THE ROLE OF NATIONAL INFORMATION IN EURO AREA MONETARY POLICY-MAKING: BOUND TO VANISH ON THE WAY TO FULL CONVERGENCE?

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Abstract

Recent empirical studies suggest that the effectiveness of euro area monetary policy-making may be considerably enhanced if the ECB pays due attention to economic developments in individual countries, even if its objective function is consistent with its mandate (i.e., it is correctly defined solely in terms of aggregate variables). Intuitively, the under-perfomance of monetary policy rules that ignore the information content of national developments mirrors the asymmetries that still exist among euro-area economies.

In this paper we investigate how the role of national information in the conduct of euro area monetary policy could change if those asymmetries were to disappear in the future (indeed, some convergence is widely expected to take place). First, we examine whether there is evidence in the most recent data of increasing similarity among euro area economies. Secondly, assuming that some convergence will occur in the future, we analyze the consequences of a convergence of economic structures and that of exogenous disturbances. Finally, we investigate the effects of different speeds of convergence for the various aspects of the euro area economies.

Our results indicate that there are not (yet?) signals that the economic structures of euro area countries are becoming more similar; nor is there strong evidence suggesting that the cross-country correlation of shocks is now different from that of the past. The usefulness of national information for the single monetary policy hinges on both, the asymmetry of structures and that of disturbances. Finally, the speed of convergence turns out to be a key factor; interestingly, the usefulness of national information might actually become larger, at least temporarily, on the way to full convergence, provided that convergence proceeds at different paces for the various aspects of the economies.

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1. Introduction

The mandate of the ECB unequivocally prescribes that the European monetary policy-maker only be concerned with the pursue of area-wide objectives. This is widely held to imply that the ECB's monetary policy strategy should focus exclusively on the area-wide developments and effects of monetary policy, a view that may be found in a number of ECB documents[1] and is well summarized by the following statement released by President Duisenberg at the press conference following the Governing Council meeting of 9 September 1999: "... our decisions today, again and as always, were based on a *euro area-wide analysis* of economic and financial developments —*and nothing else*" (italics added).

By contrast, Angelini *et al.* (2002) argue that the appropriate policy might require that the monetary authorities react to national developments, rather than (or in addition to) area-wide aggregates, even when their objectives are exclusively framed in area-wide terms.[2] This may be the case if the economies of the area are characterized by significant structural differences, in particular concerning the monetary transmission mechanism. In these circumstances, a given shock may have different short and medium-term effects on the economy of the area depending on which country is initially or most prominently hit. The effects of the shock will reflect not only the relative weight of that country (as measured by the proportion of its GDP on the total for the area), but also the structural relations that characterize its economy, as well as its trade links with the rest of the Union.

To investigate the role of the national information in European monetary policy-making, Angelini *et al.* (2002) compute and compare the performance of two classes of simple optimal

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0 The views expressed are the authors' own and do not necessarily reflect those of the Banca d'Italia.

1 According to the initial exposition of the ECB strategy "... policy decisions must be made in a manner that reflects conditions across the euro area in its entirety, rather than specific regional or national developments" (ECB 1999, p. 47). Also, monetary policy decisions are motivated in terms of economic developments in the area as a whole, both in the Bulletin and in the press releases following the Governing Council meetings. Furthermore, the statistical section of the ECB Monthly Bulletin shows only aggregate statistics for the area, with no national breakdown, except for fiscal positions.

2 Some observers (see, e.g., De Grauwe, Dewachter and Aksoy, 1999; De Grauwe, 2000; De Grauwe and Piskorski, 2001) argue that national developments may in practice play an unduly large role in the decision-making process. According to this view, while the ECB does every effort to convince the public that only area-wide developments are relevant for its policy stance, in practice monetary policy decisions are likely to be influenced by national interests, reflecting the prominent role played by NCB Governors within the Governing council of the Eurosystem. In the following, we assume that this is not the case and that the definition of the objectives is strictly consistent with the ECB's mandate.

reaction functions. "Multi country information-based rules" (MCIBR) allow the interest rate to be a function of country-specific variables (plus the lagged value of the interest rate to allow for some instrument smoothing). By contrast, rules in the second class, labelled "area-wide information-based rules" (AWIBR), are restricted so that their arguments can only be area-wide variables; in other words, the monetary authority is assumed not to react to individual country variables separately, but only to their aggregation. The differences in the minimized expected loss under the two alternative policy rules provides an estimate of the cost of neglecting country-specific information. Their results indicate that the cost of neglecting national information is large.[3]

The analysis in Angelini *et al.* (2002) is based on a small multi-country model for the three largest economies in the area (France, Germany and Italy, accounting for over 70 per cent of the area GDP) estimated with data from the late 1970's to 1998, just prior to the introduction of the single currency. It might be argued that their conclusions no longer hold following the introduction of the single currency. Indeed, it is often expected that some form of convergence (of economic structures and/or of exogenous disturbances) of the euro area economies would tend to eliminate the asymmetries among them. As those are the key factor underlying the role of national information, the latter should shrink as the asymmetries tend to vanish.

In this paper we check the robustness of this conjecture. As a preliminary step, we first test whether there is any statistical evidence of an on-going convergence process, which should have presumably intensified in the last few years. We do not find evidence that the model presented in Angelini *et al.* (2002) has become unstable after the introduction of the euro. Nevertheless, we move on to explore how their conclusions should be amended if convergence were to occur in the future. In the process, we examine whether structural asymmetry or asymmetry of shocks are more relevant in securing a role to national information, and investigate the consequences of the speed of convergence being non-uniform for the various aspects of the euro area economies.

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[3] Angelini *et al.* (2002) conjecture that neglecting regional information is likely to be less of an issue for other monetary unions, as the heterogeneity among the euro area countries is, *a priori*, likely to be larger. The differences in institutional features and economic structures (e.g. legal system, contract enforcement and corporate law, labor market arrangements, independent fiscal policies) are much more pronounced than in other monetary unions or federal States (the US being the most obvious comparison), and are likely to persist for some time in the future. In addition, convergence of fundamentals (such as the inflation rate, the level of interest rates, the budget deficits and the public debt) has been only a recent — and in some cases incomplete — achievement; language and cultural differences, tending to hinder labor mobility, may be a relevant obstacle for the foreseeable future.

