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Jarko Fidrmuc - Iikka Korhonen

Similarity of supply and demand shocks between the euro area and the CEECs

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

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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. Furthermore, many EU countries seem to have a much higher correlation with the core euro area countries than in the previous decades. Continuing integration within the EU seems to have aligned the business cycles of these countries as well.

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1 Introduction

We examine the correlation of supply and demand shocks between the Central and Eastern Europe countries (CEECs) and the euro area. Our purpose is to assess whether the 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 the German (the "core" country) shocks.

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). Our contribution also updates their results (although with quarterly data), and we find that in general shocks in the member countries of the euro area are quite highly correlated. Moreover, countries like Italy, which were deemed "peripheral" earlier, have become more integrated with the other euro area countries in the 1990s.

The second set of results relates to the CEECs. Even though their membership in the monetary union is several years away even with the most optimistic assumptions, 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, and therefore we feel correlation with the whole euro area 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 whole area, not single countries in it.

A priori, one could expect a quite high correlation in business cycles, as the CEECs' foreign trade is conducted largely with the EU countries. 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 members of the euro area 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. 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 the Central and Eastern Europe.[1] The third section illustrates briefly the aggregate supply-demand model underlying the empirical exercise, and the fourth section describes the method used to recover supply and demand shocks. In the fifth section we proceed to estimate the shocks and assess their nature across countries. The last section offers some concluding remarks.

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 asymmetrical 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.

A revival in the empirical testing of the OCA theory preceded the introduction of the monetary union in Europe. In the empirical studies, the

[1] If not otherwise defined, we define the Central and Eastern European countries (CEECs) as Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.

correlations between German business cycle and those in the other potential member countries were usually assessed. Especially influential was the contribution by Bayoumi and Eichengreen (1993).[2] 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). The basic idea is that an economy is hit by two types of shocks, demand and supply shocks. Demand shocks are identified with the help of the restriction that their long-term impact on the output is zero. Only supply shocks can have a permanent effect on output. Bayoumi and Eichengreen estimate first two-variable vector autoregressive (VAR) models for real GDP and implicit GDP deflator. Demand and supply shocks are then recovered from the residuals of these VARs with the help of the aforementioned restriction. Correlation coefficients of different shocks between countries (or, in this case, vis-à-vis German shocks) are used to assess the degree of similarity between the business cycles.

Bayoumi and Eichengreen place special emphasis on supply shocks, as they produce clearer results, and find that the correlation of shocks is quite high for countries like France and Belgium, i.e. countries with close geographical and economic ties with Germany. Also, Dutch and Danish supply shocks are closely correlated with the German ones. These results are naturally quite intuitive. These "core" countries have maintained close economic relations in the context of the EU membership for several decades, and in

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

many cases their economic policies have also followed German policies quite closely. For other EU countries the correlations are not so high, although they are found to be negative only for Ireland. Correlations of the demand shocks are almost uniformly lower. The magnitude of shocks also divides the countries studied by Bayoumi and Eichengreen into two distinct groups. The "core" countries have clearly smaller shocks than the more peripheral countries. In the end, Bayoumi and Eichengreen conclude that the EU is divided into two groups, and that the "core" countries may represent an optimum currency union. The obvious caveat is that they used annual data from 1960 to 1988, and the degree of correlation may have changed in the 1990's with the completion of the single market and liberalization of the capital flows. This issue is taken up in our own analysis later.

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 are expected to join the monetary union at some point in the future.[3] The European Union, including the Eurosystem, has outlined a three-step approach to the monetary integration for candidate countries from Central and Eastern Europe. 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 convergence criteria, accede to Economic and Monetary Union. Therefore, the eventual goal for the accession countries as regards monetary arrangements is clear. The is-

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

sue is the timing of monetary union membership 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 membership in the monetary union. A more thorough survey of the related literature is provided e.g. by Järvinen (2000).

Frenkel et al. (1999) 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. find that the correlation between shocks in the euro area and the non-euro EU countries 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 are a number of difficulties in interpreting the results. Perhaps the most serious difficulty is with the 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. More problematic is the fact that 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 a longer sample, this problem can be alleviated to a certain degree. This was done by Horvath (2001), but for a smaller set of comparative countries.

There are also some studies which address directly the degree of correlation between business cycles in the euro area (or the EU) and the accession countries. Boone and Maurel (1998) basically calculate correlation coefficients between the cyclical components of industrial production and unemployment rates for the accession countries[4] against Germany and the EU. The trend for industrial production and the unemployment rate is estimated with the Hodrick-Prescott filter. Generally they find a relatively high degree of 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. However, correlations with the whole EU are not so high.

