Similarity of Supply and Demand Shocks Between the Euro Area and the CEECs*

Jarko Fidrmuc
Foreign Research Division
Oesterreichische Nationalbank
POB 61, A-1011 Vienna, Austria
Jarko.Fidrmuc@OeNB.at

Iikka Korhonen
Institute for Economies in Transition
Bank of Finland
PO Box 160, 00101 Helsinki, Finland
iikka.korhonen@bof.fi

January 16, 2003

Abstract

We assess the correlation of supply and demand shocks between the countries of the euro area and the accession countries in the 1990s. Shocks are recovered from estimated structural VAR models of output growth and inflation. We find that some accession countries have a quite high correlation of the underlying shocks with the euro area. However, even for many advanced accession countries, the shocks remain significantly more idiosyncratic. Continuing integration within the EU is likely to align the business cycles of these countries similarly to the synchronisation of supply and demand shocks we document for the EU in the 1990s.

Keywords: optimum currency area, EU enlargement, structural VAR.
JEL Classification Numbers: E32, F42.

*We have benefited from comments by Jukka Pirttilä, Peter Backé, Jesus Crespo-Cuaresma, Alois Geyer and Robert Kunst. The views expressed in this paper are those of the authors and do not necessarily represent the position of the Oesterreichische Nationalbank or of the Bank of Finland. The standard disclaimer applies.

1 Introduction

In this study, we examine the correlation of supply and demand shocks between the Central and Eastern European countries (CEECs) and the euro area. Our purpose is to assess whether the EU accession countries belong to the same optimum currency area as the current members of the monetary union. At the same time, we use data from the past decade to assess the similarity of the shocks within the euro area. This is the first attempt to assess the similarity of shocks vis-à-vis the euro area shocks, as previous studies have almost uniformly concentrated on correlation with German (the "core" country) shocks. Furthermore, we show that concentration on Germany is likely to bias the results in the 1990s because of the idiosyncratic development of the German economy after reunification.

However, the optimum currency area theory does not provide clear critical values ensuring that the gains are higher than the costs from the participation in a currency union. Therefore, it is necessary to compare each country with some reference set of countries. It is obvious to compare potential members of a currency union with earlier currency unions (e.g. USA) or more recently with the member states of the Economic and Monetary Union (EMU). We follow the latter approach in our paper. Moreover, we compare the correlation of supply and demand shocks in the perspective new members of the EU/EMU also with the non-European OECD countries. We show that the inclusion of a broader set of reference countries is important for the interpretation of the results.

In practice the supply and demand shocks are recovered from two-variable (output and inflation) vector autoregressive (VAR) models with the help of the decomposition developed by Blanchard and Quah (1989). The different shocks are identified from the VAR residuals with the help of the restriction that demand shocks cannot have a permanent effect on output. The same procedure has been used before to assess whether the current European monetary union constitutes an optimum currency area, e.g. by Bayoumi and Eichengreen (1993).

Even though the membership of the CEECs in the monetary union is several years away even with the most optimistic assumptions,[1] it is of interest to see how closely they correspond to the criteria of an optimum currency area. In all previous studies correlation of shocks has been calculated against Germany or perhaps France, which are thought to form the "core" of the euro area. However, the German experience in the 1990s may have been unique because of unification. Therefore, we argue that a correlation with the euro area as a whole is the appropriate benchmark. Moreover, as a common monetary policy is conducted for the whole euro area, it is appropriate to assess how well the CEECs are integrated with the entire euro area, not with single countries within this aggregate.

A priori, one could expect a quite high correlation in business cycles, as the CEECs' foreign trade is conducted largely with the EU countries

[1] However, these countries are supposed to join the ERM II soon after the accession to the EU. Our results can be also applied to the fixed exchange rate policy during the membership in the ERM II.

(see Fidrmuc, 2001). It turns out that shocks in some accession countries are indeed quite highly correlated with the euro area shocks. Especially Hungary and Estonia are very close to smaller euro area countries in this regard. Generally, demand shocks are quite different in the CEECs, perhaps reflecting their different policy priorities during the transition towards market economies in the 1990s. Our results indicate that there are accession countries for which prospective membership in the monetary union would probably not pose too many problems, at least not because of asymmetric business cycles. For other CEECs the asymmetry of business cycles continues to be quite high, and hence early membership in the monetary union could be problematic.

The paper is organized as follows. The next section reviews literature on optimum currency area theory, as it relates to the accession countries of Central and Eastern Europe.[2] The third section describes the method used to recover supply and demand shocks. In the fourth section we proceed to estimate the shocks and assess their nature across countries. The last section offers some concluding remarks.

[2] We define the Central and Eastern European countries (CEECs) as Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. In addition, we include Croatia and Turkey into our analysis for comparison with the CEECs.

2 The Optimum Currency Area Theory and the EMU Enlargement

The optimum currency area (OCA) theory goes back to Mundell (1961). He conjectured that a country would find it more advantageous to peg the external value of its currency if the business cycles of the two countries are highly correlated. In practice the correlation is of course never perfect, but the problem of asymmetric shocks would be alleviated if factors of production could move between the countries (or regions). After the breakdown of the Bretton Woods system, the OCA analysis was regularly used to assess the desirability of having a fixed exchange rate in different countries. Generally it was found that especially labor movement between countries (or even regions in Europe) was extremely slow, making fixed exchange rates undesirable on these grounds (see McKinnon, 2002).

A revival in the empirical testing of the OCA theory preceded the introduction of the monetary union in Europe. Usually empirical studies assessed the correlations between the German business cycle and those in the other potential member countries. Especially influential was the contribution by Bayoumi and Eichengreen (1993). They recovered the underlying supply and demand shocks in the prospective members of the monetary union using the technique developed by Blanchard and Quah (1989).[3] The basic idea is that an economy is hit by two types of shocks, demand and supply shocks. De-

[3] They also assess whether the United States is an optimum currency area with the same method.

mand and supply shocks are identified with the help of the restriction that the long-term impact of demand shocks on the output is zero. Only supply shocks are assumed to have a permanent effect on output.

This approach can be justified within a Neokeynesian model of aggregate supply and demand curves (McKinnon, 2000). This framework is based on sticky wages, which cause a gradual adjustment process to a new equilibrium if an economy is hit by demand or supply shocks. The Neokeynesian model distinguishes between short-run and long-run equilibria for the economy. Thus, economic policy can reduce the adjustment costs, for example, by selecting of an appropriate exchange rate regime (floating exchange rates against fixed exchange rates or participation in a monetary union).

For the CEECs, the issue of joining the monetary union is becoming more and more topical. When the new member countries join the EU, they will be expected to join the monetary union at some point in the future.[4] Kopits (1999) and Backé (1999) describe this approach in detail. Basically, applicants first join the EU, then enter the EU's exchange rate mechanism (ERM II), and finally, after they meet the Maastricht convergence criteria, accede to the monetary union. The issue is the timing of membership in the monetary union and the optimal interim exchange rate arrangement. If there is already a significant degree of correlation between the business cycles of the euro area and the accession countries, the costs of giving up monetary independence may not be very high. This could in turn lead to early EMU

[4]There will be no opt-outs from monetary union.

membership. A more thorough survey of the related literature is provided e.g. by Järvinen (2000) and Nuti (2002).

There is mixed evidence as to the convergence of business cycles in the EU and the CEECs. First of all, the level of GDP in the CEECs grew slowly in relation to Western European countries during the period of the centrally planned system. The divergence between Western and Eastern Europe speeded up in the 1970s and the 1980s. Thus, the increasing welfare gap between market and centrally planned economies in Europe was one of the major reasons for the introduction of early reforms in some countries of Central and Eastern Europe. There were few signs of convergence between the CEECs in this period. Estrin and Urga (1997) find only limited evidence of convergence in the former Soviet Union or within various groups of Central European command economies. More surprisingly, Fidrmuc et al. (1999b) conclude that the Czech Republic and Slovakia converged neither between 1950 and 1990 nor within a subsample from 1970 to 1990. By contrast, Kočenda (2001) and Kutan and Yigit (2002) find increasing convergence between the accession countries and the EU.

