EU Enlargement and Endogeneity of OCA Criteria: Evidence from the CEECs[1]

March, 2003

Jan Babetski

CERGE-EI, Charles University, and
. CNRS-ROSES, University of Paris-1
E-mail: jan.babeckij@cerge-ei.cz

Abstract

This paper analyzes the degree of synchronization of demand and supply shocks between the European Union (EU) and candidate countries over the past decade. Using time-varying estimation technique, we revise the results of Babetski, Boone and Maurel (2002,2003) that demand shocks converge, while supply shocks diverge. The estimated patterns of shocks are then confronted with the indicators of trade and exchange rates. We find that (i) an increase in trade intensity leads to higher symmetry of demand shocks but to lower symmetry of supply shocks; (ii) a decrease in exchange rate volatility is associated with demand shocks convergence. The results support the endogeneity argument in the optimal currency area (OCA) criteria discussion, which states that trade links and monetary integration synchronize business cycles between countries, thus increasing benefits from sharing a common currency. Policy implications concerning optimal exchange rate strategies during the period between EU accession and adoption of the Euro are drawn in the conclusion.

Keywords: EU enlargement, business cycle, trade, OCA (optimal currency area)

JEL Classification: E32, F30, F42

[1] This research was undertaken with support from the Czech National Bank (CNB). Usual disclaimer applies. The author is deeply indebted to Alexis Derviz for valuable discussions and suggestions. Comments provided by Jan Kmenta, Evzen Kocenda, Daniel Munich, Gerard Roland, Jan Svejnar and seminar participants at the CNB and CERGE-EI are also highly appreciated.

1. Introduction

According to recent European Union (EU) decisions at summits in Brussels and Copenhagen[2], EU enlargement is scheduled for 1 May 2004. Ten countries – Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia – are invited to enter the European Union[3]. A question of sharing a common monetary policy will then emerge. By looking at the degree of synchronization of business cycles, which is one of several optimal currency area (OCA) criteria, we assess if it would be beneficial for candidate countries to join the European Monetary Union (EMU) immediately upon entering the EU, or postponing for a number of years. More specifically, the paper has the following two main objectives.

The first objective is to estimate whether aggregate demand and supply shocks between EU and candidate countries are becoming more symmetric as enlargement negotiations proceed. According to the OCA theory, higher symmetry of shocks between countries, *inter alia*, leads to lower cost of sharing a common monetary policy. As far as the EU candidate countries are concerned, empirical studies have only recently begun to appear, when longer time series are becoming available. The still scarce evidence suggests that selected Central and Eastern European countries (CEECs) have achieved some synchronization of their business cycles with the EU, at least on the demand side.[4] It is commonly stressed, however, that the period of transition is too short to draw robust conclusions. For this reason, we use several alternative approaches to estimate the degree of shock asymmetry in the CEECs.

The second, and the main objective of the paper, is to analyze factors that affect the synchronization of shocks. As argued in the literature, OCA criteria fulfillment may be endogenous, i.e. that they are likely to be more satisfied *ex post*, as both monetary and trade integration deepens[5]. In particular, trade links and exchange rate pegs can transmit shocks from one country to another and make business cycles more similar. Since trade of the CEECs with the EU has significantly increased over the transition period, and since several accession

[2] 18 November and 12-13 December 2002, correspondingly.
Source: Press releases of the European Commission (http://www.eu.int).
[3] The accession of Bulgaria and Romania is set on 2007.
[4] See Boone and Maurel (1998, 1999a, 1999b), Horvath (2002a), and Babetski, Boone and Maurel (2002,2003).
[5] See Bayoumi and Eichengreen (1997), Frankel and Rose (1997, 1998), and Rose (2000).

countries have pegged their currencies to the Deutschmark, subsequently replaced by the Euro, we face a sort of natural experiment for testing the endogeneity hypothesis.

Besides, in addition to a comparative analysis over ten CEECs, we illustrate demand shock convergence and its link to trade integration in the Czech Republic case.

Methodologically, we apply a bi-variate vector autoregressive procedure proposed by Blanchard and Quah (1989) theoretically anchored in the sticky price paradigm for open economies, in order to identify supply and demand shocks for candidate countries, Germany and the aggregate EU-15 as alternative benchmarks. Then, using the Kalman filtering technique in a way advocated by Boone (1997), we construct time-varying correlation of shocks between candidate countries and the aggregate EU-15 and Germany as alternative benchmarks. New results are in line with previous estimates by Babetski et al. (2002) and show more clear-cut patterns. In particular, the results demonstrate that demand shocks have converged (to levels comparable to present EU member countries like Ireland, Portugal and Spain), while asymmetries of supply shocks prevail. Next, we confront time-varying estimates of supply and demand shocks convergence with indicators of trade and exchange rates. We find that (i) an increase in trade intensity is accompanied by higher symmetry of demand shocks, and by lower symmetry of supply shocks; (ii) a decrease in exchange rate volatility is associated with demand shocks convergence.

The results can be interpreted as follows. Demand shocks convergence is due to trade and monetary integration. Since intra-industry trade accounts for a large share of trade for candidate countries, the total effect of trade on demand shock symmetry is positive. Attempts of the candidate countries to tie their monetary policy (the exchange rate policy in particular) decisions to European Central Bank policies also contribute to the synchronization of demand shocks.

On the supply side, asymmetries of shocks can be interpreted as a process of catching-up at work: productivity gains in candidate countries translate into increases in incomes per capita. These increases in incomes themselves represent a sort of long-lasting shock. Supply shock asymmetry can, therefore, be viewed as an indication of restructuring. Results show that supply shocks are more idiosyncratic when countries are more extensively involved in international trade. Since an increase in trade intensity for accession countries is largely due to the expansion of intra-industry trade, which represents a new type of commerce, the results suggest a positive link between trade and restructuring. Next, to the extent that supply shocks have a long-term impact on output, there is no significant impact of the nominal exchange rate volatility on supply shocks symmetry.

The results support the endogeneity argument of optimal currency area (OCA) criteria, namely that trade links and monetary integration synchronize business cycles between countries, thus increasing benefits from sharing a common currency. Policy implications concerning optimal exchange rate strategies during the period between entering the EU and adopting the Euro are mentioned in the conclusion.

2. Shock asymmetry, trade, and monetary regimes: what do we expect?

2.1. Theoretical background

The issue of shock asymmetry has received particular attention due to the development of the OCA theory that originates in the work of Mundel (1961), McKinon (1963) and Kenen (1969). According to classical OCA criteria, two countries or regions would benefit from forming a monetary union if they are characterized by a high similarity of business cycles, have strong trade links, and if they possess an efficient adjustment mechanism[6] that can mitigate the adverse effect of asymmetric shocks. The first criterion is often considered the key one. Indeed, if business cycles of two countries are highly synchronized, or in other words if countries are exposed to symmetric shocks, a common monetary policy response does not introduce imbalances between countries. Much interest, therefore, has been focused on the estimation of the degree of shock asymmetry between countries or regions. Along with the measurement issue, another question concerns the determinants and the mechanism of shock propagation. Trade and exchange rate regimes are two channels, one real and another a monetary one, that can transmit shocks from one country to another.

Frankel and Rose (1998) open a large debate on the endogeneity of the OCA criteria fulfillment. They put forward an argument that closer trade links could lead to business cycle synchronization and thus increase the symmetry of shocks. According to traditional points of view, e.g. Krugman (1993), the opposite effect should prevail: international trade increases specialization, making shocks more asymmetric. The overall impact of trade integration on shock symmetry could thus be ambiguous, at least theoretically. Modern formal models of optimum currency areas do not seem to offer a unique answer either[7]. Frankel and Rose (1998) stress the necessity of further analysis of the role of international trade by distinguishing between inter-industry and intra-industry trade. Inter-industry links reflect specialization, thus potentially causing asymmetries, while intra-industry trade should lead to business cycle co-movement. There is an on-going theoretical work in this direction[8].

The concept of integration can be considered in a broader sense, including monetary integration as well. Ricci (1997a) builds a two-country model of the optimum currency areas, which incorporates monetary, and real variables. One of the model's key implications is that "the adoption of fixed exchange rates endogenously increases the desirability of this currency area by reducing the shock asymmetry." Note that in Ricci's model exchange rates affect shock asymmetry indirectly, through trade: flexible exchange rates favor specialization compared with fixed rates. It means that exchange rate arrangements may matter for business cycles correlation, at least to the extent that specialization leads to asymmetric responses.

Naturally, other determinants beside bilateral trade, its specialization patterns, and exchange rate regimes may influence business cycle transmission between countries. One might think about tariffs and non-tariff barriers, institutional agreements, border effects, etc.

2.2. Measuring shock asymmetry

A number of studies focus on measuring the degree of shock asymmetry across countries. In earlier research, judgment about shocks was based on cross-country correlation of real output, industrial production, or real exchange rate cycles[9]. Such approach, however, does not allow one to distinguish between shocks themselves and reactions to shocks. Since both components are present in actual series, similar results in terms of correlation coefficients might be observed in the presence of various combinations of shocks and responses to shocks.

Blanchard and Quah (1989) propose a bi-variate vector autoregressive (VAR) procedure in order to separate shocks from responses. Moreover, this method makes it possible to identify

---

[6] e.g. labor mobility, flexibility of factor prices, and a system of fiscal transfers
[7] See Ricci (1997b); see also Horvath (2002b), pp. 21-23, for a recent review of OCA models.
[8] See, among others, Kose and Yi (2001).
[9] See, for example, Cohen and Wyplosz (1989), Weber (1991), De Grauwe and Vanhaverbeke (1993), Artis and Zhang (1995).

the origins of shocks, for example, supply and demand. Blanchard and Quah (1989) define shocks linear combinations of the residuals from a bi-variate VAR representation of the real output growth and inflation. By construction, one type of shocks (labeled as "demand") have only transitory impact on the level of output, while another type of shocks (labeled as "supply") might have a long-term impact on the level of output.