Boone and Maurel (1999) use a different methodology from that in their earlier work to assess the similarity between business cycles in the accession countries[5] 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 a German or EU-wide shock. In the second stage they look at correlation in the propagation of the shock. Boone and Maurel find that the share of variation explained by the German shock is fairly high for all accession countries, and highest for Hungary and Slovakia. The accession countries

[4]But not for the Baltic countries.

[5]Here the Czech Republic, Hungary, Poland and Slovakia.

with the highest correlations in impulse responses to a German shock were 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.

Brada and Kutan (2001) look at a slightly narrower concept of convergence of monetary policy. They concentrate on the movements in the monetary base in the accession countries, Germany and some new EU members. Monetary convergence is assessed in a cointegration framework. Brada and Kutan find that of the accession countries, Cyprus and Malta have converged to the German monetary policy to a large degree, while for the transition countries convergence is smaller or non-existent. Interestingly, the degree of convergence does not seem to depend on the exchange rate regime.

Fidrmuc (2001) tests the Frankel and Rose (1998) endogeneity hypothesis of optimum currency area criteria. He shows that the convergence of business cycles relates to intraindustry trade, but has 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 is strongly correlated 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).

Korhonen (2001) looks at monthly indicators of industrial production in the euro area and nine accession countries (excluding Bulgaria) in the Central and Eastern Europe. The issue of correlation is assessed with the help of separate VARs for the difference of the euro area production and production (both in logs) in each of the accession countries. Correlation of impulse responses to euro area shock is to be taken as evidence of symmetry of the business cycles. Korhonen finds that the most advanced accession countries (especially Hungary and perhaps also Slovenia) 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 member countries of the monetary union.

Summing up, empirical evidence seems to indicate that economic cycles in the more advanced accession countries are quite highly correlated with the euro area cycle. This seems to be case especially for Hungary, and perhaps also Slovenia. Although 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. Production of reasonably similar products as in the EU may also account for similarity in economic cycles.

3 Aggregate Demand and Supply Model

McKinnon (2000) makes the remark that the optimum currency area theory has Neokeynesian foundations, given its roots in the 1960s. This framework is based on sticky wages, which cause an adjustment process to a new equilibrium if an economy is hit by demand or supply shocks. The Neokeynesian model distinguishes between the short-run and the long-run equilibria for the economy. Thus, an appropriate policy may reduce the adjustment costs, for example, by the selection of an appropriate exchange rate regime (floating exchange rates against fixed exchange rates or participation in a monetary union).

The early analyses of optimum currency area theory concentrated on the similarity of business cycles among countries and regions supposed to participate in a monetary union. However, the business cycle includes all the shocks affecting the economy in the particular period as well as the influence of past shocks still having a damped influence on the economy. It is therefore important to identify the original shocks affecting members of a monetary union.

In particular, the aggregate demand and supply model allows supply and demand shocks to be identified. This theoretical framework assumes that the long-run aggregate supply curve (LRAS), which is vertical, is likely to differ from the short-run supply curve (SRAS), which is positively sloped. The difference between the shape of the short-run and the long-run supply curve is caused by sticky wages. Therefore, higher prices imply lower real wages in the economy in the short-run. In the long-run, however, real wages adjust to price changes. The aggregate demand curve (AD) is negatively sloped both in the short and the long-run. This reflects the assumption that lower prices boost demand.

The effects of a (positive) demand shock are shown in Figure 1. As a result of a demand shock,[6] the aggregate demand curve, AD, shifts upwards, as denoted by AD'. As long as wages are sticky, the equilibrium moves from E to the intersection with the short-run supply curve, which is denoted by D'. This raises both output and prices in the short-run, depending on the slopes of both curves. In the long-run, the equilibrium adjusts further to the intersection of AD' and the long-run aggregate supply curve, as denoted by D". As a result, output moves back to its initial level, Y, while prices increase further to P". Figure 2 illustrates the effect of a (positive) supply shock (e.g., increased productivity). In this case, both the short-run aggregate supply curve and long-run aggregate supply curve shift right by the same amount. In the short-run, the new equilibrium, S', is given by the intersection of the new short-run aggregate supply curve, SRAS', and the aggregate demand curve, AD. Thus, the short-run adjustments include disinflation and a rise in output. Furthermore, the long-run adjustment to S" goes in the same

[6] In this very simple framework, a demand shock could originate e.g. from fiscal or monetary policy, insofar as they have no influence on the long-run productivity of the economy.

direction, i.e. it reduces the price level to P" and increases output level to Y".