The organization of the paper is as follows. Section 2 illustrates the simple euro area multi-country model used in the analysis. Section 3 summarizes the experimental set-up and the results of Angelini *et al.* (2002); the statistical significance of their conclusions is also tested, sampling the shocastic distribution of the estimated residuals and model parameters. Section 4 tests whether the model is unstable with out-of-sample data (1997.Q1 to 2001.Q4). Section 5, under a particular way of modelling convergence, examines its impact on the role of national information in European monetary policy-making. Section 6 summarises the main findings.

2. A small empirical model for the main euro area economies

We take the euro area economy to be described by the simple model presented in Angelini *et al*. (2002), which includes two equations for each of the three largest economies in the euro area (Germany, France and Italy): an aggregate supply (AS) curve (also referred to as Phillips curve) and an aggregate demand (AD) curve . The first equation determines inflation in each country as a function of lagged inflation and the output gap in the same country, as well as of inflation ”imported” from the other two. The sum of the coefficients on lagged and imported inflation is constrained to be one (a restriction accepted by the data), so that an accelerationist version of the Phillips curve holds for all countries. The second equation relates the output gap of each country to its own lagged values and the real interest rate, as well as to the output gap in the other two countries (a design meant to capture the trade links among euro area economies).[4] Euro area output gap and inflation are generated as weighted averages of the corresponding individual country variables. The output gaps are aggregated using 1999 GDP weights (under PPP); 1999 consumer spending weights (under PPP) are used to aggregate the inflation rates (for full details as to data construction, see Lippi and Monteforte (2002)).

As the model allows for simultaneous cross-country linkages, it was estimated with 3SLS. For most of the sample period (from 1978.Q1 to 1998.Q4, thus totalling 84 observations), the exchange rates among the German, French and Italian currencies were not fixed, though constrained by the Exchange rate mechanism of the European monetary system. Accordingly, the measure of ”inflation imported in country i from country j” was constructed

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[4] Inflation is given by the quarter-on-quarter rate of change of the households' consumption deflator. Potential output was estimated by applying the band-pass filter (Baxter and King (1995)) to the (log) GDP for each country.

as the sum of the inflation rate in country j and the quarter-on-quarter percentage change of the exchange rate between the two countries (units of currency of country i needed for 1 unit of country j's currency).[5]

The general form of the two-equation sub-model for country j ($j = G,\ F,\ I$ for, respectively, Germany, France and Italy) is the following:

$$(1)\quad \pi^j_{t+1} = \sum_{k=1}^{p} \alpha_{j,k}\pi^j_{t+1-k} + \sum_{i\neq j}\sum_{k=0}^{p} \beta_{j,i,k}(\pi^i_{t+1-k} + \dot{e}^{i,j}_{t+1-k}) + \sum_{k=0}^{p} \eta_{j,k} y^j_{t+1-k} + u^j_{t+1}$$

$$(2)\quad y^j_{t+1} = \sum_{k=1}^{p} \theta_{j,k} y^j_{t+1-k} + \sum_{i\neq j}\sum_{k=0}^{p} \varphi_{j,i,k} y^i_{t+1-k} + \sum_{k=1}^{p} \psi_{j,k}(i^j_{t+1-k} - 4\,\pi^j_{t+1-k}) + v^j_{t+1}$$

where π^j_{t+1} is the quarter-on-quarter consumer inflation rate in country j, $e^{i,j}_{t+1-k}$ is the quarter-on-quarter rate of change of the exchange rate between country i and country j (units of country j's currency for 1 unit of country i's currency, y^j_{t+1} is the utput gap in country j, i^j_{t+1} is the short-term interest rate in country j, on an annual basis.

The starting specification included on the right-hand-side of each estimated equation the first 6 lags of all relevant variables. After dropping all insignificant lags the parsimonious specification presented in Table 1 was found.[6] This framework is admittedly a very simple one, as it only models the three major economies in the area, and in a sketchy way. While this choice was made primarily for computational reasons, a fully-fledged model for the euro area that were to include all twelve countries, paying closer care to country-specific institutional

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[5] Given the well-know difficulties to find satisfactory empirical specifications for the exchange rate, no attempt was made to augment the model with exchange rate equations. However, lagged values of all variables included in the model were used as instruments for the exchange rates. At any rate, in the experiments presented below, the percentage change of the exchange rate was set identically equal to zero, consistently with the introduction of the single currency as of 1 January 1999.

[6] The simple model presented in this section is entirely backward-looking and its parameters cannot be given a structural interpretation in terms of "deep" underlying parameters relating to preferences and technology. Hence, it is clearly potentially affected by the well-known difficulties associated with the evaluation of policy changes on the basis of behavioural relationships found to hold under a different policy set-up (Lucas (1976)). There are, however, several general reasons to believe that the Lucas Critique may in practice be less damaging than it is widely held (for a review, see Altissimo, Siviero and Terlizzese (1999)). Moreover, we follow here a recent trend in the literature, initiated by Rudebush and Svensson (1999), which shares the same methodological apparatus. Finally, the empirical evidence overwhelmingly supports the hypothesis of structural stability for the model, even for the most recent period when, arguably, a major shock to the policy regime has taken place.

features (e.g., labour market arrangements, tax structures, fiscal policy mechanisms), would likely result in more pronounced asymmetries.[7]

To recall a few prominent features of the model, that can be gauged from the pattern of impulse responses (see Angelini *et al.* for the details):

- neither AS nor AD disturbances have permanent effects on output and inflation; however, the deviations from equilibrium tend to be remarkably persistent, at least in some cases;
- a positive shock to the Phillips curve induces a dampened oscillatory reaction of both inflation and the nominal interest rate, and results in a contraction of output that reaches its maximum in the course of the third year after the shock;
- a positive monetary policy shock results in a temporary contraction of output that reaches a maximum in the course of the second year after the shock; it also tends, initially, to affect output more than inflation, which shows the largest reduction three to four years after the shock.

These features of the model are broadly consistent with well-established stylised facts about the timing of the impact of a monetary policy shock on output and inflation[8].