More precisely, if real output and prices are used as inputs to the VAR model, then "demand" shocks are defined so that they do not have a long-term impact on either output or prices, while "supply" shocks might have a long-term effect on output. The VAR decomposition has become an especially popular tool in identifying shocks after it was applied by Bayoumi and Eichengreen (1993,1996) to assess the similarities of economic cycles in the case of European monetary integration.

Later, measuring co-movements of shocks across countries and regions were used for the assessment of OCA criteria. For example, high correlation between two countries' series of shocks indicates that economic structures of the countries under consideration are quite similar. This methodology allows Bayoumi and Eichengreen (1996) to identify the "core" European countries, for which the cost of a common monetary policy could thus be low.

Note that the coefficient of correlation of shock series represents a static measure. Therefore, it is difficult to judge if shocks become more symmetric or not. However, since the degree of economic integration change over time, there are few reasons to believe that shock asymmetry remains constant. The dynamics can be partially assessed by splitting the whole period and calculating the correlation coefficient by sub-periods, provided that sub-intervals are long enough. There is, however, more fundamental critique to this approach. Fontagne and Freudenberg (1999) argue that "the central critique to be addressed to studies based on VAR estimates of asymmetric shocks refers to the assumption of structural asymmetries. The only way to relax this assumption is to use a Kalman filter in order to tackle the issue of a dynamic convergence of shocks."

Boone (1997) applies the Kalman filter technique in order to obtain time-varying estimates of shock symmetry. Her results for Western European countries are consistent with those reported by Bayoumi and Eichengreen (1996) and, notably, give rich information about the dynamics of evolving symmetries. The results are generally interpreted in favor of the endogeneity hypothesis: the observable increase in supply and demand shock correlation goes along with deepening European integration.

The increasing number of studies focus on the analysis of symmetries between current European Union members and accession countries. Fidrmuc and Korhonen (2001), Horvath (2002a), Babetski, Boone and Maurel (2002) follow the structural VAR identification methodology developed by Blanchard and Quah (1989) and Bayoumi and Eichengreen (1996). Supply and demand shocks are extracted from quarterly series of the real output and prices. Short time series (less then ten years of quarterly observations) complicates the econometric analysis.

Horvath (2002a) concludes that correlation of neither demand nor supply shocks can be interpreted in favor of convergence. Fidrmuc and Korhonen (2001) find that supply shock correlation vary substantially from country to country. Correlation of demand shocks between the EU and the CEECs is substantial for Hungary and Estonia, while other accession countries show modest results. Compared to the earlier studies for Western European countries, current results indicate an increase in synchronization between the EU "core" and Italy and Portugal, previously considered "peripheral" countries.

Babetski, Boone and Maurel (2002) extend the analysis of supply and demand shocks by measuring time-varying correlation in a way advocated by Boone (1997). Their results stress an ongoing process of demand shocks convergence between the EU and accession countries. Supply shocks tend to diverge, which is interpreted as due restructuring process at work and the Balassa- Samuelson effect.

The debate has been centered so far on the measurement issue, namely how to identify shocks and how to measure cross-country correlation of disturbances. One serious issue has been omitted. A natural question concerns the determinants and sources of observable increases or decreases in shock symmetry. To some extent, all the studies mentioned above try to discuss factors that drive the cycles' symmetries or asymmetries. Integration in various interpretations of this broad concept is often said to be the key factor that affects understanding business cycle co-movements. Yet such a potentially important explanatory variable is missing from the analysis. This is the subject to which we now turn.

2.3. Determinants of shock transmission

Frankel and Rose (1998) in their influential work argue that international trade increases the convergence of business cycles. The estimates are performed on a large cross-section of OECD countries over thirty years, and the results seems be very robust to the choice of indicators of bilateral trade and business cycles. Trade, represented by either exports, imports or total bilateral volumes, is further confronted with the intra-industry trade. Although not directly tested, it is the later that is said to be particularly relevant for business cycle convergence. Additional inclusion of the exchange rate regime dummy does not qualitatively change the results. At least one important question remains, however, after reading this article. All constructed indicators of business cycles belong to the same class. Namely, they represent detrended indicators of economic activity. Hence, shocks and the responses to shocks enter the analysis together. Kenen (2001) argues that the results are biased since trade, a real variable, is not exogenous to fluctuations of another real variable like economic activity. Kenen sketches a simple Keynesian framework where correlation of countries' business cycles is determined by bilateral trade intensity.

Fidrmuc (2001) reesimates the specification of Frankel and Rose (1998), focusing on a cross-section of OECD countries over the last ten years and working different frequency (quarterly data). Aware of Kenen's (2001) criticism, Fidrmuc (2001) reconfirms the interpretation by Frankel and Rose (1998) and bypasses Kenen's criticism. This is done by direct inclusion of intra-industry trade into the regression. Thus, according to the main poin of Fidrmuc (2001), it is the particular structure of trade that matters for business cycles transmission.

Using disaggregate trade data, Fontagne and Freudenberg (1999) find the evidence that exchange rate variability depresses intra-industry trade, and consequently, as they argue, should lead to a higher symmetry of shocks. Based on historical data, Flandreau and Maurel (2001) argue that there is a positive impact of both monetary arrangements and trade on business cycle correlation.

This analysis of the literature is far from being complete. However, looking at these and other studies not discussed here, one can note a surprising segmentation in research interests. Two entirely separate classes of studies seem to co-exist: those focused on measuring correlation of shocks, and another ones concentrated on assessing a link between business cycles fluctuations and trade, exchange rate and other explanatory variables. More specifically, studies of the first group illustrate static or dynamic patterns of shock correlation, stressing the importance of distinguishing between shocks and responses to shocks. Studies of the second group identify the effects of trade and other variables on various business cycle indicators containing both shocks and responses to shocks. To our knowledge, there are no direct estimates of the determinants of shock asymmetry.

In our work we will try to make a bridge between these two groups of studies, by confronting time-varying estimates of shock asymmetry with trade and exchange rate variables. Before proceeding with estimates, the following sub-section will briefly illustrate the patterns of trade and exchange range regimes in countries from our sample.

2.4. Some stylized facts from candidate countries

In our study we focus on candidate countries since they represent a kind of "natural experiment" for testing the endogeneity hypothesis of the OCA theory. Indeed, the past decade has been characterized by an increase in trade openness of the CEECs, trade and monetary integration with EU member countries. These three factors altogether, briefly illustrated below, may affect the degree of business cycle co-movements.

In 2001, shares of total bilateral trade in GDP represented more than one hundred percent for eight CEECs from our sample. In the remaining two "big" candidate countries, Poland (population of 39 million) and Romania (22 million) trade contributed to 63% and to 75% of GDP respectively (see Table 1). Compared to 1993, there has been a significant increase in trade openness for the majority of candidate countries. The two exceptions are Latvia and Lithuania, but these countries have already achieved high shares of trade in GDP during the earlier transition period.

[Insert Table 1]

Table 2 illustrates the shares of trade with the EU and Germany in total trade of the CEECs. In 2001, bilateral trade of the CEECs with the European Union varied from roughly 50% of total trade for Lithuania to 70% of total trade for the Czech Republic. For comparison, this is on average higher than the share of trade of Germany with other EU member countries (54%). Germany itself represents an important trade partner for the majority of the CEECs, accounting in 2001 for 20 to 40 percent of total bilateral trade for half of the accession countries. Overall, we observe an important increase of trade with the European Union and Germany.

[Insert Table 2]

Along with trade openness and trade integration, substantial convergence of exchange rates with the Euro has been visible. As illustrated in Table 3, in many cases, candidate countries peg their currencies to the DM (replaced with the Euro since the beginning of 1999). Other monetary authorities (e.g. in the Czech Republic, Slovakia, recently also in Hungary and Poland), who formally follow a free float policy, use the Euro as the reference currency in formulating their preferred exchange rate developments. Thus, the actual exchange rate regimes in these countries can be characterized as managed float with Euro-based intervention levels. The actual volatility of exchange rates under this kind of policy has been decreasing over time (Table 4).

[Insert Tables 3 and 4]

Figure 1 and Table 5 show convergence of GDP-deflator based inflation rates. Not only did inflation levels decrease but so did the variability of inflation rates across the CEECs.

[Insert Figure 1 and Table 5]

3. Data and Methodology

This section starts with the description of the data set, followed by empirical methodology which contains three main procedures: (i) identifying supply and demand disturbances, (ii) constructing time-varying correlation of shocks, and (iii) confronting shock asymmetry with the indicators of trade and exchange rate volatility. Last part of the section describes econometric specifications for illustrating the endogeneity argument of the OCA theory.

3.1. Data used

The sample covers ten accession countries (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia), plus Germany, EU-15 aggregate, United States, Ireland, Portugal, and Spain.

The series of real output (GDP in 1995 prices, in billions of national currency), prices (GDP deflator, rebated to 100 for 1995), exports and imports (in millions of current US dollars) are quarterly, ranging from 1990:Q1 to 2002:Q2.

The following sources are used: OECD Analytical Database, IMF International Financial Statistics, EIU Country Data, IMF Direction of Trade Statistics, and National Statistical Committees. OECD is the main source for the series of real output and prices. These data are available in a seasonally adjusted form. The remaining output and price series were deseasonalized by applying the US Bureau of Sensus X11 procedure, the same method as used by the OECD[10]. The data for some accession countries are unavailable prior to 1994. Trade data cover the period up to 2001:Q4.

3.2. Step 1. Identification of shocks

In the first step, we decompose fluctuations of macroeconomic aggregates into shocks and responses to the shocks. There is no unique identification strategy. We choose a bi-variate structural VAR method proposed by Blanchard and Quah (1989) in their influential *American Economic Review* paper, in a way Bayoumi and Eichengreen (1992) apply this decomposition to extract supply and demand shocks from quarterly series of real output and prices. As discussed in section 2.2, such an approach is quite popular in the studies of business cycles convergence for developed countries and there is recent evidence for accession countries as well.