As a result, the aggregate demand and supply model provides two distinct features of the original shocks affecting the economy. First, only supply shocks have permanent effect on output. This property will be directly used for the definition of structural models of economies (structural VAR) in the next section. Second, positive demand shocks raise prices (have inflationary effects), while positive supply shocks reduce the price level. This property, which is referred to by Bayoumi and Eichengreen (1993) as an overidentifying condition, will not be used directly in the modeling part. Nevertheless, we will use this condition to assess the performance of our models in the following sections.

Insert Figures 1 and 2 about here!

4 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 (as in the simplified model sketched in the previous section). Supply shocks have a permanent effect on the output, whereas demand shocks have only transitory effects on output. On the other hand, 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.

The method used to separate supply and demand shocks is due to Blanchard and Quah (1989). They estimate a two-variable VAR with GNP and unemployment, and proceed to identify the two aforementioned shocks in that framework. Similarly to our own analysis, 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,

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

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,

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

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 $A_i = C_i A_0$ and $\sum_{i=0}^{\infty} A_i = \sum_{i=0}^{\infty} C_i A_0$ helps us to identify A_0, but to recover the four elements of A_0 we need four restrictions. Two restrictions are simply normalizations which define 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 $A_0 A_0' = \Omega$. 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.

5 Empirical Results

5.1 Correlation of GDP and Inflation

There is mixed evidence as to the convergence of business cycles in the EU and the CEECs. On the one hand, the level of GDP grew slowly in relation to the Western European countries during the period of the central planning system. The divergence between Western and Eastern Europe speeded up in the 1970s and the 1980s. Thus, the increasing welfare difference between market and central planning 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 Central and Eastern European countries 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, Horvath and Fidrmuc (1999) conclude that the Czech Republic and Slovakia did not converge between 1950 and 1990 or within a subsample from 1970 to 1990.

Several authors report increasing similarities of business cycles between the EU (mainly Germany) and the CEECs since the economic reforms were introduced. As mentioned in the previous section, Boone and Maurel (1998 and 1999) find a significant convergence between business cycles (as measured by unemployment rates) in Germany and select CEECs (the Czech Republic, Hungary, Poland and Slovakia). Similarly, Fidrmuc (2001) shows increasing convergence of business cycles in the CEECs with that in the EMU after 1993. Indeed, our data set confirms that the business cycles in some CEECs have become more similar to the business cycle of the EU area since 1993 (see Table 1). At the beginning of the 1990s, production development in the CEECs was determined by the so called "transitional" recession. However, the recovery in these countries has been strongly influenced by the 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 growth of real GDP[7] 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). Slovenia, Estonia and Latvia also faced a business cycle which followed the pattern of development in the euro area. By contrast, GDP development in the Czech Republic, Lithuania, Poland and Slovakia has been dominated by the domestic factors.

Insert Figure 3 and Table 1 about here!

Beyond the correlation of business cycles, Table 1 and Figure 3 reveal a possible relation between the similarity of GDP development and inflation. Those countries displaying a high and positive correlation of seasonally adjusted GDP growth show also a high and positive correlation of seasonally adjusted prices, and vice versa. This relation is likely to be 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 and a few smaller OECD countries.

[7] In order to deal with seasonality, we report correlation for the fourth difference of quarterly data for the whole available period of selected countries here.

The second group includes EU countries and Estonia, Latvia and Slovenia. 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, these countries 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 true also 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 demand and supply shocks.

5.2 Correlation of Supply and Demand Shocks

Assessing 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. In the VARs our variables are changes in (the log of) real quarterly GDP (industrial production for Greece, Ireland and Romania) and in (the log of) prices.[8] For the series which are not seasonally adjusted, we also included three seasonal dummies.

[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. These are not reported here, but are available from the authors upon request.

