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Monetary Policy in the Euro Area -
Lessons from the First Years

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Abstract

This paper investigates in a consistent semi-structural empirical framework three current issues of monetary policy in the euro area. First, regarding policy transmission we offer a three-stage procedure to combine the efficient estimation of economic structure *prior* to EMU with *current* ECB monetary policy. Second, we test whether the regime change leads – before or after – EMU to structural instability. Third, we investigate the stance of monetary policy in Europe. We compare a "counterfactual" ECB reaction function based on average interest rates prior to EMU with actual ECB policy. Furthermore, we compare actual ECB policy with interest rate projections using Bundesbank reaction functions and euroland data.

JEL-classification: E52, F41

Keywords: European Monetary Union, Monetary policy, Semi-structural modelling, Reaction function, Taylor rule, Transmission mechanism

1. Introduction

Since the start of European Monetary Union (EMU) in 1999, three areas of empirical research in monetary economics increasingly attract interest: The most active line focuses on the transmission mechanism of monetary policy in the euro area because the effective conduct of European Central Bank (ECB) policy requires reliable information on the strength and the timing of the aggregate effects of monetary policy. Considerable attention is also paid to the differences in monetary policy transmission across the EMU member countries. A recent comprehensive survey is provided by Angeloni et al. (2002).

A second strand investigates whether the regime change in monetary policy caused a structural break in the underlying macroeconomic relationships. Before the start of EMU, some authors expected substantial changes (e.g. Arnold and De Vries, 2000). In this case, past data and empirical analyses cease to contain useful information on economic behaviour in the new monetary environment. This would seriously undermine the effective conduct of monetary policy in Europe. As one of the first studies in this area, Mihov (2001) also includes data *after* the establishment of EMU. Based on the accuracy of out-of sample forecasts for output and inflation in the euro area, he did not detect significant deviations and concludes that empirical research based on pre-EMU data continues to be relevant after the establishment of EMU.

A third upcoming line investigates the overall stance of ECB policy. In particular, how actual ECB policy relates to the previous behaviour of the Deutsche Bundesbank.[1] Drawing on Clarida et al. (1998), Alesina et al. (2001) and Faust et al. (2001) apply an estimated reaction function of the Bundesbank to euroland data and compare the implied interest rate projections with actual ECB policy rates. Taking this benchmark, they find ECB rates to be consistently below those values that would have been chosen by the Bundesbank. Mihov (2001) finds that ECB behaviour resembles more an aggregate behaviour of the central banks in Germany, France and Italy than of the Bundesbank alone.[2]

This paper develops an empirical approach that is able to address in a consistent framework all three research strands simultaneously. We adopt a semi-structural modelling approach. It attempts to exploit the advantages of both, VAR and more structural models, while trying to

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[1] Begg et al. (2002) compare the actual ECB policy with projections of Fed policy for the euro area. They apply a Taylor rule, which explains US interest rates, to euroland data and find that the Fed would have responded to the slowdown in Europe in 2001 in a similar quantitative dimension, but probably somewhat earlier.

[2] Aksoy et al. (2002) take a related, but somewhat different perspective. They analyse to which extent ECB interest rate setting based on euroland data differs from the interest rate setting being optimal only based on German data.

avoid the well-known disadvantages. VAR models tend to be over-parameterised, rarely allow for informative cross-equation restrictions, and the test procedures tend to have low power. Structural models, on the other hand, impose numerous restrictions such that they often fail to capture the data generating process (DGP); in particular the underlying dynamics. Our combination of these data-led and theory-led approaches imposes sufficient restrictions to yield structurally meaningful equations, which are still admissible representations of the underlying data generating process.

We propose a three-stage modelling procedure in order to capture the specific context of EMU: In the first stage, we estimate in the period *prior* to EMU a system of nine equations. For each of the three largest EMU countries we specify an inflation equation, an output gap equation and a policy reaction function for interest rates. In the second stage, we hold the macroeconomic structure estimated in the first step *constant* and only estimate a single policy reaction function based on euro area aggregates. This allows us to model the changeover to EMU on the policy side assuming the economic structure to remain invariant. In the third stage, we study the impulse responses in the individual countries to a common interest rate shock.

Our specific set-up combines the efficient estimation of the pre-EMU economic structure with current ECB monetary policy making. Prior to EMU, the macroeconomic developments in the individual countries were affected by the *national* developments of interest rates and by the national effective exchange rates *including* the intra-European exchange rates. Therefore, these data ought to be used for an efficient estimation of the macroeconomic structure. After the establishment of EMU, however, we need to model introduction of a common monetary policy and the loss of the exchange rate channel between EMU members. Our semi-structural approach in conjunction with the three-stage modelling procedure exactly meets these requirements.

Our approach contributes to all three research strands mentioned above: First, we combine the pre-EMU economic structure with current ECB monetary policy making and analyse how interest rate shocks are transmitted across different EMU members. Our impulse responses illustrate the aggregate as well as the differential effects in euroland. Second, our econometric design allows for statistical tests for structural instability before and after the establishment of EMU. Our semi-structural approach enables us to exactly identify the equation(s) being subject to structural change. Third, we analyse ECB behaviour by estimating a "counterfactual" ECB reaction function based on past average interest rate data. We contrast our estimates with actual ECB rates to investigate how well this equation fits the data.

Furthermore, we compare ECB interest rates with interest rate projections based on euroland data and Bundesbank reaction functions. Moving beyond previous studies in this research area, we perform direct statistical tests of the significance of observed differences between actual and projected interest rates.