Moreover, a number of interesting features emerge that can be related to individual countries:[9]

- the effects on area-wide inflation of shocks hitting the French Phillips curve tend to vanish less rapidly than the effects coming from a shock to either the Italian or the German Phillips curves;
- similarly for aggregate demand shocks: in the case of France, their effects are much more persistent, particularly as far as aggregate euro area inflation is concerned;

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[7] In keeping with the approach followed in similar literature, the simulation model does not include any constant terms, and it may be taken to provide a description of (small) deviations from the equilibrium. This amounts to implicitly assuming that the same equilibrium values apply to all countries, a condition that does not hold in the sample period, particularly regarding the (implied) equilibrium real interest rates. This likely downplays the welfare gains obtainable with the use of national information

[8] See, e.g., the evidence presented at the Conference "Monetary Policy Transmission in the Euro Area", ECB, Frankfurt, 18-19 December 2001.

[9] Most of those individual country features are in accordance with the recent results in van Els, Locarno, Morgan and Villetelle (2001).

– for both aggregate supply and aggregate demand shocks, their effects are smallest, and least volatile, if the shocks originate in Italy;
– monetary policy takes longer to affect inflation in France than in either Italy or Germany; the time-pattern of the effects in the latter two countries is similar, but the effects are markedly more pronounced in Italy than elsewhere;
– the timing of the effects of monetary policy on the output gap are very similar across countries. The German output gap is the most reactive, followed by the Italian one.

3. Is there a case for exploiting national information in euro area monetary policy-making?

In this section we recall the experimental set-up of Angelini *et al.* (2002) and their main conclusions.

3.1 *Experimental design*

As in Angelini *et al.* (2002), let us assume the policymaker's loss function to be quadratic and time-separable; its arguments include the deviation of inflation from its target value (assumed to be zero), the output gap, and a term accounting for the central bank's dislike for excessive interest rate volatility:

$$L = E_t \sum_{\tau=0}^{\infty} \delta^{\tau} [\pi_{t+\tau}^2 + \lambda \cdot y_{t+\tau}^2 + \mu \cdot (\Delta i_{t+\tau})^2] \tag{3}$$

where δ is a discount factor, and λ and μ are parameters that reflect the policymaker's preferences. Note that no country-specific variables appear in the loss function, implying that the monetary policy authority is solely interested in area-wide developments.

For $\delta \longrightarrow 1$ (a scaled version of) the intertemporal loss function can be interpreted as the unconditional mean of the period loss functions, which in turn is given by the weighted sum of the unconditional variances of the target variables (see Rudebusch and Svensson, (1999)):

$$L_{t+\tau} = \text{var}(\pi_{t+\tau}) + \lambda \cdot \text{var}(y_{t+\tau}) + \mu \cdot \text{var}(\Delta i_{t+\tau}) \tag{4}$$

We restrict attention to Taylor-type rules, i.e. rules in which only contemporaneous inflation and output gap appear among the arguments, augmented with a lagged interest

rate term.[10] The difference between the AWIBR and the MCIBR is that in the former case the policymaker is assumed only to react to *area-wide* inflation and output gap (so that the reaction of the policy rate to a change in any country's inflation and output is given by the average impact, multiplied by the corresponding country weights), whereas in the latter the policymaker is allowed complete freedom to react to each country's inflation and output variables. Thus, the AWIBR includes three arguments :

$$i_t = \gamma_1^A \cdot \pi_t + \gamma_2^A \cdot y_t + \gamma_3^A \cdot i_{t-1} \tag{5}$$

The MCIBR, instead, includes seven arguments:

$$i_t = \gamma_{1G}^M \cdot \pi_t^G + \gamma_{1F}^M \cdot \pi_t^F + \gamma_{1I}^M \cdot \pi_t^I + \gamma_{2G}^M \cdot y_t^G + \gamma_{2F}^M \cdot y_t^F + \gamma_{2I}^M \cdot y_t^I + \gamma_3^M \cdot i_{t-1} \tag{6}$$

The optimal instrument rule that depends on all state variables of the multi-country model (15 in all) may also be computed as a benchmark, and is labelled FOR.

It is clear from the foregoing discussion that the performance of an optimal MCIBR cannot be worse, by construction, than the performance of the AWIBR, as the latter is a constrained version of the former. It turns out, however, that the welfare gains at stake are large, large enough to conclude that exploiting all available national information is worthwhile. Note that the variances of the goal variables depend, besides the parameters of the policy rule, from the variance-covariance matrix of the stochastic terms in the estimated equation (the matrix of correlations is given in Table 2). The historical variance-covariance matrix is rather sparse. Indeed, assuming that the off-diagonal block (i.e., the one that includes the covariances between the set of the three aggregate supply equations and the set of the three aggregate demand equations) is identically zero does not perceivably modify the results.[11]

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[10] As shown in Rudebusch and Svensson (1999), rules of this kind tend to produce an outcome often similar to the one associated with the optimal instrument rule; this will be shown to be also the case for (some of) the experiments carried out below.

[11] The consequences of assuming a different (less sparse) variance-covariance matrix will be examined in Section 4 below, where we consider the possibility of a gradual increase in the degree of symmetry of the shocks hitting the euro area economies.

3.2 *Empirical results*

The main results of Angelini *et. al* (2002) (also referred to below as "benchmark exercise") are reported in Table 3 and Figures 1 and 2. The table displays the (long-run values of the) coefficients of the three instrument rules described in the previous section, for different choices of the weights λ and μ assigned to output gap and interest rate variability in the loss function.[12] The table also shows the standard deviations of inflation, output-gap and interest rate change, as well as the loss function obtained for each rule. The top panel of Figure 1 shows the percentage reduction in the loss achieved with the MCIBR relative to the AWIBR, for a wider and finer grid of values for λ and μ than those reported in Table 3; the bottom panel expresses this reduction as a percentage of the difference between the AWIB and the fully optimal (FO) loss. Figure 2 presents the optimal inflation/output gap frontiers (in terms of unconditional standard deviations) for both the AWIBR and the MCIBR, as well as for the fully optimal one; the frontiers have been computed, for given μ, by letting λ take a grid of values between 0 (north-west) and 3 (south-east).

A few features are worth recalling (see Angelini *et al*. (2002) for a discussion).