The lag length of the VARs was chosen according to sequential likelihood ratio tests for different lag lengths. Usually, this was also the same lag length as that chosen by the Akaike information criterion. In practice the optimum lag length was usually two, sometimes three quarters.[9] The over-identifiying restriction mentioned in section 3 (i.e. that the accumulated effect of supply shock on prices is negative) was satisfied in almost all VARs. 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 4 show the contemporaneous correlation between supply and demand shocks in the whole euro area and in individual countries in the first column of the particular blocks of the table. The next two columns of each block, in turn, give the minimum and maximum pairwise correlations vis-à-vis the individual countries of the euro area (excluding Greece and Ireland) for both types of shocks.[10] Some interesting results emerge. First, for present members of the monetary union, our correlation coefficients are generally lower than those obtained in Bayoumi and Eichengreen (1993) vis-à-vis German shocks. This is quite natural, as we use quarterly data, which is bound to be more noisy than annual data used by Bayoumi and Eichengreen. However, for many countries formerly dubbed "peripheral", the correlation especially of

[9] Details on VARs are available from the authors upon request.

[10] 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.

supply shocks seemed to be quite high during the 1990s. In this respect, our results are more or less in line with Frenkel et al. (1999), who calculate correlation vis-à-vis quarterly German and French shocks. However, they do not calculate correlations with shocks of the whole euro area.

A comparison of Figures 3 and 4 reveals two interesting features. First, supply and demand shocks are less strongly correlated than GDP growth and inflation in the selected countries. 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 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 similar development of both GDP growth and inflation with the euro are, despite largely idiosyncratic demand shocks.

In Table 2, the correlations are calculated vis-à-vis the euro area shocks. Therefore, it is quite natural that this indicator is high for the largest euro

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

area countries like Germany and France. Also, the supply shocks[12] of the Benelux countries and Austria are highly correlated with the euro area (correlation coefficient around 0.4–0.5), which is not surprising. But supply shocks in countries like Portugal and Italy have also been quite highly correlated with the whole euro area (correlation 0.45–0.5). The continuing integration of European economies — first in the context of single market and then in preparation for the monetary union — has apparently brought also more peripheral countries closer to the "core." It is also interesting to note that the three EU countries still outside the monetary union — Denmark, Sweden and the UK — have an almost identical correlation of supply shocks with the euro area (0.20–0.25). However, they differ clearly in the correlation of demand shocks, where Denmark and Sweden do not stand out from the members of the monetary union, but the UK has a negative correlation. This would imply that Denmark and Sweden have geared their economic policies more to the core euro area countries during the 1990s, whereas the UK has not. Of course, Denmark has pegged its currency to the Deutsche Mark and to the euro already for over 20 years, which has obviously affected its aggregate demand management. In the case of opt-outs, our results differ markedly from those of Frenkel et al. (1999), most likely owing to our longer estimation period.

For demand shocks the situation is somewhat different, and correlations

[12] In our view, supply shocks are more relevant in assessing the costs and benefits of different exchange rate regimes. Supply shocks have permanent output effects, whereas demand shocks have only transitory effects.

are generally clearly lower than was the case in Bayoumi and Eichengreen (1993). If demand shocks are to a large extent a result of national economic policies, a low correlation is perhaps to be expected. However, the launch of the monetary union may also mean a higher correlation of demand shocks in the future.

For the accession countries a quite different picture emerges. There is a handful of countries which have a fairly high correlation of supply shocks with the euro area. Especially Hungary stands out with both high correlation of 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 (Fidrmuc, 2001), and the same applies to Estonia, where e.g. Finland is the major trading partner accounting for more than one third of exports. On the other hand, for many accession countries, the correlation of supply shocks is below 0.1. Lithuania even has a negative correlation, which may be caused by the peculiar production structure of the country.[13] 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 bias the results somewhat, although the difference in estimation periods is not too large.

As with the current members of the monetary union, the correlation of demand shocks is generally lower than that of supply shocks. Hungary and

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

Poland stand out as having at least as high a correlation as many current members of the monetary union. Also Estonia 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 the euro area demand shocks.

Figure 4 plots the supply and demand shocks. We can see that the largest members of the monetary union have the highest correlation of both supply and demand shocks, which is to be expected. It is interesting to note that the present members of the monetary union are all clustered fairly closely together. Also, Denmark and Sweden appear to be quite close to the smaller monetary union members, as are Estonia and especially Hungary. Other accession countries, including Turkey (actually still an applicant country) are further away.

Pairwise correlations between countries are also notable. It may be somewhat surprising that even for most "core" countries, the correlation with German shocks was quite low in the 1990s. German unification and the economic boom which followed in Germany has undoubtedly influenced this. Austria has the highest correlation with German supply shocks, 0.48. Correlations vis-à-vis France are generally clearly higher.[14] Countries with a supply shock correlation of over 0.3 with France are Germany, Italy, the Netherlands, Belgium, Austria, Portugal, the UK and Hungary. Also for demand shocks, correlations with French shocks are higher than with German shocks.