The paper is organised as follows. Section 2 presents the econometric model. Section 3 analyses the counterfactual ECB reaction function based only on historical data prior to EMU. Section 4 compares the behaviour of the ECB and the Bundesbank. Section 5 concludes.

2. Econometric model

This section briefly outlines the underlying semi-structural model (see Clausen and Hayo 2002 for more details). We estimate a nine equation simultaneous equation model using full-information maximum likelihood techniques (FIML). The EMU in our model consists of France, Germany, and Italy, which together account for about 75% of total output in EMU. For each country, three equations are specified: an output gap, an inflation, and an interest rate equation. We use quarterly data from 1979:1, the start of the European Monetary System (EMS), to 2000:4, the most recent official data available to us. The data source are the IMF International Financial Statistics, and the actual estimation period is 1979:1 to 1996:4. We keep eight observations for out-of-sample tests before and after the establishment of EMU, respectively.

According to standard diagnostic tests for serial correlation, non-normality, and parameter stability, our model is an acceptable representation of the DGP.[3] In addition, we perform an out-of-sample stability analysis. Again, we do not detect a problem with our specification (see Appendix, Table A). The Appendix also provides the FIML results for the output gap and inflation equations (Tables B and C). The labels F, G, and I represent France, Germany, and Italy, respectively. The short-term interest rate is denoted by *Int*, the output gap by *Gap*, the effective exchange rates by *EMU* and *ROW*, and the inflation rate by *Infl*. All variables are quarter-to-quarter growth rates expressed in percent, except for the exchange rate, which is a four-period moving average of its natural logarithm.

In the *output gap equations*, the interest rate variables are found to be significantly negative but at different lags. The own lagged output gap is always significant. On the other hand, it is

[3] The estimations and statistical tests were performed with PC FIML 9.0. See Doornik and Hendry (1997) for a detailed description of the tests. We also computed robust standard errors (White 1980) to check for possible problems with heteroscedasticity. The corresponding test results are similar except for one case mentioned later in the text.

hard to detect reliable international output spill-over effects. The same holds for the exchange rate effects, which are typically significant but often display opposite signs at different lags.

Table C in the Appendix presents the estimates for the *inflation equations*. In all countries, the output gap has a significant impact on inflation. In France, it is slightly above the 10%-significance level but considerably lower when heteroscedasticity corrected standard errors are used (p-value: 0.079). The inflation dynamics are fairly similar with significant and similar coefficients occurring at the same lag length.[4]

Table 1 presents the estimates of the interest rate reaction functions. We make the conventional assumption that the inflation rate and the output gap enter the policy reaction function. Note that we employ the current values of these variables, which makes the system a true simultaneous equation model. Given the lags in statistical reporting, this amounts to a forward looking procedure in practice. We also allow for interest rate smoothing up to lag four. In a consistent testing-down process, we are able to reduce the number of lags to two. Persistence in interest rates is considerable, with own lags having a coefficient of at least 0.84 (France: 0.84, Germany: 0.89, Italy: 0.87). The German interest rate equation contains a constant term, which represents the "anchor" interest rate. In view of the interaction in the EMS, we include the German interest rate as an "anchor" in the French and Italian reaction functions. In the case of France, we find that the current German interest rate dominates the inclusion of an additional constant term. In the case of Italy, however, this EMS connection is weaker, which is consistent with economic experience. However, we keep this symmetric specification for the sake of comparability.

Table 1: FIML-system: Interest rate reaction functions

France	Coeff.	S.E.	Germany	Coeff.	S.E.	Italy	Coeff.	S.E.
$FInt_{t-1}$	0.75**	0.072	$GInt_{t-1}$	1.42**	0.091	$IInt_{t-1}$	0.63**	0.068
$FInt_{t-4}$	0.10(*)	0.049	$GInt_{t-2}$	-0.54**	0.089	$IInt_{t-4}$	0.24**	0.059
$FGap_t$	0.27*	0.104	$GGap_t$	0.06	0.060	$IGap_t$	0.85**	0.164
$FInfl_t$	0.36*	0.145	$GInfl_t$	0.33*	0.148	$IInfl_t$	0.70**	0.123
$GInt_t$	0.13*	0.054	Constant	0.46*	0.175	$GInt_{t-4}$	0.05	0.043
D81:2	4.09**	0.745	D91:1	1.16*	0.504	D92:3	3.09**	0.651
σ	0.779			0.431			0.829	

Notes: (*), *, ** indicate statistical significance at a level of 10%, 5% and 1%, respectively.

For France and Italy, we find that both, output gap and inflation, have a significant positive impact on interest rates. In Germany, the output gap does not have a significant influence on

[4] This conclusion is based here only on visual inspection. Clausen and Hayo (2002) perform a wide range of statistical tests for asymmetric monetary policy transmission in the EMU across the national output gap and inflation equations and across different time horizons.

interest rates, while the coefficient on inflation is relatively large. Furthermore, a dummy capturing reunification is also included and found to be significant. Dummy variables for the other countries reflect the October 1981 realignment of the Franc and the EMS crisis in 1992. Since these events turned out to be insignificant in the German reaction function, this can be interpreted as further evidence of German dominance in the EMS (see, e.g., Wyplosz, 1989, von Hagen and Fratianni, 1990). Statistical tests based on the short-run coefficients confirm that Germany places the highest relative weight on inflation, followed by France and with Italy at the end of the spectrum. The implied long-run reaction functions further illustrate this result (Table 2). The Bundesbank reaction function places in comparison the greatest weight on inflation, followed by the Bancque de France and the Banca d'Italia.