First, neglecting the information contained in individual countries developments leads to a big worsening of the overall performance of monetary policy. Relative to the loss achievable with the AWIBR, the MCIBR yields a loss reduction generally comprised between 25 and 50 per cent (see Figure 1), the exception being the case of pure inflation targeting, where the loss reduction amounts to about 12 per cent.[13] When inflation variability and interest rate smoothness are the only concerns of monetary policy the relative loss reduction associated with the MCIBR ranges between 40 and 50 per cent.

Moreover, the MCIBR does a very good job relative to the FOR (see the bottom panel of Figure 1 and Figure 2).

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[12] The choice of the values for λ and μ range from the case in which the monetary policymaker is only interested in inflation ($\lambda = \mu = 0$) to the case in which the policymaker attaches a very high cost to deviations of the output gap from its equilibrium value and to the volatility of the policy-controlled interest rate ($\lambda = \mu = 3$). Table 3 does not show the results for the cases in which either λ or μ or both are exactly zero; while a solution may be computed for any of those cases, the resulting coefficients are not plausible, as they differ dramatically from any estimates that may be computed on the basis of the observed behavior of the monetary policy-maker.

[13] However, as mentioned above the case of pure inflation targeting implies unrealistic values of the coefficients of the rules, indicating that, on the basis of the policy-maker's observed behavior, it is likely that the latter does in fact attach some cost to interest rate volatility and/or to deviations of the output gap from its target.

Finally, all the features of the economies seem to matter for both the parameters of the rules and their relative performances: degree of inertia in individual countries and in the area as a whole; effectiveness of policy; causal structure of the model; correlation structure of the shocks. As these several ”dimensions” are simultaneously at play even in a simple model such as the one used here, it is difficult to disentagle them from one another.

3.3 *Testing the relevance of national information*

While the size of the welfare gains associated with the MCBIR is undisputedly large, its statistical significance has not yet been established.

To tackle this issue, we perform two stochastic simulation exercises: in the first we compute, for each particular realization of the stochastic disturbances, the value of the objective function under the alternative assumptions that the AWIBR or the MCIBR are followed; in the second we repeat the same computation sampling the stochastic distribution of the estimated parameters.

Moving to the details, in the first exercise we extract 1,000 replications from the set of estimated residuals and simulate the model under either one or the other of the two competing rules. Each replication consists of 800 realizations of the shocks for the six stochastic equations in the model. The model is simulated over 800 periods, but only the average outcomes in the last 400 periods are used to evaluate the objective function (given that we begin simulating from a situation of equilibrium, a few periods are needed before the variance of the simulation approaches the unconditional variance of the model). This we repeat for all combinations of preference parameters in the welfare function.

In almost 99 per cent of all replications, and for any combination of the preference parameters, the MCIBR delivers a better outcome than the AWIBR (the lowest figure being 97 per cent for the case of pure inflation targeting). Hence, not only the average gain is large, but is also systematic. Fig. 3 furthermore shows that, except in the immediate neighborhood of $\lambda = \mu = 0$, the gain associated with the MCIBR amounts to at least 20 per cent of the loss associated with the AWIBR in at least 90 per cent of cases. Finally, we formally tested the hypothesis that the average welfare loss with the MCIBR is lower than the average loss with the AWIBR (the test is a one-sided test based on comparing the averages of the objective function outcomes associated with the MCIBR and the AWIBR for all 1,000 replications). The

results are overwhelmingly supportive of the hypothesis: for all combinations of preference parameters, the tail probability is virtually zero.

Next, we explicitly consider the stochastic nature of the estimated model coefficients. In the previous paragraph, as well as in much of the literature on policy rules, the model used to derive and appraise the optimal rules is assumed to accurately describe the functioning of the economy. Actually, the most one could argue is that the "true" coefficients lie in a neighborhood of the estimated coefficients with a certain probability. It could then be that the variance-covariance matrix of the estimated rule coefficients is so "large" as to make statistically irrelevant whatever differences one finds between the performances of competing rules. In a sense, this exercise can be interpreted as a check of the "robustness" of our main result: indeed, we check whether the latter would survive were the "true" model somewhat different from the one used to derive the two rules.

In more detail, to account for the variability of the estimated coefficients we extract 5,000 replications from the empirical distribution of the estimated coefficients and, without re-computing the AWIBR and MCIBR, we rekord for each replication of the model coefficients the associated loss function (almost half of the replications had to be discarded, as they resulted in explosive estimates of the unconditional variance-covariance matrix with either the AWIBR or the MCIBR, and in general with both). We then examine the distribution of the loss function under the two rules. These steps are repeated for 49 combinations of values for the preference parameters λ and μ.

A first set of results are shown in Fig. 4 (top chart). It can be seen that in at least 85 per cent of all the "alternative worlds" that are plausible given the estimate of our model, the MCIBR does strictly better that the AWIBR, with the exception of the pure inflation targeting case, where the percentage is slightly smaller. Hence, coefficient variability is not such as to jeopardize our conclusions above. For most preference parameters, in at least two thirds of the replications the MCIBR delivers a reduction of the loss function of at least 20 per cent (bottom chart of Fig. 4).

Finally, as in the exercise above we formally test the hypothesis that the average (across replications) welfare loss associated with the MCIBR is lower than the average loss attainable with the AWIBR. Somewhat surprisingly, given the results just mentioned, the null hypothesis is rejected for about 40 per cent of the total 49 combinations of parameters that we consider

(using a 95 per cent confidence level; the rejection region tends to cluster around low values of λ and μ). Looking more closely, it can be noted that some of the individual drawings of the parameters of the model result in extreme outcomes (e.g. the inflation process has roots larger than 1 while at the same time the policy instrument becomes virtually uneffective). If only the drawings are retained for which both the MCIBR and the AWIBR result in objective function values not larger than 1000 times their corresponding value in the benchmark case, the tail probability of the test is always much lower than 1 per cent for all preference parameters.

Overall, these results clearly indicate that, whatever the "true" data generating process, the MCIBR tends to be significantly better that the AWIBR (provided that our model is a reasonable approximation of the DGP): not only the welfare loss associated with the AWIBR is large, but it is also statistically significant and, at least in most cases, "robust" to parameters uncertainty.