[14]This finding is supported by Horvath (2001).

There are also some interesting regional clusters of correlation among 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.[15] Also Latvian and Lithuanian supply shocks are correlated, as are Danish and Polish supply shocks.

Insert Figure 4 and Table 2 about here!

6 Conclusions

We have assessed the correlation of supply and demand shocks between the euro area and EU accession countries during the 1990s. In addition, we have estimated corresponding correlations for most present EU countries. Supply and demand shocks were recovered from structural vector autoregressive models.

For accession countries some clear results emerge. First, the correlation of supply shocks, which in our view is more relevant as an OCA criterion, differs greatly from country to country. Second, some countries are at least as well correlated with the euro area shocks as are many current members of the monetary union. The two countries with the highest correlation of supply shocks are Hungary and Estonia. Not coincidentally, these two countries have also received most foreign direct investment on a per capita basis, and

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

they have very extensive trade relations with the euro area countries (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 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.

For the present EU members our results differ from those of some previous studies, which used mainly data up to the beginning of the 1990s. We find that some countries previously considered "peripheral" (such as Italy and Portugal) are actually quite highly correlated with the euro area shocks. Moreover, many present members of the monetary union are more correlated with French than German shocks, which may perhaps be explained by the influence of German unification. Therefore mere correlations with the German shocks could give a quite misleading picture of true economic convergence, both for the accession countries and the present members of the monetary union. Our results would support the claims that closer economic policy cooperation within the framework of the EU has also increased the correlation of business cycles among the member countries. This obviously has implications for the accession countries as well.

Concerning the accession countries, our findings seem to at least partially confirm results of e.g. Boone and Maurel (1999), Fidrmuc (2001) 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 geographically close to the EU, and therefore it is not surprising that their economic cycles are correlated with that of the EU (or 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.

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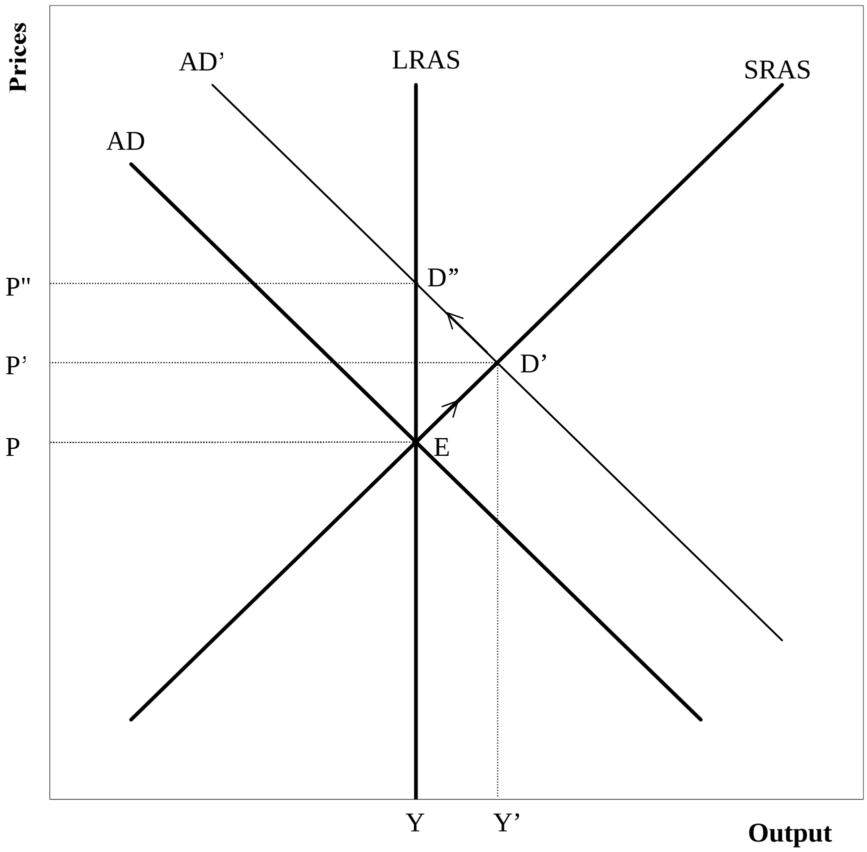