Table 2: Long-run reaction functions

	Output gap	Inflation rate	Nominal "anchor"
France	1.73	2.28	3.26
Germany	0.49	2.89	4.02
Italy	2.46	2.02	0.48

We checked our system for structural instability in the run-up to EMU. Using the out-of-sample observations from 1997:1 to 1998:4, Chow-tests do not indicate any instability. Thus, in the two years preceding EMU, no significant changes in economic behaviour can be observed.

3. A counterfactual ECB reaction function

Modelling EMU requires two modifications to the structure of our baseline model: First, the intra-EMU exchange rate channel is removed. Therefore, we now keep the nominal intra-EMU effective exchange rate at its value in 1998:4. Second, monetary policy decision-making is transferred to the ECB. The national reaction functions and interest rates have to be replaced by a common reaction function and a European interest rate. In general, this reaction function may be assumed a priori or it can be estimated. In a first step, we estimate an EMU reaction function based on past average interest rates while restricting the rest of the system to the pre-EMU parameter estimates. Using this baseline model, we are then able to perform policy analyses conditional on a constant structure of the three economies.

We define aggregate EMU variables for the interest rate, inflation and the output gap based on weighted averages of national variables. The corresponding weights are the shares of national GDP in the aggregate GDP of the three countries in our sample (France: 0.304, Germany:

0.451, Italy: 0.245). Estimating a single reaction function for the average European interest rate while keeping the parameters in the output gap and inflation equations fixed yields (standard errors in brackets):

$$\underset{}{EUInt_t} = \underset{(0.07)}{1.08}\, EUInt_{t-1} - \underset{(0.07)}{0.22}\, EUInt_{t-2} + \underset{(0.18)}{0.57} + \underset{(0.11)}{0.31}\, EUInf_t + \underset{(0.06)}{0.31}\, EUGap_t$$
$$+ \underset{(0.33)}{1.69}\, D81{:}2 + \underset{(0.33)}{0.67}\, D91{:}1 + \underset{(0.31)}{2.73}\, D92{:}3 \qquad (1)$$

The estimate for the interest rate smoothing parameter is 0.86, which is within the range of estimates for the national reaction functions displayed in table 1. It is slightly lower than estimates by Clarida et al. (1998), who generally find values above 0.90 for the Fed, the Bundesbank, and the Bank of Japan. The policy weights on inflation and the output gap are identical.[5] The dummies in 81:2, 91:1 and 92:3 are again related to realignments in the EMS and to German reunification.

The restricted pre-EMU part of the model is now combined with the estimated ECB reaction function to analyse the transmission of monetary policy in the euro area. The impulse responses in figure 1 illustrate the dynamic effects of an interest rate hike by one percentage point. As it is apparent from the first graph in the last row of figure 1, European interest rates (EUInt) need about eight quarters to gradually return to their initial value. In response, all three countries experience a decline in output and inflation (see first row of graphs in figure 1). The negative impact is strongest in Germany. It occurs after two quarters and vanishes after 10 quarters. In Italy, the trough occurs after six quarters and the output gap returns to normal after 12 quarters. In France, the minimum is found after seven quarters, while the economy needs 22 quarters to return to the original equilibrium. Statistical tests show that the reactions in Germany and Italy are indeed significantly stronger than in France (Clausen and Hayo, 2002).

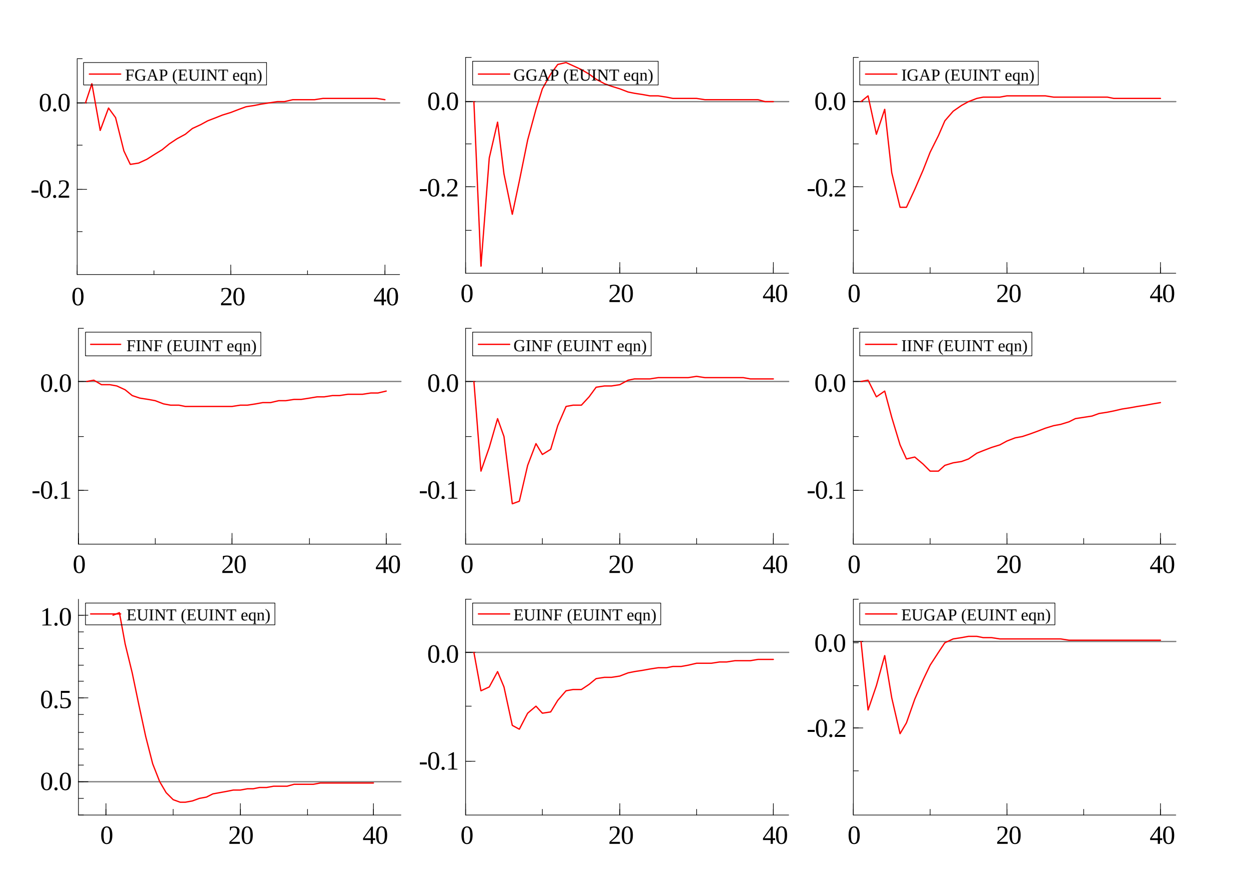
The reaction of inflation follows the development of the output gaps (see second row in figure 1). The fall in inflation is strongest in Germany, followed by Italy and France. Germany also shows the earliest reaction, while the effect in France is weak, with its minimum occurring after four years. Moreover, persistence is much lower in Germany than in the other countries.