4. What could be ahead?

The literature on optimal currency areas shows that one of the conditions that are needed for a single currency area is that participating countries should be similar to one another both as regards the shocks that hit the individual economies and as regards the way in which the economies respond to the shock. A relatively sizeable body of empirical evidence regarding the euro area generally leads to the conclusion that the euro area is (still) characterized by the presence of relevant asymmetries. A partial list of recent papers includes Dornbusch, Favero and Giavazzi (1998), Ramaswamy and Sloek (1998), Guiso, Kashyap, Panetta and Terlizzese (1999), Dedola and Lippi (2000), Clements, Kontolemis and Levy (2001), Ciccarelli and Rebucci (2001), and the papers presented at the ECB conference mentioned earlier. Most of those papers focus on the asymmetry of structures. Other works, such as Bayoumi and Eichengreen (1993) and Demertzis *et al.* (1998), have tackled the issue of the symmetry, or lack thereof, of the shocks. The empirical evidence shows that, although the European economies have followed rather similar policies in the last years, there is (still) little evidence of a strengthening in the degree of symmetry of the disturbances affecting the various economies.

Now, the under-performance of the AWIBR relative to the MCIBR clearly hinges on this lack of symmetry: should all countries be the same, there would be no gain from exploiting

any particular country's information, as indeed confirmed by the results below. As there is a widely held expectation, both in policy circles and in the academia, that EMU will eventually bring about a significant convergence of the European economies (see for example Frankel and Rose (1997)), a preliminary issue to be tackled is whether signs of convergence can be detected in the data that would affect the model used in the preceding sections of the paper. This is of interest for two reasons. First, because it provides a further robustness check (the under-performancer might no longer hold in the most recent period). Secondly, it might give us some hint as to the sort of convergence (whether of economic structures, of disturbances, or both) that could be expected in the future.

4.1 *Empirical evidence*

In the following we present some evidence regarding the stability, or lack thereof, of the parameters of our model and of the variance-covariance matrix of its disturbances in the last few years.

First, we re-estimated the model using data from 1978.Q1 to 1996.Q4; the coefficient estimates are basically unchanged with respect to those obtained with the sample including 1997 and 1998, as in the model used earlier. Second, we tested the out-of-sample stability of the model estimated with data up to the end of 1996, using data for 1997-2001. Although the single currency was introduced only on January 1st, 1999, it may be argued that, at least since late 1996, the monetary policies for the three countries we consider had been tightly constrained: the bilateral exchange rates remained basically constant at about the same level as the irrevocable exchange rates with which those countries joined the euro area two years later,[14] and the financial markets attributed a high probability that those countries would participate in the single country (with the exception, at least for 1997, of Italy). Moreover, fiscal policies were also tightly constrained by the convergence process. Hence, we consider the whole period 1996-2001 as representative, at least approximately, of what might happen in the near future in the euro era.

The results are shown in Table 4 and Figure 5. The empirical evidence overwhelmingly rejects the hypothesis that the model is unstable and little signs of convergence can be detected

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[14] In particular, Italy, having abandoned the ERM of the EMS in September 1992, re-joined it in late 1996, at the same bilateral exchange rate with the DM as the one irrevocably fixed when the euro was introduced in 1999.

in the estimated parameters. In fact, although the coefficient variability is negligible (as shown in Fig. 5), it turns out that the cross-country dispersion of a given parameter (say, the autoregressive term in the AD equation) is, if anything, slightly higher using the whole sample up to 2001, rather than using the samples up to 1996 or 1998 (the only exception being that of the impact on interest rates in the AD equation, that tends to be just slightly more similar across countries). Although these results clearly do not rule out sizeable changes in the future, we can at least conclude that the relevance of country specific information for the conduct of the single monetary policy is not (yet?) fading away and should be expected to continue to apply at least in the near future.[15]

The variance-covariance matrix computed with the 20 out-sample observations suggests, by contrast, that the symmetry of shock has somewhat risen since 1996, in particular for the disturbances in the AD equations. However, not too much weight should be put on a variance-covariance matrix for 6 stochastic disturbances estimated with just 20 observations, and one cannot reject the hypothesis that the matrix is the same as the one computed in-sample with data up to 1996 or 1998 (both of the latter are almost-diagonal matrices).

At any rate, taking the most recent estimate of the variance-covariance matrix at face value, we computed the value of the objective function, using the optimal values of the coefficients for both the MCIBR and AWIBR that are found if the model parameters and the variance-covariance of the residuals are estimated with data up to 1996. In other words, we investigate what would have happened if optimal monetary policy rules computed on the basis of pre-euro data had been used in the early stages of the euro era (which, as explained above, we take to have started in 1997; as the model parameters are rather stable, we keep using the model estimated with data up to the end of 1996). *A priori*, the results could come out either way: the under-performace of the AWIBR could be somewhat attenuated in comparison to the benchmark case (because of the higher cross-country correlation of shocks), or could be magnified (if the pre-euro AWIBR is less robust with respect to the change in the variance-covariance matrix). It so happens that the results tend to be slightly more unfavorable to the AWIBR than in the benchmark experiment: the welfare gains associated with using the MCIBR can be as high as almost 60 per cent (with a low of about 10 per cent for $\lambda = \mu = 0$).

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[15] This evidence is of course of relevance also from the viewpoint of the Lucas Critique. Although the introduction of the euro can safely be deemed a major change in the policy rules, our simple model shows no sign of instability of behavioral equations

To sum up, the recent evidence seems supportive of the claim that the role of national information is not shrinking lately, and is likely to remain non negligible at least in the near future.

5. Convergence toward a more symmetric Europe: What consequences for the role of national information?

Thus far, our results have been derived using the actual estimated model of the (three largest countries in the) euro area economy that was presented in Section 2, or its companion discussed in Section 4 (estimated with data up to 1996.Q4 only).

In this section we explore how the comparison between the AWIBR and the MCIBR would be affected were more symmetry to prevale among the euro area countries than can be detected even in the most recent past.

Of course, convergence could occurr (provided that it does) in many different ways: all countries' economic structures could become similar to some average of what they are now; the smaller countries could become more and more similar to the largest one; or the final outcome of the convergence process could well be something that does not at all resemble the current situation. In fact, there is no reason why convergence should necessarily take place; moreover, there is at present no compelling evidence that much convergence has taken place in the early years of the euro area, despite the lengthy run-up process.