Identification strategy is based on a stylized representation of the economy described by aggregate supply and demand curves. The aggregate demand (AD) curve is negatively sloped in both short-run and long-run, meaning that lower prices increase aggregate demand. The aggregate supply curve is upward-sloping in the short-run and is vertical in the long-run. A positively sloped short-run aggregate supply (SRAS) reflects the existence of nominal rigidities, therefore a nominal variable (prices) has a temporary effect on the real variable

[10] X11 is a sort of moving average filtering procedure with time-evolving seasonal factors.

(output). Finally, a vertical long-run aggregate supply (LRAS) curve implies a full-capacity use of the production factors.

Shocks in this simple model correspond to the shifts in aggregate supply and demand curves away from the equilibrium. Supply shocks which are associated with the shift in the aggregate supply curve, have both short-term and long-term impacts on both output and prices. Demand shocks have also short-term effects on both variables. However, since the long-term supply curve is vertical, demand shocks do not have a long-term effect on the level output. A structural bi-variate VAR decomposition makes it possible to identify supply and demand shocks from the observable movements of output and prices.

Formally, consider stationary variables y_t and p_t, for example the first differences of GDP and prices: $y_t = \log GDP_t - \log GDP_{t-1}$ and $p_t = \log P_t - \log P_{t-1}$.
Then the following VAR representation can be estimated:

$$y_t = b_{01} + \sum_{k=1}^{K} b_{11k} y_{t-k} + \sum_{k=1}^{K} b_{12k} p_{t-k} + e_t^y \qquad (1)$$

$$p_t = b_{02} + \sum_{k=1}^{K} b_{21k} y_{t-k} + \sum_{k=1}^{K} b_{22k} p_{t-k} + e_t^p \qquad (2)$$

where e_t^y and e_t^p are white-noise disturbances, b_{ijk} are coefficients, and the lag length K is chosen so that e_t^y and e_t^p are serially uncorrelated. Disturbances e_t^y and e_t^p are not structural, they simply represent unexplained components in output growth and inflation movements. In order to recover structural disturbances, i.e. those having economic interpretation of supply and demand shocks, the following two relationships are proposed:

$$e_t^y = c_{11}\boldsymbol{e}_t^D + c_{12}\boldsymbol{e}_t^S \qquad (3)$$

$$e_t^p = c_{21}\boldsymbol{e}_t^D + c_{22}\boldsymbol{e}_t^S \qquad (4)$$

where $\boldsymbol{e}_t^D$ and $\boldsymbol{e}_t^S$ are demand and supply disturbances, correspondingly. These equations state that unexplainable components in the movements of output growth and inflation are linear combinations of supply and demand shocks. In a matrix form, $e_t = C\boldsymbol{e}_t$. Vector of structural disturbances $\boldsymbol{e}_t$ can be obtained by inverting matrix *C*: $\boldsymbol{e}_t = C^{-1} e_t$.

In order to recover four coefficients of matrix *C*, four restrictions have to be imposed. Knowledge of variance-covariance matrix of the estimated disturbances $\boldsymbol{e}_t^D$ and $\boldsymbol{e}_t^S$ is sufficient to specify three restrictions:

$$c_{11}^2 + c_{12}^2 = Var(e^y) \tag{5}$$

$$c_{21}^2 + c_{22}^2 = Var(e^p) \tag{6}$$

$$c_{11}c_{21} + c_{12}c_{22} = Cov(e^y, e^p) \tag{7}$$

These restrictions on the coefficients of matrix C are directly derived from eq.(3) and eq.(4) using normalization conditions:

(i) variance of demand and supply shocks is unity: $Var(\boldsymbol{e}^D) = Var(\boldsymbol{e}^S) = 1$

(ii) demand and supply shocks are orthogonal: $Cov(\boldsymbol{e}^D, \boldsymbol{e}^S) = 0$

The fourth restriction on coefficients c_{ij} is that demand shocks $\boldsymbol{e}_t^D$ have no long-term impact on the level of output. To put this restriction into a mathematical form, one should substitute equations (3) and (4) into the VAR system given by eq. (1) and eq. (2), and then express variables y_t and p_t as a sum of contemporaneous and past realizations of structural disturbances $\boldsymbol{e}_t^D$ and $\boldsymbol{e}_t^S$:

$$y_t = c_{01} + \sum_{k=0}^{\infty} c_{11k}\boldsymbol{e}_{t-k}^D + \sum_{k=0}^{\infty} c_{12k}\boldsymbol{e}_{t-k}^S \tag{8}$$

$$p_t = c_{02} + \sum_{k=0}^{\infty} c_{21k}\boldsymbol{e}_{t-k}^D + \sum_{k=0}^{\infty} c_{22k}\boldsymbol{e}_{t-k}^S \tag{9}$$

System (8)-(9) is an infinite moving-average representation of the VAR form (1)-(2). Coefficients c_{ijk} - called impulse response functions - characterize the effect of structural disturbances on the left-hand side variables after *k* periods (c_{ijk} can be expressed in terms of the four coefficients of interest c_{ij} and the estimated coefficients b_{ij} but the algebra is messy). The restriction that a cumulative effect of demand disturbances on output growth is zero, for all possible realizations of demand disturbances, means that $\sum_{k=0}^{\infty} c_{11k} = 0$. This restriction also implies that demand disturbances have no long-term impact on the level of output itself. Indeed, since c_{11k} represents the effect of the demand disturbance $\boldsymbol{e}_{t-k}^D$ on $y_t = \log GDP_t - \log GDP_{t-1}$, output growth after *k* periods, it is the same as to write the effect of $\boldsymbol{e}_{D,t}$ on $y_{t+k} = \log GDP_{t+k} - \log GDP_{t+k-1}$.

Therefore, the sequence $c_{110}, c_{111}, c_{112}, \ldots, c_{11k-1}, c_{11k}$ represents the effect of $\boldsymbol{e}_{D,t}$ on $(\log GDP_t - \log GDP_{t-1})$, $(\log GDP_{t+1} - \log GDP_t)$, $(\log GDP_{t+2} - \log GDP_{t+1}), \ldots,$ $(\log GDP_{t+k-1} - \log GDP_{t+k-2})$, $(\log GDP_{t+k} - \log GDP_{t+k-1})$. Hence, the cumulative restriction $\sum_{k=0}^{N} c_{11k} = 0$ states that the effect of $\boldsymbol{e}_{D,t}$ on $(\log GDP_{t-1} - \log GDP_{t+N})$ equals zero, i.e. that the level of output does not change in the long-run: $\log GDP_{t-1} = \log GDP_{t+N}$. It can be furthermore shown that the restriction $\sum_{k=0}^{\infty} c_{11k} = 0$ translates into the parameters of interest c_{ij} and estimated coefficients $b_{ij}(k)$ of unrestricted VAR system (1)-(2) as:

$$c_{11}\left(1 - \sum_{k=0}^{K} b_{22}(k)\right) + c_{21}\left(\sum_{k=0}^{K} b_{12}(k)\right) = 0 \qquad (10)$$

Restrictions (5),(6),(7),(10) serve to identify four coefficients c_{ij} which, in turn, are used to recover supply and demand disturbances from VAR residuals by inverting matrix C: $\boldsymbol{e}_t = C^{-1} e_t$.

3.3 Step 2. Calculating "time-varying correlation" of supply and demand disturbances

Following Boone (1997) we use the Kalman filter to compute the "time-varying correlation coefficient" between countries *i* and *j* given by b_t:

$$(X_t^j - X_t^i) = a_t + b_t (X_t^j - X_t^k) + e_t \qquad (11)$$

$$a_t = a_{t-1} + v_t^a \qquad (12a)$$

$$b_t = b_{t-1} + v_t^b \qquad (12b)$$

where *X* are the supply or demand shocks, error terms *e* and *v* are white noise disturbances; index *i* denotes an accession country, *j* stands for Germany or EU, and *k* is the United States. Equation (11) is called the *measurement* or *observation equation*. Coefficients a_t and b_t are allowed to vary in time according to (12a) and (12b), which are called *transition* or *state equations*.

The intuition behind this specification is simple. For example, in the presence of perfect correlation of shocks between countries *i* and *j* both coefficients a_t and b_t go to zero. Shocks for an accession country *i* are thus explained by those for a reference country j (Germany or the European Union). If b_t diverge from zero, then the United States have a stronger effect on country i shocks than the reference country j. The United States is used as a benchmark since it is the major trade partner for the EU and an important trade partner for the CEECs. For a convergence process to be at work, we expect a_t be close to zero and b_t to decrease over time.

Technically, the Kalman filter represents a recursive algorithm for computing the optimal estimator of unknown parameters a_t and b_t. This is done by maximizing a likelihood function given the information available at time t. The estimator is optimal in the sense that it minimizes the mean square error (MSE). Furthermore, if all disturbances are normal, the Kalman filter provides the maximum likelihood (MLE) estimator of a_t and b_t. Details on the Kalman filter estimations of the representation (11)-(12) are available in Annex A in Boone (1997).

The main advantage of the method in hand is that it gives optimal estimations of time-varying coefficients in the presence of structural changes, which is the case of accession countries. As a drawback, the Kalman filter does not explain why coefficients change over time; the filter simply draws the time path of a model's parameters. It is the objective of the next sub-section to confront dynamics of coefficient b_t - an indicator of shock asymmetry - with such potentially important variables as indicators of bilateral trade intensity.

