suggest that in case of the industry-specific shock domination, the similarity of economic structures or intra-industry trade is the main determinant of the synchronicity of the business cycles correlation, since the coefficients β are insignificant. However, the coefficients β are also positive, which could imply that openness to trade leads to vertical specialization as well as the country-specific shocks have a stronger effect on business cycle synchronization.

The main variable of our interest is product diversification. The signs of coefficients φ are quite surprising as they show that diversification in imports and exports actually do not affect the business cycle correlation. Moreover, the results seem to suggest that the effect of diversification is negative in case when industry-specific shocks dominate business cycle synchronization. Therefore, if diversification criterion is a test of a country's vulnerability to industry-specific shocks than the effect of diversification is quite paradoxical, since it should be positive in case of industry-specific shocks domination. On the other hand, the coefficients φ have the expected positive sign with business cycle correlation in case when country-specific shocks dominate business cycle correlation.

In all specifications for the second period 1995-2004, the coefficients γ and β_1 are positive and in almost all of them are also significant. The results also confirm a negative relationship between the trade intensity or the inter-industry trade intensity and business cycle correlation. This suggests that the industry-specific shocks dominate business cycle synchronization. The effect of diversification is once more negatively associated with the bilateral correlations of business cycles and also significant at two cases.

However, the important differences in the significant of the coefficients β_2 among samples of different period suggest that the impact of the industry-specific shocks on cycle correlation for the period 1995-2004 is much stronger. This also represents much stronger negative effect of specialization on the business cycle synchronization.

5. b. Transition Countries

In the specifications where the business cycle correlation is measured by real GDP, the coefficients β and β_2 are positive and significant. Meanwhile, the coefficients of product diversification are also significant and positive. This could suggest that the country-specific shocks dominate business cycle synchronization. Since the coefficients γ and β_1 are insignificant, the results also seems to suggest that in case of the country-specific shock domination, the trade intensity, inter-industry trade and diversified trade are the main determinants of the synchronicity of the business cycles correlation. However, an important problem with the second model is that intra-industry trade and inter-industry trade are highly correlated. The VIF (Variance Inflation Factor) for these variables are also very high. This means that including both variables simultaneously could lead to serious multicollinearity problems. For this reason, the additional tests are performed. I drop the inter-industry (or intra-industry) trade variables from estimated equitation which are reported in the last line of Table 1. The coefficients of intra-industry trade are significant and positive in both specifications which could suggest that in case of the country-specific shock domination, the intra-industry trade has also positive effects on business cycle correlation (however, in the first model the coefficients of intra-industry trade are insignificant). This conclusion is also consistent with the model prediction that a more similar structure of trade should lead to more coordinated business cycles since the country-specific shocks have positive effects on business cycle correlation regardless of the structure of trade. Nevertheless, the inter-industry trade seems to be more important in explaining business cycles synchronization.

In the second specifications where the business cycle correlation is measured by industrial production, the results are not robust with respect to inclusion of the gravity model variables into (almost all the coefficients have inversely signs in basic specifications). However, the coefficients β and β_2 are positive again. This could indicate that the samples are also influenced by the country-specific shocks.

6. Conclusion

This article focuses on the product diversification as an explanation of business cycles synchronization in the context of the endogeneity hypothesis of optimum currency area criteria introduced by Frankel and Rose (1996). The idea behind this study is that diversified economies can theoretically lead to more synchronized business cycles. The effect of diversification should be positive in case of industry-specific shocks domination and, although intuitive, it is also expected to be positive in case when country-specific shocks dominate business cycle synchronization. Furthermore, the diversification and specialization in production could be endogenous. Economic integration could lead either to more diversified economies, following Ricci (1995), which leads to symmetric effects of industry-specific shocks, or more specialized economies and, thus, to asymmetric effects of industry-specific shocks as predicted by Krugman (1991).

The results of the empirical analysis are quite paradoxical and do not support theoretically argument, according to which diversified trade links synchronize industry-specific shocks. They indicate that diversified economic structures are irrelevant in case when industry-specific shocks dominate business cycle synchronization. Moreover, the evidence seems to suggest that effect of diversification is negatively associated with the bilateral correlations of business cycles. On the contrary, the effect of diversification is positive and stronger (also partly significant) in case when country-specific shocks dominate business cycle synchronization. This supports intuitive argument that the country-specific shocks have positive effects on business cycle correlation regardless of production or trade structure.