Frenkel et al. (1999) and Frenkel and Nickel (2002) use a similar approach as Bayoumi and Eichengreen to the issue of business cycle correlation. They recover quarterly supply and demand shocks for various countries, including most of the EU accession countries. Frenkel et al. (1999) find that the correlation between shocks in the euro area and in the nonparticipating member states is quite high, as it is for the remaining EFTA countries. The correlation of shocks is very different between the euro area (proxied by Germany and France) and the accession countries. However, there is a number of difficulties in interpreting the results. Perhaps the most serious caveat is related to data used for estimation. Frenkel et al. use quarterly data from the first quarter of 1992 to the second quarter of 1998. The time period is quite short, but this is a problem which cannot really be avoided in such studies. Moreover, for some of the accession countries the first two or three years in the sample belong to the period of transformational recession, i.e. the output losses were related to the change in economic system. This makes the interpretation of economic shocks quite difficult. In our different and longer sample, this problem can be alleviated to a certain degree. This is done also by Horvath (2000) and Frenkel and Nickel (2002), but for a smaller set of comparative countries.

Further differences between these papers and our contribution can be found in treatment of seasonal effects. The previous studies do not pay much attention to this issue. Both Horvath (2000) and Frenkel and Nickel (2002) estimate VAR models with four lags. We find that shorter lag structure is more appropriate if seasonal dummies are used. The overall performance of the models is improved as well (this model specification is also supported by the Akaike information criterion).

There are also some studies which use different measures of correlation between business cycles in the euro area (or the EU) and the accession countries. Boone and Maurel (1998) calculate correlation coefficients between the cyclical components of industrial production and unemployment rates for the accession countries (except for the Baltic countries) against Germany and the EU. Generally they find a relatively high degree of business cycle correlation for the accession countries with Germany, higher e.g. than for Portugal or Greece. This implies relatively low costs for giving up monetary sovereignty and joining a monetary union with Germany.

Boone and Maurel (1999) use a different methodology from that in their earlier work to assess the similarity between business cycles in selected accession countries (Czech Republic, Hungary, Poland and Slovakia) against Germany and the EU. They fit a univariate time series model for the unemployment rate in an accession country, using its own lags and those of EU unemployment. In this framework they ask first how large a share of the variation in the unemployment rate can be explained by German or EU-wide shocks. Then they look at correlation in the propagation of the shock. Boone and Maurel find that the share of variation explained by the German shocks is fairly high for all accession countries, and highest for Hungary and Slovakia. The accession countries with the highest correlations of responses to a German shock are Poland and Slovakia. Boone and Maurel conclude that the business cycles in these countries are close enough to the German cycle so that joining the monetary union would bring net benefits.

Korhonen (2001) looks at monthly indicators of industrial production in the euro area and nine accession countries (excluding Bulgaria) in Central and Eastern Europe. The issue of correlation is assessed with the help of separate VARs for the first difference of the euro area production and production in each of the accession countries. The correlation of impulse responses to euro area shock is to be taken as evidence of symmetry of the business cycles. Korhonen finds that the many advanced accession countries (especially Hungary) exhibit a quite high correlation with the euro area business cycle. Moreover, correlation seems to be at least as high as in some small current EMU member countries.

Fidrmuc (2001) and Maurel (2002) stress the Frankel and Rose (1998) endogeneity hypothesis of optimum currency area criteria. Fidrmuc shows that the convergence of business cycles relates to intraindustry trade, but finds no significant relation between business cycles and bilateral trade intensity. Furthermore, he finds that the business cycle (defined as detrended industrial production) in Hungary, Slovenia and, to a lesser extent, Poland strongly correlates with the German cycle. Moreover, he finds that because of an already high degree of intraindustry trade, there is significant potential for increasing the correlation between business cycles in the EU and accession countries (here the aforementioned three countries plus the Czech Republic and Slovakia).

Summing up, empirical evidence seems to indicate that economic cycles in the most advanced accession countries are quite highly correlated with the euro area cycle. This seems to be case especially for Hungary, and perhaps also for Slovenia. Although the Baltic countries have been included in only few of the aforementioned studies, there is also some evidence that Estonia has achieved some convergence with the euro area cycle.

What explains this convergence in cycles? Fidrmuc (2001) has already emphasized the importance of intraindustry trade in fostering common cyclical behavior. Kaitila (2001) looks at the foreign trade of the accession countries and finds that especially Hungary and Estonia have moved towards more skill-intensive products in their trade with the EU. Foreign direct investment in these countries seems to explain this shift to a large degree. Increasing similarity of production and intra-industry trade may also account for similarity in economic cycles.

3 Identification of Supply and Demand Shocks

In this section we present the methodology used to recover the supply and demand shocks in different economies. We use a structural vector autoregressive (VAR) model with two variables, output and prices. It is assumed that fluctuations in these two variables result from two types of shocks: supply and demand shocks. Supply shocks have a permanent effect on output, whereas demand shocks have only transitory effects. Furthermore, both supply and demand shocks have permanent effects on the price level. A supply shock depresses the price level, whereas a demand shock increases it.[5]

The method used to separate supply and demand shocks is based on Blanchard and Quah (1989). They estimate a two-variable VAR with GNP

[5] This feature is referred to as the over-identifying condition, because this property is not directly used in the estimation of structural VARs, but it is involved for model evaluation.

and unemployment, and proceed to identify the two aforementioned shocks in that framework. Similarly, Bayoumi and Eichengreen (1993) estimate a VAR with the differences of GDP and the price level (in logs) as variables. The joint process of two variables (GDP and prices) can also be written as an infinite moving average representation of supply and demand shocks,

$$X_t = A_0\epsilon_t + A_1\epsilon_{t-1} + A_2\epsilon_{t-2} + A_3\epsilon_{t-3} + ... = \sum_{i=0}^{\infty} L^i A_i \epsilon_t, \tag{1}$$

where X_t is a vector of differences of logs of output and prices $[\Delta y_t, \Delta p_t]'$, ϵ is a vector of demand and supply disturbances $[\epsilon_{dt}, \epsilon_{st}]'$, A_i are the 2×2 matrices which transmit the effects of the shocks to the variables, and L^i is the lag operator. The long-run restriction that demand shocks do not affect the level of output is the same as saying that the cumulative effect of demand shocks on the change of output is zero, i.e. $\sum_{i=0}^{\infty} a_{11i} = 0$. Also, it is assumed that supply and demand shocks are uncorrelated and their variance is normalized to unity, i.e. $Var(\epsilon) = I$. A finite version of the model represented by equation 1 can be estimated as a VAR. The estimated VAR representation can then be used to recover the original supply and demand disturbances. Because the vector X_t is stationary, the VAR representation can be inverted to obtain the Wold moving average representation. Here e_t is the vector of residuals from the two estimated equations,

$$X_t = e_t + C_1 e_{t-1} + C_2 e_{t-2} + C_3 e_{t-3} + ... = \sum_{i=0}^{\infty} L^i C_i e_t. \tag{2}$$

The variance-covariance matrix of residuals is $Var(e) = \Omega$. Equations 1 and 2 directly yield the relationship between the estimated residuals (e) and the original shocks (ϵ): $e_t = A_0\epsilon_t$. Therefore, we need to know the elements in A_0 to calculate the underlying supply and demand shocks. The matrices C_i are known from estimation. Knowing that $A_i = C_iA_0$ and $\sum_{i=0}^{\infty} A_i = \sum_{i=0}^{\infty} C_iA_0$ helps us identify A_0, but to recover the four elements of A_0 we need four restrictions. Two restrictions are simply normalizations defining the variance of the shocks ϵ_{dt} and ϵ_{st}. The third restriction is the assumption that demand and supply shocks are orthogonal, which with our notation means that $A_0A_0' = \Omega$. The fourth restriction has already been mentioned, i.e. the long-run response of output to demand shocks is zero. The aforementioned restrictions uniquely determine the elements of A_0, which allows us to recover supply and demand shocks from the residuals of an estimated VAR.

4 Empirical Results

4.1 Correlation of GDP and Inflation

Our data set confirms that the business cycles in some CEECs have become more similar to the business cycle of the EU area in the second half of the 1990s (see Table 1). At the beginning of the 1990s, production development in the CEECs was determined by the so-called "transitional" recession (see Campos and Coricelli, 2002). However, the recovery in these countries has been strongly influenced by their growing exports to the EU. As a result, the business cycle of the EU has increasingly determined the developments in the CEECs' economies since 1993.

