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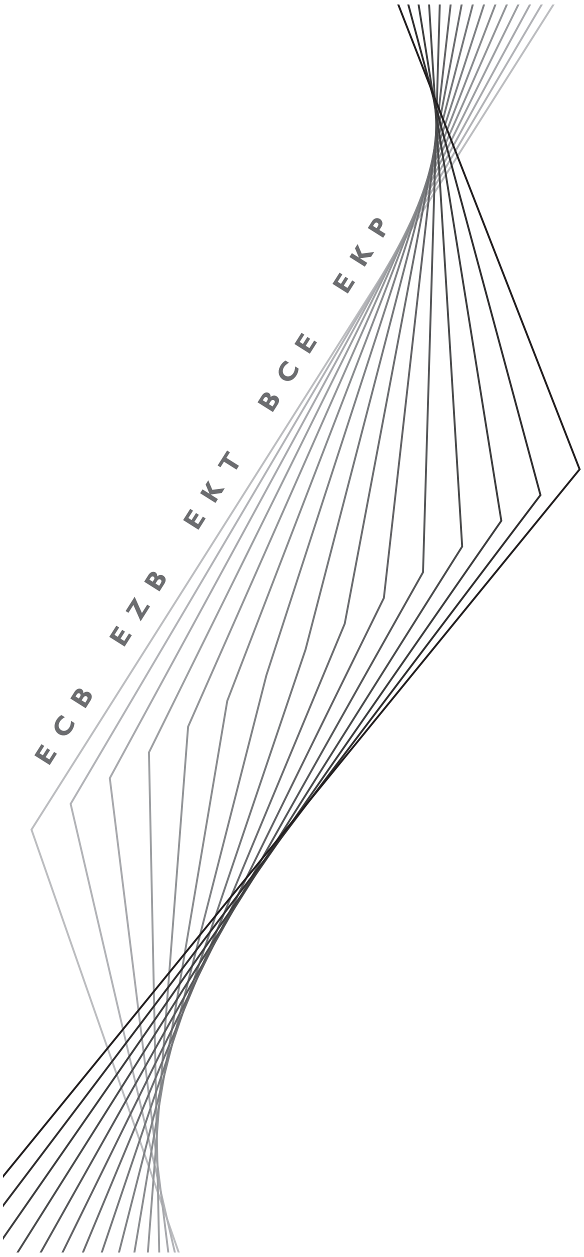

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FROM THE ERM TO THE EURO: NEW EVIDENCE ON ECONOMIC AND POLICY CONVERGENCE AMONG EU COUNTRIES*

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May 1999

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Abstract

Skeptic views on EMU are usually cast around three arguments. First, the single European currency will be harmful unless the EU satisfies "Optimum Currency Area" (OCA) conditions, and this is not likely to be the case except for a small number of "core" countries. Second, heterogeneous economic and financial structures will create undesired differences in the local impact of the single monetary policy. Third, the shift from domestic to area-wide considerations may give rise to conflicts in the decision making process of the European Central Bank (ECB).

We present some evidence relevant for the first and third of these issues. We show that, first, cross-country correlation of real cycles and inflation have risen significantly in recent years among EMU participants, which implies a tendency towards a fulfillment of (at least part of) the OCA conditions. Second, we provide evidence that the monetary policy rules followed by the main EMU participating central banks have converged though significant differences still exist. Convergence in economic performance and broadly common central bank rules imply that the transition to the third stage of EMU is a step in an ongoing process, not a one-time regime change.

1 Introduction

In recent years, as the launch of the single European currency was approaching, the debate about its potential implications has focused mainly on three issues.

First, EMU critics have often reminded that the euro will be harmful if the participating countries do not satisfy Optimum Currency Area (OCA) conditions. Tests of whether these conditions apply to the EU have flourished in the last ten years; while the verdict remains uncertain, the balance tends to tilt towards a negative answer, largely based on a series of influential papers by B. Eichengreen[1]. Some have pushed this argument far, warning against the potentially catastrophic consequences of imposing a single currency to an ill-suited area[2]. Secondly, many note that different economic structures imply asymmetries in policy transmission, and thus in the effects of the single monetary policy on each participating nation. Thirdly, even EMU supporters stress the difficulties in the transition from several autonomous central bank policies to a single one, due to potential conflicts within the European Central Bank (ECB) decision making bodies and to the need of devising an appropriate communication strategy for an entirely new institution[3].

In this paper we provide new empirical evidence relevant for the first and the last of these issues. After a brief summary of the recent empirical literature on applying the OCA theory on Europe, in section 2 we present recent evidence on the cyclical movements in the euro-area. Specifically, we analyze how the correlations of output and prices between Germany and other European countries have evolved through time and compare them with similar correlations between European and non-European countries. Correlations are also computed among the underlying demand and supply shocks, identified using Bayoumi and Eichengreen's (1993) structural VAR methodology.

In section 3 we estimate central bank reaction functions for the 6 main EU countries (the UK plus the 5 largest EMU participants) over the ERM period (1980-97), with three main goals in mind: seeing whether and how central bank policy rules have evolved during this period; testing cross-country homogeneity restrictions among the reaction function coefficients; verifying whether area-wide factors, as opposed to domestic ones, have been or become relevant in guiding monetary policy in each country in the period under consideration. The common denominator of these three questions is to understand how easily individual central bank rules can be combined into a single monetary policy with an area-wide objective.

Section 3 contains a summary of our results and discusses some interpretations and limitations of our analysis.

2 Cross-country cyclical correlations in Europe

2.1 The recent literature

Most recent analyses of the benefits and costs of EMU have been cast within the theoretical framework provided by the "Optimum Currency Area" (OCA) literature, developed in the early sixties following the pioneering contributions of Mundell (1961), McKinnon (1964) and Kenen (1969). In summary, this literature suggests that monetary unions are beneficial if the gains

1 See Eichengreen (1992) and Bayoumi and Eichengreen (1993, 1996a and 1996b).
2 See Feldstein (1997a, 1997b).
3 The last two issues are jointly considered by Dornbusch, Favero and Giavazzi (1998).

stemming from lower transaction costs and greater transparency of relative prices outweigh the costs of adjusting to asymmetric economic shocks through means other than monetary policy, namely, wage and price adjustments, labor mobility and fiscal policy. The final judgment as to whether a given area is well suited for a single currency is inherently empirical, since the benefits and costs stemming from each of those sources depend on institutional and structural features of the area concerned.

In order to evaluate the OCA properties of the euro area, it is of crucial importance to determine the likely size and correlation of shocks across the participating countries. If asymmetric demand and supply shocks in the area are not large, the potential costs from the loss of monetary autonomy will be limited, even in the presence of rigidities of labor and goods markets and without a major stabilizing role of fiscal policy. An entire recent line of research has concentrated on this issue, using the experience of other areas were currency unions are successfully operated as a reference for comparison.

A key issue in this respect is the degree of diversification and specialization of regional economic structures. If countries or regions tend to specialize in production, they are more prone to sector specific demand and supply disturbances than they are if their economic structures are relatively well diversified. Several authors have shown that European countries tend to display more overlap and diversification in their output composition than US states (Bini Smaghi and Vori (1993); Helg et al. (1994)). The problem in drawing conclusions concerning the viability of a single European currency on this basis is that specialization could itself be endogenous, resulting from the greater intensity of trade flows that the currency union is likely to bring about (Krugman (1993)).

In a series of influential contributions, Bayoumi and Eichengreen (1993, 1996b) approached these issues by directly measuring the importance of asymmetric demand and supply shocks in the EU and comparing them with the ones prevailing in the US. A key premise of their approach is that a distinction needs to be made between cross-country correlations of *observed economic variables* (like output and prices) and those of *underlying structural shocks* (demand and supply disturbances originating from shifts in technology, preferences, policy changes, etc.). The latter transmit their influence to the former through a complex chain of links, both domestic and international (through trade flows and the transmission via the financial markets). Observed economic variables can display strong international correlations even if the underlying shocks are not interrelated, if the international transmission mechanism is sufficiently strong[4]. After identifying these shocks through a structural VAR methodology, Bayoumi and Eichengreen (1993) conclude that, first, the correlation among supply and demand shocks is on average smaller among EU countries than across US states, and, second, that "core" European countries (Germany, France, Belgium, Netherlands, Austria) display stronger "structural" correlation than "peripheral" ones (UK, Italy, Spain, Ireland, Portugal, Greece).

Bayoumi and Eichengreen's approach highlights the question of whether it is the correlation of underlying shocks that matters for determining the potential costs of adopting a common currency or it is that of the observed variables. The answer to this question is not obvious. On one side, one could argue that structural economic shocks often reflect more basic and permanent features of the economy and thus provide a more reliable basis for measuring economic homogeneity across countries. However, this is not always the case, as the obvious examples of some conspicuous one-time shocks (like German reunification) clearly illustrate. On

[4] *Canova and Dellas (1993) build a real business cycle model in which trade intensity induces international correlation of business cycles, and test it on a panel of 10 countries. Their estimates confirm the existence of such link.*

the other side, if cross-country links are sufficiently strong to generate systematic international comovements of inflation and output, then from a policy standpoint it is of little importance how and where the underlying disturbances have originated. Bayoumi and Eichengreen express their view on this key issue as follows: *"One may argue that differences across economies in both the symmetry of disturbances and the speed of response are in fact relevant to the decision of whether to fix the exchange rate or adopt a common currency (...). But from an analytical point of view, it is still important to know whether a high correlation of output movements reflect symmetric shocks or rapid, symmetric responses. About this observed output movements tell us little".*

In a series of recent papers, Frankel and Rose (1996, 1997) provide new evidence centered on the role that trade intensity plays in fostering cross-country correlation of business cycles. Their key message is that the conditions for qualifying as an OCA are likely to be endogenous to the exchange rate regime: a country not fulfilling them at the outset may satisfy them ex-post once its economic structure has adapted to the currency union. Trade flows, fostered by the single currency, give rise over time to stronger international correlation of output and inflation. Frankel and Rose therefore challenge the view, expressed by Krugman (1993), according to which currency unions tend to exacerbate asymmetric shocks by inducing regional specialization in production. After regressing output comovements on proxies of trade intensity for a sample of 20 industrialized countries, Frankel and Rose (1997) conclude that *"close trade linkages between two countries are strongly and consistently associated with more tightly correlated economic activity between the two countries".*

A further, related set of empirical results is provided by Artis and Zhang (1996, 1997), who focus on the role of the ERM in inducing common business cycles among participating countries. The interpretation they propose is roughly similar to that of Frankel and Rose, but their perspective is somewhat different. Artis and Zhang view the ERM as strengthening cyclical correlation in Europe by fostering coordination in fiscal and monetary policies more than by increasing trade intensity. The evidence they provide, however, is compatible with both interpretations since they focus directly on changes in cyclical correlation before and after the ERM start (1961-79 and 1979-95). Comparing the evidence in the two periods, Artis and Zhang (1996) find stronger evidence of a European business cycle under the ERM, while the correlation of ERM participants' cycles with the US and other non-participant EU countries has not increased. Evidence is also found of a negative relation between exchange rate volatility and the correlation of cyclical movements.