The results also suggest that in case of the industry-specific shock domination, the similarity of economic structures or intra-industry trade is the main determinant of the synchronicity of the business cycles correlation. Therefore, from the view point of classic theory of OCA, only Mundell′s (1961) criterion of similarity in production structures dilutes the asymmetric effects of industry-specific shocks. On the other hand, in case of the country-specific shock domination, the impact of trade intensity, inter-industry trade and diversified trade are more important than the intra-industry trade. This implies that the results could support Kenen’s (2000) theoretically argument that the impact of trade integration (as well as the trade structure) on business cycles synchronization depends on the type of shocks.

The article also investigates the relation between the type of shocks and the convergence in business cycles among industrial countries and also among industrial-transition (the EMU and the CEEC-EU-8) country pairs. The important differences in the pattern of trade structures among country pairs of different type suggest that the impact of type of shocks on cycle correlation in transition countries is differ from that among industrial countries. In fact, industry-specific shocks are more important in explaining business cycles synchronization for industrial countries, while for the transition countries country-specific shocks dominate business cycle synchronization. However, the results also suggest that in the 1990s the country-specific shocks have a stronger effect on business cycle synchronization also for industrial countries. That could imply that the role of the industry-specific shocks has increased recently. This conclusion is also supported in Funke et al. (1999), who show that the country-specific shocks have declined over the period 1971-1993. Overall, these could be also the sign of a general movement of convergence of the symmetric trade structure and the industry-specific shocks domination among transition countries and the EMU in future. Further coordination of economic and political policy in transition countries with the EMU, the growth of intra-industry trade and especially the endogenous processes of economic and monetary integration will foster convergence of business cycles.