3.4. Step 3 Explaining the dynamics of shocks: general framework

Endogeneity hypothesis proposed by Frankel and Rose (1998) states a relationship between trade intensity and correlation of business cycles:

$$\overline{Corr(Q_i, Q_j)} = c_1 + c_2 \overline{\log(TI_{ij})} + e_{ij} \qquad (13)$$

where the bars denote period-averaged values of the correlation of business cycles $Corr(Q_{it}, Q_{jt})$ and trade intensity $\log(TI_{ijt})$. Business cycle Q_{it} in country i is defined as detrended component of real economic activity (e.g. GDP, an index of industrial production, total employment and unemployment). For a pair of countries i and j trade intensity is defined with respect to exports, imports, and total bilateral trade according to the following expressions:

$TI_{ijt}^{EX} = EX_{ijt} / (EX_{it} + EX_{jt})$

$TI_{ijt}^{IM} = IM_{ijt} / (IM_{it} + IM_{jt})$

$TI_{ijt}^{T} = (EX_{ijt} + IM_{ijt}) / (EX_{it} + EX_{jt} + IM_{it} + IM_{jt})$

where EX_{ijt} exports from country i to country j, EX_{it} total exports from country i, and IM denotes imports.

Note that indicators of business cycles used in the left-hand side of (13) characterize shocks and reactions to shocks, both components are present in the fluctuations of real economic activity given by the variables Q_{it} and Q_{jt}. Therefore, the same outcome, in terms of the correlation coefficient, can be observed for oppositely different situations, for example in the case of a symmetric reaction to asymmetric shocks or an asymmetric reaction to symmetric shocks.

Our endogeneity hypothesis is different from the one discussed, in two ways. First, we separate shocks from reactions to shocks and focus on correlation of shock series $\{X_t^i\}$ and $\{X_t^j\}$, where X can be either supply or demand shocks. Second, due to the presence of structural changes among accession countries, we relax the assumption that the correlation coefficient and trade intensity are constant in time. So, our hypothesis states

$$Corr_t(X_{it}, X_{jt}) = c_1 + c_2 \log(TI_{ijt}) + \boldsymbol{e}_{ijt} \qquad (14)$$

In other words, our main hypothesis to be tested asks: “Is there a relationship between trade integration and shock asymmetry?” Now we will briefly discuss econometric specifications.

3.5 Impact of trade intensity and exchange rate pegs on the asymmetry of supply and demand shocks: final specifications

Specification 1: simple correlation coefficient

For a pair of countries i and j we calculate correlation between shock asymmetry and trade intensity, over 1994 – 2001, quarterly

$$\boldsymbol{r}(i, j) = Corr(b(i, j)_t, \log[TI(i, j)_t]) \qquad (15)$$

where i denotes accession country, j stands for Germany or EU. To assess robustness of results, correlation coefficient $\boldsymbol{r}(i, j)$ is calculated for two types of shocks (supply and demand) and three indicators of trade intensity (with respect to export, imports, and total bilateral trade). Shock asymmetry $b(i, j)_t$ is given by the time-varying coefficient b_t from equation (11): closer b_t to zero, lower the asymmetry of the underlying supply or demand shocks between countries *i* and *j*.

Note that $b(i, j)_t$ is not an observable variable like trade intensity $TI(i, j)_t$ but a product of estimation. Strictly speaking, the distribution of $b(i, j)_t$ is unknown and inclusion of $b(i, j)_t$ into further regression might seem inappropriate. Therefore, at the very limit, one can stop at calculating correlation between shock asymmetry and trade intensity. Another option is to treat shock asymmetry as a classical variable, in the spirit of Frankel and Rose (1998) who link fluctuations of real economic activity to trade intensity and other explanatory variables.

<u>Specification 2: time series framework</u>

As an alternative to correlation coefficient, shock asymmetry is regressed on trade intensity:

$$b(i, j)_t = c_1 + c_2 TI(i, j)_t + e(i, j)_t \quad (16)$$

For a given pair of countries *i* and *j*, the error term $e(i, j)_t$ depends on time only. Linear relationship (16) is justified as far as the residuals $e(i, j)_t$ exhibit conventional properties. Additional insight on a link between trade intensity and shock asymmetry can be obtained from estimating (16) in a panel framework.

<u>Specification 3: panel estimates</u>

For a given benchmark country *j* (EU or Germany), and a group of candidate countries *i* (*i*=Bulgaria, Czech Republic, Estonia, etc), we estimate the following equation (fixed effects):

$$b(j)_{it} = c_{1i} + c_2 \log[TI(j)_{it}] + e(j)_{it} \quad (17)$$

Further sensitivity analysis can be done by including exchange rate volatility:

$$b(j)_{it} = c_{1i} + c_2 \log[TI(j)_{it}] + c_3 ERV_{it} + e(j)_{it} \qquad (18)$$

where ERV_{it} is the exchange rate volatility, calculated as standard deviation of the nominal exchange rate in candidate country i to the Euro over the past 12 months. ERV_{it} is chosen as a proxy for exchange rate pegs to Euro[11].

So, the endogeneity argument of the OCA theory will be assessed upon comparison between the correlation coefficient (15), the results from time series specification (16), and panel frameworks (17) and (18).

4. Results

This section begins with the illustration of methodology in the Czech Republic case. Using demands shocks as an example, time-varying estimates of shock convergence are derived and then confronted with indicators of bilateral trade intensity. Second part covers supply and demand shocks and their determinants for a large group of EU candidate countries. Sensitivity is performed by considering alternative indicators of shock asymmetry and trade intensity.

4.1 The Czech Republic case, demand shocks

Figures 2a) and 2b) plot Czech demand shocks compared to German or EU demand shocks respectively.

[Insert Figures 2a and 2b]

One can see some similarities between Czech and EU or German patterns of demand shocks, at least over certain periods. For example, around the beginning of 1997, there is a noticeable negative demand shock observed in the Czech Republic, Germany and EU. The next question is to quantify the degree of similarity of shock series co-movements.

[11] This measure artificially increases volatility when a country operates under a crawling peg: changes in the crawl are interpreted as volatility.

Kalman Filter estimates help to draw the "time-varying correlation coefficient" of shock series between the Czech Republic, on one hand, and Germany or EU on the other hand. Estimates of a_t and b_t from (11) over 1994:Q1 – 2002:Q2 suggest that Czech demand shocks converge to the corresponding German and EU shocks: coefficients a_t decline towards zero, indicating that there is no "autonomous" convergence; coefficients b_t decrease, meaning that dissimilarities between Czech and German / EU shock series diminish over time.

[Insert Figure 3]

Note that since eq. (11) is specified in differences, values of b_t characterize relative importance of EU/German shocks versus American ones in explaining Czech shock series. In case of convergence to Germany, for example, b_t close to zero indicates that Czech shocks are more similar to German than to US shocks. Intuitively, the average value of b_t over 1996-97 (0.3) approximately corresponds to the weights of German and US currencies in a basked for the Czech crown (65% DEM and 35% USD) over the same period.

Next, we confront indicators of shock asymmetry and trade intensity. Figure 4 illustrates a scatter plot of coefficients b_t (horizontal ax) versus total bilateral trade intensity (in logarithms; vertical ax).

[Insert Figure 4]

There is a strong negative relationship between the asymmetry of demand shocks and trade intensity with Germany, captured by high correlation coefficient (-0.81) or, alternatively, by significant slope from an OLS regression (-0.46). Almost identical similar results hold for the Czech-EU case. These results can be interpreted in favor of the hypothesis that trade intensity reduces demand shock asymmetry.

4.2. Asymmetry of shocks, trade intensity, and exchange rate volatility

Tables 6 reports average values of shock asymmetry over 1994-2002 and two sub-periods. Decreasing averages and variance of time-varying coefficients b_t from eq. (11) mean that asymmetry of the underlying shocks diminish[12]. The results can be interpreted in favor of demand shock convergence, while the pattern of supply shocks (Table 6b) is rather diverging. Note that average values of supply and demand shock asymmetries for the CEECs do not differ much from the corresponding levels for Ireland, Portugal, and Spain.

[Insert Table 6a-b, Figure 5a-b]

An increase in trade intensity (Figure 5) leads to higher symmetry of demand shocks and to lower symmetry of supply shocks (Tables 7 and 8). The results are robust with respect to three indicators of trade and two benchmarks (EU aggregate and Germany). Demand shocks convergence can be interpreted as due to trade and monetary integration. Since intra-industry trade accounts for a large share of trade for candidate countries, the total effect of trade on demand shock symmetry is positive. A link between trade intensity and correlation of demand shocks is similar to the link between trade intensity and output correlation, found by Frankel and Rose (1998) and Fidrmuc (2001), among others. This is not surprising, given that demand shocks, by construction, can have only short-term effect on output and prices. On the supply side, asymmetries of shocks characterize the process of catching-up at work: productivity gains in candidate countries translate into increases in per capita incomes. Higher trade intensity, due to an increase in intra-industry trade, goes along with more intensive restructuring; hence follows the observed positive impact of trade on supply shocks asymmetry.

When exchange rate volatility is added, the coefficient of trade intensity does not change significantly. A decrease in exchange rate volatility is accompanied by demand shock convergence, while no notable effect on supply shocks is observed. Attempts of some candidate countries to fix their currencies to the Euro contribute to the synchronization of demand shocks. To the extent that supply shocks have a long-term impact on output, there is no significant impact of the volatility of nominal exchange rate on supply shocks symmetry.

[Insert Table 7a-b, Table 8a-b]

[12] It is also verified that a constant term a_t converges to zero for both supply and demand shocks Results are available upon request.