2.2 Some new empirical evidence

Building on these recent results, we provide new evidence on cross-country comovements of economic cycles among EMU participants, adding to the existing literature in three ways:

a) by looking more closely at the developments within the ERM period, particularly after the ERM crisis. Although this period could be thought to have reduced the existing interdependence among EU countries, due to demise of the ERM, the expectation of EMU may have strengthened such links by constraining economic policies and providing a reference to private agents' expectations.

b) by looking at the fluctuations in prices as well as in real economic performance. Price correlations are important in at least two ways: first, because the ECB has price stability as its main target; second, because a high cross country correlation of prices reduces the need for nominal exchange rate adjustments. We look at both the CPI, which is more relevant as a policy target, and the GDP deflator, which may be a better indicator of the underlying tendencies of domestic prices and costs.

c) by considering both observed economic variables and underlying demand and supply shocks. To this end, we replicate Bayoumi and Eichengreen's analysis, extending it to the more recent period and to quarterly data, and compare the (change over time of) the cross-country correlations computed on both types of data.

A first look at the data is provided in **fig. 1 and 2**, showing the cyclical movements of industrial production, real GDP, domestic consumption and gross fixed investment, the GDP deflator and the CPI for the EMU area (excluding Germany) over the 1970-97 period.

To isolate the cyclical component we tried three detrending techniques: the 1-quarter (1Q) logarithmic difference; the 4-quarter (4Q) logarithmic difference; the deviations from the Hodrick-Prescott (HP) trend[5]. The correlation pattern emerges more clearly in the 4Q and the HP than from the 1Q filtered data; this is a sign that the link factors inducing international cycle comovements do not operate quickly enough to be discernible within the quarter, but become visible when a lower frequency filter is used.

In fig. 2, an increase in the correlation in the latter part of the sample is visible for industrial production as well as for GDP; for the latter, the increase seems to be more recent. This suggest that the factors inducing a synchronous cycle among the main European economies have strengthened and extended their effect to the non-tradable sectors of the economies. To a lesser extent, correlation seems to have increased also for real investment and consumption. With regard to the former, the 1992-93 cyclical slowdown appears more synchronous than in the case of other movements in the past. With regard to the latter, the recent movements of German consumption, in particular, appear to be much more in line with those of the other countries than during most part of the 1980s. Turning to prices, a particularly sharp cyclical convergence is visible for the GDP deflator, starting in the late 1980s and continuing thereafter, while for CPI the correlation seems roughly constant over the 1980s and 1990s, though much greater than in the 1970s.

Tables 1 to 5 report bilateral contemporaneous correlation coefficients of 4Q-filtered output and price measures (the results using HP, available but not included here, are not substantially different), of each country with Germany and, as a benchmark for comparison, with the US. We distinguish among 4 time periods that seem of particular interest: 1965-1979Q1 ("pre-ERM"); 1979Q2-1985 ("soft ERM"); 1986-1992 ("hard ERM"; see Giavazzi and Spaventa (1990) for an interpretation of the changing nature of the ERM in these years); 1993-1997Q1 ("pre-EMU"). We also compute correlations for four groups of countries[6]: large EMU participants (except Germany), or EMU(L); all EMU participants (except Germany); non-EMU EU countries; non EU countries (see the Appendix for the exact composition of these groups). The tables report asymptotic significance tests for these correlation coefficients and for the differences between the coefficient of the last period and those of the preceding periods[7].

Focusing initially on the results for industrial production (**Table 1**), we notice, first, that correlations coefficients with Germany are high and significant for most countries and

5 The 1-quarter and 4 period log differences are adequate for removing first-order stochastic trends; the HP filter removes non stationary components up to the second order of integration.

6 The correlations involving groups of countries are calculated by aggregating the group as a weighted average, using GDP weights computed with PPP exchange rates.

7 The asymptotic standard error of the correlation coefficient is expressed by the inverse of the square root of the number of observations. The significance level is 10 percent, and the test is 2-tailed for the level of the correlation coefficients and 1-tailed for the differences; therefore, in the latter case the null hypothesis of no change in the correlation is tested against the alternative that the correlation has increased. More detailed empirical results are contained in an earlier version of this paper (Angeloni and Dedola (1998)).

subperiods. Correlations with the US are also important in many cases[8], but lower in absolute size. A significant and economically relevant increase has taken place in the last period, with respect to the previous one, in France, Spain, and the UK, as well as in EMU(L). In other cases, and in the whole EMU group, the increase is sizeable but not statistically significant. In evaluating these results we must remember that in the "hard-ERM" period cyclical correlations with Germany tended to be reduced by the asymmetric shock determined by the German reunification.

The data for real GDP (**Table 2**[9]) do not modify and, if anything, strengthen the basic message. The increase in last period's correlation is sharp and significant in all relevant cases, except in instances where the coefficient was already high to begin with. Interestingly, a low and insignificant correlation exists between GDP in the group of EMU(L) and the US, relative to what seen with regard to industrial production. The results of this table reinforce the message, already detected in the figures, that the sources of comovement of European cycles are sufficiently strong and pervasive to affect the non-traded sectors of the economies as well as the manufacturing ones.

Table 3 displays cross-country correlations among stock market indices. There are several reasons why equity prices are interesting in the context of this paper. First, they contain leading information on future developments in aggregate demand and output, and thus may reveal, from a different angle, whether an increase in cyclical coherence has actually taken place. Second, cross-country equity market correlation has been shown to vary inversely with: a) the importance of country-specific shocks, e.g. due to national economic policies, other country-specific demand/supply factors, exchange rate changes; b) the differences in the sectoral composition of national outputs, as reflected by the composition of stock market indices, which make national stock market performance diverge when sectoral shocks occur[10]. If equity markets turn out to be highly correlated across countries, this should imply that nation-specific disturbances are relatively unimportant *and* that economic structures are broadly similar; in both cases OCA conditions are more likely to be satisfied. The results of table 3 are, on the whole, encouraging in this respect; in the most recent period we consider (1993-97), bilateral as well as EMU-wide correlations with Germany are high, always greater than 50 percent, statistically significant and greater than the corresponding correlations with the US and with the "out" countries. For the EMU and EMU(L) groups, correlations in this period are .88 and .85 respectively; a significant increase is visible from the mid-1980s onwards.

Moving to prices, **Table 4** documents the existence in the recent period of a significant correlation of GDP deflators across countries, particularly significant between Germany and France, Spain and some of the smaller EU economies (surprisingly, not Austria and the Netherlands), as well as with the groups of EMU(L) and EMU. The picture changes considerably when the CPI is considered (**Table 5**). Here the "pre-EMU" period is one of remarkably *low* correlations of CPI movements between Germany and EU partners, perhaps lower than one would suspect by looking at figg. 2 and 3. By closer inspection, this reveals to be due to the sharp divergence in inflation performance between 1993-94, a time in which German inflation was still influenced by the lagged effects of the country's reunification, and 1995, when most other EU countries were subject to the inflationary impact of the exchange rate turmoil of the early part of that year. In both cases, the lack of correlation is attributable more to special, one-time events or

8 In particular, Germany's correlation with the US is around .5 and significant, with the exception of the 1986-92 period. This result is attributable to the asymmetric shock occurred as a consequence of the German reunification.

9 Data availability forced us to reduce the number of countries and/or the time periods in this and some of the following tables.

10 Heston and Rouwenhorst (1994) estimated these two components using the returns on 829 stocks in 12 European countries over the 1978-92 period. They found that cross-country differences in stock market returns are due mostly to nation-specific shocks; the differences in the sectoral composition of national stock market indices play a minor role.

to the effect of unusual nominal exchange rate volatility[11] than to lack of comovement in the underlying elements of inflation.

Tables 6 to 8 show similar correlations, based no longer on observed economic variables, but on demand and supply shocks identified using an econometric technique identical to that of Bayoumi and Eichengreen (1993), applied to each country to two price/quantity data sets[12]: GDP and its deflator; industrial production and CPI. Bayoumi and Eichengreen's (1993) calculations are here extended to a longer sample and applied to quarterly data, instead of annual ones[13]. The purpose of looking at these correlations in conjunction with those of the previous tables is that, assuming that the econometric procedure correctly identifies the structural shocks, the comparison allows us to draw indications on the relative importance of the shocks themselves vs. the transmission mechanism in generating coherent movements in observed economic variables. Unfortunately, significance tests of the type used in the previous tables cannot be computed here because the underlying data are themselves the result of previous estimates. Nevertheless, the tables suggest that the structural correlations are generally not strong in any periods and particularly in the "pre-EMU" one. There is no general tendency for this period to display greater correlations than in the past. No specific pattern seems to characterize the estimates obtained using the two different data samples, or the demand as opposed to the supply shocks.

All in all, the results presented in this section suggest that the cyclical patterns within the euro-area have evolved, in the recent years, in a direction consistent with the adoption of a single currency.

A related but separate question is whether a convergence has taken place also in the priority that central banks – and, more broadly, public opinions – accord to alternative policy objectives. Even if national economies displayed perfectly homogeneous performances, different policy preferences could still undermine the single monetary policy process. We thus turn to examine the policy rules followed by the main EU central banks, with two main questions in mind: have such rules tended to converge in recent times? Do significant asymmetries still exist?

3 Comparing monetary policy reaction functions in the main EU countries

Our cross-country comparison of monetary policy reaction functions across EU countries draws substantially, as far as theory and econometric specifications are concerned, on few well known recent contributions to the literature on monetary policy rules. Our starting point is the formulation found by Taylor (1993) to adequately describe the behavior of the US Federal Reserve Board during the Volcker and Greenspan years, which assumes the short term interest rate to be the control variable of the central bank and relates it to deviations of inflation and the output gap from their target levels. Empirical applications of the rule normally allow for interest rate "smoothing" on the part of the central bank, expressed by lagged values of the dependent variable in the regression.

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11 This highlights the fact, reminded above in connection with OCA tests based on relative prices, that considerable caution needs to be exercised when interpreting observed real exchange rate changes as signs that a relative price change is needed.

12 We estimated bivariate VARs for each country. In all cases the number of lags was set to 4, enough to make the residuals white noise for every model and so as to make the results comparable across countries. Using industrial production and the CPI, the estimation period is 1964Q1-1997Q1. Seasonal dummies were included. For GDP and the corresponding deflator, the estimation period is 1970Q2 -1997Q2. Despite the different data frequency and sample period, the resulting impulse response functions are roughly in line with those reported by Bayoumi and Eichengreen (1993).

13 As shown by Faust and Leeper (1993), estimates using higher frequency data may mitigate the problem of commingling of structural shocks arising from temporal aggregation of the data.