Figure 1: The Short-Run and Long-Run Adjustments to a Demand Shock

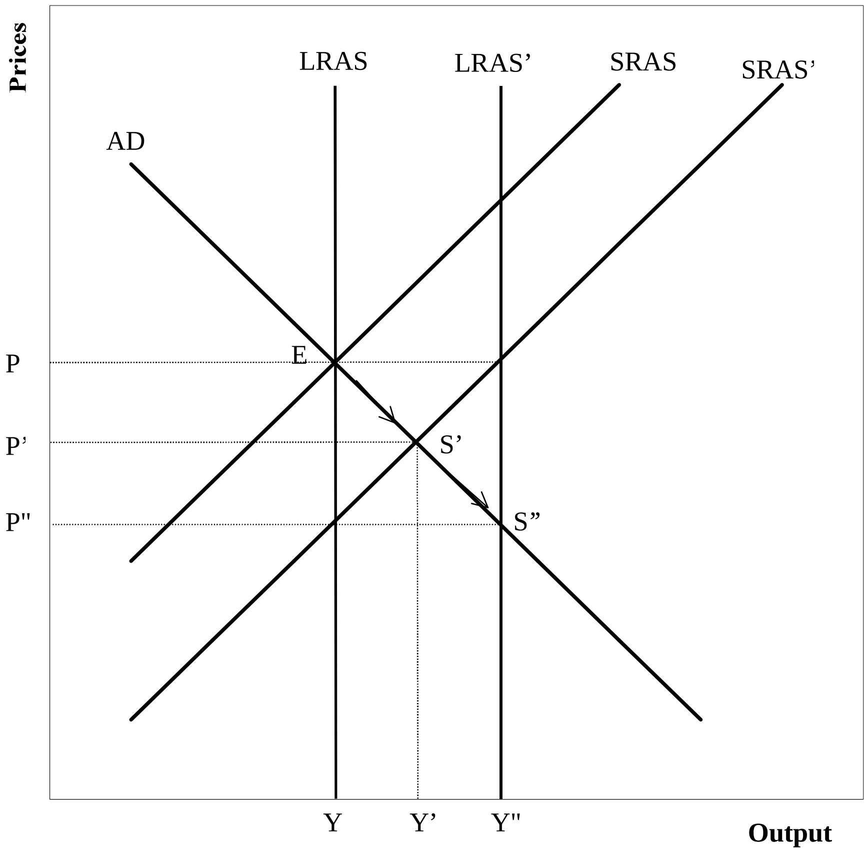

Figure 2: The Short-Run and Long-Run Adjustments to a Supply Shock

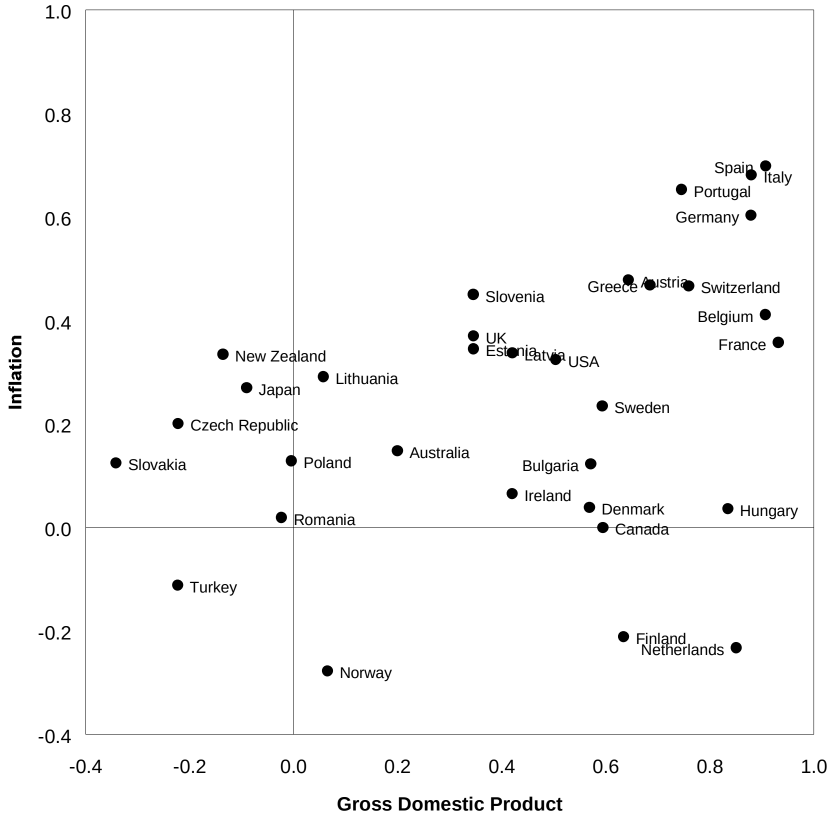

Figure 3: Correlation of GDP and Inflation with the Euro Area

Table 1: Correlation of GDP and Inflation with the Euro Area

	GDP growth			Inflation		
Country	Euro area[a]	Min[b]	Max[b]	Euro area[a]	Min[b]	Max[b]
Austria	0.64	0.17	0.66	0.48	0.03	0.87
Belgium	0.91	0.48	0.84	0.41	0.03	0.89
Finland	0.63	0.17	0.76	-0.21	-0.08	0.20
France	0.93	0.60	0.89	0.36	0.06	0.77
Germany	0.88	0.35	0.83	0.60	-0.07	0.92
Greece	0.42	0.44	0.70	0.06	0.17	0.83
Ireland	0.69	0.15	0.47	0.47	0.05	0.51
Italy	0.88	0.47	0.84	0.68	-0.25	0.70
Netherlands	0.85	0.59	0.90	-0.23	-0.25	0.20
Portugal	0.75	0.52	0.83	0.65	-0.08	0.92
Denmark	0.57	0.08	0.63	0.04	-0.47	0.28
Sweden	0.59	0.10	0.62	0.23	-0.07	0.85
UK	0.35	-0.02	0.76	0.37	-0.24	0.57
Bulgaria	0.57	-0.03	0.60	0.12[c]	-0.27[c]	0.61[c]