In particular, the correlation of real GDP[6] growth between the euro area and Hungary (0.83 between 1995 and 2000) has been slightly higher than the corresponding correlation of euro countries on average (0.81 between 1991 and 2000). The business cycles of Slovenia, Estonia and Latvia also followed the pattern of euro area development. By contrast, GDP development in the Czech Republic, Lithuania, Poland and Slovakia has been dominated by domestic factors.

Insert Figure 1 and Table 1 about here!

Beyond the correlation of business cycles, Table 1 and Figure 1 reveal a possible relation between the similarity of GDP development and inflation. Those countries displaying a high and positive correlation of GDP growth also show a high and positive correlation of inflation. Within the euro area this relation may have been caused by the increasing competition pressure in the Single Market.

Given GDP and inflation correlation, we can identify two or three country groups. First, we have a group of candidate countries with a low similarity of both price and GDP development. This group includes the Czech Republic, Lithuania, Poland, Slovakia, Turkey as well as a few smaller OECD countries and possibly Croatia (despite the negative correlation of price development). The second group includes EU countries and Estonia, Latvia and Slovenia.

[6] In order to deal with seasonality, we report correlations for the fourth difference of (quarterly) data in the euro area and in the selected countries. We deal similarly with price data. Tables A.1 and A.2 specify time periods avaialble for the original data.

From the point of view of GDP development, Denmark, Ireland, Hungary, Bulgaria, Canada, Finland and the Netherlands also belong to this group. However, these countries faced a different price development than the euro area. Therefore, they should be viewed as a different group or subgroup.

In general, the CEECs are a less homogeneous group than the EU countries or the euro area. Furthermore, this is also true for particular regional groupings in Central and Eastern Europe (e.g. the so-called Visegrad countries or the Baltic states). The policy implications of these results are, however, restricted because they do not reveal the role of underlying demand and supply shocks.

4.2 Correlation of Supply and Demand Shocks

Our assessment of the correlation between supply and demand shocks in different countries starts by estimating two-variable vector autoregressive (VAR) models for all the individual countries and the euro area (published as an aggregate of all member countries by the Eurostat).[7] In the VARs our variables are first differences of (the log of) real quarterly GDP (industrial production for Greece, Ireland and Romania) and in (the log of) prices (GDP deflator).[8] For the series that are not seasonally adjusted, we also included three seasonal dummies. The lag length of the VARs was chosen according

[7] Estimation periods are listed in the first column of Table 3.

[8] We performed unit root tests for the series. It is quite obvious even from a mere visual observation of the data that the series have to differenced once to be rendered stationary, and this was indeed confirmed by augmented Dickey-Fuller (ADF) tests.

to sequential likelihood ratio tests for different lag lengths. Usually, this was also the same lag length as the one chosen by the Akaike information criterion. In practice the optimum lag length was usually two, sometimes three quarters. The over-identifying restriction mentioned in Section 4.4 (i.e., the accumulated effects of supply and demand shock on prices are negative and positive, respectively) was satisfied in almost all VARs (see Figure 3 and Section 4.4). The only exceptions were the Baltic countries, Finland, Japan and Poland.

From the estimated VARs we recovered the underlying supply and demand shocks as described in the previous section. Table 2 and Figure 2 show the contemporaneous correlation between supply and demand shocks in the euro area and in individual countries in the first column of the particular blocks of the table. The next two columns of each block, for comparison, give the pairwise correlations vis-à-vis Germany and France. These two countries were selected because they are the largest national economies within the euro area.[9]

In general, we can see that the correlations computed for the euro area provide a better picture than comparable indicators for selected national economies. The latter indicators seem to be much more volatile. Surprisingly, this feature is especially true for Germany, which is usually taken as a proxy for the euro area (see for example Frenkel et al., 1998, Boone and Mau-

[9]The whole correlation matrix of supply and demand shocks between the analyzed countries is available from the authors. The text below refers to the whole set of computed correlations.

rel, 1998 and 1999, and Fidrmuc, 2001). As far as this finding is supported by Horvath (2000), it seems that those studies may be biased by the concentration on Germany because of its different development after the German reunification.

As a result, we concentrate on correlations between supply and demand shocks of individual countries and those of the euro area (see Figure 1). For present members of the monetary union, we can see that our correlation coefficients are generally lower than those reported by Bayoumi and Eichengreen (1993). This is quite natural, as we use quarterly data, which are bound to be noisier than the annual data used by Bayoumi and Eichengreen. However, for many countries formerly dubbed "peripheral," especially the correlation of supply shocks is quite high during the 1990s. This finding shows that business cycles can converge relatively fast if the countries make important integration progress. Actually, countries like Spain, Italy and Belgium have moved from the periphery according to Bayoumi and Eichengreen (1993) to the core of the euro area accoding to our results.[10]

A comparison of Figures 1 and 2 reveals further interesting features. First, supply and demand shocks are less strongly correlated than GDP growth and inflation. Second, we can find two nearly separate country groups despite the first finding. The first group includes all EU countries except for Ireland and Greece,[11] as well as Hungary, and possibly Australia and Poland. These

[10] This conclusion is fully confirmed by shocks' correlations of these countries with those estimated for Germany and France.

[11] Note, however, that we use industrial production and producer prices for these two

countries show a relatively high correlation of at least one type of the decomposed shocks. The second group includes all remaining OECD countries and the CEECs. Latvia and Lithuania are revealed to be outliers with a high negative correlation of the demand shocks with the euro area. Both findings indicate that the Blanchard and Quah decomposition of VAR residuals may lead to significantly different policy conclusions with regard to the OCA criteria. For example, Latvia is found to have a development of both GDP growth and inflation similar to the euro area, despite largely idiosyncratic demand shocks.

Nevertheless, there is a handful of countries which have a fairly high correlation of supply shocks with the euro area. Especially Hungary stands out with high correlation of both supply (0.46) and demand shocks (0.24). Also Estonia (0.25) and Latvia (0.30) seem to have quite a high correlation of supply shocks. Hungary is very highly integrated with the EU both through foreign trade and direct investment (see Fidrmuc, 2001), and the same applies to Estonia, whose major trade partner, Finland, accounts for more than one third of exports. For many accession countries, however, the correlation of supply shocks is below 0.1. Lithuania even has a negative correlation, which may be caused by the country's peculiar production structure.[12] However, it should be noted for the Baltic countries and Hungary that the estimation period was slightly shorter than for the other accession countries, which may

EU countries.

[12] For example, a single oil refinery accounts for a sizeable share of industrial production.

bias the results somewhat, although the difference in estimation periods is not too large.

As with the current members of monetary union, the correlation of demand shocks is generally lower than that of supply shocks. Hungary and Poland stand out as having at least as high a correlation as many current EMU members. Also Estonia[13] has quite a high correlation of demand shocks with the euro area, whereas the other two Baltic countries are negatively correlated. Some accession countries (e.g. Slovakia and Slovenia) show very little correlation with euro area demand shocks.

Although we consider the correlations pairs computed for Germany and France as a base country to be less reliable than those against the euro area, there is actually one interesting feature we should note. We find high correlation of Hungarian supply and demand shocks with those estimated for France (and also for Italy), but low correlation with German (and also Austrian) shocks. On the first glance, this result is surprising because Germany and Austria are the most important trade partners of Hungary in transition countries. However, this pattern of business cycle may correspond to the specialization pattern, where transition countries are taking similar positions like several catching-up South East European countries (see Fidrmuc et al., 1999a).

There are also some interesting regional clusters of correlations among

[13] Note, however, that Poland and Estonia do not fulfill the over-identifying restriction. Therefore, these results may be more difficult to interpret.

accession countries and also some current EU countries. For example, Hungarian and Polish supply shocks seem to be quite correlated. Estonian supply shocks are highly correlated with Lithuanian, Polish and Swedish shocks.[14] Also Latvian and Lithuanian supply shocks are correlated, as are Danish and Polish supply shocks. Czech supply and demand shocks are relatively similar to those of Slovakia, while Croatia stands relatively close to Slovenia. We can see that these country groupings can be easily attributed to obvious regions. Basically, this confirms the reliability of our results.