In Taylor's original formulation, inflation and output had weights respectively equal to 1.5 and .5, applied to percent deviations of the two target variables from their goals. Subsequent contributions have applied this simple empirical specification to other countries and policy contexts and, on a more theoretical vein, have attempted to interpret it as the outcome of more elaborate monetary policy strategies, such as inflation targeting. In particular, a Taylor-type rule was found by Clarida and Gertler (1996) and Clarida, Gali and Gertler (1998) to be suitable for most European countries as well as for the US, provided the basic rule is "augmented" by explanatory variables expressing the ERM constraint. In a series of contributions, Svensson (1997a, 1997b and 1998) showed that, under certain conditions, the optimal reaction function derived from an inflation targeting strategy can be expressed as an "augmented" Taylor rule, and that such rule can encompass other strategies as well, such as monetary or exchange rate targeting. Rudebusch and Svensson (1998) have conducted numerical simulations of alternative monetary policy rules of this kind within a skeleton US macro-model, studying their optimality properties given certain central bank objective functions.

A detailed econometric study of the policy rules followed by the EU central banks in the recent history is outside the scope of this paper. Our focus here is to provide elements to judge whether these rules have evolved over time in such a way to allow a smooth transition to the single monetary policy. To this aim, we kept our specification as simple as possible, in order to facilitate cross-country comparability. Our work was organized as follows:

a) central bank reaction functions for the six largest EU economies (Germany, France, Italy, the UK, Spain, the Netherlands[14]) were estimated for two separate subperiods, ranging from the creation of the ERM to 1997. The breakpoint of the sample is 1987, which leaves in the second period both the "hard ERM" and the "pre-EMU" phases;
b) the Taylor formulation provides the basis for the specification, but we also include other variables when necessary to account for the ERM constraint;
c) we explicitly test several hypotheses concerning the cross-country homogeneity of the reaction function coefficients;
d) we also test hypotheses concerning the role of "area-wide" vs. "domestic only" variables as explanatory variables in these functions.

Our econometric model consists of a set of bivariate systems of equations, estimated with monthly data, each including Germany and one other individual country. This "pairwise" modeling strategy seems appropriate in light of the fact that German monetary conditions are likely to have been relevant for each of the countries concerned[15]; therefore, a consistent estimation procedure is necessary to correct for simultaneity bias[16]. On the other hand, cross-country influences in monetary policy are likely to be much less important among countries other than Germany; therefore, estimating a full, n-country system of equations would probably entail an efficiency loss.

In the empirical specification, we follow Clarida, Gali and Gertler (1998) in two respects. First, we calculate the output gap as the residual of the monthly industrial production (in logs) from a quadratic trend. Second, we explicitly introduce both *future* and *past* inflation in the Taylor equation. The authors just mentioned find that the forward formulation fits the data better than the backward one, when applied to the main European central banks. Rudebusch and Svensson (1998) find that both formulations perform rather well under a broad class of central bank preference functions.

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14 Excluding the UK, these countries cover roughly 90 percent of the euro area's GDP.
15 But the reverse should not hold, given the well known asymmetry of the ERM.
16 Simultaneity bias is present if German monetary policy is relevant for other countries and the equations' residuals are correlated.

Our estimates, obtained with the Generalized Method of Moments (GMM[17]), are contained in **Tables 9a to 9c**, separately for the first and the second of or estimation periods. In particular, 9a presents estimates including both future (12-month forward) and past (12-month backward) inflation; in table 9b and 9c we present "backward only" and "forward only" estimates, respectively. In the tables, the numbers reported for the coefficients (except for the lagged dependent variable) refer to the long-run (equilibrium) values. The equations for Germany are those obtained in the pairwise estimation with France.

Our first result is that, contrary to our expectations, no definite pattern emerges as to the choice between the forward and the backward formulation for inflation. When both terms are included (table 9a), a clear dominance of one specification against the other emerges only in the first period for the UK (forward) and in the second period for France and Italy (forward) and Spain (backward). In all other cases, the backward and forward terms are either both significant or both insignificant, perhaps due to collinearity, or occasionally have wrong signs. We will return to this issue later, when discussing our results for the second estimation period.

Focusing on the first period (1980-87; **left side of Tables 9b and 9c)**, the most striking aspect is the wide cross-country differentiation among the selected regressors and their coefficient size. While our starting point was an "ERM augmented" Taylor specification[18], we found necessary in most cases to depart significantly from this formulation. Focusing for convenience on table 9b, the only country for which both inflation and the output gap enter significantly and with the expected sign is Germany; however, the coefficient on inflation is very low and an important role is played by other variables, namely M3, the US interest rate and the real effective exchange rate. The two latter variables suggest that monetary policy in Germany was significantly affected by external conditions in this period; in particular, the negative coefficient on the real effective exchange rate can be interpreted as the attempt, on the part of the Bundesbank, to protect itself against external inflationary impulses[19]. As to the other countries, the output coefficient has a "wrong" sign in France and Italy. M3 is significant and has the expected sign only in France, apart from Germany. The foreign interest rate (expected sign: positive) enters as expected in all cases, except Spain. The dollar-DM exchange rate (expected sign: negative for all ERM countries except Germany[20]) enters the equations for Spain, the Netherlands and the UK, but with a wrong sign. The real effective exchange rate (expected sign: uncertain[21]) enters with a negative sign in Germany, France and the UK, but positive in Spain. As to the Netherlands, a strong and significant effect is played by the German rate, as expected, followed by the $/DM exchange rate and the output gap. The inflation term, significant but with a "wrong" sign, is somewhat of a puzzle; a possible interpretation is that the exchange rate constraint prevented the central bank from responding to the strong decline in inflation occurred in this period with a relaxation of monetary policy.

It is interesting to compare the results just commented with those obtained from the 1988-97 sample **(Tables 9b and 9c, right side)**. A sharp change is apparent: in the more recent period

17 We computed the weighting matrix using Andrews (1991) data dependent method.

18 As in Dornbusch, Favero and Giavazzi (1998).

19 The relevance of external conditions on the behavior of the German central bank is discussed in Clarida and Gertler (1996). In the 1980-87 period, inflation was on average significantly higher in other G7 and EU countries than in Germany; it is thus not surprising that the central bank may have been particularly sensitive to external inflationary conditions.

20 Based on the following reasoning: when the dollar appreciates relative to the DM, German monetary policy tightens to reduce domestic inflationary pressure; in other ERM countries the effect is opposite, if the central bank wishes to stabilize the exchange rate with the DM. Shocks of this type were particularly important during this period, due to the sharp appreciation of the US dollar and its subsequent depreciation after the Plaza agreement of September 1985.

21 The monetary policy impact of a real exchange rate appreciation is likely to depend on the nature of the underlying shock. If it is higher domestic (producer price) inflation, the central bank would probably tighten monetary policy; if it is a nominal appreciation, a monetary expansion is likely.

all countries' central bank rule appear to conform broadly with the "augmented" Taylor specification, with rather similar coefficients. This is true under both the backward and the forward specification of inflation. Choosing between the two on pure statistical grounds is not easy, since the fit is very similar for all countries; thus our results do not support the contention of Clarida, Gali and Gertler (1998), based on a less recent sample period, that the forward formulation performs better for Germany, France, Italy and the UK. On the whole, our preference goes rather to the backward specification, for two reasons: first, the coefficient of the lagged dependent variable for Germany in the forward equation is very close to unity, suggesting that the estimate may be plagued by unit root problems; second, the coefficients of the German equation are very stable across different bivariate estimates in the backward case, but not in the forward case[22].

We thus focus our comments on table 9b, although those of table 9c convey a broadly similar message. Among the group of EMU(L) (Germany, France, Italy, Spain) the coefficient on inflation ranges between 1.16 (France) and 1.41 (Germany). The extent to which this coefficient exceeds unity, which coincides with the reaction of the real short term rate to changes in inflation, (inversely) measures the degree of monetary accommodation; it is noteworthy that in our estimates for the recent period, contrary to those reported by Clarida, Gali and Gertler (1998) and Dornbusch, Favero and Giavazzi (1998), this coefficient exceeds unity for all EMU(L) countries[23]. The coefficient on the output gap ranges between .19 (France) and .37 (Spain). The UK equation is similar in structure to the preceding ones, but displays a higher relative weight on the gap relative to inflation. In the case of the Netherlands, the inflation term is again significant with a wrong sign; our conclusion is that the close link with the DM makes the Taylor rule an unsuitable description of the Dutch monetary policy. The foreign interest rate (the US federal funds rate for Germany, the German short term rate for all other countries), is an important explanatory variable in all equations, confirming that the Taylor rule needs to be "augmented" by external factors when applied in the European context; the coefficient is highest for the Netherlands (1.23) and France (.82). The $/DM exchange rate has the expected sign in all countries, with the exception of the Netherlands[24].

Overall, the results presented so far support the view that a convergence has taken place in the monetary policy rules of the largest EMU participating central banks. This, however, does not necessarily imply that a high degree of homogeneity has been reached, let alone that a 'soft' transition to the single monetary policy is to be expected. We thus move a step forward in our analysis by testing equality restrictions, for each country (except the Netherlands, whose monetary policy is not adequately described by a Taylor rule) vis-à-vis Germany, of the key coefficients in our central bank reaction functions during the 1988-97 period. Under both the backward and the forward inflation specification, we test for equality of: a) the coefficients on the lagged dependent variable (i.e., the speed of adjustment to equilibrium); b) the equilibrium coefficients of inflation; c) the equilibrium coefficients of the output gap; d) all the above coefficients (a joint test of the equilibrium values *and* of the adjustment speed)[25].

The results (**Table 10, upper part**) suggest, first, a sharp distinction between the UK and all other countries. The homogeneity restrictions are generally and strongly rejected in the case of the Bank of England, while they are often accepted for the other central banks. Focusing on the

22 Simultaneous estimates of the German equation obviously change according to the other country included in the bivariate system. Complete estimation results are available on request.

23 Macroeconomic models tend to become dynamically unstable if the central bank's reaction function does not satisfy this condition; see Taylor (1998).

24 As discussed above, this coefficient should be positive for countries whose monetary policy targets (at least to some extent) the dollar exchange rate, negative for those who peg to the DM.

25 In all these tests we used the backward specification for Germany, which, as explained earlier, is empirically more robust.

latter, we first note that the homogeneity restrictions are almost always accepted if the backward formulation for inflation is used: only for France, the joint hypothesis on all coefficients is marginally rejected. If the forward specification is applied, homogeneity is rejected on the lagged dependent variable for France and Italy, and on the output gap for France. On the whole, these results provide evidence of a remarkable, but not complete, homogeneity among the main central banks reaction functions (except the UK, where homogeneity is strongly rejected).

Our next and final step is a test of whether area-wide variables have been relevant in influencing central bank policy in the countries considered. To this aim, we introduce in the reaction functions area-wide measures of inflation and the output gap[26], using the following "encompassing" formulation:

(1) $r_j = a_0 + a_1[q_1 INF_j + (1-q_1) INF^*] + a_2[q_2 GAP_j + (1-q_2) GAP^*]$
+ (other variables);

where r_j, INF_j and GAP_j are the short term rate, inflation and the output gap in country *j*, respectively, INF* and GAP* refer to the EMU-11 area and the other variables are those included in the right hand side of tables 9a to 9c. The tests are computed using only the backward specification for inflation, in view of its better statistical properties and economic interpretation.