Czech Rep.	-0.22	-0.63	0.26	0.20	-0.53	0.74
Estonia	0.35	-0.51	0.70	0.34	-0.58	0.82
Hungary	0.83	0.05	0.83	0.04	-0.59	0.78
Latvia	0.42	-0.29	0.67	0.34	-0.62	0.83
Lithuania	0.06	-0.63	0.61	0.29	-0.65	0.86
Poland	-0.00	-0.35	0.50	0.13	-0.54	0.75
Romania	-0.03	-0.20	0.34	-0.28	-0.20	0.68
Slovakia	-0.34	-0.51	0.10	0.12	0.11	0.69
Slovenia	0.35	0.11	0.57	0.45	-0.47	0.77
Australia	0.20	0.00	0.53	0.15	-0.14	0.37
Canada	0.59	0.15	0.73	0.00	-0.20	0.36
Japan	-0.09	-0.20	0.08	0.27	-0.06	0.79
New Zealand	-0.14	-0.24	0.10	0.33	-0.24	0.41
Norway	0.07	-0.18	0.24	-0.28	-0.62	0.34
Switzerland	0.76	0.50	0.78	0.47	-0.40	0.79
Turkey	-0.22	-0.37	-0.10	-0.11	-0.34	0.72
U.S.A.	0.50	0.11	0.66	0.32	-0.15	0.73

Note: See Data Appendix for data description. [a] - correlation of national shocks with the shocks of the aggreate of the Euro area, [b] - minimum and maximum value of correlation vis-à-vis the individual countries of the euro area. [c]excluding 1997:1–1997:4.