We do not report any sensitivity analysis, but previous studies on the optimum currency area between the EU and the CEECs can be taken as corresponding reference values for this purpose. Our findings for Hungary and Poland are actually very similar to the studies reviewed in Section 2. For the Czech Republic, Horvath and Jonas (1998) and Horvath (2000) find rather low correlation with the selected countries of the European Union. Thus, their findings support our results. By contrast, Frenkel and Nickel (2002) stress that the correlation of supply and demand shocks between the Czech Republic and the core countries of the European Union is high.[15] More differences can be found for the Baltic States and Slovenia, which corresponds maybe to larger data problems for these countries.

Insert Figure 2 and Table 2 about here!

[14] And Slovenian shocks, but this would be harder to explain by regional proximity or close economic ties.

[15] However, the lines for the Czech Republic and Estonia are fully identical, see Frenkel and Nickel (2002, Table 2).

4.3 Size of Supply and Demand Shocks

In addition to the similarity of shocks between the accession countries and the Euro area, the size of shocks matters as well. It may be more costly for the candidate countries to keep a fixed exchange rate if the shocks which they face are large. Thus, the size of shocks may be also viewed as another possible criterion for participation in the monetary union. Bayoumi and Eichengreen (1993) argue that this is particularly true for supply shocks, which may require a more painful adjustment. Supply shocks are especially relevant, if demand shocks originate mainly from domestic economic policies, since in a monetary union economic policies should converge to a large extent.

For the European Union, our estimations (Table 3) of supply and demand shocks actually show smaller variance of the supply shocks in the so-called "core countries" of the EU than in the other member states, which is consistent with Bayoumi and Eichengreen. By contrast, there are no clear differences between euro area countries and the EU countries outside the euro area. The UK has even the lowest standard deviation of supply shocks in the EU, although the shocks in Denmark and Sweden are larger than in the EU average.

Surprisingly, the USA seems to be more affected by the demand shocks than by the supply shocks, while the opposite is true for Europe. Thus, it supports the view that the creation of the Single Market and the Economic and Monetary Union has induced strong supply changes in Europe. This is further strengthened by the observation that all three former EFTA-countries

(Austria, Finland and Sweden) have faced higher variance of supply shocks than the other member states. The visual inspection of the supply shocks in these countries also shows that the variance (of both types of shocks) was significantly higher in the middle of the 1990s. There are much less differences in the size of demand shocks between the current member states of the EU.

With respect to the transition economies, we find only two accession countries (Poland and Slovenia)[16] that have higher standard deviation of supply shocks than in the EU. The size of shocks in the Czech Republic and in Estonia is even clearly lower than in the core EMU countries. Furthermore, it seems that demand shocks dominated in the second half of the 1990s in transition economies, but the size of supply shocks was moderate in all CEECs with the exception of Bulgaria. The Baltic States facing higher supply than demand shocks represent an exception. This is also a quite reliable result indicating the recovery of domestic demand as well as a better integration into the European economic cooperation in nearly all CEECs (except for Bulgaria suffering a currency and banking crisis in the investigated period), while the Baltic States faced new structural adjustments in the wake of the Russian crisis in this period again. Also, the Baltic economies are very small and consequently not very diversified, implying larger relative size of shocks. As a result, the participation of the majority of the CEECs in the Euro are would likely not pose for these countries additional problems

[16] Croatia and Turkey also faced larger supply as well as demand shocks than the EU.

given the small relative volatility of the supply and demand shocks. It is also interesting to note that generally size of the shocks does not seem to depend on the size of the economy, although a priori one could expect smaller economic units to have larger shocks.

Insert Table 3 about here!

4.4 Adjustment to Shocks

The estimation of structural VAR models for relatively short time series is obviously a subject to the critique that the results are likely to be biased. This is more crucial for quarterly data than for estimations based on annual data. Therefore, we have put much attention to model selection and evaluation. In particular, the aggregate demand and aggregate supply model defines the so called 'over-identifying' condition. Positive demand and supply shocks are supposed to rise and reduce the price level, respectively. It is important to keep in mind that this condition is not predetermined in the empirical models. As a result, the behavior of estimated impulse-response functions provides important information whether structural VAR are consistent with the underlying economic model. The sensitivity analysis presented here looks at the estimated impulse-response functions (see Figure 3) of the euro area, its core countries (Germany and France), and three transition economies (Czech Republic, Hungary, and Poland).

We can see that the euro area and the both core countries are fulfilling the over-identifying condition. The comparison of the results reported by Bayoumi and Eichengreen (1993) with our estimations of the impulse-response functions shows remarkable similarities. This indicates that the estimations of structural VARs lead to basically consistent results despite short time series. However, the results for the transition economies are slightly worse, although the over-identifying condition is fulfilled for all CEECs with the exception of Poland and the Baltic states.[17] The examples of the Czech Republic and Hungary show more 'irregularities' in the estimated response countries than for OECD countries in general. This irregular pattern revealed for transition economies is likely to be a result of outliers and seasonal pattern, which could not be dealt sufficiently with the seasonal dummies.

However, we can also find interesting differences between our estimations of the impulse-response functions and those reported by Bayoumi and Eichengreen (1993). In particular, their results suggest that output development is dominated by the demand shocks in the short run (about two years). Our estimates show that the aggregated responses of output to supply shocks are clearly higher than the responses to the demands shock in the short run and in the long run. This behavior is found for the euro area, Germany, France and the majority of the members of the euro area, but surprisingly not for Hungary (although only for one period) and other transition economies, which are actually more similar to the results reported by Bayoumi and Eichengreen. Possibly, this indicates the importance of the supply shocks in the 1990s (the so called New Economy) in the EU. Similarly, economic transition has

[17]Nevertheless, note that the impulse responses to a demand shock lie above those to a supply shock in Poland. This is valid also for the other countries.

induced significant demand shocks in the transition economies.

Furthermore, Figure 3 indicates the speed of output adjustment to supply and demand shocks. In addition to the similarity of supply and demand shocks, also the responses of the output to the shocks should follow a similar pattern in an optimum currency area. This shows whether a common monetary policy in response to the correlated shocks is appropriate for the members of a currency union. Bayoumi and Eichengreen propose the value of aggregated impulses after some period of time in comparison to the long-run level of the responses as a measure of the speed of adjustment.

According to our estimations, the euro area and the core countries of the euro area display a comparably fast adjustment to supply and demand shocks. However, it is important to note that there are also important differences within the euro area. On the one hand, Germany adjusts faster to the supply shocks than France. The long run level of response to a supply shock is also much higher in France than in Germany. We find that only 63% of the long-run level of aggregated response to a supply shock is reached after four quarters in France, while this indicator is nearly 87% for Germany and already 100% for the euro area. Also after two years, there is still a difference between the core countries (84% in France and 92% in Germany). The bulk of adjustment is reached only after three years (about 95% of the long-run value of responses).[18] Overall, German responses to a supply shock are very similar to those of the euro area.

[18] Bayoumi and Eichengreen find for annual data als that the major part of adjustment to a supply shock follows within three years.

On the other hand, the adjustment of output to a demand shock is comparably slower in Germany, while the French responses are generally very low. France and the euro area reach the long-run (zero) level already after two years, while Germany is facing small positive responses even after four years. Thus, France and Germany are representing the lower and upper bands of the interval, with the estimated impulse-responses for the euro area being located between these two values.

Finally, our estimations show that the responses of selected accession countries to both types of shocks are relatively volatile in the first four quarters. Nevertheless, we can see a fast adjustment to these shocks. The Hungarian and Polish output responses to a supply shock follow the pattern of development of the French response after four quarters and their long-run values are also nearly the same as in France. By contrast, the long-run value of response to a supply shock in the Czech Republic is much higher than in the selected core countries of the euro area. The output responses to a demand shock in Hungary and the Czech Republic are within the interval defined by French and German responses after one year, while they are very low during the whole period in Poland. Thus, we can conclude that also the speed of adjustment of output to supply and demand shocks is very similar to those in the euro area in Hungary and Poland. The Czech Republic displays a similar behavior pattern in response to demand shocks, but different behavior for supply shocks.

The example of Hungary is especially important for the interpretation of our results. It demonstrates that the underlying behavior of the Hungarian economy has been already relatively stable since the middle of the 1990s. Furthermore, this gives more weight to our results presented above. As Hungary began economic reforms before other CEECs, the Hungarian economy seems to have rapidly adjusted to a market economy during the 1990s. This can be seen both at the relatively robust estimation of the aggregate demand and aggregate supply model, as well as at the relatively high similarity of demand and supply shocks to those in its most important trade partners. Actually, this adjustment fully corresponds to the so-called 'endogeneity' hypothesis of the optimum currency area (Frankel and Rose, 1998). If so, we can expect a similar development also in the other CEECs, despite the worse statistical performance of estimated structural VARs and low similarity of recovered demand and supply shocks during the 1990s.