[5] This stands in contrast with most previous estimates of Taylor rules, see Clarida et al. (1998), Gerlach and Schnabel (2000) and Faust et al. (2001. Typically, the weight on the output gap is found to be comparatively smaller. This is generally explained by considerable uncertainty about the output gap.

After 20 quarters, the pre-shock inflation rate is reached again. In the other countries, this adjustment requires about 48 quarters.

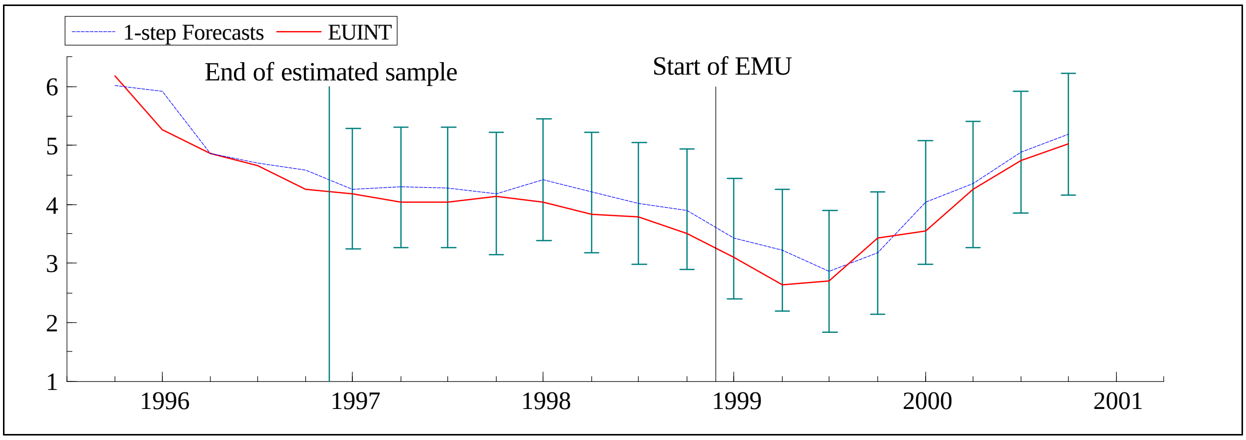
Finally, the last two graphs in figure 1 display the development of the aggregate EMU values resulting from the evolution of national values. The minimum output gap value occurs five periods after the shock. In other words, the maximum negative impact of a tightening of monetary policy takes place after less than one and a half years. European output needs less than three years to get back to its starting value. The maximum deflationary effect of monetary policy in the euro area can be observed six periods after the shock, thus lagging about one quarter behind output. The development of European prices is much more persistent, though.

Figure 1: Impulse responses to a one percentage point increase in ECB interest rates



We check the stability of the system in order to detect potential structural changes in the run-up to and after the start of EMU using 16 observations from 1997:1 to 2000:4. The conventional Chow test ($F(112,65) = 1.59^*$) as well as the Chow test taking parameter uncertainty into account ($F(112,65) = 1.50^*$) reject the null hypothesis of stability at a 5% level. However, this system instability is *not* due to the interest rate equation. Comparing one-step ahead forecasts with their 95%-confidence intervals and actual values of EMU interest rates indicates that the observations are well within the corridor of statistical uncertainty (see figure 2).