Equation (1) allows us to test some interesting hypotheses concerning the relevance of area-wide variables. If q_1 and q_2 equal unity, only domestic variables count; if, instead, these parameters are equal to zero, only area-wide considerations matter. Intermediate values of these parameters represent cases in which area-wide variables have some, but not exclusive, relevance in the central bank decision making process. Finally, values below the 0-1 interval indicate that the central bank is not only indifferent to area-wide considerations, but actually cares about the *discrepancy* between domestic and foreign variables; for example, if $q_1<0$ (and $a_1<0$), the central bank will take advantage of any increase in inflation in the neighbor countries to *reduce* the own interest rate, thereby increasing the own inflation rate towards the area-wide level.

The results, shown in **Table 10, lower part**, suggest that area-wide concerns have so far not been relevant in the conduct of monetary policy for the main European central banks. Considering the 10 combinations arising from the two coefficients (q_1 and q_2) and the five countries considered, in 8 cases the coefficient is closer to unity than to zero. In 5 out of 10 cases, however, the coefficient cannot be statistically distinguished either from zero or from unity, indicating a lack of identification; this is not surprising given the high correlation in output and inflation among EMU-11 countries reported in section 2, which implies collinearity among domestic and area-wide variables. In the remaining 5 cases, the "area-wide only" hypothesis (q_1 or $q_2 = 0$) is always rejected; this happens, notably, in both Germany and France. For Italy, the coefficient on inflation is negative and significant, implying that the inflation differential vis-à-vis other European partners played a key role in guiding monetary policy.

Taken as a whole, the results of table 10, though still tentative, suggest that the central bank reaction functions in the EMU(L) group have the potential of being merged into a single, coherent monetary policy. Even the evidence that monetary policy decisions have predominantly been based on domestic factors may not have overly serious implications given that business cycles and price movements in the euro area are increasingly correlated across national economies.

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[26] *See Appendix for the definition of area-wide variables.*

4 Conclusions

We have presented new empirical evidence on cyclical correlation among EU economies and on the recent evolution of the reaction functions of the main EU central banks before the beginning of Stage Three of EMU. Our purpose was to understand how easily individual central bank rules can be combined into a single monetary policy with an area-wide objective.

In section 2 we found that in the most recent period intra-area correlations of output, stock market indices, aggregate and prices have increased. This does not appear to be attributable much to shifts in the correlation patterns of the underlying demand and supply shocks, that we identify using Bayoumi and Eichengreen's (1993) approach, but conceivably to a stronger influence of the international transmission process, operating through trade links, financial market prices, expectations, etc., and to a greater coherence of monetary policies.

In section 3 we compared central bank reaction functions for the 6 main EU countries (the UK plus the 5 largest EMU participants). Our findings here were twofold. First, in the last ten years central bank policy rules among the main participants in the single currency have displayed a remarkable tendency to converge. As mentioned, convergence of policy rules is likely to be a factor behind the increased correlation of economic performance documented in the first part of this paper.

Overall, our results suggest that no major inconsistencies or conflicts in the conduct of the single monetary policy should arise as a consequence of divergences in economic performance or policy objectives among the participating countries. Four important caveats must, however, be mentioned.

First, our estimates also show that area-wide considerations did not play, in the time period under consideration, a significant role in monetary policy formulation. From this point of view, Stage Three is thus a genuine regime change.

Second, the convergence we find among central bank reaction rules was not complete. In particular, we detected some significant differences between Germany and France. This can perhaps be explained by the length of our estimation period, since the evolution is likely to have continued during the period itself.

Third, we have not examined the second of the three issues mentioned in the introduction, namely, the existence of cross-country differences in the monetary policy transmission process. The presence of such differences was documented in a recent research project coordinated by the BIS[27], where the dynamic responses of the main industrial economies to changes in central bank rates were examined using "state of the art" econometric models. However, as comprehensive and accurate as this evidence may be, it must be borne in mind that EMU is likely to induce structural changes in areas that are crucial for determining the size and speed of monetary policy transmission: specifically, in banking structures, credit markets, portfolio preferences, capital mobility, not to mention fiscal and labor market policies. We feel, though we do not provide evidence here, that these changes will go in the direction of *reducing* any differences in the transmission mechanisms that may have existed in the past.

Finally, and perhaps more seriously, our analysis was centered exclusively on *cyclical movements* and on the role that monetary policy plays in controlling inflation and short term economic fluctuations. This is fully justified by the EU Treaty, which assigns to the ECB the overriding goal

[27] *Bank of International Settlements (1995).*

of price stability and implicitly assumes that supply factors are the sole responsible for *longer time trends* in employment, productivity, growth and regional disparities in the area. In practice, long-standing economic imbalances, no less than cyclical swings, can create dilemmas and conflicts in the conduct of the single monetary policy, regardless of whether the Treaty's implicit assumption holds true in all circumstances. Structural policies, directed primarily towards reducing European unemployment, are crucial also because they will help reducing the strains and improving the tradeoffs in the single monetary policy. On such longer term issues, however, the analysis of this paper has no guidance to offer.

Appendix

The data: definitions and sources

Output, consumption and investment:

- Real GDP, quarterly data from OECD Quarterly National Accounts (1970:1 - 1997:3);
- Industrial production, monthly and quarterly indices from OECD Main Economic Indicators (1960:1 - 1997:4);
- Real consumption and investment, quarterly data from OECD Quarterly National Accounts (1970:1 - 1997:3);

Equity prices:

- Broad stock market indices, quarterly averages from BIS databank.

Prices:

- CPI monthly and quarterly data from OECD Main Economic Indicators (1960:1 - 1997:4);
- GDP deflator, quarterly data, obtained using nominal GDP from OECD Quarterly National Accounts (1970:1 - 1997:3);

Monetary indicators:

- Interest Rates: monthly averages of day-to-day Rate (Germany), Federal Fund Rate (US), three month interbank rate for all other countries; from BIS Data Bank (1980:1 - 1997:4). For Italy, three month interbank rate from domestic screen-based market (MID);
- Exchange rates: monthly averages of the real effective (trade weighted) exchange rate from IFS ("rec" line) (1980:1 - 1997:4);
- Money stock: broad money aggregates, national definitions, monthly data from BIS Data Bank (1980:1 - 1997:4);

Definition of country groups:

- EMU(L): weighted averages of France, Spain and Italy calculated with OECD weights based on shares of GDP (for GDP, GDP deflator, investment, interest rates), consumption (for Consumption and CPI) and industrial production (for industrial production and output gap) from OECD, Main Economic Indicators.
- EMU: weighted averages of all EMU countries (excluding Germany for CPI and IP and Austria, Germany, Belgium, Ireland, Portugal for GDP, GDP deflator, consumption and investment) calculated with the above OECD weights.
- OUT: weighted averages of non-EMU EU countries: UK, Sweden, Greece for CPI and IP, UK, Denmark and Sweden for GDP, GDP deflator, consumption, investment calculated with the above OECD weights.
- NEU: weighted averages of non EU countries (Canada, Japan) calculated with the above OECD weights.

The series relative to Germany were adjusted, when necessary, to take into account the reunification of the country, by backward application of the percentage changes of the old (West German) series to the new (pan-German) levels.

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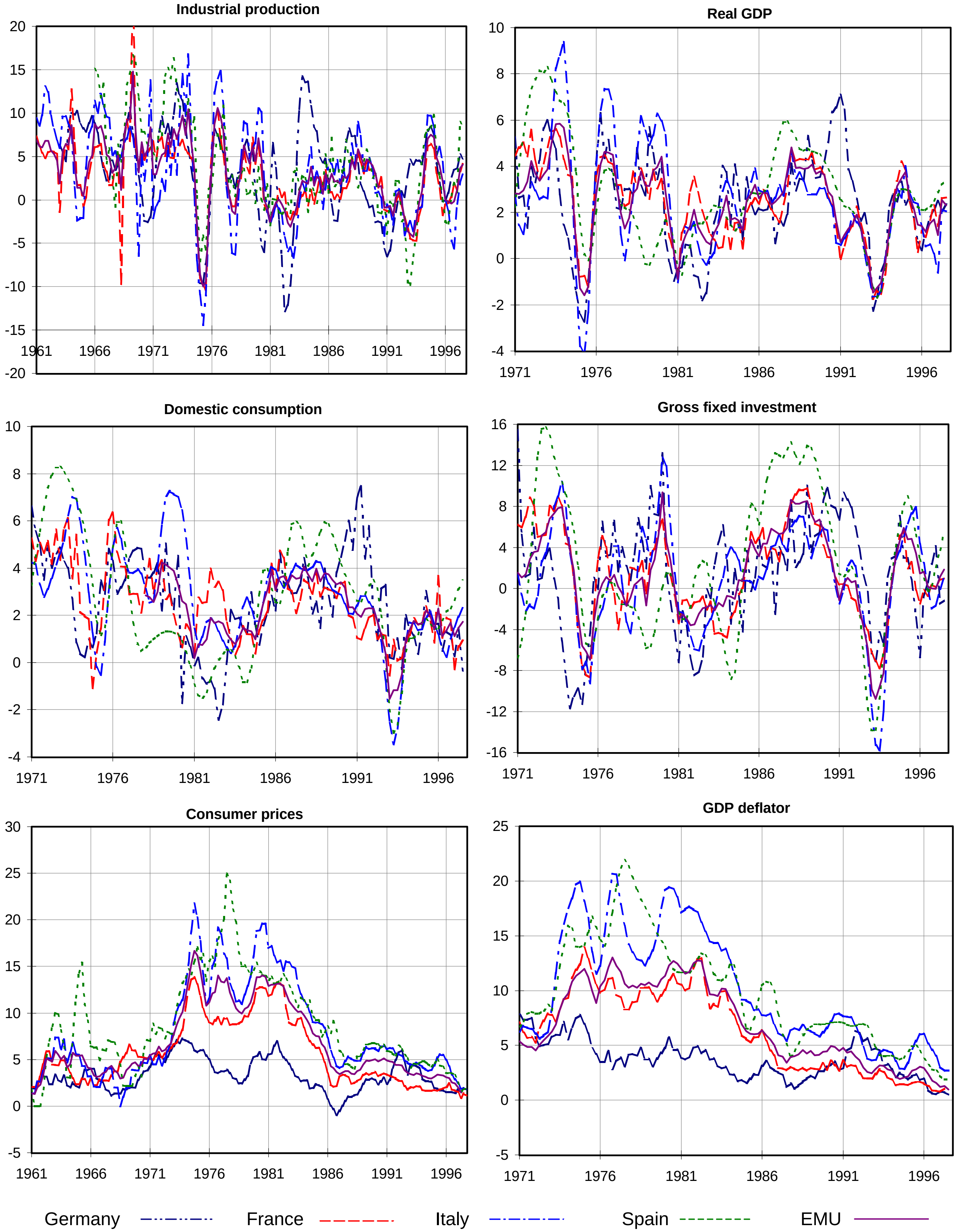
Detrended measures of real output and prices