Insert Figure 3 about here!

5 Conclusions

In this paper, we have assessed the correlation of supply and demand shocks between the euro area and EU accession countries as compared to selected countries during the 1990s. Supply and demand shocks were recovered from structural vector autoregressive models. First, we find that the correlation of supply shocks differs considerably from country to country. Also, correlation of demand shocks in the accession countries with euro area is usually lower than correlation of supply shocks.

Second, some countries are at least as well correlated with the euro area shocks as are many current members of EMU. The two countries with the highest correlation of supply shocks are Hungary and Estonia, although the estimated structural VAR for the latter country shows worse statistical performance. Not coincidentally, these two countries have also received most foreign direct investment on a per capita basis and they have very extensive trade relations with the countries of the euro area (and the EU in general). Hungary also has a high correlation of demand shocks. For many other accession countries, the degree of correlation is clearly lower. This holds true even for many advanced transition countries, e.g. the Czech Republic and Slovenia. In Latvia and Lithuania, the demand shocks are negatively correlated, even though for Latvia the correlation of supply shocks is positive.

Third, the size of shocks is relatively low for all accession countries with the exception of Poland and Slovenia. The size of shocks in the Czech Republic and in Estonia is even clearly lower than in the core EMU countries. This finding also supports an easy addoption of euro in these countries. Finally, the adjustment of output to supply and demand shocks is very similar to those in the euro area in Hungary and Poland. The Czech Republic displays a similar behavior pattern in response to demand shocks, but different behavior for supply shocks

Thus, our findings seem to at least partially confirm the results of e.g. Frenkel et al. (1999), Boone and Maurel (1999), Fidrmuc (2001), Frenkel and Nickel (2002), and Korhonen (2001). In all these studies the Hungarian economic cycle is quite well correlated with the European cycle. The same applies to Slovenia and perhaps also to Estonia. The latter two are very small economies which are geographically close to the EU, and it is therefore not surprising that their economic cycles are correlated with that of the EU (or the euro area). For the other accession countries, the correlation was perhaps not very high during the 1990s, but the situation may have changed over time.

Some policy conclusions emerge from our study. First, for some accession countries (e.g. Hungary and Estonia) joining the euro area fairly quickly would not imply large welfare losses because of asymmetric business cycles. Correlation of their supply and demand shocks with the euro area does not differ much from the smaller euro area countries' correlation. A reasonable short time within the ERM II could also be expected for these countries. On the other hand, for many countries (e.g. Lithuania and Slovakia) correlation of shocks remains very low. Therefore a soon membership in the monetary union could prove to be detrimental for them. The same argument could apply also to a membership in the ERM II, although this arrangement does offer wide fluctuation bands around the central parity and a chance to change the central parity if needed. At the same time, one can argue that membership in the monetary union by itself will foster further integration and higher correlation of business cycles.

References

Backé, P., 1999, Exchange Rate Regimes in Central and Eastern Europe: A Brief Review of Recent Changes, Current Issues and Future Challenges, *Focus on Transition,* 2:47-67.

Bayoumi, T. and B. Eichengreen, 1993, Shocking Aspects of European Monetary Integration, in: F. Torres and F. Giavazzi, eds., *Growth and Adjustment in the European Monetary Union,* (Cambridge University Press, Oxford) 193-230.

Blanchard, O. and D. Quah, 1989, The Dynamic Effects of Aggregate Demand and Supply Disturbances, *American Economic Review* **79**, 4: 655-673.

Boone, L. and M. Maurel, 1998, Economic Convergence of the CEECs with the EU, Discussion Paper No. 2018, (CEPR, London).

Boone, L. and M. Maurel, 1999, An Optimal Currency Area Perspective of the EU Enlargement to the CEECs, Discussion Paper No. 2119, (CEPR, London).

Campos, N F. and F. Coricelli, 2002, Growth in Transition: What We Know, What We Don't, and What We Should, *Journal of Economic Literature* **XL**, September: 793–836.

Estrin, S. and G. Urga, 1997, Convergence in Output in Transition Economies: Central and Eastern Europe, *1970-95,* Discussion Paper No. 1616, (CEPR, London).

Fidrmuc, J., 2001, The Endogeneity of the Optimum Currency Area Criteria, Intraindustry Trade, and EMU Enlargement, Discussion Paper

No. 106/2001 (Centre for Transition Economics, Katholieke Universiteit, Leuven).

Fidrmuc, J., D. Grozea-Helmenstein and A. Wörgötter, 1999a, East-West Intra-Industry Trade Dynamics, *Weltwirtschaftliches Archiv* **135**, 2: 332-346, June.

Fidrmuc, J., J. Horvath and J. Fidrmuc, 1999b, Stability of Monetary Unions: Lessons from the Breakup of Czechoslovakia, *Journal of Comparative Economics,* **27**, 4: 753-81, December.

Frankel, J.A. and A.K. Rose, 1998, The Endogeneity of the Optimum Currency Area Criteria, *Economic Journal,* **108**, 449: 1009-1025, July.

Frenkel, M. and C. Nickel, 2002, How Symetric are the Shocks and the Shock Adjustment Dynamics between the Euro Area and Central and Eastern European Countries?, Working Paper No. 02/222, (IMF, Washington D.C.).

Frenkel, M., C. Nickel and G. Schmidt, 1999, Some Shocking Aspects of EMU Enlargement, Research Note No. 99-4, (Deutsche Bank, Frankfurt am Main).

Horvath, J., 2000, Supply and Demand Shocks in Europe: Large-4 EU Members, Visegrad-5 and Baltic-3 Countries, Mimeo.

Horvath, J., and J. Jonas, 1998, Exchange Rate Regimes in the Transition Economies: Case Study of the Czech Republic 1990-1997, Working Paper No. B11 (Center for European Integration Studies, ZEI, Bonn).

Järvinen, M., 2000, Central and Eastern Europe: Prospects for EMU Membership, Discussion Paper No. 64, (Finnish Ministry of Finance, Helsinki).

Kaitila, V., 2001, Accession Countries' Comparative Advantage in the Internal Market: A Trade and Factor Analysis, Discussion Paper No. 3/2001, (Bank of Finland, Institute for Economies in Transition, Helsinki).

Kočenda, Evžen, 2001, Macroeconomic Convergence in Transition Economies, *Journal of Comparative Economics* **29**, 1: 1-23.

Kopits, G., 1999, Implications of EMU for Exchange Rate Policy in Central and Eastern Europe, Working Paper No. 99/9, (IMF, Washington D.C.).

Korhonen, Iikka, 2001, Some Empirical Tests on the Integration of Economic Activity Between the Euro Area and the Accession Countries, Discussion Paper No. 9/2001, (Bank of Finland, Institute for Economies in Transition, Helsinki).

Kutan, A. M. and T. M. Yigit, 2002. Nominal and Real Stochastic Convergence Within the Transition Economies and to the European Union: Evidence From Panel Data, Mimeo (Southern Illinois University Edwardsville).

Maurel, M., 2002, On the Way of EMU Enlargement Towards CEECs: What is the Appropriate Exchange Rate Regime?, Discussion Paper No. 3409, (CEPR, London).

McKinnon, R. I., 2000, Mundell, the Euro and the World Dollar Standard, *Journal of Policy Modeling,* **22**, 3: 311-324.

McKinnon, R. I., 2002, Optimum Currency Areas and the European Experience, *Economics of Transition,* **10**, 2: 343-364.

Mundell, R., 1961, A Theory of Optimum Currency Area, *American Economic Review,* **51** (September), 657-665.

Nuti, M. D., 2002, Costs and Benefits of Unilateral Euroization in Central Eastern Europe, *Economics of Transition* **10** (2), 419-444.