This leaves us with many, indeed too many, ways to model convergence, and we have no clear-cut criterion to offer as to which of them could be more plausible. Nevertheless, we believe that exploring the sensitivity of our results to some form of convergence can be informative, even if the eventual convergence process were to follow a different path.

To proceed, we will assume that countries that become more intimately tied to one another tend to share the same shocks and tend to mutually influence each other's features, proportionately to their relative size (the largest country exerting a comparatively stronger effect on the other two, and so on).

More in detail, regarding the convergence of stochastic disturbances we take full AD shock convergence to mean that the shocks in the AD equation become exactly the same in all countries (hence, the cross-country correlation equals 1); as in De Grauwe and Piskorski (2001), we assume that, once full convergence has been reached, the common variance (as

well as covariances) is given by the square of a weighted average of the historical estimated standard deviations:

$$\sigma^2_{y|FC} = (\omega_{y_G}\sigma_{y_G} + \omega_{y_F}\sigma_{y_F} + \omega_{y_I}\sigma_{y_I})^2 \tag{7}$$

where $\sigma^2_{y|FC}$ denotes the variance of the common AD shock under convergence; $\sigma_{y_G}, \sigma_{y_F}, \sigma_{y_I}$ are the estimated standard deviation of AD disturbances in the three countries; $\omega_{y_G}, \omega_{y_F}, \omega_{y_I}$ are the GDP weights of the three countries.

We also consider the possibility of partial convergence, which we assume to be parameterized by ξ_{AD}, ranging from 0 (no convergence) to 1 (full convergence). For any given choice of the ξ_{AD} parameter, the corresponding elements of the variance-covariance matrix of the disturbances are given by:

$$\sigma^2_{y_i|PC} = \xi_{AD}\sigma^2_{y|FC} + (1 - \xi_{AD})\sigma^2_{y_i} \tag{8}$$

$$\sigma_{y_j y_i|PC} = \xi_{AD}\sigma_{y_i|PC}\sigma_{y_j|PC} \tag{9}$$

for all i, j, so that the correlation of shocks among countries is given by ξ_{AD} itself.[16]

Full and partial convergence of AS disturbances are defined in an analogous way, with the convergence process now parameterized by ξ_{AS}.

Moving to convergence of structures, let us consider, for concreteness, convergence of AD equations (AS convergence is treated in an analogous fashion). It is assumed that, under full convergence, the way in which the output gap responds to its determinants (own lagged output gap, other countries' output gap and the real interest rates) is the same for all countries, except than for the effects of country size. Each parameter of the AD equations is given by a weighted average of the corresponding parameters (for the three countries) in the original model, so that, for country j, the AD equations under full convergence become:

$$y^j_{t+1|FC} = \sum_{k=1}^{p}(\omega_{y_G}\theta_{1,k} + \omega_{y_F}\theta_{2,k} + \omega_{y_I}\theta_{3,k})y^j_{t+1-k|FC}$$

---

[16] It would of course be possible to introduce the further complication that the speed of convergence is not the same for all countries. However, for the sake of simplicity we ignore that possibility. Let us just remark that our concept of partial convergence tends to make cross-country heterogeneity disappear more smoothly that it would be conceivably possible.

$$+\sum_{i\neq j}\sum_{k=0}^{p}\frac{\omega_{y_i}}{\sum_{h\neq j}\omega_{y_h}}(\omega_{y_G}\varphi_{1,k}+\omega_{y_F}\varphi_{2,k}+\omega_{y_I}\varphi_{3,k})y^i_{t+1-k|FC}$$

(10)
$$+\sum_{k=1}^{p}(\omega_{y_G}\psi_{1,k}+\omega_{y_F}\psi_{2,k}+\omega_{y_I}\psi_{3,k})(i^j_{t+1-k}-4\,\pi^j_{t+1-k}),\quad j=1,2,3$$

Hence, all countries become the same, other than for their size (as reflected by the fact that the cross-country effects are scaled by the country weights). In particular, they end up influencing each other is an analogous way (whereas, according to the estimated model, a clear-cut hierarchical ordering is apparent in history). We also experimented with a concept of convergence that only affects the parameters θ's and ψ's above, while the φ's remain unaffected (hence, cross-country linkages remain unchanged with respect to history); these results will be briefly mentioned below.

As in the case of convergence of disturbances, we allow for the possibility of partial convergence of structures; the relevant driving parameter for AD equations is ξ'_{AD}, similarly to before (ξ'_{AS} for AS equations). Partial AD convergence is given by:

(11)
$$y^j_{t+1|PC}=\xi'_{AD}y^j_{t+1|FC}+(1-\xi'_{AD})y^j_{t+1}$$

where y^j_{t+1} is the (left-hand side of the) estimated equation for country j and $y^j_{t+1|FC}$ is (left-hand side of) eq. (10) above.[17]

5.1 *Convergence of structures vs. convergence of disturbances*

The first issue we want to address is: which kind of heterogeneity is a key ingredient for the observed under-performance of the AWIBR in the benchmark case recalled in Section 3? In other words: is any of the two kinds of lack of convergence a necessary and/or sufficient condition for the results in Section 3 to emerge?

The results (for $\lambda=\mu=1$; similar results obtain for all other possible combinations) are shown in Table 5.

First, with full convergence of both structures and shocks, the underperformance of the AWIBR completely vanishes, as should be expected.

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[17] As in the previous case, we ignore the possibility that the speed of convergence differs from country to country, but we retain the possibility of different convergence speeds on the AD and AS sides.

Second, the results show that heterogeneity of both country structures and country disturbances is needed for national information to be clearly more valuable than aggregate information. As soon as any of those two kinds of asymmetry vanishes, then the case for exploiting national information vanishes as well (to be precise, the convergence of country structures makes the gain associated with using the MCIBR to fall to about 3 per cent, while the gain remains somewhat larger, of the order of 7 per cent, in the case of convergence of shocks). In other words, neither kind of asymmetry is sufficient, while both are necessary for the results in Section 3 to apply.

Therefore, the European policy-maker will be able to safely rely on an AWIBR, thus ignoring national information, as soon as the correlation of shocks across countries becomes equal to 1 (and the variance of shocks becomes the same), or the structure of AS and AD equations becomes the same for all countries.