One can see a strong negative correlation between trade intensity and shock asymmetry on the demand side: more trade intensity means lower asymmetry. On the supply side, correlation is close to zero (Germany) or positive (EU)

Conclusion

This paper supports the hypothesis about demand shock convergence and divergence of supply shocks between candidate countries, the EU-15, and Germany as alternative benchmarks. Estimated time-varying coefficients of shock asymmetry are then confronted with several indicators of bilateral trade intensity and exchange rate volatility. The results are in line with Frankel and Rose's (1998) endogeneity hypothesis, which states that countries are more likely to satisfy criteria for a monetary union membership *ex-post*, as economic integration deepens. It follows that pegging national currencies to the Euro or even entering the EMU would not be so costly for candidate countries, in terms of costs associated to shocks asymmetry; indeed, EU candidate countries are characterized by the levels of supply and demand shocks asymmetries comparable to those for the present EU member countries such as Ireland, Portugal, and Spain. However, the importance of the OCA criteria to the analysis of a membership in a monetary union should not be overemphasized. The degree of symmetry of contemporaneous shocks is only one aspect of costs associated with monetary union membership. The still existing substantial asymmetries, in terms of shocks, among the present EMU countries suggest that this is probably not the most important criterion. Another way of looking at shock asymmetries is to recall the risk sharing argument proposed by Mundel (1973) and recently discussed by McKinnon (2002, p.344). Asymmetric shocks are not necessarily bad: "asset holding for international risk sharing is better served by a common currency spanning a wide area – within which countries or regions could be, and perhaps should best be, quite different."

References

Artis, M. and Zhang, W. 1995. "International Business Cycles and the ERM: Is There a European Business Cycle?" *CEPR Discussion Paper*, No1191, August.

Babetski, Jan; Boone, Laurence and Maurel, Mathilde. 2003. "Exchange Rate Regimes and Supply Shocks Asymmetry: the Case of the Accession Countries." *CERGE-EI Working Paper*, No.206, January. (Also forthcoming in the *Journal of Comparative Literature*)

Babetski, Jan; Boone, Laurence and Maurel, Mathilde. 2002. "Exchange Rate Regimes and Supply Shocks Asymmetry: the Case of the Accession Countries." *CEPR Discussion Paper*, DP3408, June.

Bayoumi, Tamim and Eichengreen, Barry. 1997. "Ever Closer to Heaven? An Optimum Currency Area Index for European Countries." *European Economic Review*, (41)3-5, pp. 761-770.

Bayoumi, Tamim and Eichengreen, Barry. 1996. "Operationalizing the Theory of Optimum Currency Areas." *CEPR Discussion Paper* n° 1484.

Bayoumi, Tamim and Eichengreen, Barry. 1993. "Shocking Aspects of European Monetary Integration", in Torres, Francisco and Giavani, Francesco (eds.) *Growth and Adjustment in the European Monetary Union*, pp.193-230. Cambridge, UK, Cambridge University Press and CEPR.

Blanchard, Olivier J. and Quah, Danny. 1989. "The Dynamic Effects of Aggregate Demand and Supply Disturbances." *American Economic Review*. September, 655-673.

Boone, Laurence. 1997. "Symmetry and Asymmetry of Supply and Demand Shocks in the European Union: A Dynamic Analysis." *CEPII Working Paper*, No. 97/03, February. (Also published in *Economie Internationale*, in French)

Boone, Laurence and Maurel, Mathilde. 1999 a, "L'ancrage de l'Europe centrale et orientale à l'Union européenne (Targeting of the Central and Eastern European Countries to the European Union)". *Revue économique*, Vol. 50, n°6.

Boone, Laurence and Maurel, Mathilde. 1999 b, "An Optimal Currency Area Perspective of the EU Enlargement to the CEECss." *CEPR Discussion Paper*, n° 2119.

Boone, Laurence and Maurel, Mathilde. 1998. "Economic Convergence of the CEECss with the EU." *CEPR Discussion Paper*, n° 2018.

Cohen, Daniel and Wyplosz, Charles. 1989. "The European Monetary Union: An Agnostic Evaluation", in R. C. Bryant et al., (eds.), *Macroeconomic Policies in an Interdependent World*. International Monetary Fund, Washington.

De Grauwe, P. and Vanhaverbeke, W. 1993. "Is Europe an Optimum Currency Area? Evidence from Regional Data", in P. Masson and M. Taylor, (eds.), *Policy Issues in the Operation of Currency Unions*, Cambridge University Press, Cambridge.

Fidrmuc, Jarko. 2001. "The Endogeneity of the Optimum Currency Area Criteria, Intraindustry Trande, and EMU Enlargement." *LICOS Discussion Paper*, June.

Fidrmuc, Jarko and Korhonen, Iikka. 2001. "Similarity of Supply and Demand Shocks Between the Euro Area and the CEECss." *BOFIT Discussion Paper*, No.14.

Fontagne, Lionel and Freudenberg, Michael. 1999. "Endogenous Symmetry of Shocks in a Monetary Union." *Open Economics Review*. 10: 263-287.

Frankel, Jeffrey A. and Rose, Andrew K. 1998. "The Endogeneity of the Optimum Currency Area Criteria." *Economic Journal*, 108(449), July, pp.1009-25.

Frankel, Jeffrey A. and Rose, Andrew K. 1997. "Is EMU More Justifiable Ex Post than Ex Ante?" *European Economic Review*, (41)3-5, pp. 753-760.

Horvath, Julius. 2002 a. "Supply and Demand Shocks in Europe: Large 4 EU Members, Visegrad 5, and Baltic States." *ACE Phare Project No. P98 1061*. The full text of the paper is available at http://econserv2.bess.tcd.ie/fidrmucj/ACE/Horvath4.pdf

Horvath, Julius. 2002 b. "The Optimum Currency Area Theory. A Review." *ACE Phare Project No. P98 1061*. http://econserv2.bess.tcd.ie/fidrmucj/ACE/Horvath2.pdf

Kenen, P.J. 1969. "The Theory of Optimum Currency Areas: an Eclectic View", in Mundell R.A. and Swoboda A.K., eds. "Monetary Problems of the International Economy." University of Chicago Press, 41-60.

Kenen, Peter B. 2001. "Currency Areas, Policy Domains, and the Institutionalization of Fixed Exchange Rates". *Centre for Economic Performance*, August.

Kose, M. Ayhan and Yi, Kei-Mu. 2001. " International Trade and Business Cycles: Is Vertical Specialization the Missing Link?" *American Economic Review*, vol. 91/2, pp.371-375

Krugman, Paul. 1993. "Lessons of Massachusetts for EMU" in Francisco Torres and Francesco Giavazzi (eds.) *Adjustment and Growth in the European Monetary Union*, pp.241-261. Cambridge, UK, Cambridge University Press and CEPR.

McKinnon, R. 1963. "Optimum Currency Area." *American Economic Review*. 53, 717-725.

McKinnon, R. 2002. "Optimum Currency Area and the European Experience." *Economics of Transition*. 10(2), 343-364.

Mundell, R.A. 1961. "A Theory of Optimum Currency Area." *American Economic Review*. 51, pp.657-665.

Mundell, R.A. 1973. "Uncommon Arguments for Common Currencies", in Johnson H.G. and Swoboda A.K., eds. "The Economics of Common Currencies." Allen and Unwin, 114-132.

Nuti, Mario D (ed). 2002. "A Symposium on Exchange Rate Regimes in Transition Economies: the Euroization Debate". *Economics of Transition*. 10(2), 339-512.

Ricci, Luca A. 1997 a) "Exchange Rate Regimes and Location." *The International Monetary Fund Working Paper*, 97/69.

Ricci, Luca A. 1997 b). "A Model of the Optimal Currency Area." *The International Monetary Fund Working Paper*, 97/76.

Rose, Andrew K. 2000. "One Money, One Market: Estimating The Effect of Common Currencies on Trade." *Economic Policy*, Vol. 17, pp. 7-46.

Weber, A. A. 1991. "EMU and Asymmetries and Adjustment Problems in the EMS", in "The Economics of EMU", *European Economy*, Special Edition 1.

IMF. *Annual Report on Exchange Rate Arrangements and Exchange Rate Restrictions.* Several issues (1991 – 2001). Washington, DC.

Table 1. Size and degree of openness of the CEECs

Country	[Exports+Imports]/GDP (%)		GDP per capita (USD)		Population (millions)	
	1993	2001	1993	2001	1993	2001
Bulgaria	84	119	1,190	1,603	8.5	7.9
Czech Republic	109	145	3,391	5,551	10.3	10.3
Estonia	144	188	985	3,830	1.5	1.4
Hungary	61	123	3,790	5,215	10.3	9.9
Latvia	130	103	813	3,275	2.6	2.4
Lithuania	173	106	719	3,245	3.7	3.5
Poland	45	63	2,229	4,561	38.5	38.6
Romania	51	75	1,157	1,768	22.8	22.4
Slovak Republic	122	157	2,489	3,794	5.3	5.4
Slovenia	116	121	6,368	10,605	2.0	2.0
CEECs average	103	120	2,313	4,345	10.5	10.4
Germany	45	68	24,120	22,530	81.2	82.4
United States	21	24	25,742	35,367	258.1	284.8

Sources: Trade and population: IMF International Financial Statistics (2002), author's computations; GDP per capita: IMF World Economic Outlook Database (2002)

Table 2. Shares of trade with the EU and Germany in total trade of the CEECs (ordered by decreasing shares of trade with the EU in 2001)

Country	European Union		Germany	
	1993	2001	1993	2001
Czech Republic	0.52	**0.69**	0.27	0.38
Poland	0.67	**0.68**	0.32	0.31
Hungary	0.56	**0.66**	0.23	0.31
Slovenia	0.62	**0.65**	0.26	0.23
Romania	0.44	**0.64**	0.15	0.18
Latvia	0.30	**0.55**	0.08	0.16
Estonia	0.55	**0.55**	0.09	0.07
Slovak Republic	0.29	**0.54**	0.13	0.27
Bulgaria	0.44	**0.52**	0.13	0.13
Lithuania	0.31[1)]	**0.49**	0.13[1)]	0.16
CEECs average	0.47	0.60	0.18	0.22
Germany	0.56	0.54		

Source: IMF Direction of Trade Statistics (2002), author's computations
Note: [1)] 1994 values