Fig. 1

(quarterly data; 4 quarter log changes)

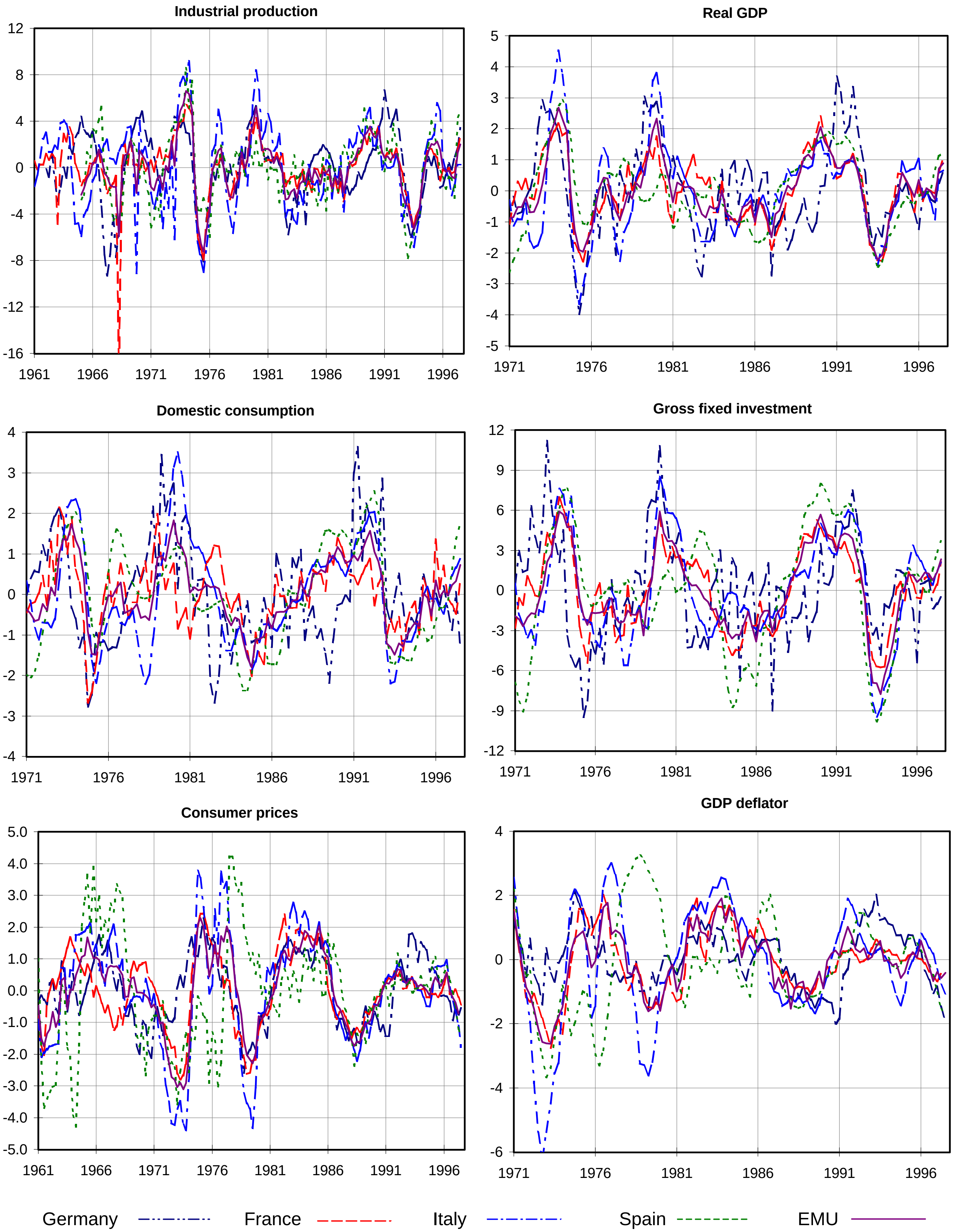


(1) EMU: a) excluding Germany (industrial production and consumer prices); b) excluding Germany, Belgium, Ireland and Portugal (other series).

Detrended measures of real output and prices

Fig. 2

(quarterly data; Hodrick-Prescott detrended)



(1) EMU: a) excluding Germany (industrial production and consumer prices); b) excluding Germany, Belgium, Ireland and Portugal (other series).

Table 1

Cross-country correlations of industrial production

(quarterly data; simultaneous correlations of 4 quarter log changes)

Time periods:	DE	FR	IT	UK	ES	BE	IE	NL	AT	PT	FI	SW	US	CA	JP	EMU(L)	EMU	OUT	NEU
											Correlations with Germany								
a) 6501 - 7901	1.00	0.59 *	0.41 *	0.61 *	0.56 *	0.75 *	0.52 *	0.79 *	0.75 *	0.48 *	0.47 *	0.46 *	0.52 *	0.60 *	0.59 *	0.56 *	0.64 *	0.72 *	0.62 *
b) 7902 - 8504	1.00	0.73 *	0.67 *	0.53 *	0.45 *	0.71 *	0.36 *	0.79 *	0.83 *	-0.05	0.54 *	0.68 *	0.55 *	0.58 *	0.76 *	0.76 *	0.81 *	0.68 *	0.79 *
c) 8601 - 9204	1.00	0.51 *	0.28	-0.14	0.28	0.43 *	-0.07	0.46 *	0.80 *	0.61 *	-0.23	0.19	-0.45 *	-0.37 *	0.72 *	0.39 *	0.47 *	-0.04	0.64 *
d) 9301 - 9701	1.00	0.93 *	0.59 *	0.42 *	0.89 *	0.67 *	0.46 *	0.67 *	0.86 *	0.54 *	0.63 *	0.86 *	0.44 *	0.32	0.83 *	0.82 *	0.86 *	0.69 *	0.86 *
d-a		0.33	0.18	-0.20	0.33	-0.09	-0.06	-0.12	0.11	0.06	0.16	0.40 *	-0.09	-0.28	0.24	0.26	0.22	-0.03	0.24
d-b		0.19	-0.08	-0.12	0.44 *	-0.05	0.09	-0.12	0.04	0.59 *	0.09	0.18	-0.12	-0.27	0.08	0.06	0.05	0.01	0.07
d-c		0.42 *	0.30	0.56 *	0.61 *	0.23	0.52 *	0.22	0.06	-0.06	0.87 *	0.67 *	0.89 *	0.69 *	0.11	0.44 *	0.39	0.73 *	0.22
											Correlations with US								
a) 6501 - 7901	0.52 *	0.46 *	0.54 *	0.61 *	0.56 *	0.61 *	0.62 *	0.36 *	0.45 *	0.55 *	0.27 *	0.11	1.00	0.86 *	0.51 *	0.57 *	0.59 *	0.63 *	0.56 *
b) 7902 - 8504	0.55 *	0.11	0.33 *	0.27	0.32 *	0.37 *	0.69 *	0.76 *	0.47 *	-0.42 *	0.16	0.62 *	1.00	0.95 *	0.62 *	0.30	0.38 *	0.38 *	0.77 *
c) 8601 - 9204	-0.45 *	0.41 *	0.45 *	0.80 *	0.30	0.39 *	0.64 *	-0.33 *	-0.21	-0.15	0.72 *	0.50 *	1.00	0.92 *	0.15	0.44 *	0.40 *	0.75 *	0.27 *
d) 9301 - 9701	0.44 *	0.63 *	0.47 *	0.71 *	0.53 *	-0.01	0.00	0.04	0.46 *	-0.13	0.77 *	0.43 *	1.00	0.90 *	0.27	0.58 *	0.53 *	0.61 *	0.36 *
d-a	-0.09	0.17	-0.07	0.09	-0.04	-0.61	-0.62	-0.32	0.01	-0.68	0.50 *	0.32		0.04	-0.24	0.01	-0.06	-0.02	-0.20
d-b	-0.12	0.52 *	0.14	0.44 *	0.21	-0.37	-0.69	-0.72	-0.01	0.28	0.61 *	-0.19		-0.05	-0.36	0.28	0.15	0.24	-0.42
d-c	0.89 *	0.23	0.02	-0.09	0.23	-0.39	-0.65	0.37	0.67 *	0.01	0.05	-0.07		-0.02	0.11	0.13	0.13	-0.13	0.09

Country groups: EMU(L) : Large EMU participants excluding Germany (France, Italy, Spain); EMU: EMU participants excluding Germany (10 countries); OUT: Non-EMU European countries (Denmark, Sweden, UK); NEU: Non EU countries (Canada, Japan).
Group correlations are computed as weighted averages based on GDP valued at PPP exchange rates.

Table 2

Cross-country correlations of real GDP

(quarterly data; simultaneous correlations of 4 quarter log changes)

Time periods:	DE	FR	IT	UK	ES	NL	AT	PT*	FI	SW	US	EMU(L)	EMU	OUT
						Correlations with Germany								
a) 7902 - 8504	1.00 *	0.30	0.73 *	0.55 *	0.03	0.82 *	0.69 *	- #	0.32 *	0.16	0.62 *	0.63 *	0.71 *	0.55 *
b) 8601 - 9204	1.00 *	0.01	-0.12	-0.46 *	0.05	0.49 *	0.64 *	- #	-0.28	-0.05	-0.59 *	-0.03	0.03	-0.41 *
c) 9301 - 9701	1.00 *	0.91 *	0.72 *	0.76 *	0.88 *	0.84 *	0.94 *	0.18	0.91 *	0.88 *	0.48 *	0.88 *	0.89 *	0.88 *
c-a		0.61 *	-0.01	0.21	0.84 *	0.01	0.25	#	0.59 *	0.72 *	-0.14	0.25	0.18	0.33
c-b		0.90 *	0.84 *	1.22 *	0.83 *	0.35	0.30	#	1.19 *	0.93 *	1.06 *	0.90 *	0.87 *	1.30 *
						Correlations with US								
a) 7902 - 8504	0.62 *	-0.30	0.20	0.42 *	0.14	0.61 *	0.09	- #	-0.30	-0.01	1.00	0.04	0.13	0.42 *
b) 8601 - 9204	-0.59 *	0.66 *	0.57 *	0.76 *	0.38 *	0.06	-0.03	- #	0.78 *	0.47 *	1.00	0.60 *	0.60 *	0.74 *
c) 9301 - 9701	0.48 *	0.42 *	-0.01	0.64 *	0.28	0.56 *	0.54 *	0.12	0.31	0.09	1.00	0.24	0.27	0.52 *
c-a	-0.14	0.71 *	-0.22	0.22	0.14	-0.05	0.45 *	#	0.61 *	0.10		0.20	0.13	0.10
c-b	1.06 *	-0.25	-0.58	-0.12	-0.10	0.50 *	0.57 *	#	-0.47	-0.39		-0.36	-0.33	-0.22

Country groups: EMU(L) : Large EMU participants excluding Germany (France, Italy, Spain); EMU: EMU participants excluding Germany, Belgium, Ireland and Portugal (7 countries); OUT: Non-EMU European countries (Denmark, Sweden, UK).