Of course, perfect convergence is a rather extreme assumption to make and, moreover, according to the evidence presented in Section 4 there is scarcely any indication that things have even started moving in that direction.

Therefore, it may be of interest to try to appraise what could happen on the way to full convergence; whether convergence of AS factors (both structure and shocks) or of AD factors is more relevant from out viewpoint; what are the implications of the speed of convergence; more specifically, of different speeds of convergence for the two aspects of the economy (AS and AD). To these issues we now turn

5.2 *Partial convergence of structures*

In this paragraph we assume that the variance-covariance matrix of stochastic disturbances remains the historically estimated one, and examine the implications of gradual convergence of the economic structures. In other words, we assume $\xi_{AD} = \xi_{AS} = 0$, and let ξ'_{AD} and ξ'_{AS} move in the interval [0,1] (we consider 11 equally spaced values), independently from one another (we do not require that convergence of AS and AD behavioral equations proceeds hand-in-hand; it could be that all supply-side structural features converge either partially of fully, while no similar tendency shows on the demand side, or viceversa).

The results of the experiment are shown in Figure 6, where the welfare gains associated with using the optimal MCIBR (relative to using the AWIBR) are shown for all combinations

of ξ'_{AD} and ξ'_{AS} (the figure refers to the case in which equal weight is given to the three arguments in the objective function; similar results are obtained for all other combinations of preference parameters).

Several features of the results are worthwhile commenting, as the results are, at least at first sight, surprising for at least one feature.

First, if one proceeds along the diagonal of the base plane, the relevance of national information declines monotonically, as one would tend to guess *a priori*. The degree of uniform convergence that is needed for the relevance of national information to vanish is rather high: for the welfare gains associated with the MCIBR to fall below 10 per cent, one needs $\xi'_{AD} = \xi'_{AS} = 0.5$.

But what happens if the paces of convergence on the demand and supply sides differ?

As the AS equations become more and more similar to one another in all countries, the relevance of national information may be seen to unambiguously decline, even if convergence proceeds much more slowly (or does not proceed at all) on the AD side. Full AS convergence, with no AD convergence at all, results in a welfare gain of 3 per cent, i.e., negligible for all practical purposes.

On the basis of the remarks above, one is inclined to conclude that differences in supply-side behavior across euro area countries is one of the key factors that determine the under-performance of the AWIBR. While this conclusion is undoubtedly strongly suggested by our results, we feel that it needs to be checked with a more reliable model than the simple one we are using here.

That conclusion does not apply to the case of AD convergence without AS convergence. The results look puzzling at first sight: as the countries become more and more similar, at least as far as the demand side is concerned, the AWIBR and the MCIBR become increasingly far apart from one another.[18]

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[18] Note that, in few cases, the welfare gain associated with following the MCIBR cannot even be computed, because the search for an optimum fails for both the AWIBR and the MCIBR, or for just one of them. While there is of course no reason why any economy should be controllable by means of simple rules such as the ones we consider, the fact that for some convergence parameter values a solution cannot be computed might indicate that the convergence process could more likely be of a different kind than the one assumed here.

In fact, the explanation is simple. All that matters in designing the optimal policy is the reduced-form relationship between the instrument and the targets. There is a priori no reason why convergence of a subset of the structural equations should necessarily result in an increased similarity of the reduced-form relationships. In other words, individually more similar structural form components may result in larger differences as far as the reduced-forms are concerned. What is happening here is that, as the AD equations converge while the AS do not, the reduced-forms for the three countries become increasingly more dissimilar.

A couple of remarks are in place here. First, the results are not a "zero measure" event; the parameter space in which that inverse relationship between structural and reduced-form convergences may occurr is not a tiny one. Second, convergence of reduced-forms is not the only legitimate form of convergence to consider. It might well be that wage bargaining mechanisms become more similar across the euro area (hence resulting in less AS heterogeneity) while consumers' habits remain largely unchanged.

At any rate, a few interesting indications emerge from the analysis: AS convergence may be more relevant, from our specific viewpoint, than AD convergence; substantial convergence is needed before policy may safely rely on area-wide information only; it is possible that the relevance of national information actually increases on the way to full convergence, to the extent that the various aspects of the economy do not proceed along the convergence path at the same identical speed. All in all, our conclusions in Section 3 appear likely to remain valid at least for some time into the future, even if a tendency to converge should soon start to manifest itself.

5.3 *Partial convergence of disturbances*

This paragraph reports the results of an exercise that is the mirror-image of the one in the previous paragraph: now we assume $\xi'_{AD} = \xi'_{AS} = 0$, while ξ_{AD} and ξ_{AS} move from 0 to 1, not necessarily hand-in-hand.

The results are summarised in Figure 7.

If one proceeds along the diagonal of the base plane, the relevance of national information declines monotonically, as expected. The degree of convergence that is needed for the relevance of national information to vanish is, however, very high: for the welfare gains associated with the MCIBR to fall below 10 per cent, one needs $\xi'_{AD} = \xi'_{AS} = 1$, i.e.,

full convergence; for $\xi'_{AD} = \xi'_{AS} = 0.8$ the welfare gains associated with the MCIBR are still as large as 20 per cent. Differently from the case of convergence of structures, it seems that almost perfect convergence of shocks is needed for national information to become negligible in setting monetary policy for the euro area.

Again differently from the case of structural convergence, there is no indication that convergence on the AD and AS sides have different implications for the issue that we are interested in.

6. Concluding remarks

The asymmetries among the economies participating in the euro area make it worthwhile to exploit national information in the conduct of the single monetary policy: as shown in previous work, the under-performance of a monetary policy that were to rely solely on aggregate (area-wide) information is far from negligible.

In this paper we first show that the welfare gains associated with following a rule that relies on national information are not only large, but also statistically significant.

We then examine whether there are signs that the asymmetries on which those results rest have started fading away in the recent past; extending the sample originally used to estimate the model, we find no evidence of parameter instability in the most recent period. Moreover, if one computes the optimal area-wide information based and multi-country information based rules with data up to 1996 and compares their performances in the period 1997-2001, the latter rule is once again clearly preferable to the former, despite some increase in the cross-country correlation of shocks.