Table 3. Exchange rate regimes in the CEECs over 1990-2001

Country	Period	Exchange Rate Regime	Currency Basket / Target Currency	Fluctuation band
Bulgaria	02/91 - 30/06/97	Managed Float		
	01/07/97 - 31/12/98	Currency Board	DM	0%
	01/01/99 - 31/12/2001	Currency Board	Euro	0%
Czech Republic	12/90 - 26/05/97	Peg	DM(65%), USD(35%)	±7.5%
	27/05/97 - 31/12/2001	Managed Float		
Estonia	06/92 - 31/12/98	Currency Board	DM	
	01/01/99 - 31/12/2001	Currency Board	Euro	
Hungary	03/95 - 31/12/98	Crawling Band	DM(70%), USD(30%)	±2.25%
	01/01/99 - 31/12/99	Crawling Band	Euro(70%), USD(30%)	±2.25%
	01/01/2000 - 05/2001	Crawling Band	Euro	±2.25%
	05/2001 - 30/09/2001	Crawling Band	Euro	±15%
	01/10/2001 - 31/12/2001	Horizontal Band	Euro	±15%
Latvia	02/94 - 31/12/2001	Peg	SDR	±1%
Lithuania	10/92 - 03/94	Independent Float		
	04/94 - 31/12/2001	Currency Board	USD	0%
	Since 01/02/2002	Currency Board	Euro	0%
Poland	05/01/91 - 15/05/98	Peg	USD(45%), DM(35%), BP(10%), FF(5%), SwF(5%)	
	16/05/98 - 31/12/98	Crawling Peg	USD(45%), DM(35%), BP(10%), FF(5%), SwF(5%)	±7%
	01/01/99 - 03/2000	Crawling Peg	Euro (55%), USD(45%)	±7%
	04/2000 - 31/12/2001	Independent float		
Romania	08/1992 - 31/12/2001	Managed Float		
Slovak Republic	14/07/94 - /96	Peg	DM(60%), USD(40%)	±1.5%
	/96 – 01/10/98	Peg	DM(60%), USD(40%)	± 7%
	02/10/98 - 31/12/2001	Managed Float		
Slovenia	1992 – 31/12/2001	Managed Float		

Sources:
Koen Shoors (2001) "L'euroisation des pays d'Europe centrale et orientale .. " (The Euroisation of the Central and Eastern European Countries..), *Revue d'Etudes Comparatives Est Ouest*, vol.31, No4, pp.27-57.
Halpern, L. and Wyplosz, C. (2001) "Economic Transformation and Real Exchange Rates in the 2000s: The Balassa-Samuelson Connection." Table 2. Exchange Rate Arrangements. *UNECE Occasional Paper* (http://www.unece.org/ead/misc/papers.htm)
Central Europe Weekly (2001, January 18) JP Morgan - Economic Research, p.10.
Author's updates from press releases

Table 4. Volatility of nominal exchange rates[1] (%)

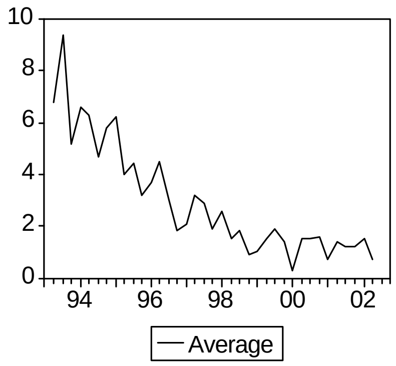
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Bulgaria	n.a.	24.5	5.5	39.7	20.1	77.0	85.6	15.2	0.4	0.0	0.0
Czech Rep.	n.a.	n.a.	n.a.	1.4	1.2	1.0	4.4	4.3	2.9	2.6	2.8
Hungary	8.0	6.2	4.4	9.6	16.0	10.3	5.8	7.9	4.3	1.8	2.3
Poland	6.9	17.3	12.6	14.5	9.5	4.9	5.7	4.7	5.4	3.7	5.6
Romania	94.7	77.5	48.5	41.7	19.2	22.1	36.9	14.8	26.7	13.2	14.8
Slovakia	n.a.	n.a.	n.a.	3.9	1.6	0.9	1.5	3.9	6.7	2.8	1.6
Slovenia	n.a.	n.a.	14.4	8.4	2.1	5.6	3.2	2.0	2.4	3.5	3.4
Estonia	n.a.	n.a.	2.1	0.8	1.6	1.3	1.8	0.5	0.5	0.1	1.0
Latvia	n.a.	n.a.	17.1	13.8	2.5	1.3	3.4	2.0	3.8	6.4	2.6
Lithuania	n.a.	n.a.	n.a.	10.5	6.4	2.4	6.1	3.4	4.4	8.6	4.6
CEECs average	36.5	31.4	14.9	14.4	8.0	12.7	15.4	5.9	5.8	4.3	3.9
US	5.8	5.8	6.5	3.7	5.9	2.4	6.1	3.4	4.4	8.6	4.6

Note: [1] Standard deviations in percent to average nominal exchange rates to ECU/Euro over two preceding years

Source: Author's computations based on the IMF International Financial Statistics (2002), monthly averages

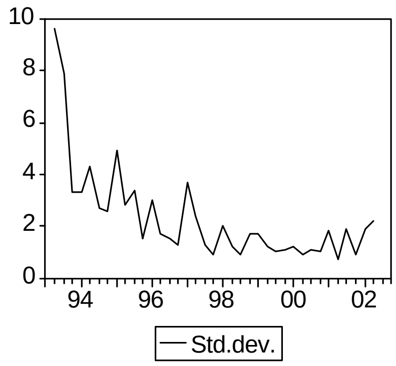
Figure 1. Inflation[1] convergence across the CEECs, 1993 – 2002

Average inflation



CEECs average quarterly inflation rates (excluding Bulgaria and Romania)

Sigma-convergence



Variability of quarterly inflation rates across CEECs (excl. Bulgaria and Romania)

Note: [1]GDP-deflator based

Source: Author's calculations

Table 5. Inflation[1] convergence across the CEECs

	1994-1998	1999-2002
CEECs average	6.3	2.0
CEECs: sigma-convergence	7.7	2.6
CEECs average. (excl. Bulgaria and Romania)	3.6	1.2
CEECs (excl. Bulgaria and Romania): sigma-convergence	2.4	1.3
Germany average	0.3	0.2
EU-15 average	0.5	0.5
Euro Area average	0.5	0.4

Note: [1]GDP-deflator based

Source: Author's calculations

Figure 2a). German and Czech demand shocks over 1994 – 2002, quarterly

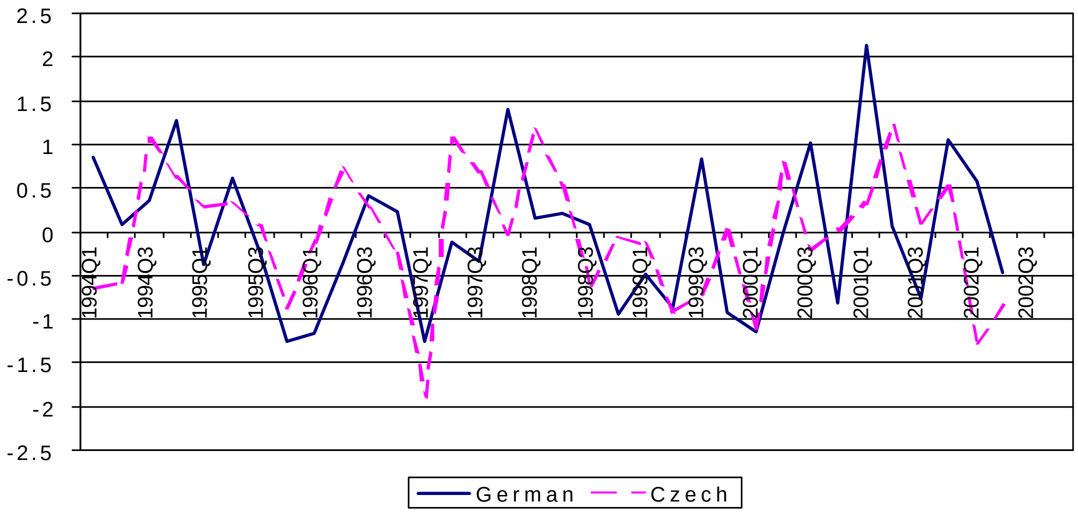


Figure 2b). EU and Czech demand shocks over 1994 – 2002, quarterly

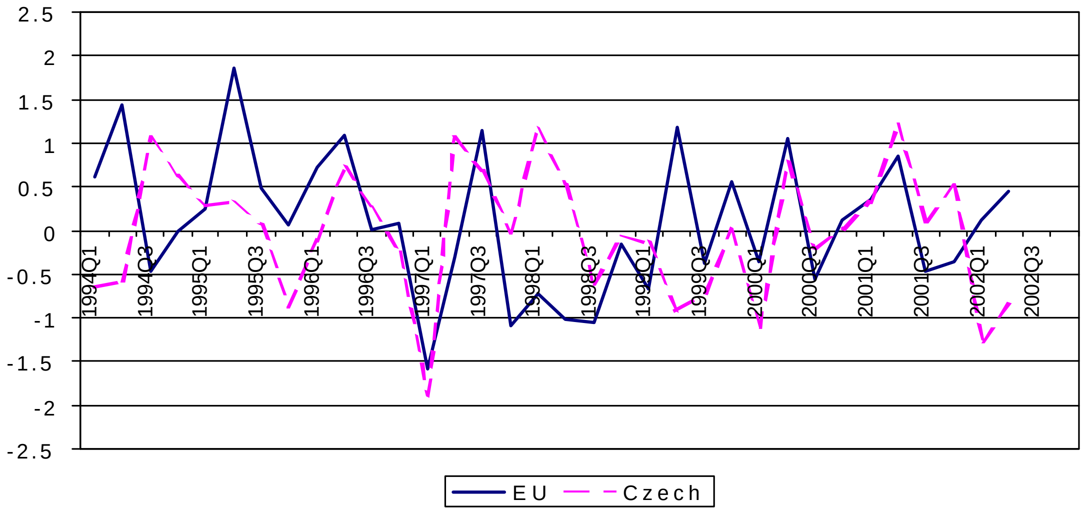
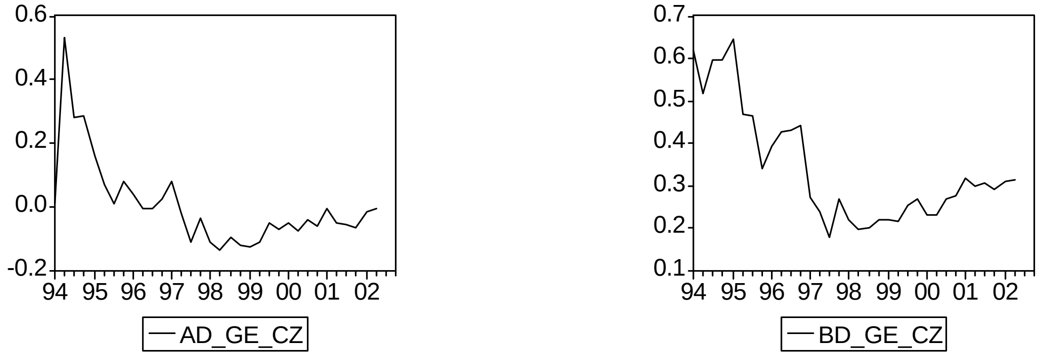