Group correlations are computed as weighted averages based on GDP valued at PPP exchange rates.

Cross-country correlations of stock price indices
(quarterly data; simultaneous correlations of 4 quarter log changes)

Time periods:	DE	FR	IT	UK	ES	BE	IE	NL	AT	PT	FI	SW	US	CA	JP	EMU(L)	EMU	OUT	NEU
									Correlations with Germany										
a) 6501 - 7901	1.00	-	-0.16	0.60 *	-	0.46 *	-	-	-0.06		0.02	0.44 *	0.47 *	0.36 *	0.15	-	-0.11	0.62 *	0.19
b) 7902 - 8504	1.00	-	0.04	0.59 *	-	0.55 *	-	0.93 *	0.67 *		0.11	0.34 *	0.46 *	0.21	0.59 *	-	0.32 *	0.61 *	0.56 *
c) 8601 - 9204	1.00	0.84 *	0.79 *	0.51 *	0.03	0.66 *	0.62 *	0.85 *	0.72 *		0.10	0.61 *	0.68 *	0.50 *	0.25	0.85 *	0.84 *	0.56 *	0.28
d) 9301 - 9701	1.00	0.84 *	0.62 *	0.57 *	0.93 *	0.93 *	0.84 *	0.96 *	0.92 *		0.55 *	0.75 *	0.19	0.84 *	0.42 *	0.85 *	0.88 *	0.65 *	0.49 *
d-a			0.78 *	-0.04		0.48 *			0.98 *		0.54 *	0.32	-0.29	0.48 *	0.27		1.00 *	0.02	0.29
d-b			0.58 *	-0.03		0.38		0.03	0.24		0.45 *	0.41 *	-0.27	0.63 *	-0.18		0.56 *	0.03	-0.07
d-c		0.00	-0.17	0.06	0.90 *	0.28	0.22	0.11	0.20		0.46 *	0.14	-0.49	0.33	0.17	0.00	0.04	0.09	0.21
									Correlations with US										
a) 6501 - 7901	0.47 *	-	-0.01	0.71 *	-	0.62 *	-	-	0.17		0.10	0.49 *	1.00	0.72 *	0.32 *	-	0.09	0.73 *	0.41 *
b) 7902 - 8504	0.46 *	-	0.40 *	0.67 *	-	0.07	-	0.52 *	0.37 *		-0.11	0.37 *	1.00	0.76 *	0.10	-	0.53 *	0.69 *	0.43 *
c) 8601 - 9204	0.68 *	0.77 *	0.65 *	0.93 *	0.52 *	0.77 *	0.79 *	0.66 *	0.29		0.28	0.69 *	1.00	0.87 *	0.47 *	0.79 *	0.71 *	0.92 *	0.52 *
d) 9301 - 9701	0.19	0.29	-0.42 *	0.49 *	0.15	0.32	0.18	0.37	-0.17		-0.39	0.14	1.00	0.24	-0.12	-0.05	-0.03	0.43 *	-0.08 *
d-a	-0.29		-0.41	-0.22		-0.31			-0.34		-0.49	-0.36		-0.48	-0.44		-0.12	-0.30	-0.48
d-b	-0.27		-0.82	-0.18		0.25		-0.15	-0.54		-0.28	-0.24		-0.52	-0.22		-0.56	-0.25	-0.51
d-c	-0.49	-0.48	-1.07	-0.44	-0.37	-0.46	-0.61	-0.29	-0.46		-0.67	-0.55		-0.63	-0.58	-0.85	-0.75	-0.49	-0.60

Country groups: EMU(L) : Large EMU participants excluding Germany (France, Italy, Spain); EMU: EMU participants excluding Germany, Portugal and countries for which data were not available in the period (4 to 9 countries); OUT: Non-EMU European countries (Sweden, UK); NEU: Non EU countries (Canada, Japan).
Group correlations are computed as weighted averages based on GDP valued at PPP exchange rates.

Cross-country correlations of GDP deflator
(quarterly data; simultaneous correlations of 4 quarter log changes)

Time periods:	DE	FR	IT	UK	ES	NL	AT	PT*	FI	SW	US	EMU(L)	EMU	OUT
						Correlations with Germany								
a) 7902 - 8504	1.00 *	0.86 *	0.92 *	0.72 *	0.64 *	0.89 *	0.55 *	- #	0.32 *	-0.95 *	0.78 *	0.91 *	0.89 *	0.72 *
b) 8601 - 9204	1.00 *	-0.13	-0.18	-0.07	0.25	0.43 *	0.66 *	- #	-0.76 *	-0.36 *	-0.24	-0.10	-0.26	-0.19
c) 9301 - 9701	1.00 *	0.93 *	-0.05	0.18	0.67 *	0.36	0.29	0.88 *	0.55 *	0.59 *	0.70 *	0.66 *	0.70 *	0.34
c-a		0.08	-0.97	-0.54	0.03	-0.53	-0.26	#	0.23	1.53 *	-0.08	-0.25	-0.18	-0.39
c-b		1.06 *	0.12	0.25	0.42 *	-0.07	-0.36	#	1.31 *	0.95 *	0.94 *	0.76 *	0.97 *	0.52 *
						Correlations with US								
a) 7902 - 8504	0.78 *	0.71 *	0.87 *	0.85 *	0.63 *	0.83 *	0.43 *	- #	0.56 *	0.36 *	1.00	0.81 *	0.82 *	0.84 *
b) 8601 - 9204	-0.24	-0.19	0.39 *	0.81 *	-0.30	0.42 *	-0.15	- #	0.47 *	0.59 *	1.00	-0.03	0.15	0.83 *
c) 9301 - 9701	0.70 *	0.67 *	-0.10	0.14	0.75 *	-0.08	-0.34	0.53 *	0.56 *	0.65 *	1.00	0.48 *	0.54 *	0.35
c-a	-0.08	-0.04	-0.96	-0.71	0.12	-0.91	-0.78	#	0.00	0.29		-0.33	-0.28	-0.50
c-b	0.94 *	0.86 *	-0.49	-0.67	1.05 *	-0.50	-0.19	#	0.09	0.07		0.50 *	0.38	-0.49

Country groups: EMU(L) : Large EMU participants excluding Germany (France, Italy, Spain); EMU: EMU participants excluding Germany, Belgium, Ireland and Portugal (7 countries); OUT: Non-EMU European countries (Denmark, Sweden, UK).
Group correlations are computed as weighted averages based on GDP valued at PPP exchange rates.

Table 5

Cross-country correlations of CPI

(quarterly data; simultaneous correlations of 4 quarter log changes)

Time periods:	DE	FR	IT	UK	ES	BE	IE	NL	AT	PT	FI	SW	US	CA	JP	EMU(L)	EMU	OUT	NEU
									Correlations with Germany										
a) 6501 - 7901	1.00	0.53 *	0.52 *	0.59 *	0.31 *	0.69 *	0.60 *	0.74 *	0.82 *	0.40 *	0.57 *	0.52 *	0.43 *	0.50 *	0.67 *	0.50 *	0.55 *	0.66 *	0.69 *
b) 7902 - 8504	1.00	0.94 *	0.86 *	0.72 *	0.82 *	0.46 *	0.95 *	0.91 *	0.67 *	-0.29	0.80 *	0.68 *	0.74 *	0.95 *	0.64 *	0.91 *	0.92 *	0.78 *	0.82 *
c) 8601 - 9204	1.00	0.08	0.35 *	0.22	-0.20	0.64 *	0.14	0.91 *	0.87 *	-0.04	0.05	0.12	0.27	-0.35 *	0.67 *	0.14	0.39 *	0.19	0.34 *
d) 9301 - 9701	1.00	0.34	0.15	-0.76 *	0.46 *	0.79 *	-0.35	0.63 *	0.90 *	0.90 *	0.74 *	0.84 *	0.16	-0.08	0.82 *	0.30	0.57 *	0.11	0.76 *
d-a		-0.20	-0.37	-1.35	0.15	0.10	-0.95	-0.11	0.08	0.50 *	0.17	0.32	-0.27	-0.58	0.16	-0.20	0.02	-0.54	0.08
d-b		-0.60	-0.71	-1.48	-0.36	0.33	-1.30	-0.28	0.23	1.18 *	-0.06	0.17	-0.58	-1.03	0.18	-0.61	-0.35	-0.67	-0.05
d-c		0.26	-0.20	-0.98	0.66 *	0.15	-0.49	-0.28	0.03	0.93 *	0.69 *	0.72 *	-0.12	0.28	0.15	0.16	0.18	-0.07	0.42 *
									Correlations with US										
a) 6501 - 7901	0.43 *	0.92 *	0.75 *	0.69 *	0.48 *	0.71 *	0.73 *	0.48 *	0.54 *	0.81 *	0.65 *	0.53 *	1.00	0.86 *	0.68 *	0.77 *	0.78 *	0.74 *	0.76 *
b) 7902 - 8504	0.74 *	0.77 *	0.78 *	0.96 *	0.80 *	-0.12	0.74 *	0.76 *	0.56 *	-0.40 *	0.64 *	0.69 *	1.00	0.74 *	0.89 *	0.81 *	0.78 *	0.97 *	0.91 *
c) 8601 - 9204	0.27	0.71 *	0.47 *	0.83 *	-0.36 *	0.68 *	-0.12	0.31	0.37 *	0.48 *	0.81 *	0.74 *	1.00	0.48 *	0.63 *	0.36 *	0.48 *	0.79 *	0.70 *
d) 9301 - 9701	0.16	0.07	-0.20	-0.29	-0.24	0.20	-0.33	-0.20	0.14	0.06	0.51 *	0.10	1.00	0.58 *	0.07	-0.20	-0.15	-0.05	0.22
d-a	-0.27	-0.85	-0.96	-0.98	-0.72	-0.51	-1.06	-0.69	-0.40	-0.75	-0.14	-0.43		-0.28	-0.62	-0.98	-0.93	-0.79	-0.54
d-b	-0.58	-0.70	-0.99	-1.25	-1.05	0.31	-1.07	-0.96	-0.42	0.47 *	-0.13	-0.59		-0.16	-0.83	-1.01	-0.93	-1.02	-0.70
d-c	-0.12	-0.64	-0.67	-1.11	0.12	-0.49	-0.22	-0.51	-0.24	-0.41	-0.30	-0.63		0.10	-0.56	-0.56	-0.63	-0.84	-0.49

Country groups: EMU(L) : Large EMU participants excluding Germany (France, Italy, Spain); EMU: EMU participants excluding Germany (10 countries); OUT: Non-EMU European countries (Denmark, Sweden, UK); NEU: Non EU countries (Canada, Japan).

Group correlations are computed as weighted averages based on GDP valued at PPP exchange rates.