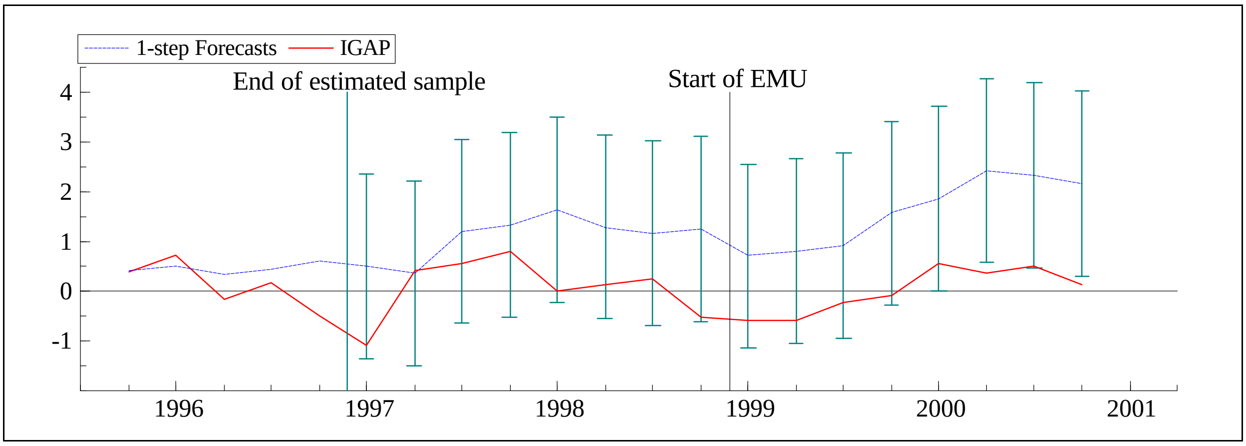
Figure 2: Structural stability of “counterfactual” ECB reaction function



Mihov (2001) describes a similarly close tracking of actual values by his estimates as “remarkable”. However, it must be noted that the equation is primarily driven by the interest smoothing parameter. Given the considerable persistence in interest rates, the actual influence of output gap and inflation weights on the overall fit of the equation is rather small.

In our model, the source of system instability lies in the Italian output gap equation. Figure 3 shows that our equation consistently overestimates the extent of the output gap. This suggests that the adjustment of the Italian economy during the early phase of EMU was associated with considerable costs in terms of lost real output. In absolute terms and ignoring estimation uncertainty, these costs amount to up to 2 percentage points of the output gap. Even more troubling, these costs do not seem temporary and to be growing over time. Note, however, that only the two observations in 2000:2 and 2000:4 actually fall outside the confidence intervals and, therefore, the output loss might in fact be lower.

Figure 3: Italian output gap equation under the EMU reaction function

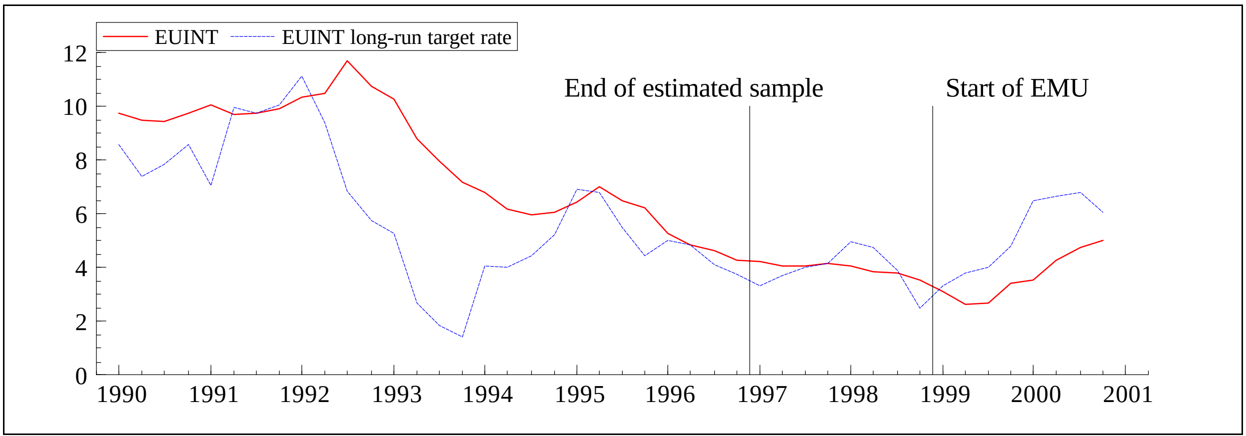


As indicated above, the focus on the actual interest rates versus the fitted values based on the short-run reaction function may be misleading, because the large coefficients of the lagged dependent variables are bound to generate a good fit of the series. Thus, in the following, we compare the actual interest rate with the target interest rate based on the *long-run equilibrium*. The static long-run is derived by replacing the lagged dependent variables and by setting the dummies to zero:

$$EUInt = 3.91 + 2.15\ EUInf + 2.12\ EUGap \qquad (2)$$

Figure 4 compares the long-run target values with the average of the three interest rates over the 1990s. From 1999 onwards, actual ECB rates are used.

Figure 4: Comparison of actual interest rates with long-run target values



The long-run target rate is below the average interest rates from the early 80s to early 90s. At the end of the period, however, long-run rates based on the estimated ECB reaction function suggest that actual interest rates are too low. This finding is analysed in more detail in the next section.