Figure 3 Czech Republic, convergence of demand shocks

Convergence to Germany as opposed to the US

Coefficients a(t) Coefficients b(t)



Convergence to EU as opposed to the US

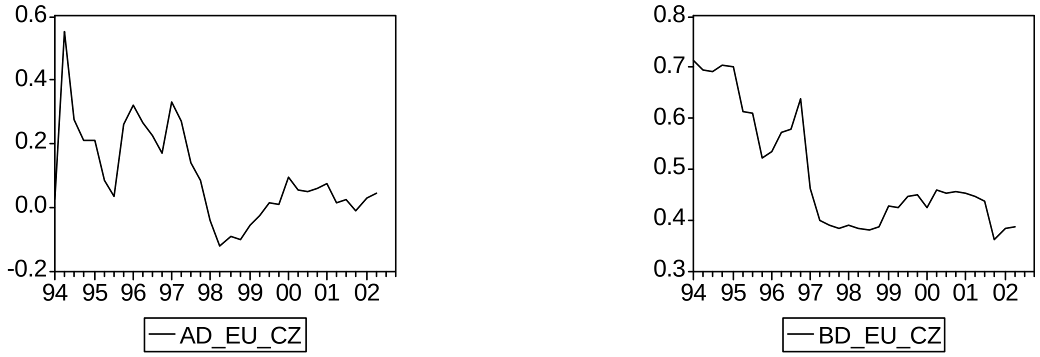
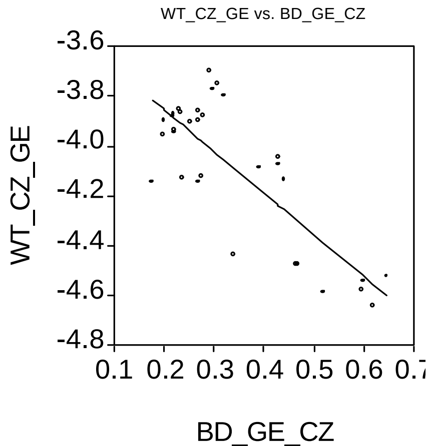
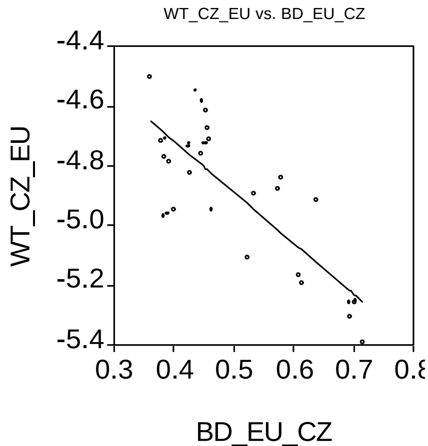


Figure 4 Czech Republic case, link between trade intensity and demand shock asymmetry, over 1994-2001, quarterly

Czech Republic versus Germany	Czech Republic versus EU

Trade intensity (vertical axis) versus shock asymmetry (horizontal axis)





Correlation between shock asymmetry and trade intensity

$r_{CZ\_GE} = -0.81$

$r_{CZ\_EU} = -0.81$

OLS regression of shock asymmetry on trade intensity
(Standard errors are in parentheses)

$b_t^D = -1.56 - 0.46\ TI$
(0.23) (0.06)

$b_t^D = -1.66 - 0.44\ TI$
(0.30) (0.06)

	Czech Republic versus Germany	Czech Republic versus EU
Number of obs.	32	32
Adjusted R-squared	0.64	0.66
S.E. of regression	0.08	0.07

Table 6. Shocks asymmetry, over 1994 - 2002[1]

(Standard deviations in parentheses.)

(a) Demand shocks

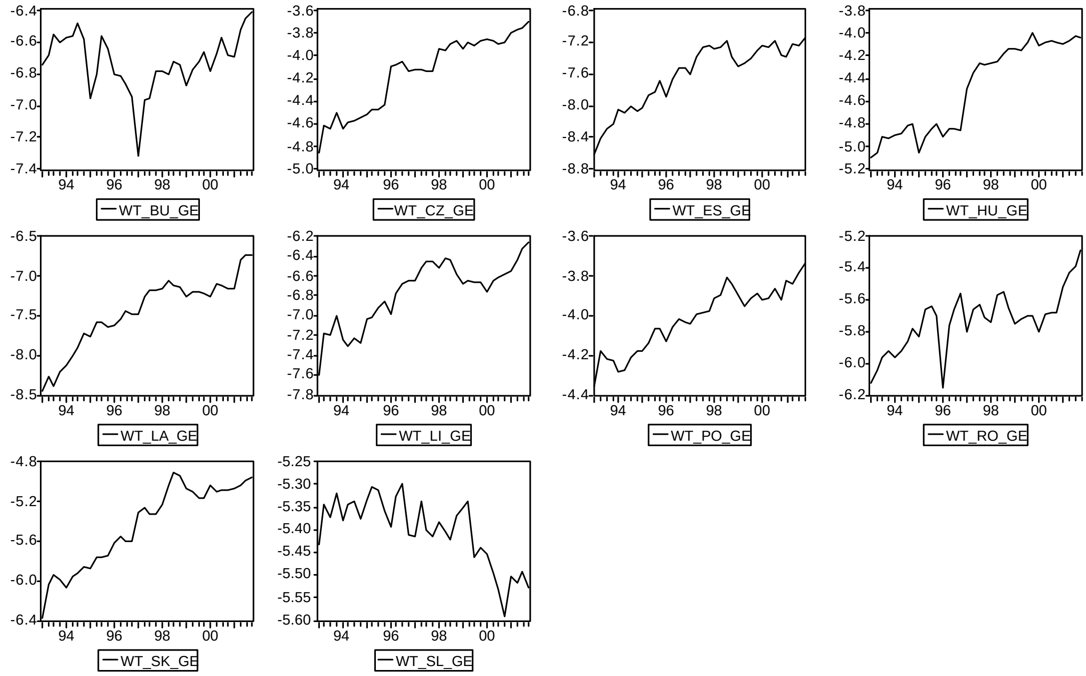
	Germany			European Union		
	1994 -2002	94 – 98	99 - 02	1994 -2002	94 - 98	99 - 02
Czech Republic	0.34	0.39	**0.27**	0.49	0.54	**0.43**
	(0.13)	(0.16)	(0.04)	(0.11)	(0.13)	(0.03)
Estonia	0.41	0.39	0.43	0.36	0.41	**0.29**
	(0.07)	(0.08)	(0.06)	(0.10)	(0.10)	(0.02)
Hungary	0.50	0.52	**0.47**	0.35	0.37	**0.32**
	(0.07)	(0.08)	(0.04)	(0.04)	(0.04)	(0.02)
Latvia	0.44	0.49	**0.37**	0.35	0.45	**0.22**
	(0.11)	(0.12)	(0.05)	(0.16)	(0.14)	(0.07)
Poland	0.60	0.61	**0.60**	0.50	0.63	**0.32**
	(0.09)	(0.11)	(0.06)	(0.19)	(0.12)	(0.08)
Romania	0.72	0.84	**0.54**	0.89	0.93	**0.82**
	(0.35)	(0.39)	(0.16)	(0.42)	(0.39)	(0.47)
Slovakia	0.60	0.68	**0.52**	0.59	0.64	**0.53**
	(0.14)	(0.17)	(0.05)	(0.09)	(0.09)	(0.02)
Slovenia	0.58	0.64	**0.53**	0.78	0.83	**0.71**
	(0.08)	(0.08)	(0.04)	(0.09)	(0.05)	(0.08)
CEECs average	0.52	0.57	**0.47**	0.54	0.60	**0.46**
Ireland	0.50	0.50	0.50	0.45	0.44	0.45
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)
Portugal	0.49	0.49	0.49	0.35	0.35	0.35
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Spain	0.61	0.60	0.61	0.49	0.49	0.49
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