Table 6

Contemporaneous correlations of structural shocks

(model with real GDP and GDP deflator)

Time periods:	DE	FR	IT	UK	ES	US	DE	FR	IT	UK	ES	US
	Aggregate supply shocks						Aggregate demand shocks					
	Correlations with Germany											
7102 - 7804	1.00	0.29	0.42	0.27	0.08	0.15	1.00	0.16	0.19	0.28	-0.12	0.13
7901 - 8504	1.00	0.28	0.10	0.63	0.02	0.30	1.00	0.28	0.17	0.29	0.30	-0.11
8601 - 9204	1.00	0.15	0.06	0.03	-0.26	-0.56	1.00	-0.06	-0.05	0.08	0.35	0.14
9301 - 9702	1.00	0.17	0.00	0.33	-0.18	0.30	1.00	-0.06	0.04	-0.20	0.04	-0.03
7102 - 9702	1.00	0.26	0.21	0.33	-0.01	0.06	1.00	0.14	0.12	0.23	0.14	0.06
7901 - 9702	1.00	0.21	0.05	0.38	-0.07	-0.04	1.00	0.11	0.06	0.15	0.27	-0.01
8601 - 9702	1.00	0.15	0.04	0.08	-0.23	-0.27	1.00	-0.07	-0.06	0.03	0.25	0.11
	Correlations with US											
7102 - 7804	0.15	0.12	-0.14	0.18	0.15	1.00	0.13	0.15	-0.27	0.26	-0.26	1.00
7901 - 8504	0.30	0.08	0.24	0.27	0.03	1.00	-0.11	-0.12	0.16	-0.12	-0.29	1.00
8601 - 9204	-0.56	0.01	0.14	0.07	-0.01	1.00	0.14	-0.02	0.01	0.09	0.13	1.00
9301 - 9702	0.30	-0.03	-0.27	0.27	-0.29	1.00	-0.03	-0.49	-0.69	-0.52	0.26	1.00
7102 - 9702	0.06	0.07	-0.04	0.18	0.07	1.00	0.06	0.00	-0.09	0.10	-0.14	1.00
7901 - 9702	-0.04	0.03	0.07	0.19	-0.03	1.00	-0.01	-0.11	0.05	-0.09	-0.13	1.00
8601 - 9702	-0.27	0.00	-0.06	0.12	-0.08	1.00	0.11	-0.12	-0.20	-0.03	0.17	1.00

Table 7

Contemporaneous correlations of aggregate demand shocks

(model with industrial production and CPI)

Time periods:	DE	FR	IT	UK	ES	BE	IE	NL	AT	PT	FI	SW	US	CA	JP
								Correlations with Germany							
6501 - 7901	1.00	0.02	0.00	0.15	0.10	0.35	-0.12	0.20	0.23	0.02	-0.23	0.20	0.30	0.31	0.35
7902 - 8504	1.00	0.58	0.16	0.54	0.38	0.35	0.12	0.08	-0.02	0.45	0.24	0.17	0.08	-0.25	0.42
8601 - 9204	1.00	0.52	0.20	-0.26	0.38	0.44	0.36	0.47	0.39	0.00	-0.10	0.19	-0.07	-0.39	0.24
9301 - 9701	1.00	0.06	0.26	0.15	0.06	-0.22	-0.16	0.23	0.12	0.48	0.20	0.10	0.11	0.28	0.22
7902 - 9701	1.00	0.48	0.21	0.26	0.32	0.19	0.13	0.27	0.16	0.33	0.12	0.18	0.06	-0.20	0.33
8601 - 9701	1.00	0.35	0.22	-0.14	0.26	0.10	0.15	0.39	0.28	0.14	0.00	0.16	-0.01	-0.19	0.23
								Correlations with US							
6501 - 7901	0.30	0.16	0.17	1.00	0.14	0.20	-0.04	0.18	0.04	0.21	-0.10	-0.13	1.00	0.43	0.15
7902 - 8504	0.08	0.27	0.30	1.00	0.24	0.10	0.00	0.32	0.31	0.44	0.19	0.60	1.00	0.63	0.01
8601 - 9204	-0.07	0.24	0.33	1.00	-0.10	-0.10	0.19	0.12	0.10	0.23	0.02	0.06	1.00	0.47	0.03
9301 - 9701	0.11	0.58	0.24	1.00	0.03	-0.20	0.10	0.00	0.46	-0.18	0.34	0.13	1.00	0.25	-0.21
7902 - 9701	0.06	0.31	0.32	1.00	0.13	0.02	0.07	0.22	0.26	0.39	0.17	0.38	1.00	0.57	0.02
8601 - 9701	-0.01	0.33	0.29	1.00	-0.05	-0.13	0.17	0.09	0.20	0.12	0.10	0.09	1.00	0.42	-0.04

Cross-country correlations of aggregate demand shocks estimated applying Bayoumi and Eichengreen (1992) bivariate structural VAR methodology, using quarterly data. For details, see text.

Contemporaneous correlations of aggregate supply shocks
(model with industrial production and CPI)

Time periods:	DE	FR	IT	UK	ES	BE	IE	NL	AT	PT	FI	SW	US	CA	JP
								Correlations with Germany							
6501 - 7901	1.00	0.13	-0.18	0.41	0.24	0.23	0.09	-0.40	0.32	-0.02	0.11	0.12	0.12	0.06	0.04
7902 - 8504	1.00	0.12	0.23	0.44	0.03	0.41	0.25	-0.24	0.28	-0.28	-0.03	0.23	0.28	0.31	-0.19
8601 - 9204	1.00	0.34	0.34	0.26	-0.18	0.41	0.08	0.09	0.06	-0.08	-0.04	-0.36	0.09	-0.58	-0.08
9301 - 9701	1.00	0.30	0.20	-0.54	0.27	0.45	-0.05	-0.11	0.08	0.31	0.17	0.39	0.02	-0.02	-0.18
7902 - 9701	1.00	0.24	0.25	0.23	-0.03	0.41	0.14	-0.09	0.16	-0.07	0.03	0.04	0.16	-0.13	-0.14
8601 - 9701	1.00	0.32	0.29	0.00	-0.06	0.43	0.04	0.03	0.07	0.06	0.06	-0.05	0.07	-0.36	-0.12
								Correlations with US							
6501 - 7901	0.12	0.16	-0.09	1.00	-0.13	0.16	0.07	-0.07	-0.08	0.14	0.09	-0.11	1.00	0.18	0.28
7902 - 8504	0.28	0.10	0.21	1.00	-0.04	0.03	-0.03	-0.04	0.06	0.10	-0.03	0.38	1.00	0.12	-0.32
8601 - 9204	0.09	0.52	0.34	1.00	-0.08	0.32	-0.04	0.09	-0.09	0.10	0.04	0.15	1.00	0.30	0.25
9301 - 9701	0.02	0.37	-0.02	1.00	0.21	0.08	0.03	-0.04	0.03	0.10	0.06	-0.02	1.00	0.58	-0.15
7902 - 9701	0.16	0.29	0.22	1.00	-0.03	0.12	-0.02	0.01	0.00	0.10	0.03	0.21	1.00	0.25	-0.04
8601 - 9701	0.07	0.47	0.25	1.00	-0.02	0.22	0.00	0.06	-0.05	0.10	0.08	0.13	1.00	0.36	0.14

Cross-country correlations of aggregate supply shocks estimated applying Bayoumi and Eichengreen (1992) bivariate structural VAR methodology, using quarterly data. For details, see text.

Table 9a

Central bank reaction functions in selected EU countries

(with backward and forward inflation terms)

	DE	FR	IT	ES	NL	UK	DE	FR	IT	ES	NL	UK
	Estimation period: 1980:01 - 1987:12						*Estimation period: 1988:01 - 1997:04*					
Constant	-	-	5.55 * (0.48)	23.15 * (2.46)	0.98 * (0.27)	7.85 * (0.8)	-3.14 * (0.91)	-	2.54 * (0.78)	-	-	1.50 * (0.33)
Lagged dependent	0.90 * (0.02)	0.87 * (0.03)	0.88 * (0.01)	0.87 * (0.01)	0.68 * (0.02)	0.87 * (0.02)	0.91 * (0.01)	0.78 * (0.03)	0.89 * (0.02)	0.92 * (0.01)	0.89 * (0.02)	0.86 * (0.02)
Inflation												
- *backward*	0.20 (0.15)	-0.12 (0.40)	0.96 * (0.10)	0.42 * (0.20)	-0.37 * (0.06)	-0.40 (0.28)	1.29 * (0.10)	-0.44 * (0.22)	0.16 (0.21)	1.36 * (0.52)	-2.30 * (0.38)	0.61 * (0.08)
- *forward*	-0.07 (0.15)	0.39 (0.40)	-0.76 * (0.13)	1.54 * (0.20)	-0.02 (0.60)	0.72 * (0.22)	0.55 * (0.15)	1.61 * (0.14)	1.10 * (0.19)	0.51 (0.32)	-0.38 (0.28)	0.32 * (0.14)
Output gap	0.34 * (0.05)	-0.45 * (0.17)	-0.11 * (0.04)	-	0.08 * (0.03)	0.60 * (0.16)	0.13 * (0.06)	0.08 (0.05)	0.22 * (0.06)	0.32 * (0.06)	0.39 * (0.07)	0.73 * (0.11)
Foreign interest rate	0.57 * (0.08)	0.64 * (0.26)	1.03 * (0.09)	-1.12 * (0.2)	1.15 * (0.07)	1.32 * (0.45)	0.67 * (0.11)	0.81 * (0.04)	0.35 * (0.12)	0.27 (0.14)	2.02 * (0.18)	0.45 * (0.09)
$/DM exchange rate	-	-	-	0.38 * (0.10)	0.07 * (0.02)	-	0.11 * (0.03)	-0.13 * (0.03)	-0.70 * (0.12)	-0.46 * (0.11)	0.19 * (0.04)	-0.09 * (0.04)
M3	0.27 * (0.13)	0.50 * (0.12)	-	-1.43 * (0.23)	-	-0.33 * (0.11)						
Real effective exchange rate	-1.28 * (0.35)	-0.60 * (0.25)	-	0.47 * (0.13)	-0.11 * (0.09)	-0.91 * (0.21)						
Adjusted R^2	0.98	0.96	0.97	0.88	0.97	0.94	0.99	0.96	0.92	0.98	0.98	0.98
s.e.	0.33	0.59	0.48	1.03	0.40	0.62	0.19	0.45	0.59	0.42	0.29	0.36
J-statistic	0.28	0.28	0.20	0.23	0.59	0.45	0.29	0.29	0.18	0.32	0.16	0.22

Dependent variables : Day-to-day rate for Germany and 3-month interbank rate for all other countries (monthly averages of daily data, in percent).

Right-hand variables (all in percent) : Inflation : twelve month log change of CPI at time *t* (backward) and *t+12* (forward). - Output gap: log deviation of industrial production from its quadratic trend. - M3: 12-month log change of broad money stock. - Foreign interest rate: US Federal Funds rate for Germany, German day-to-day rate for all other countries. - $/DM: 1-month log change of dollar-DM exchange rate (DM per one dollar), lagged for Germany and contemporaneous for all other countries. - Real effective exchange rate: lagged 1-month log change of trade weighted real exchange rate. For data definitions and sources, see the Appendix.