4. The ECB as a Bundesbank Clone?

It may be inappropriate to estimate a reaction function for the ECB based on an average of past interest rates of EMU member countries. The ECB is a new institution that has been specifically designed to conduct a monetary policy different from what most member countries' central banks have done in the past. In particular, it has been shaped after the Deutsche Bundesbank, one of the most stability-oriented central banks in the world. It is interesting now to ask whether the ECB has been successful in emulating the Bundesbank's monetary policy stance.

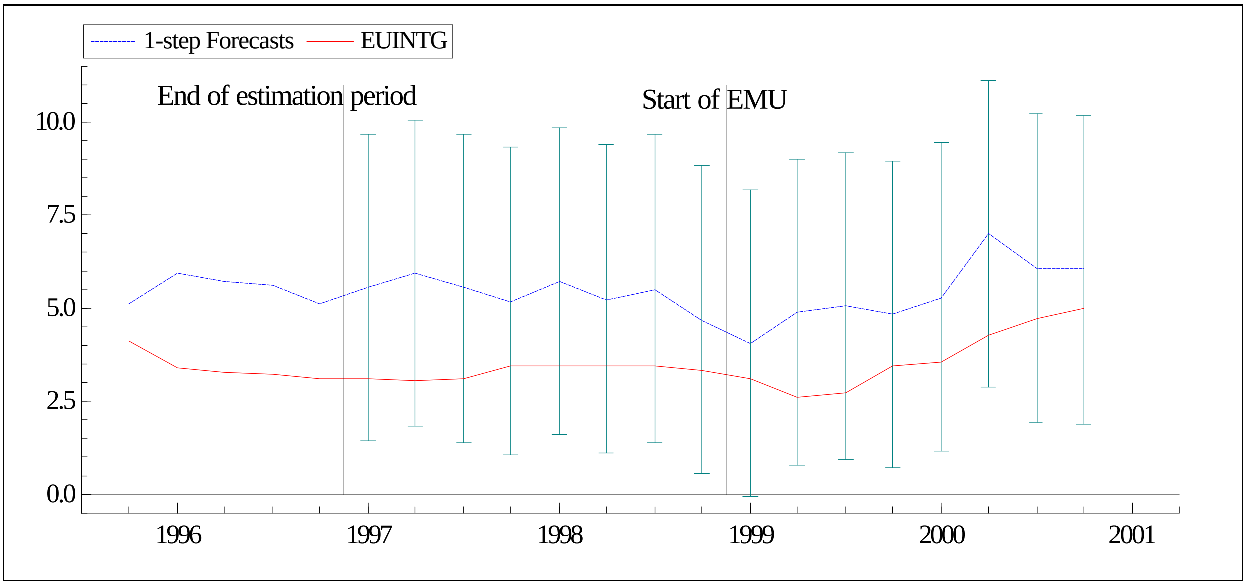
Faust et al. (2001) compare the interest rates that would have been set if the Bundesbank were in charge of EMU monetary policy using a long-run Bundesbank reaction function based on the approach by Clarida et al. (1998). They find that interest rates actually set by the ECB tend to be below the projected Bundesbank rates. Evaluating various arguments that may explain this consistent deviation, they find that none is able to explain the gap between actual ECB interest rates and projected Bundesbank rates. Hence, in their view, the ECB has, at least so far, performed a relatively more expansionary monetary policy than the Bundesbank would have done.

We analyse the claim by Faust et al. (2001) in our framework. Keeping the output gap and inflation equations restricted to their pre-EMU specification, we implement the German long-run reaction function based on the estimates of table 3 as the interest rate function in the system.

$$EUIntG = 0.49\ EUGap + 2.89\ EUInfl + 4.02 \qquad (3)$$

The interest rate series consists of German rates until the start of EMU and ECB rates afterwards (EUIntG). Figure 5 compares one-step ahead forecasts with actual interest rates.

Figure 5: Comparing Bundesbank-based projected interest rates with actual ECB rates



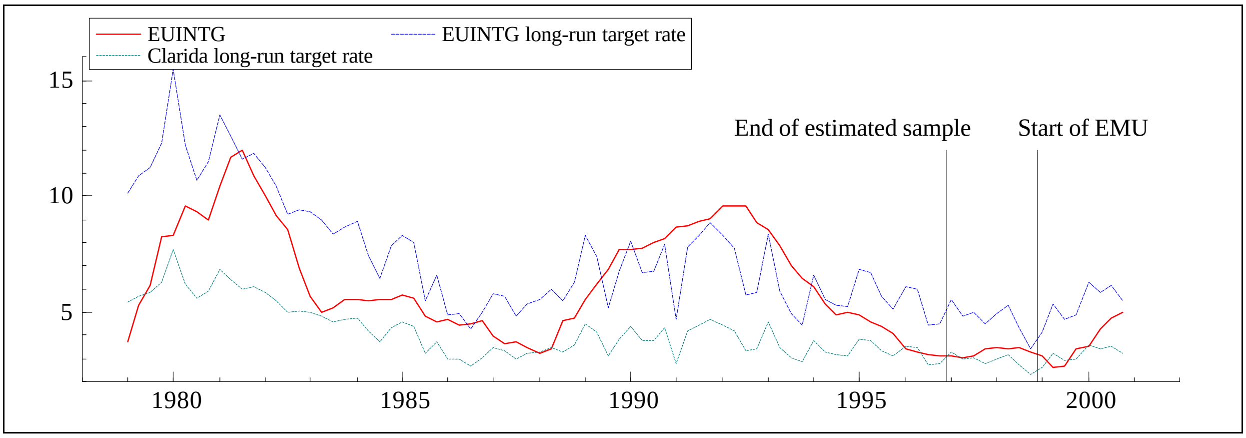
We also observe after the establishment of EMU that our projected Bundesbank interest rates are consistently higher than actual ECB interest rates. This confirms the finding by Faust et al. (2001). As indicated above, this outcome is also apparent from figure 4, which displays the long-run interest rate target for the estimated ECB reaction function based on past average interest rates. So even using an interest rate function based on average EMU member country interest rates we come to the same conclusion.