Table 1: Estimates for testing the endogeneity hypothesis of OCA criteria

		First Model					Second Model				
		α	β	γ	φ	Adjusted R^2	α	β_1	β_2	φ	Adjusted R^2
Industrial countries 1991-1998	GDP (growth)	2,746 (2,574)	-0,048 (-1,135)	-0,00050 (-0,208)	0,00145 (1,326)	0,314	2,239 (2,058)	-0,0230 (-0,505)	-0,0303 (-0,460)	0,00139 (1,282)	0,287
	GDP (HP)	1,681 (1,845)	0,019 (0,469)	-0,00179 (-0,757)	0,00102 (0,898)	0,290	1,330 (1,385)	-0,0169 (-0,403)	0,0350 (0,570)	0,00091 (0,805)	0,265
	IP (growth)	-1,001 (-0,660)	-0,006 (-0,072)	0,00881 (2,917)	-0,00157 (-0,900)	0,084	-0,233 (-0,143)	0,1700 (2,577)	-0,1754 (-1,731)	-0,00198 (-1,158)	0,086
	IP (HP)	-0,678 (-0,501)	0,031 (0,453)	0,00582 (2,263)	-0,00149 (-0,953)	0,081	-0,051 (-0,035)	0,1283 (2,332)	-0,0954 (-1,098)	-0,00185 (-1,204)	0,086
Industrial countries 1995-2004	GDP (growth)	0,249 (0,311)	-0,032 (-1,046)	0,00448 (3,104)	-0,00014 (-0,181)	0,236	0,476 (0,588)	0,0850 (2,842)	-0,1148 (-2,897)	-0,00019 (-0,253)	0,241
	GDP (HP)	1,443 (1,900)	-0,035 (-0,915)	0,00513 (2,803)	-0,00027 (-0,324)	0,236	1,682 (2,162)	0,0926 (2,432)	-0,1275 (-2,492)	-0,00030 (-0,367)	0,232
	IP (growth)	-0,568 (-0,527)	-0,036 (-1,007)	0,00415 (1,956)	-0,00087 (-0,948)	0,279	-0,604 (-0,521)	0,0677 (1,540)	-0,1083 (-2,185)	-0,00090 (-0,986)	0,279
	IP (HP)	0,944 (0,820)	-0,047 (-1,347)	0,00729 (3,684)	-0,00176 (-1,997)	0,358	1,287 (1,082)	0,1278 (3,040)	-0,1779 (-3,736)	-0,00182 (-2,099)	0,353
Transition countries 1995-2004	GDP (growth)	-5,775 (-3,900)	0,289 (4,347)	-0,00478 (-1,153)	0,00571 (3,004)	0,238	-5,675 (-3,703)	0,0143 (0,232)	0,2525 (2,414)	0,00528 (2,728)	0,242
	GDP (HP)	-4,714 (-3,685)	0,286 (4,694)	-0,00540 (-1,650)	0,00502 (2,912)	0,311	-4,773 (-3,532)	-0,0149 (-0,308)	0,2845 (3,068)	0,00471 (2,683)	0,315
	IP (growth)	-7,214 (-3,850)	0,071 (1,046)	-0,00164 (-0,350)	-0,00045 (-0,222)	0,223	-6,855 (-3,399)	0,0337 (0,407)	0,0343 (0,273)	-0,00043 (-0,209)	0,228
	IP (HP)	-8,376 (-4,621)	0,121 (1,813)	-0,00197 (-0,420)	9,36E-05 (0,046)	0,287	-7,960 (-4,118)	0,0446 (0,541)	0,0710 (0,574)	9,12E-05 (0,045)	0,295
Transition countries (Additional tests) 1995-2004	GDP (growth)						-4,396 (-3,194)	0,1434 (4,044)		0,00391 (1,989)	0,206
	GDP (growth)						-5,802 (-4,161)		0,2721 (4,516)	0,00532 (2,811)	0,250
	GDP (HP)						-3,332 (-2,703)	0,1305 (4,547)		0,00317 (1,734)	0,259
	GDP (HP)						-4,640 (-3,916)		0,2641 (4,951)	0,00466 (2,706)	0,322
	IP (growth)						-6,625 (-3,854)	0,0518 (1,255)		-0,00061 (-0,290)	0,237
	IP (growth)						-7,177 (-4,135)		0,0758 (1,225)	-0,00038 (-0,185)	0,236
	IP (HP)						-7,482 (-4,532)	0,0822 (2,009)		-0,00028 (-0,137)	0,300
	IP (HP)						-8,386 (-4,935)		0,1261 (2,094)	0,00016 (0,077)	0,300

Notes:
White heteroscedasticity-robust t-statistics are in parentheses. The results are taken from the sensitivity analysis. The gravity model variables are including the log of distance between the two countries, the log of the product of the two countries′ GDPs and per capita GDPs, a dummy for geographic adjacency, a dummy for the euro area country pairs, a dummy for the CEEC-EU-8 country pairs and a dummy for the member states of the CEFTA. Maximum sample size = 116.

GDP (growth) – The real economic activity is measured by real GDP and de-trended by fourth differences; BDP (HP) – The real economic activity is measured by real GDP and de-trended by Hodric-Prescott filter; IP (growth) – The real economic activity is measured by industrial production index and de-trended by fourth differences; IP (HP) – The real economic activity is measured by industrial production index and de-trended by Hodric-Prescott filter.

Source: Author

Appendix: More sensitivity analyses

Table A-1: Estimates for testing the endogeneity hypothesis of OCA criteria (the diversification is measured by Herfindahlov index)