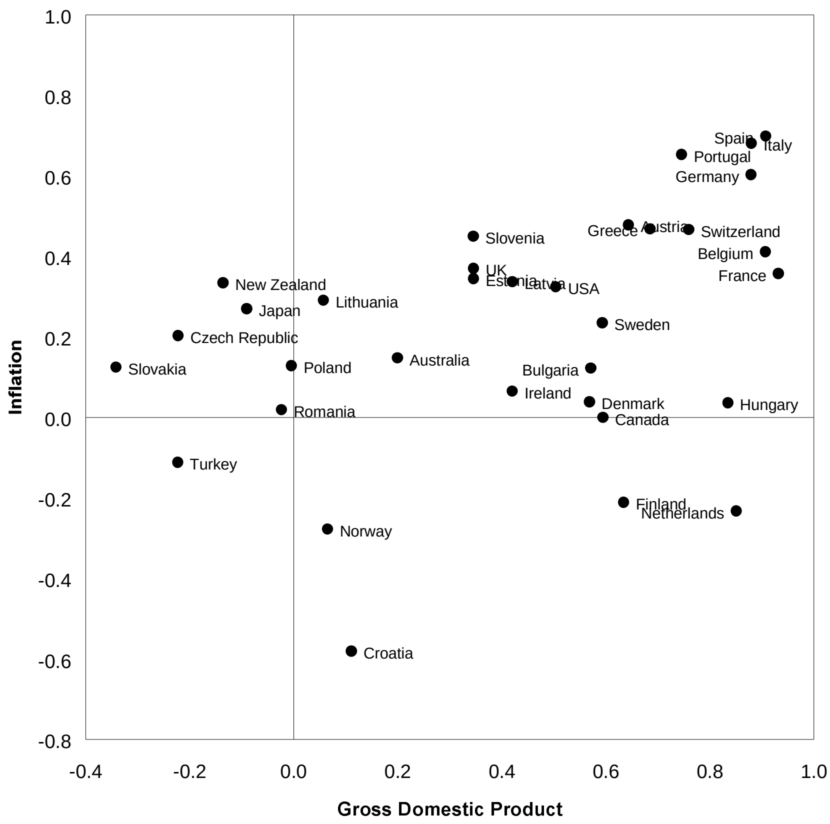

Figure 1: Correlation of GDP Changes and Inflation with the Euro Area in the 1990s

Table 1: Correlation of GDP and Inflation

	GDP growth			Inflation		
Country	Euro area[a]	Germany	France	Euro area[a]	Germany	France
Austria	0.64	0.57	0.66	0.48	0.85	0.74
Belgium	0.91	0.83	0.78	0.41	0.89	0.77
Finland	0.63	0.35	0.60	-0.21	-0.07	0.12
France	0.93	0.74	1.00	0.36	0.74	1.00
Germany	0.88	1.00	0.74	0.60	1.00	0.74
Greece	0.42	0.49	0.68	0.06	0.71	0.79
Ireland	0.69	0.33	0.40	0.47	0.05	0.31
Italy	0.88	0.72	0.75	0.68	0.44	0.70
Netherlands	0.85	0.60	0.83	-0.23	0.03	0.06
Portugal	0.75	0.52	0.78	0.65	0.92	0.59
Spain	0.91	0.65	0.89	0.70	0.80	0.63
Denmark	0.57	0.55	0.41	0.04	-0.25	-0.47
Sweden	0.59	0.42	0.62	0.23	0.62	0.85
UK	0.35	0.20	0.23	0.37	0.35	0.44
Bulgaria	0.57	0.33	0.60	0.12[c]	0.32[c]	0.61[c]
Czech Rep.	-0.22	0.06	-0.42	0.20	0.74	0.56
Estonia	0.35	0.42	-0.02	0.34	0.33	0.79
Hungary	0.83	0.67	0.73	0.04	0.48	0.78
Latvia	0.42	0.41	0.06	0.34	0.40	0.79
Lithuania	0.06	0.08	-0.15	0.29	0.46	0.86
Poland	-0.00	0.18	-0.31	0.13	0.47	0.75
Romania	-0.03	-0.05	-0.11	-0.28	0.62	0.68
Slovakia	-0.34	-0.17	-0.51	0.12	0.67	0.52
Slovenia	0.35	0.45	0.29	0.45	0.71	0.77
Croatia	0.11	0.19	-0.18	-0.58	-0.16	-0.15
Australia	0.20	0.00	0.26	0.15	-0.14	0.15
Canada	0.59	0.41	0.54	0.00	-0.20	0.02
Japan	-0.09	-0.05	-0.20	0.27	0.79	0.74
New Zealand	-0.14	-0.10	-0.24	0.33	0.23	0.35
Norway	0.07	0.14	-0.18	-0.28	-0.62	-0.52
Switzerland	0.76	0.53	0.78	0.47	0.74	0.74
Turkey	-0.22	-0.14	-0.26	-0.11	0.06	0.20
USA	0.50	0.43	0.45	0.32	0.53	0.75

Note: [a] correlation with the the aggregate of the euro area. [c]excluding 1997:1–1997:4. See Tables A.1 and A.2 for data availability.