However, this outcome is not a direct consequence of the actual transferral of monetary policy to the ECB, as we obtain a very similar gap for the period 1996:1 to 1998:4. Hence, already in the run-up to EMU the Bundesbank departed from its long-run interest rate targets. If we accept that the ECB sets lower interest rates than those based on the German reaction function, then this is already part of the convergence process prior to EMU. In other words, no major structural change occurred after the hand-over of national monetary policy autonomy to the ECB. The transition is remarkably smooth.

On the other hand, it may be premature to accept the conclusion of a “softer” ECB based on a simple comparison of data points and projections. The projections are subject to uncertainty, which needs to be taken into account. Within our set-up, out-of-sample forecasting tests of the long-run reaction function can be used to assess whether the ECB interest rates are *significantly* lower than the projected Bundesbank rates. The confidence intervals in figure 5 around the one-step ahead forecasts indicate that the statistical uncertainty does not allow to discriminate between expected interest rates based on the Bundesbank reaction function and observed rates.

Finally, we compare our estimated long-run reaction function for Germany as a proxy for the ECB reaction function with a recent estimate by Faust et al. (2001), who use the same procedure as Clarida et al. (1998). Apparently, our estimated interest rate series in Figure 6 is in comparison much more volatile.

Figure 6: Comparison of long-run target interest rates with actual rates



Notes: The actual interest rate series is the German short-term interest rate until the start of EMU and the official ECB money market rate afterwards.

Further, our estimate is clearly superior in the earlier part of the sample period, while over the period 1995-1998, the other rule is closer to the actual interest rate series. However, at the end of the sample, the Clarida et al. (1998) rule fails to capture the rise in rates appropriately, while the our reaction function estimate performs clearly superior.[6]

Why is that the case? First, the Faust et al. and Clarida et al. estimates use higher frequency data. Given the non-availability of GDP data at monthly frequency, the authors had to resort to industrial production values. Second, their estimate is based on expected inflation as a variable in the short-run reaction function. Third, they rely on single-equation estimates. Fourth, the sample period slightly differs.

Checking the potential impact of these differences, we find the following: Results are somewhat sensitive to the estimation period, but we remain unable to replicate the Clarida et al. estimates. Estimating our reaction function in a single-equation context tends to widen the difference to the Clarida et al. estimates (the single-equation long-run estimate using German data is: GInt = 4.54 + 0.71 GGap + 2.65 GInfl). The way expected inflation rates are calculated is also an unlikely candidate for generating these differences. This leaves the use of industrial production and of monthly values as the most likely candidate for an explanation of the differences. Since the ECB ought to focus on overall GDP and not only on (volatile) industrial production, this raises doubts about the usefulness of the Clarida et al. specification for monetary policy. Moreover, higher frequency data do not have any obvious advantages with regard to long-run target values.

5. Conclusions

This paper provides new results on how monetary policy is transmitted in the three main EMU member countries, whether there was a notable structural break in response to the new monetary regime, and how actual ECB interest rate policy compares with interest rate projections based on estimated reaction functions for the euro area and for the Bundesbank. The underlying econometric model is quite powerful. The nine equation simultaneous equation system allows for a structural interpretation, but still passes standard diagnostic tests. The transition towards EMU is modelled as a change in the policy reaction function while keeping the remaining economic structure constant.

[6] Gerlach and Schnabel (2000) also provide estimates of a European Taylor rule using only data for the 1990s. The long-run form of their estimate is: EUInt = 1.58 EUInf + 0.45 EUGap + 2.4. This equation fits very well during the first year of EMU, but less well over the run-up to EMU. Moreover, it fails to capture the rise in interest rates in the year 2000.

We arrive at the following conclusions: First, regarding policy transmission, we found that an ECB monetary policy shock affects the German output gap most strongly, followed by Italy and France. The differences between Germany and Italy compared to France are statistically significant. Hence, we find asymmetric monetary policy effects over the short- and medium run. The differences are no longer significant over the long-run. European aggregate values also show the well-known hump-shaped responses to contractionary monetary policy shocks. The largest negative impact on the European output gap occurs after less than one and a half years. European Inflation is lagging behind by one period and is much more persistent than output.

Second, out-of-sample tests for structural stability suggest that in general the transmission mechanisms in Europe did not experience a structural break before or after the establishment of EMU. We explain this result by showing that the transition from the Bundesbank regime to the ECB was not accompanied by a structural break in the monetary regime. We do find, however, a break in the Italian output equation, which starts to significantly under-predict output gaps. This suggests that Italy's nominal and fiscal convergence prior to EMU resulted in non-trivial and lasting real output costs.