		First Model					Second Model				
		α	β	γ	φ	Adjusted R^2	α	β_1	β_2	φ	Adjusted R^2
Industrial countries 1991-1998	GDP (growth)	2,765 (2,594)	-0,048 (-1,135)	-0,00044 (-0,183)	0,00190 (1,322)	0,314	2,262 (2,085)	-0,0217 (-0,476)	-0,0316 (-0,482)	0,00181 (1,278)	0,286
	GDP (HP)	1,692 (1,861)	0,019 (0,471)	-0,00175 (-0,742)	0,00134 (0,895)	0,290	1,343 (1,404)	-0,0161 (-0,384)	0,0343 (0,561)	0,00119 (0,804)	0,265
	IP (growth)	-1,009 (-0,667)	-0,006 (-0,073)	0,00878 (2,910)	-0,00211 (-0,905)	0,084	-0,254 (-0,157)	0,1688 (2,559)	-0,1742 (-1,721)	-0,00262 (-1,149)	0,086
	IP (HP)	-0,683 (-0,507)	0,031 (0,451)	0,00579 (2,256)	-0,00202 (-0,962)	0,081	-0,067 (-0,047)	0,1272 (2,315)	-0,0945 (-1,088)	-0,00246 (-1,200)	0,086
Industrial countries 1995-2004	GDP (growth)	0,274 (0,344)	-0,034 (-1,105)	0,00458 (3,165)	-0,00038 (-0,387)	0,237	0,504 (0,626)	0,0866 (2,888)	-0,1175 (-2,979)	-0,00045 (-0,459)	0,243
	GDP (HP)	1,464 (1,935)	-0,037 (-0,953)	0,00515 (2,830)	-0,00056 (-0,517)	0,237	1,704 (2,202)	0,0929 (2,447)	-0,1286 (-2,536)	-0,00060 (-0,560)	0,234
	IP (growth)	-0,587 (-0,547)	-0,035 (-0,988)	0,00410 (1,946)	-0,00112 (-0,924)	0,279	-0,454 (-0,404)	0,0654 (1,494)	-0,1048 (-2,122)	-0,00116 (-0,957)	0,276
	IP (HP)	0,899 (0,781)	-0,045 (-1,294)	0,00716 (3,630)	-0,00224 (-1,910)	0,356	1,232 (1,036)	0,1256 (2,995)	-0,1741 (-3,655)	-0,00232 (-2,010)	0,351
Transition countries 1995-2004	GDP (growth)	-5,579 (-3,710)	0,282 (4,071)	-0,00285 (-0,679)	0,00870 (3,203)	0,248	-5,624 (-3,614)	0,0141 (0,227)	0,2519 (2,332)	0,00710 (2,481)	0,232
	GDP (HP)	-4,540 (-3,513)	0,276 (4,342)	-0,00427 (-1,252)	0,00743 (2,793)	0,315	-4,756 (-3,476)	-0,0158 (-0,322)	0,2864 (2,982)	0,00646 (2,496)	0,309
	IP (growth)	-7,204 (-3,844)	0,071 (1,030)	0,07052 (1,030)	-0,00071 (-0,257)	0,223	-6,844 (-3,392)	0,0338 (0,408)	0,0333 (0,264)	-0,00067 (-0,245)	0,228
	IP (HP)	-8,355 (-4,612)	0,120 (1,785)	-0,00195 (-0,415)	5,06E-06 (0,002)	0,287	-7,938 (-4,108)	0,0447 (0,543)	0,0696 (0,560)	7,28E-07 (0,000)	0,295
Transition countries (Additional tests) 1995-2004	GDP (growth)						-4,321 (-3,138)	0,1412 (3,901)		0,00501 (1,781)	0,197
	GDP (growth)						-5,752 (-4,086)		0,2713 (4,315)	0,00718 (2,571)	0,240
	GDP (HP)						-3,273 (-2,661)	0,1288 (4,381)		0,00408 (1,563)	0,254
	GDP (HP)						-4,613 (-3,869)		0,2647 (4,750)	0,00638 (2,521)	0,317
	IP (growth)						-6,622 (-3,857)	0,0515 (1,253)		-0,00090 (-0,321)	0,237
	IP (growth)						-7,166 (-4,135)		0,0750 (1,209)	-0,00061 (-0,222)	0,236
	IP (HP)						-7,475 (-4,539)	0,0817 (2,009)		-0,00048 (-0,172)	0,300
	IP (HP)						-8,365 (-4,934)		0,1248 (2,067)	8,67E-05 (0,032)	0,300

Notes:
White heteroscedasticity-robust t-statistics are in parentheses. The results are taken from the sensitivity analysis. The gravity model variables are including the log of distance between the two countries, the log of the product of the two countries′ GDPs and per capita GDPs, a dummy for geographic adjacency, a dummy for the euro area country pairs, a dummy for the CEEC-EU-8 country pairs and a dummy for the member states of the CEFTA. Maximum sample size = 116.