All equations are estimated with GMM, as part of a 2-equation system with Germany. The coefficients for Germany are those obtained with the joint estimation with France. All reported coefficients, except for lagged dependent variables, are long-run (equilibrium) values. Standard errors of coefficients in parenthesis; an asterisk denotes significance at 5% level.The instruments used were: a constant; contemporaneous German interest rate and $/DM for all countries but Germany; 6 lags of inflation, output gap, 12-month log-change of the index of primary commodity prices, M3 (in the first period) for all countries; 3 lags of the dependent variable, the foreign interest rate and the real effective exchange rate for all countries; 1 lag of $/DM for Germany. The J-statistic refers to the validity of the overidentifying moment restrictions; its distribution is χ^2 with degrees of freedom equal to the difference between the number of instruments and parameters.

Table 9b

Central bank reaction functions in selected EU countries

(with backward inflation terms)

	DE	FR	IT	ES	NL	UK	DE	FR	IT	ES	NL	UK
	Estimation period: 1980:01 - 1987:12						*Estimation period: 1988:01 - 1997:04*					
Constant	-	-	4.94 * (0.72)	19.85 * (0.30)	1.33 * (0.28)	9.53 * (0.88)	-2.03 * (0.91)	-	2.80 * (0.66)	-	0.93 * (0.17)	1.53 * (0.32)
Lagged dependent	0.90 * (0.01)	0.83 * (0.02)	0.86 * (0.02)	0.81 * (0.01)	0.68 * (0.02)	0.88 * (0.01)	0.93 * (0.01)	0.91 * (0.01)	0.92 * (0.01)	0.93 * (0.01)	0.87 * (0.02)	0.87 * (0.01)
Backward inflation	0.20 * (0.10)	-	0.45 * (0.06)	1.50 * (0.34)	-0.36 * (0.06)	-	1.41 * (0.11)	1.16 * (0.23)	1.22 * (0.19)	1.34 * (0.14)	-1.36 * (0.21)	0.59 * (0.08)
Output gap	0.32 * (0.04)	-0.29 * (0.08)	-0.32 * (0.04)	-	0.13 * (0.03)	0.55 * (0.13)	0.30 * (0.03)	0.19 * (0.06)	0.30 * (0.07)	0.37 * (0.04)	0.24 * (0.03)	1.08 * (0.06)
Foreign interest rate	0.52 * (0.05)	0.70 * (0.14)	0.84 * (0.09)	-0.74 * (0.29)	1.11 * (0.07)	0.95 * (0.33)	0.65 * (0.12)	0.82 * (0.08)	0.41 * (0.15)	0.41 * (0.10)	1.23 * (0.04)	0.58 * (0.08)
$/DM exchange rate	-	-	-	0.54 * (0.15)	0.07 * (0.02)	0.24 * (0.12)	0.19 * (0.04)	-0.26 * (0.06)	-0.97 * (0.18)	-0.62 * (0.08)	0.08 * (0.03)	0.07 * (0.03)
M3	0.24 * (0.12)	0.55 * (0.06)	-	-1.14 * (0.30)	-	-0.27 * (0.08)						
Real effective exchange rate	-1.23 * (0.28)	-0.56 * (0.16)	-	0.43 * (0.15)	-	-0.83 * (0.12)						
Adjusted R^2	0.98	0.96	0.98	0.88	0.97	0.94	0.99	0.96	0.92	0.98	0.99	0.99
s.e.	0.33	0.57	0.47	1.04	0.40	0.62	0.19	0.48	0.59	0.43	0.26	0.37
J-statistic	0.28	0.28	0.18	0.24	0.58	0.48	0.27	0.27	0.21	0.20	0.15	0.21

Dependent variables: Day-to-day rate for Germany and 3-month interbank rate for all other countries (monthly averages of daily data, in percent).
Right-hand variables (all in percent) : Inflation : twelve month log change of CPI at time t (backward) and t+12 (forward). - Output gap: log deviation of industrial production from its quadratic trend. - M3: 12-month log change of broad money stock. - Foreign interest rate: US Federal Funds rate for Germany, German day-to-day rate for all other countries. - $/DM: 1-month log change of dollar-DM exchange rate (DM per one dollar), lagged for Germany and contemporaneous for all other countries. - Real effective exchange rate: lagged 1-month log change of trade weighted real exchange rate. For data definitions and sources, see the Appendix.
All equations are estimated with GMM, as part of a 2-equation system with Germany. The coefficients for Germany are those obtained with the joint estimation with France. All reported coefficients, except for lagged dependent variables, are long-run (equilibrium) values. Standard errors of coefficients in parenthesis; an asterisk denotes significance at 5% level.The instruments used were: a constant; contemporaneous German interest rate and $/DM for all countries but Germany; 6 lags of inflation, output gap, 12-month log-change of the index of primary commodity prices, M3 (in the first period) for all countries; 3 lags of the dependent variable, the foreign interest rate and the real effective exchange rate for all countries; 1 lag of $/DM for Germany. The J-statistic refers to the validity of the overidentifying moment restrictions; its distribution is χ^2 with degrees of freedom equal to the difference between the number of instruments and parameters.

Table 9c

Central bank reaction functions in selected EU countries

(with forward inflation terms)

	DE	FR	IT	ES	NL	UK	DE	FR	IT	ES	NL	UK
	Estimation period: 1980:01 - 1987:12						*Estimation period: 1988:01 - 1997:04*					
Constant	-	-	-	24.11 * (1.77)	1.38 * (0.22)	8.58 * (0.80)	-	-0.60 * (0.23)	2.94 * (0.84)	-	-	2.17 * (0.53)
Lagged dependent	0.92 * (0.01)	0.85 * (0.02)	0.90 * (0.01)	0.87 * (0.01)	0.70 * (0.02)	0.89 * (0.01)	0.98 * (0.00)	0.76 * (0.02)	0.89 * (0.01)	0.92 * (0.01)	0.98 * (0.01)	0.92 * (0.01)
Forward inflation	-	0.26 * (0.11)	-	1.70 * (0.17)	-0.17 * (0.05)	-	1.55 * (0.44)	1.52 * (0.10)	1.12 * (0.20)	1.15 * (0.10)	0.03 (0.79)	0.21 (0.27)
Output gap	0.35 * (0.10)	-0.42 * (0.11)	-0.15 * (0.05)	-	0.06 * (0.02)	0.52 * (0.09)	0.30 * (0.15)	0.01 (0.03)	0.25 * (0.05)	0.43 * (0.05)	0.67 (0.40)	1.27 * (0.20)
Foreign interest rate	0.73 * (0.08)	0.63 * (0.11)	1.67 * (0.09)	-0.98 * (0.15)	0.95 * (0.04)	1.03 * (0.19)	0.95 * (0.40)	0.78 * (0.02)	0.40 * (0.10)	0.79 * (0.08)	1.05 * (0.19)	0.75 * (0.17)
$/DM exchange rate	-	-	-	0.38 * (0.08)	0.10 * (0.02)	-	0.27 * (0.11)	-0.14 * (0.02)	-0.71 * (0.12)	-0.45 * (0.07)	-0.08 * (0.09)	-0.13 * (0.06)
M3	-	0.50 * (0.07)	0.50 * (0.04)	-1.35 * (0.17)	-	-0.30 * (0.06)						
Real effective exchange rate	-1.45 * (0.53)	-0.45 * (0.17)	-	0.43 * (0.12)	-0.33 * (0.08)	-0.93 * (0.17)						
Adjusted R^2	0.98	0.96	0.98	0.88	0.97	0.94	0.99	0.96	0.92	0.98	0.99	0.99
s.e.	0.32	0.58	0.47	1.03	0.43	0.62	0.21	0.45	0.59	0.42	0.26	0.37
J-statistic	0.29	0.29	0.21	0.23	0.37	0.40	0.21	0.21	0.21	0.21	0.21	0.21

Dependent variables : Day-to-day rate for Germany and 3-month interbank rate for all other countries (monthly averages of daily data, in percent).

Right-hand variables (all in percent) : Inflation : twelve month log change of CPI at time t (backward) and t+12 (forward). - Output gap: log deviation of industrial production from its quadratic trend. - M3: 12-month log change of broad money stock. - Foreign interest rate: US Federal Funds rate for Germany, German day-to-day rate for all other countries. - $/DM: 1-month log change of dollar-DM exchange rate (DM per one dollar), lagged for Germany and contemporaneous for all other countries. - Real effective exchange rate: lagged 1-month log change of trade weighted real exchange rate. For data definitions and sources, see the Appendix.

All equations are estimated with GMM, as part of a 2-equation system with Germany. The coefficients for Germany are those obtained with the joint estimation with France. All reported coefficients, except for lagged dependent variables, are long-run (equilibrium) values. Standard errors of coefficients in parenthesis; an asterisk denotes significance at 5% level.The instruments used were: a constant; contemporaneous German interest rate and $/DM for all countries but Germany; 6 lags of inflation, output gap, 12-month log-change of the index of primary commodity prices, M3 (in the first period) for all countries; 3 lags of the dependent variable, the foreign interest rate and the real effective exchange rate for all countries; 1 lag of $/DM for Germany. The J-statistic refers to the validity of the overidentifying moment restrictions; its distribution is χ^2 with degrees of freedom equal to the difference between the number of instruments and parameters.

Table 10

Central bank reaction functions: test of homogeneity and relevance of area-wide conditions

	DE	FR	IT	ES	UK
		Tests of cross-country homogeneity with Germany (1)			
		(a) Reaction Function with contemporaneous inflation			
Coefficient:					
Lagged dependent	--	1.21	0.02	0.05	14.40 *
Inflation	--	1.24	0.42	0.18	48.45 *
Output gap	--	2.05	0.00	2.17	124.76 *
All above variables	--	10.04 *	1.83	2.55	361.94 *
		(b) Reaction Function with forward inflation			
Coefficient:					
Lagged dependent	--	63.61 *	4.05 *	0.66	0.09
Inflation	--	0.71	1.36	0.56	26.50 *
Output gap	--	37.86 *	0.71	0.99	28.73 *
All above variables	--	248.14 *	4.16	3.60	50.33 *
		Tests of relevance of area-wide conditions (2) ***(Reaction function with contemporaneous inflation)***			
Inflation: q_1	0.81 *	1.23 *	-0.97 *,✧	2.56	0.25
	(0.24)	(0.45)	(0.42)	(1.56)	(0.44)
Output gap: q_2	3.44 *	10.46 *,✧	1.03	1.74	28.10
	(1.30)	(2.57)	(3.06)	(1.47)	(22.60)

(1) Wald test of equality of coefficients (or groups of coefficients) with Germany. Asterisk indicates significance at 5% level.

(2) The estimated coefficients are reported (standard errors in parenthesis). An asterisk (diamond) indicates that the coefficient is different from 0 (1) at 5% level. A value of $\theta = 0$ implies that only the area-wide variable matters; a value of $\theta = 1$ implies that only the domestic variable matters.

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