Third, comparing actual ECB interest rate policy with projections based on the European data and estimated Bundesbank reaction functions, we find the following: Using short-run estimates of reaction functions, ECB interest setting can be predicted quite accurately. This result, though, is more due to the high persistence of interest rates than to the explanatory power of the output gap and inflation rate. In our view, it is more informative to compare the long-run target values with actual ECB interest rates. During the early phase of EMU, ECB rates have been consistently below the long-run target rates derived from a Bundesbank reaction function. This gap emerged already three years before EMU was formed. It is not directly linked to the hand-over of monetary policy to the ECB. It might reflect some co-ordination of monetary policies between member countries before the official start of EMU. On the other hand, the conclusion derived from the perceived differences between ECB rates and projected long-run interest rates based on a Bundesbank reaction function, namely that the ECB is "softer" than the Bundesbank, may be premature. When calculating the long-run values, it is not taken into account that the statistical uncertainty associated with these estimates is much higher than for the underlying short-run estimates. Evaluating long-run standard errors indicates that the observed gap between these two interest rates is statistically not significant. Hence, more observations are needed to answer this question. This must be left for future research.

Appendix

Table A: Diagnostics of the system

	AR(2)-test	Normality	Chow1-test	Chow2-test
Vector statistics	$F(162,276)=1.23$	$Chi^2(18)=22.08$	$F(72,58)=1.51$	$F(72,58)=1.22$

Notes: * and ** indicate statistical significance at a level of 5% and 1%, respectively. AR(2)-test is an LM-test for serial correlation containing two lags. Chow1-test is the standard Chow-test. Chow2-test takes parameter uncertainty into account.

Table B: FIML-system: Output gap equations

France	Coeff.	S.E.	Germany	Coeff.	S.E.	Italy	Coeff.	S.E.
$FInt_{t-1}$	0.04	0.048	$GInt_{t-1}$	$-0.38^{(*)}$	0.206	$IInt_{t-1}$	0.01	0.055
$FInt_{t-2}$	-0.14^{*}	0.064	$GInt_{t-2}$	0.48	0.299	$IInt_{t-2}$	-0.07	0.066
$FInt_{t-3}$	0.1	0.064	$GInt_{t-3}$	-0.17	0.258	$IInt_{t-3}$	0.02	0.066
$FInt_{t-4}$	-0.06	0.048	$GInt_{t-4}$	-0.14	0.168	$IInt_{t-4}$	-0.14^{**}	0.052
$FGap_{t-1}$	0.63^{**}	0.116	$FGap_{t-1}$	$-0.43^{(*)}$	0.232	$FGap_{t-1}$	-0.003	0.117
$FGap_{t-2}$	0.13	0.114	$FGap_{t-2}$	$0.42^{(*)}$	0.215	$FGap_{t-2}$	0.12	0.116
$GGap_{t-1}$	0.001	0.060	$GGap_{t-1}$	0.54^{**}	0.116	$GGap_{t-1}$	0.08	0.059
$GGap_{t-2}$	-0.14^{*}	0.060	$GGap_{t-2}$	-0.01	0.111	$GGap_{t-2}$	-0.15^{*}	0.061
$IGap_{t-1}$	0.31^{*}	0.121	$IGap_{t-1}$	0.26	0.230	$IGap_{t-1}$	0.46^{**}	0.126
$IGap_{t-2}$	-0.11	0.114	$IGap_{t-2}$	-0.55^{*}	0.219	$IGap_{t-2}$	0.01	0.114
$FEMU_{t-2}$	-34.4^{**}	7.964	$GEMU_{t-2}$	1.69	0.412	$IEMU_{t-2}$	-23.2^{**}	7.583
$FEMU_{t-3}$	37.2^{**}	8.029	$GEMU_{t-3}$	-16.6	13.04	$IEMU_{t-3}$	21.7^{**}	7.490
$FROW_{t-2}$	-8.22	11.82	$GROW_{t-2}$	22.0	13.27	$IROW_{t-2}$	19.7^{*}	7.875
$FROW_{t-3}$	3.67	11.41	$GROW_{t-3}$	-21.3	32.49	$IROW_{t-3}$	-15.4^{*}	7.905
			D90:1-93:1	12.7^{**}	31.96			
σ	0.430			0.797			0.474	

Notes: (*), *, ** indicate statistical significance at a level of 10%, 5% and 1%, respectively.

Table C: FIML-system: Inflation rate equations [7]

France	Coeff.	S.E.	Germany	Coeff.	S.E.	Italy	Coeff.	S.E.
$FInfl_{t-1}$	0.49^{**}	0.064	$GInfl_{t-1}$	0.39^{**}	0.073	$IInfl_{t-1}$	0.33^{**}	0.077
						$IInfl_{t-3}$	0.18^{*}	0.071
$FInfl_{t-4}$	0.43^{**}	0.058	$GInfl_{t-4}$	0.45^{**}	0.070	$IInfl_{t-4}$	0.40^{**}	0.083
$FGap_t$	0.06	0.037	$GGap_t$	0.22^{**}	0.060	$IGap_t$	0.18^{*}	0.071
D81:3	1.34^{**}	0.267	D91:1	-2.43^{**}	0.425			
D82:3	-2.23^{**}	0.270						
D87:1	0.82^{**}	0.260						
σ	0.296			0.573			0.487	

Notes: (*), *, ** indicate statistical significance at a level of 10%, 5% and 1%, respectively.

[7] Several impulse dummies in the French inflation equation capture outliers. The French Franc was devalued against the DM on 5 October 1981 by 8.8%, 14 June 1982 by 10.6%, and 12 January 1987 by 3%. In the case of Germany, we need one dummy to capture the reunification. The inclusion of oil prices in the inflation equations in order to account for import price shocks did not change this picture. The corresponding results are omitted for the sake of parsimony of our model.

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