GDP (growth) – The real economic activity is measured by real GDP and de-trended by fourth differences; BDP (HP) – The real economic activity is measured by real GDP and de-trended by Hodric-Prescott filter; IP (growth) – The real economic activity is measured by industrial production index and de-trended by fourth differences; IP (HP) – The real economic activity is measured by industrial production index and de-trended by Hodric-Prescott filter.
Source: Author

Table A-2: Estimates for testing the endogeneity hypothesis of OCA criteria (the diversification is measured by spread index)

		First Model					Second Model				
		α	β	γ	φ	Adjusted R^2	α	β_1	β_2	φ	Adjusted R^2
Industrial countries 1991-1998	GDP (growth)	2,707 (2,522)	-0,049 (-1,155)	-0,00060 (-0,246)	0,00112 (1,318)	0,314	2,184 (1,993)	-0,0257 (-0,563)	-0,0283 (-0,427)	0,00109 (1,291)	0,287
	GDP (HP)	1,651 (1,801)	0,018 (0,459)	-0,00186 (-0,785)	0,00079 (0,909)	0,291	1,291 (1,332)	-0,0188 (-0,447)	0,0365 (0,591)	0,00072 (0,824)	0,265
	IP (growth)	-0,992 (-0,652)	-0,005 (-0,063)	0,00885 (2,926)	-0,00114 (-0,858)	0,083	-0,186 (-0,114)	0,1724 (2,621)	-0,1773 (-1,750)	-0,00150 (-1,156)	0,086
	IP (HP)	-0,675 (-0,496)	0,032 (0,464)	0,00585 (2,270)	-0,00107 (-0,902)	0,080	-0,015 (-0,010)	0,1304 (2,372)	-0,0969 (-1,114)	-0,00138 (-1,191)	0,086
Industrial countries 1995-2004	GDP (growth)	0,237 (0,296)	-0,032 (-1,025)	0,00444 (3,090)	-5,48E-05 (-0,095)	0,236	0,467 (0,577)	0,0847 (2,831)	-0,1140 (-2,891)	-0,00011 (-0,188)	0,241
	GDP (HP)	1,461 (1,912)	-0,036 (-0,932)	0,00516 (2,814)	-0,00026 (-0,402)	0,236	1,706 (2,178)	0,0935 (2,453)	-0,1287 (-2,522)	-0,00029 (-0,458)	0,233
	IP (growth)	-0,577 (-0,532)	-0,034 (-0,964)	0,00412 (1,925)	-0,00054 (-0,784)	0,277	-0,441 (-0,387)	0,0661 (1,487)	0,1591 (3,620)	-0,00057 (-0,815)	0,274
	IP (HP)	0,931 (0,803)	-0,044 (-1,259)	0,00725 (3,633)	-0,00117 (-1,750)	0,354	1,280 (1,067)	0,1282 (3,030)	-0,1757 (-3,628)	-0,00122 (-1,863)	0,349
Transition countries 1995-2004	GDP (growth)	-5,958 (-3,964)	0,287 (4,294)	-0,00470 (-1,126)	0,00422 (3,032)	0,237	-5,850 (-3,740)	0,0135 (0,218)	0,2521 (2,382)	0,00386 (2,716)	0,241
	GDP (HP)	-4,855 (-3,723)	0,283 (4,629)	-0,005 (-1,608)	0,004 (2,874)	0,308	-4,911 (-3,551)	-0,0154 (-0,315)	0,2830 (3,014)	0,00339 (2,617)	0,312
	IP (growth)	-7,238 (-3,857)	0,073 (1,087)	-0,00167 (-0,359)	-0,00022 (-0,147)	0,223	-6,879 (-3,405)	0,0335 (0,405)	0,0363 (0,292)	-0,00021 (-0,139)	0,228
	IP (HP)	-8,425 (-4,635)	0,123 (1,870)	-0,00201 (-0,429)	0,00020 (0,131)	0,287	-8,008 (-4,130)	0,0442 (0,538)	0,0737 (0,600)	0,00018 (0,122)	0,295
Transition countries (Additional tests) 1995-2004	GDP (growth)						-4,522 (-3,232)	0,1426 (4,037)		0,00285 (2,006)	0,205
	GDP (growth)						-5,972 (-4,207)		0,271 (4,486)	0,004 (2,810)	0,249
	GDP (HP)						-3,421 (-2,718)	0,1295 (4,534)		0,00225 (1,697)	0,257
	GDP (HP)						-4,772 (-3,934)		0,2619 (4,904)	0,00336 (2,648)	0,319
	IP (growth)						-6,625 (-3,835)	0,0526 (1,269)		-0,00036 (-0,230)	0,236
	IP (growth)						-7,203 (-4,126)		0,0778 (1,267)	-0,00017 (-0,110)	0,235
	IP (HP)						-7,494 (-4,502)	0,0830 (2,019)		-0,00012 (-0,079)	0,300
	IP (HP)						-8,436 (-4,925)		0,1284 (2,149)	0,00024 (0,160)	0,301