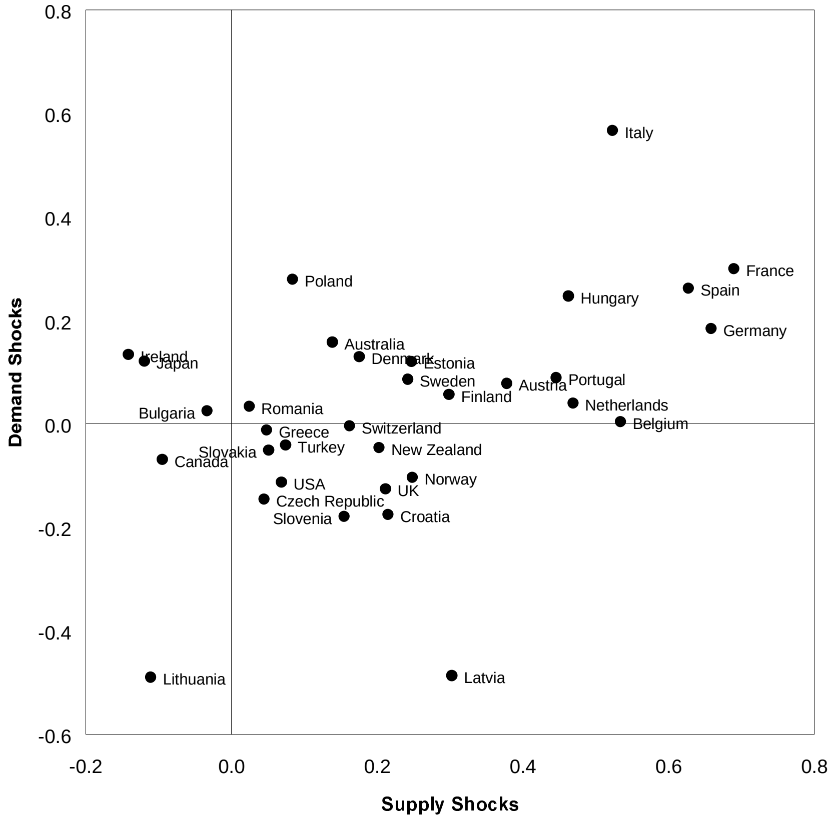

Figure 2: Correlation of Supply and Demand Shocks in the 1990s

Table 2 Correlation of Supply and Demand Shocks

Country	Supply Shocks			Demand Shocks		
	Euro area[a]	Germany	France	Euro area[a]	Germany	France
Austria	0.38	0.48	0.43	0.08	0.33	0.35
Belgium	0.53	0.18	0.36	0.00	0.21	0.46
Finland	0.30	0.17	0.26	0.06	-0.19	0.10
France	0.69	0.44	1.00	0.30	0.35	1.00
Germany	0.66	1.00	0.44	0.18	1.00	0.35
Greece	0.05	0.05	0.12	-0.01	-0.07	0.09
Ireland	-0.14	-0.12	-0.09	0.13	-0.14	0.23
Italy	0.52	0.25	0.36	0.57	0.27	0.41
Netherlands	0.47	0.11	0.60	0.04	0.29	-0.10
Portugal	0.45	0.23	0.44	0.09	0.28	-0.11
Spain	0.22	0.35	0.26	0.16	0.35	0.60
Denmark	0.18	0.30	0.13	0.13	0.09	0.13
Sweden	0.24	0.00	0.11	0.09	0.08	0.33
UK	0.21	0.12	0.31	-0.13	-0.07	0.21
Bulgaria	-0.03	0.13	-0.29	0.03	-0.17	0.12
Czech Rep.	0.04	-0.02	0.13	-0.15	-0.30	0.11
Estonia	0.25	0.34	-0.06	0.12	-0.15	0.20
Hungary	0.46	-0.10	0.65	0.25	-0.01	0.44
Latvia	0.30	0.10	0.07	-0.49	-0.09	-0.16
Lithuania	-0.11	0.00	-0.17	-0.49	0.32	-0.24
Poland	0.08	-0.04	-0.17	0.28	0.24	0.30
Romania	0.02	-0.08	-0.02	0.03	-0.05	0.08
Slovakia	0.05	0.11	-0.04	-0.05	-0.29	-0.27
Slovenia	0.15	-0.04	-0.20	-0.18	0.14	0.36
Croatia	0.21	-0.03	0.09	-0.18	0.24	0.08
Australia	0.14	0.37	0.33	0.16	-0.05	0.08
Canada	-0.09	-0.01	-0.12	-0.07	0.09	-0.07
Japan	-0.12	-0.33	-0.12	0.12	-0.13	0.04
N. Zeal.	0.20	0.09	0.08	-0.05	-0.35	0.06
Norway	0.25	0.23	0.29	-0.10	-0.27	-0.02
Switzerl.	0.16	0.15	0.09	0.00	0.03	0.17
Turkey	0.07	-0.05	0.05	-0.04	-0.02	0.23
USA	0.07	0.32	0.02	-0.11	0.07	-0.02

Note: [a] correlation with the shocks of the aggregate of the euro area. See Table 3 for estimation periods.

Table 3 Standard Deviations of Supply and Demand Shocks

Country	Estimation Period	Supply Shocks	Demand Shocks
Euro area	1991:4-2000:4	0.60599	0.46248
Austria [a]	1991:2-2000:4	1.20334	0.65589
Belgium [c]	1992:2-2000:3	0.56635	1.45137
Finland [c]	1992:1-2000:4	0.41071	1.96895
France [a]	1991:2-2000:4	0.30438	0.80387
Germany	1992:1-2000:3	0.55629	1.42145
Greece [bc]	1991:2-2000:4	1.43311	0.59008
Ireland [bc]	1991:2-2000:1	0.74324	0.95389
Italy [a]	1991:2-2000:4	1.03260	0.37636
Netherlands [c]	1992:2-2000:3	0.45929	0.98884
Portugal [c]	1991:4-2000:3	1.25803	0.65181
Spain [ac]	1991:2-2000:4	0.30336	1.29510
Denmark [c]	1991:4-2000:2	1.10080	1.15165
Sweden [a]	1993:3-2000:4	1.11245	1.00654
UK [ac]	1991:2-2000:4	0.27405	1.12873
Bulgaria	1995:2-2000:4	0.77484	3.62192
Czech Republic	1995:1-2000:4	0.29067	0.70275
Estonia	1996:1-2000:4	0.35414	0.38822
Hungary	1995:4-2000:4	0.65429	0.92300
Latvia	1996:1-2000:4	0.40964	0.35676
Lithuania	1996:1-2000:4	0.99902	0.47082
Poland	1994:4-2000:4	1.14834	0.76427
Romania[bc]	1992:1-2000:4	0.57424	0.44131
Slovakia	1994:2-2000:3	0.49619	0.75481
Slovenia	1994:1-2000:4	1.37587	0.48509
Croatia	1994:4-2000:4	1.39796	1.14701
Australia [ac]	1991:2-2000:4	0.33850	1.24278
Canada [ac]	1991:1-2000:4	0.32704	0.65176
Japan [ac]	1991:1-2000:4	1.62065	0.43039
New Zealand [ac]	1991:1-2000:4	0.62499	0.94130
Norway [ac]	1991:1-2000:4	1.09781	0.73204
Switzerl. [ac]	1991:1-2000:4	0.39138	0.34848
Turkey [c]	1991:2-2000:3	1.00470	0.82644
USA [ac]	1991:1-2000:4	0.52913	0.98222

Note: See Data Appendix for data description.

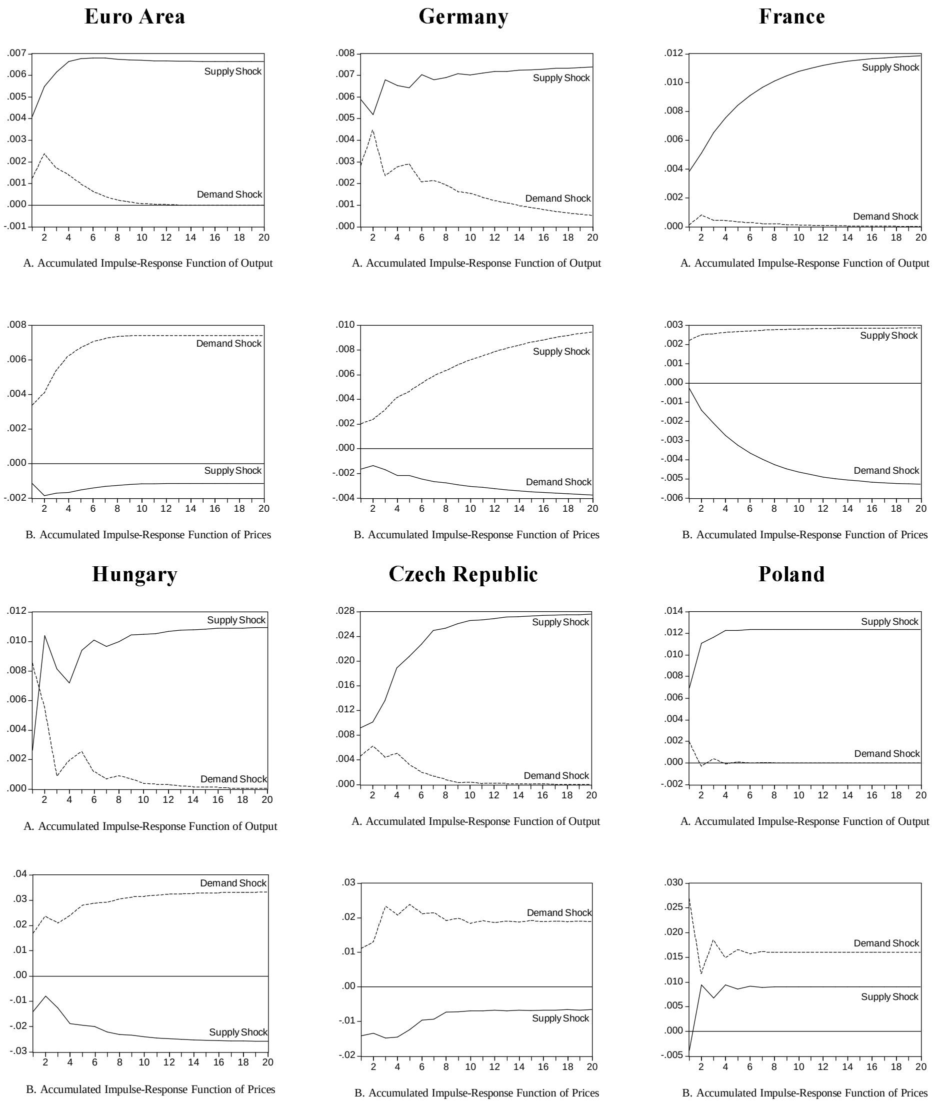

Figure 3: Aggregated Impulse-Response Functions for Selected Countries

Data Appendix

We use quarterly GDP in constant and current prices. Wherever possible, these data are used to construct the implicit GDP deflator, which is our preferred price variable. However, we have to use the industrial production and producer price index for Romania, Greece and Ireland. Wherever possible, GDP variables are taken from the OECD's Quarterly National Account database, which provides seasonally adjusted data for all EU countries and unadjusted data for the Czech Republic and Turkey. Data for the other accession countries are collected from national publications.

The length of the time series for the accession countries varies, but usually it starts from 1993 or 1994 (1995 in the case of the Baltic countries and Hungary). The data therefore omit the period of transformational recession in the accession countries. This probably makes the results more applicable for the present time period as well.