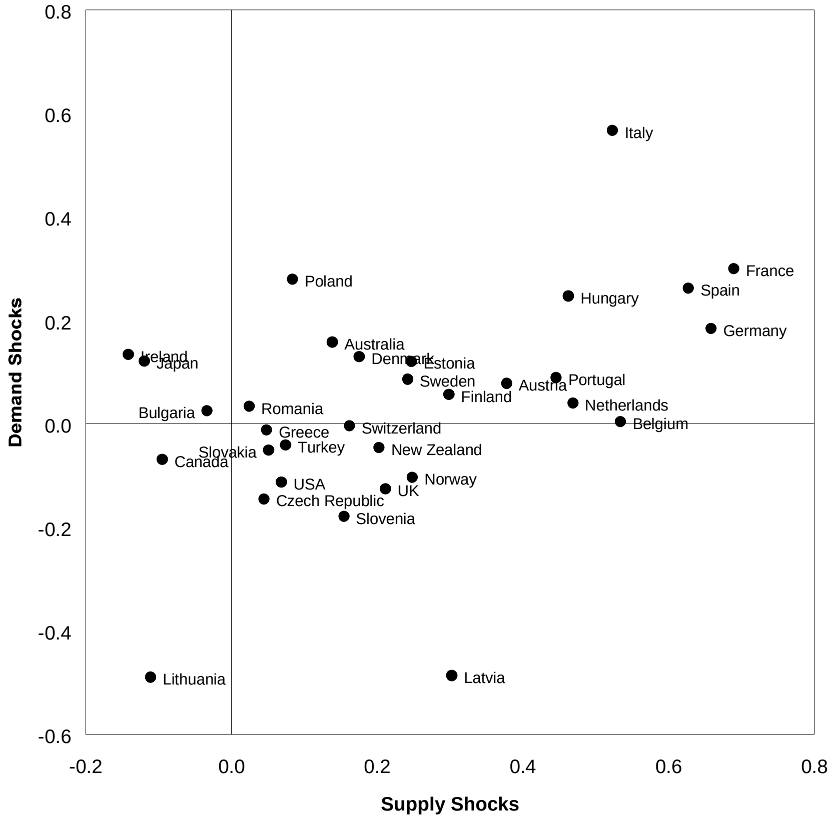

Figure 4: Correlation of Supply and Demand Shocks

Table 2 Correlation of Shocks with the Euro Area

Country	Supply Shocks			Demand Shocks		
	Euro area [a]	Min [b]	Max [b]	Euro area [a]	Min [b]	Max [b]
Austria	0.38	-0.22	0.48	0.08	-0.08	0.36
Belgium	0.53	0.08	0.47	0.00	0.01	0.46
Finland	0.30	-0.22	0.49	0.06	-0.21	0.18
France	0.69	0.26	0.60	0.30	-0.11	0.60
Germany	0.66	0.11	0.48	0.18	-0.19	0.35
Greece	0.05	-0.04	0.23	-0.01	-0.07	0.34
Ireland	-0.14	-0.51	0.16	0.13	-0.21	0.25
Italy	0.52	0.11	0.55	0.57	-0.07	0.41
Netherlands	0.47	0.07	0.60	0.04	-0.10	0.39
Portugal	0.45	0.10	0.44	0.09	-0.11	0.28
Spain	0.22	0.08	0.55	0.16	-0.21	0.60
Denmark	0.18	-0.12	0.36	0.13	-0.11	0.19
Sweden	0.24	-0.07	0.52	0.09	-0.03	0.44
UK	0.21	-0.07	0.31	-0.13	-0.24	0.25
Bulgaria	-0.03	-0.29	0.37	0.03	-0.18	0.33
Czech Rep.	0.04	-0.02	0.29	-0.15	-0.57	0.20
Estonia	0.25	-0.17	0.41	0.12	-0.46	0.20
Hungary	0.46	-0.10	0.67	0.25	-0.52	0.44
Latvia	0.30	-0.14	0.48	-0.49	-0.53	0.01
Lithuania	-0.11	-0.36	0.36	-0.49	-0.25	0.32
Poland	0.08	-0.42	0.34	0.28	-0.24	0.49
Romania	0.02	-0.29	0.34	0.03	-0.28	0.08
Slovakia	0.05	-0.48	0.18	-0.05	-0.30	0.41
Slovenia	0.15	-0.20	0.37	-0.18	-0.16	0.49
Australia	0.14	-0.32	0.37	0.16	-0.33	0.40
Canada	-0.09	-0.18	0.25	-0.07	-0.10	0.19
Japan	-0.12	-0.33	0.05	0.12	-0.20	0.24
N. Zeal.	0.20	-0.01	0.24	-0.05	-0.48	0.39
Norway	0.25	0.07	0.38	-0.10	-0.36	0.15
Switzerl.	0.16	0.03	0.28	0.00	-0.29	0.23
Turkey	0.07	-0.16	0.22	-0.04	-0.36	0.35
U.S.A.	0.07	-0.12	0.32	-0.11	-0.22	0.17

Note: See Data Appendix for data description. [a] - correlation of national shocks with the shocks of the aggreate of the Euro area, [b] - minimum and maximum value of correlation vis-à-vis the individual countries of the euro area.

Data Appendix

We use quarterly GDP in constant and current prices. If 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. If 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. The data for the other accession countries is 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 omits 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 the 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 whole available period and for the 1990s confirms the robustness of our results for all EU countries with the exception of Turkey. The time series for the euro area, as published by the Eurostat, are available only from the beginning of 1991.

Both real GDP and the GDP deflator are 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
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
U.S.A. [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
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
U.S.A. [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.

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