Notes:

White heteroscedasticity-robust t-statistics are in parentheses. The results are taken from the sensitivity analysis. The gravity model variables are including the log of distance between the two countries, the log of the product of the two countries′ GDPs and per capita GDPs, a dummy for geographic adjacency, a dummy for the euro area country pairs, a dummy for the CEEC-EU-8 country pairs and a dummy for the member states of the CEFTA. Maximum sample size = 116.

GDP (growth) – The real economic activity is measured by real GDP and de-trended by fourth differences; BDP (HP) – The real economic activity is measured by real GDP and de-trended by Hodric-Prescott filter; IP (growth) – The real economic activity is measured by industrial production index and de-trended by fourth differences; IP (HP) – The real economic activity is measured by industrial production index and de-trended by Hodric-Prescott filter.

Source: Author

Table A-3: Estimates for testing the endogeneity hypothesis of OCA criteria (intra-industry trade excluded)

		First Model					Second Model				
		α	β	γ	φ	Adjusted R^2	α	β_1	β_2	φ	Adjusted R^2
Industrial countries 1991-1998	GDP (growth)	2,786 (2,608)	-0,051 (-1,366)		0,00138 (1,361)	0,321	2,460 (2,445)		-0,0535 (-1,239)	0,00120 (1,173)	0,293
	GDP (HP)	1,825 (2,019)	0,008 (0,222)		0,00077 (0,741)	0,294	1,492 (1,799)		0,0180 (0,439)	0,00077 (0,723)	0,272
	IP (growth)	-1,020 (-0,665)	0,078 (1,022)		-0,00095 (-0,516)	0,044	-1,517 (-1,020)		0,0226 (0,271)	-0,00102 (-0,544)	0,033
	IP (HP)	-0,691 (-0,511)	0,087 (1,350)		-0,00108 (-0,684)	0,062	-1,020 (-0,772)		0,0540 (0,761)	-0,00113 (-0,696)	0,049
Industrial countries 1995-2004	GDP (growth)	0,162 (0,197)	-0,009 (-0,311)		0,00071 (0,856)	0,165	0,153 (0,192)		-0,0402 (-1,349)	0,00049 (0,604)	0,180
	GDP (HP)	1,291 (1,604)	-0,017 (-0,420)		4,01E-05 (0,048)	0,170	1,320 (1,653)		-0,0466 (-1,151)	-0,00013 (-0,159)	0,186
	IP (growth)	-0,857 (-0,829)	-0,015 (-0,400)		-0,00032 (-0,335)	0,253	-1,149 (-1,109)		-0,0475 (-1,324)	-0,00049 (-0,534)	0,264
	IP (HP)	0,231 (0,199)	-0,010 (-0,253)		-0,00062 (-0,576)	0,281	0,055 (0,049)		-0,0636 (-1,789)	-0,00091 (-0,869)	0,296

Notes:
White heteroscedasticity-robust t-statistics are in parentheses. The results are taken from the sensitivity analysis. The gravity model variables are including the log of distance between the two countries, the log of the product of the two countries′ GDPs and per capita GDPs, a dummy for geographic adjacency, a dummy for the euro area country pairs. Maximum sample size = 116.

GDP (growth) – The real economic activity is measured by real GDP and de-trended by fourth differences; BDP (HP) – The real economic activity is measured by real GDP and de-trended by Hodric-Prescott filter; IP (growth) – The real economic activity is measured by industrial production index and de-trended by fourth differences; IP (HP) – The real economic activity is measured by industrial production index and de-trended by Hodric-Prescott filter.

Source: Author

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