(b) Supply shocks

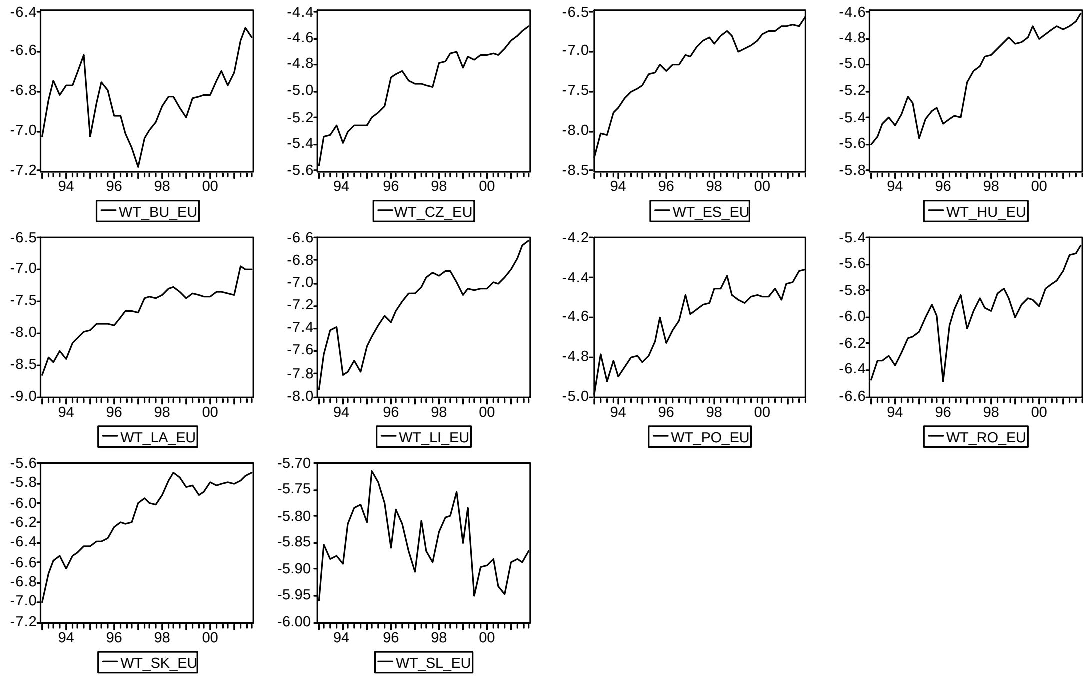
	Germany			European Union		
	1994 -2002	94 - 98	99 - 02	1994 -2002	94 – 98	99 - 02
Czech Republic	0.29	0.08	0.51	0.01	-0.22	0.26
	(0.30)	(0.26)	(0.15)	(0.28)	(0.15)	(0.16)
Estonia	0.66	0.66	0.66	0.72	0.76	**0.68**
	(0.12)	(0.15)	(0.07)	(0.20)	(0.26)	(0.11)
Hungary	0.46	0.45	0.46	0.39	0.43	**0.30**
	(0.09)	(0.11)	(0.07)	(0.14)	(0.14)	(0.09)
Latvia	0.75	0.86	**0.66**	0.34	0.26	0.48
	(0.17)	(0.19)	(0.07)	(0.14)	(0.10)	(0.07)
Poland	0.09	0.07	0.13	-0.02	-0.20	0.23
	(0.11)	(0.12)	(0.07)	(0.26)	(0.13)	(0.16)
Romania	0.25	0.25	**0.23**	0.13	0.05	0.25
	(0.11)	(0.14)	(0.05)	(0.13)	(0.07)	(0.10)
Slovakia	0.72	1.00	**0.47**	0.30	0.10	0.52
	(0.43)	(0.48)	(0.11)	(0.28)	(0.24)	(0.06)
Slovenia	0.58	0.70	**0.47**	0.55	0.72	**0.37**
	(0.16)	(0.15)	(0.07)	(0.37)	(0.45)	(0.12)
CEECs average	0.48	0.51	**0.45**	0.30	0.24	0.39
Ireland	0.36	0.36	0.36	0.42	0.42	0.43
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
Portugal	0.43	0.43	0.43	0.45	0.43	0.46
	(0.00)	(0.00)	(0.00)	(0.02)	(0.01)	(0.02)
Spain	0.46	0.46	0.46	0.50	0.50	0.50
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

[1]: *Shock asymmetry* between CEECs and Germany (EU) is measured by the coefficient b_t from Eq. (11). Lower coefficients mean higher symmetry. Values in boldface denote cases when the asymmetry of shocks diminish.

Figure 5. Total bilateral trade intensity, 1994-2001
a) Between the CEECs and Germany



b) Between the CEECs and the European Union



Total bilateral trade intensity is defined according to the following formula (natural logarithm of):

$$TI^{T}_{ijt} = (EX_{ijt} + IM_{ijt})/(EX_{it} + EX_{jt} + IM_{it} + IM_{jt})$$

where i = CEECs, j = Germany or EU, EX_{ijt} = exports from country i to country j, EX_{it} = total exports from country i, and IM denotes imports.
Source: IMF Direction of Trade Statistics (2002), author's computations

Table 7. Correlation between shock asymmetry and trade integration, over 1994 – 2001

$$r_{ij} = Corr(b_{ijt}, \log(TI_{ijt}))$$

where i = CEECs, j = Germany or EU, t = quarter

for two types of shocks[1] and three indicators of trade intensity[2]

(a) Demand shocks

	Total Germany	Exports Germany	Imports Germany	Total EU	Exports EU	Imports EU
Czech Republic	-0.81	-0.84	-0.76	-0.81	-0.84	-0.74
Estonia	0.32	0.13	0.35	-0.92	-0.86	-0.85
Hungary	-0.73	-0.71	-0.72	-0.70	-0.72	-0.66
Latvia	-0.57	-0.58	-0.54	-0.90	-0.86	-0.88
Poland	-0.46	-0.31	-0.47	-0.76	-0.75	-0.72
Romania	-0.10	-0.14	-0.07	-0.09	-0.07	-0.10
Slovakia	-0.83	-0.76	-0.84	-0.82	-0.79	-0.81
Slovenia	0.69	0.65	0.59	0.68	0.69	0.59
CEECs average	-0.31	-0.32	-0.31	-0.54	-0.52	-0.52

(b) Supply shocks

	Total Germany	Exports Germany	Imports Germany	Total EU	Exports EU	Imports EU
Czech Republic	0.36	0.40	0.30	0.80	0.77	0.76
Estonia	0.56	0.29	0.58	-0.55	-0.44	-0.60
Hungary	0.01	0.02	0.00	-0.74	-0.75	-0.71
Latvia	-0.77	-0.80	-0.70	0.63	0.68	0.56
Poland	0.30	0.09	0.38	0.67	0.77	0.58
Romania	-0.29	-0.32	-0.24	0.58	0.60	0.52
Slovakia	-0.93	-0.86	-0.95	0.51	0.65	0.35
Slovenia	0.43	0.28	0.52	0.48	0.47	0.43
CEECs average	-0.04	-0.11	-0.01	0.30	0.34	0.24

[1] *Supply or Demand Shock asymmetry* between the CEECs and Germany or the EU is measured by coefficient b_t from Eq. (11).

[2] *Trade intensity* is defined with respect to *exports*, *imports*, and *total* bilateral trade according to the following expressions (natural logarithms of):

$$TI_{ijt}^{EX} = EX_{ijt} / (EX_{it} + EX_{jt})$$

$$TI_{ijt}^{IM} = IM_{ijt} / (IM_{it} + IM_{jt})$$

$$TI_{ijt}^{T} = (EX_{ijt} + IM_{ijt}) / (EX_{it} + EX_{jt} + IM_{it} + IM_{jt})$$

where i = CEECs, j = Germany or EU, EX_{ijt} = exports from country i to country j, EX_{it} = total exports from country i, and IM denotes imports.

Table 8. Effect of trade intensity and exchange rate volatility on shock asymmetry[1]
(standard errors are in parentheses)

a) Demand shocks

Germany

	Total	Exports	Imports	Total	Exports	Imports
Trade intensity	-0.20	-0.20	-0.16	-0.22	-0.21	-0.20
	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)
Ex. rate volatility	–	–	–	4,83	4,53	4.94
				(0.06)	(0.06)	(0.07)
Number of obs.	224	224	224	224	224	224
Adjusted R-sq.	0.43	0.43	0.42	0.57	0.57	0.56
S.E. of regression	0.17	0.17	0.17	0.15	0.15	0.15

EU

	Total	Exports	Imports	Total	Exports	Imports
Trade intensity	-0.15	-0.15	-0.18	-0.16	-0.14	0.17
	(0.06)	(0.05)	(0.07)	(0.06)	(0.06)	(0.07)
Ex. rate volatility	–	–	–	5.17	4.83	5.34
				(0.06)	(0.05)	(0.06)
Number of obs.	224	224	224	224	224	224
Adjusted R-sq.	0.53	0.55	0.56	0.55	0.55	0.55
S.E. of regression	0.18	0.20	0.20	0.19	0.20	0.20

b) Supply shocks

Germany

	Total	Exports	Imports	Total	Exports	Imports
Trade intensity	0.05	0.03	0.05	0.05	0.03	0.05
	(0.06)	(0.06)	(0.05)	(0.06)	(0.06)	(0.05)
Ex. rate volatility	–	–	–	-1.58	-1.36	-1.61
				(2.24)	(2.04)	(2.51)
Number of obs.	196	196	196	196	196	196
Adjusted R-sq.	0.67	0.66	0.66	0.65	0.65	0.65
S.E. of regression	0.16	0.16	0.16	0.17	0.17	0.17

EU

	Total	Exports	Imports	Total	Exports	Imports
Trade intensity	0.14	0.09	0.16	0.15	0.09	0.16
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)
Ex. rate volatility	–	–	–	1.48	1.71	1.58
				(2.30)	(2.30)	(2.30)
Number of obs.	196	196	196	196	196	196
Adjusted R-sq.	0.58	0.57	0.58	0.55	0.56	0.56
S.E. of regression	0.22	0.22	0.22	0.24	0.24	0.25

[1]: Estimates of Eq. (17) and (18) (OLS, fixed effects):

$$b_{ijt} = c_{1i} + c_2 \log(TI_{ijt}) + e_{it}$$

$$b_{ijt} = c_{1i} + c_2 \log(TI_{ijt}) + c_3 ERV_{it} + e_{it}$$

Exchange rate volatility ERV_{it} for a candidate country *i* at quarter *t* is defined as standard deviations in percent to average nominal exchange rates to ECU/Euro over 12 preceding months