For the EU countries, the length of the time series varies as well (the time series are basically available from the 1960s or 1970s in nearly all cases except for Sweden and Turkey), but supply and demand shocks are calculated from models with an estimation period starting from 1991. This restriction was chosen in order to ensure a better comparability between the EU and the accession countries. Nevertheless, the comparison of the estimations for the entire period available and for the 1990s confirms the robustness of our results for all EU countries with the exception of Turkey. Time series for the euro area, as published by the Eurostat, are available only as of the beginning of

1991.

Both real GDP and the GDP deflator were rebased to 100 in 1995 for all countries. We use the first differences of the natural logarithm of the transformed series for our estimations. Tables A.1 and A.2 give descriptive statistics of the first difference of output and price series.

Table A.1 Descriptive Statistics of GDP Growth

Country	Period	Mean	Median	Minimum	Maximum	St.dev.
Euro area	1991:2-2000:4	0.00487	0.00558	-0.00686	0.01455	0.00458
Austria [ac]	1991:1-2000:4	0.00559	0.00547	-0.01528	0.02872	0.00779
Belgium [ac]	1991:2-2000:3	0.00541	0.00705	-0.02084	0.02135	0.00909
Finland	1991:2-2000:4	0.00862	0.01619	-0.08415	0.05813	0.04046
France [ac]	1991:1-2000:4	0.00469	0.00606	-0.00534	0.01129	0.00445
Germany	1991:2-2000:3	0.00400	0.00391	-0.01227	0.02129	0.00667
Greece [bc]	1991:2-2000:4	0.00152	0.01674	-0.12312	0.10575	0.06564
Ireland [abc]	1991:1-2000:1	0.02454	0.02521	-0.07908	0.08884	0.03136
Italy [ac]	1991:1-2000:4	0.00430	0.00472	-0.00893	0.01787	0.00591
Netherl. [c]	1991:2-2000:3	0.00718	0.00686	-0.00517	0.01395	0.00471
Portugal [c]	1991:2-2000:3	0.00732	0.00708	-0.02371	0.03946	0.01569
Denmark [c]	1991:2-2000:2	0.00648	-0.00248	-0.03495	0.06641	0.03034
Sweden [a]	1993:2-2000:4	0.00762	0.00891	-0.01189	0.01800	0.00700
UK [ac]	1991:1-2000:4	0.00585	0.00550	-0.00549	0.01437	0.00422
Bulgaria	1994:2-2000:4	-0.00141	-0.00144	-0.08649	0.08303	0.03888
Czech Rep.	1994:2-2000:4	0.00668	0.04130	-0.06646	0.07113	0.05765
Estonia	1995:2-2000:4	0.01587	0.05667	-0.14005	0.13157	0.08778
Hungary	1995:2-2000:4	0.00807	0.03802	-0.12438	0.08329	0.07200
Latvia	1995:2-2000:4	0.01274	0.00571	-0.04432	0.08567	0.03368
Lithuania	1995:2-2000:4	0.01264	0.06846	-0.17199	0.19273	0.12944
Poland	1995:2-2001:1	0.01076	0.04317	0.17140	0.12211	0.10592
Romania [bc]	1992:1-2000:4	-0.0046	0.0067	-0.1798	0.0991	0.06706
Slovakia	1993:2-2000:3	0.01733	0.01125	-0.01561	0.10674	0.02232
Slovenia	1994:1-2000:4	0.00990	0.01558	-0.05554	0.07816	0.03921
Croatia	1995:1-2001:2	0.04299	0.04265	-0.04459	0.12892	0.03820
Australia [ac]	1991:1-2000:4	0.00889	0.01055	-0.00816	0.02137	0.00696
Canada [ac]	1991:1-2000:4	0.00726	0.00797	-0.01336	0.01602	0.00568
Japan [ac]	1991:1-2000:4	0.00306	0.00311	-0.03214	0.02830	0.01007
N. Zeal. [ac]	1991:1-2000:4	0.00663	0.00865	-0.02523	0.02951	0.01039
Norway [ac]	1991:1-2000:4	0.00790	0.00479	-0.00938	0.03110	0.01023
Switzerl. [ac]	1991:1-2000:4	0.00229	0.00200	-0.00896	0.01122	0.00473
Turkey [c]	1991:1-2000:4	0.00808	-0.06798	-0.30197	0.42659	0.27175
USA [ac]	1991:1-2000:4	0.00835	0.00785	-0.00454	0.02020	0.00498

Note: [a] seasonally adjusted time series, [b] industrial production, [c]the descriptive statistics for a sub-range of the whole available period. The whole time series were used for the robustness analyses as indicated in the text.

Table A.2 Descriptive Statistics of Inflation

Country	Period	Mean	Median	Minimum	Maximum	St.dev.
Euro area	1991:2-2000:4	0.00495	0.00459	-0.00431	0.01483	0.00430
Austria [a]	1991:1-2000:4	0.00493	0.00445	-0.00200	0.01133	0.00332
Belgium [c]	1991:2-2000:3	0.00489	0.00439	-0.00007	0.01092	0.00307
Finland [c]	1991:2-2000:4	0.00471	0.00095	-0.02344	0.04409	0.01777
France [a]	1991:1-2000:3	0.00375	0.00370	-0.00025	0.01355	0.00267
Germany	1991:2-2000:3	0.00489	0.00443	-0.00184	0.01730	0.00472
Greece [bc]	1991:2-2000:4	0.01807	0.01737	-0.00978	0.04636	0.01399
Ireland [bc]	1991:2-2000:4	0.00522	0.00559	-0.01276	0.02784	0.00890
Italy [a]	1991:1-2000:4	0.00898	0.00788	-0.00062	0.02570	0.00576
Netherl. [c]	1991:2-2000:3	0.00513	0.00529	-0.00236	0.01228	0.00336
Portugal [c]	1991:2-2000:3	0.01301	0.01221	-0.01261	0.03648	0.01101
Denmark [c]	1991:2-2000:2	0.00578	0.00708	-0.02129	0.02347	0.01172
Sweden [a]	1993:2-2000:4	0.00401	0.00381	-0.00984	0.01117	0.00468
UK [ac]	1991:1-2000:4	0.00716	0.00705	-0.00442	0.01953	0.00511
Bulgaria	1994:2-2000:4	0.15321	0.08257	-0.22360	1.55597	0.36166
Czech Rep.	1994:2-2000:4	0.01689	0.01684	-0.03754	0.04884	0.01961
Estonia	1995:2-2000:4	0.02552	0.03285	-0.06083	0.13362	0.04978
Hungary	1995:2-2001:1	0.03108	0.02708	-0.00048	0.12375	0.02994
Latvia	1995:2-2000:4	0.02758	0.04170	-0.04848	0.10281	0.04162
Lithuania	1995:2-2000:4	0.01675	0.01267	-0.01940	0.07593	0.02448
Poland	1994:2-2000:4	0.03610	0.03111	-0.00130	0.12168	0.02217
Romania [bc]	1992:1-2000:4	0.14882	0.09642	0.02044	0.42776	0.11649
Slovakia	1993:2-2000:3	0.01733	0.01125	-0.00130	0.08155	0.02232
Slovenia	1994:2-2000:4	0.01660	-0.01520	-0.07816	0.23386	0.08895
Croatia	1995:1-2001:2	0.05463	0.04857	0.01113	0.09002	0.02192
Australia [ac]	1991:1-2000:4	0.00392	0.00347	-0.00305	0.02401	0.00500
Canada [ac]	1991:1-2000:4	0.00406	0.00399	-0.00904	0.01540	0.00470
Japan [ac]	1991:1-2000:4	-0.00016	-0.00050	-0.00815	0.01113	0.00448
N. Zeal. [ac]	1991:1-2000:4	0.00411	0.00389	-0.01617	0.02469	0.00783
Norway [ac]	1991:1-2000:4	0.00783	0.00749	-0.04960	-0.04960	0.01904
Switzerl. [ac]	1991:1-2000:4	0.00363	0.00304	-0.00299	-0.00299	0.00431
Turkey [c]	1991:2-2000:3	0.13600	0.12342	-0.01151	0.39773	0.07229
USA [ac]	1991:1-2000:4	0.00516	0.00505	0.00191	0.00191	0.00190

Note: [a] seasonally adjusted time series, [b] index of producer prices, [c] the descriptive statistics for a sub-range of the whole available period. The whole time series were used for the robustness analyses as indicated in the text.