Finally, we assume, despite the evidence recalled above, that some convergence will take place in the future. While the way we model convergence is just one of the (very) many conceivable ways, we believe that it provides useful indications as to how the benchmark results could change, should the asymmetries on which they rest vanish in the future. We find that: both asymmetry of shocks and asymmetry of structures are needed to secure a significant role for national information; the degree of convergence needed for national information to become irrelevant is large, especially for what concerns convergence of disturbances; regarding convergence of structures, the asymmetries that are more relevant are those on the supply side; during the interim period on the way to full convergence, the use of national

information might become more, rather than less, relevant, at least as long as that the various aspects of the economy do not converge at the same speed.

All in all, there are reasons to believe that relying solely on aggregate information is likely to remain a sub-optimal choice, from the viewpoint of monetary policy-making, for at least some time into the future.

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Table 1

THE ESTIMATED MULTI-COUNTRY MODEL

		Equations for: Germany		Equations for: France		Equations for: Italy	
Input from:		π	y	π	y	π	y
Germany	π	0.292 [-1] (0.089) 0.600 [-4] (0.069)		0.063 [0] (restr.)		0.036 [0] (restr.)	
	y	0.095 [-1] (0.036)	0.785 [-1] (0.062)				0.173 [0] (0.058)
	r		-0.073 [-2] (0.038)				
France	π	0.108 [0] (restr.)		0.937 [-1] (0.044)			
	y			0.022 [-2] (0.012) 0.022 [-3] (0.012) 0.022 [-4] (0.012) 0.022 [-5] (0.012)	0.838 [-1] (0.052)		
	r				-0.036 [-2] (0.015)		
Italy	π					0.964 [-1] (0.010)	
	y					0.064 [0] (0.028)	0.657 [-1] (0.061)
	r						-0.038 [-1] (0.016)
	R^2	0.514	0.635	0.902	0.730	0.960	0.752
	$\overline{R}^2$	0.483	0.622	0.894	0.720	0.958	0.740
	σ	0.411	0.799	0.332	0.443	0.259	0.490
	DW	2.160	2.059	2.050	1.888	2.024	1.815

In parentheses: standard error of the coefficients.

In brackets: lag with which the variables enter the equations.

Table 2

CORRELATION MATRIX OF STOCHASTIC DISTURBANCES

		Aggregate supply			Aggregate demand		
		Germany	France	Italy	Germany	France	Italy
Aggregate supply	Germany	1	-0.024	0.035	-0.056	-0.009	0.167
	France		1	0.188	-0.013	-0.128	-0.058
	Italy			1	0.182	0.009	0.002
Aggregate demand	Germany				1	0.387	0.026
	France					1	0.328
	Italy						1

Table 3

Reaction function coefficients and loss values for the optimal, the area-wide, and the multi-country case

Parameter values in the loss function:		Type of rule	Long-run coefficients on:								Standard deviation of:			**Loss**
			Inflation				Output gap				Inflation	Output gap	Interest rate change	
			Area	Ger	Fra	Ita	Area	Ger	Fra	Ita				
$\lambda = 0.1$	μ=0.1	FOR	2.99	1.61	0.90	0.48	3.48	1.20	2.00	0.28	0.58	1.23	1.05	0.60
		MCIBR	3.12	**1.45**	**1.18**	**0.49**	4.58	**2.11**	**1.96**	**0.51**	0.59	1.24	1.08	0.62
		AWIBR	**4.86**	2.16	1.33	1.37	**4.63**	1.97	1.35	1.31	0.76	1.47	1.54	1.03
	μ=1	FOR	2.08	1.16	0.67	0.25	2.40	0.78	1.48	0.14	0.75	1.22	0.57	1.04
		MCIBR	2.21	**1.02**	**0.94**	**0.25**	3.49	**1.53**	**1.45**	**0.51**	0.77	1.23	0.59	1.09
		AWIBR	**3.73**	1.66	1.02	1.05	**4.72**	2.01	1.38	1.33	1.04	1.45	0.84	1.99
$\lambda = 1$	μ=0.1	FOR	2.27	1.23	0.76	0.28	3.94	1.50	2.06	0.38	0.65	1.1	1.21	1.78
		MCIBR	2.24	**1.07**	**0.89**	**0.28**	4.28	**2.05**	**1.96**	**0.27**	0.66	1.10	1.23	1.81
		AWIBR	**3.90**	1.73	1.07	1.10	**4.59**	1.95	1.34	1.30	0.87	1.25	1.70	2.62
	μ=1	FOR	1.83	1.02	0.62	0.19	2.59	0.91	1.51	0.17	0.79	1.15	0.6	2.29
		MCIBR	1.88	**0.88**	**0.82**	**0.18**	3.38	**1.55**	**1.49**	**0.34**	0.81	1.15	0.61	2.35
		AWIBR	**3.21**	1.43	0.88	0.90	**4.12**	1.75	1.20	1.16	1.10	1.32	0.86	3.68
$\lambda = 2$	μ=0.1	FOR	2.03	1.10	0.72	0.21	4.25	1.66	2.15	0.44	0.71	1.06	1.4	2.93
		MCIBR	1.98	**0.95**	**0.82**	**0.22**	4.39	**2.10**	**2.02**	**0.27**	0.72	1.06	1.42	2.98
		AWIBR	**3.55**	1.58	0.97	1.00	**4.77**	2.03	1.39	1.35	0.96	1.19	1.89	4.09
	μ=1	FOR	1.70	0.95	0.60	0.15	2.76	1.01	1.55	0.20	0.83	1.11	0.63	3.57
		MCIBR	1.73	**0.82**	**0.76**	**0.15**	3.38	**1.58**	**1.53**	**0.27**	0.85	1.12	0.64	3.64
		AWIBR	**2.97**	1.32	0.82	0.84	**3.96**	1.68	1.16	1.12	1.17	1.26	0.90	5.33

Note:
The optimal instrument rule depends on the complete set of the 15 state variables in the multi-country model, including inflation and the output gap in the various countries for different lags; the coefficients for both inflation and the output gap reported in the table are given by the sum of the coefficients for all lags and, in the case of area-wide variables, of the coefficients for all lags and countries. For the other two rules, the coefficients reported in bold are those directly resulting from the optimisation; the other coefficients are implicit; see Angelini *et al.* (2002) for details.

Table 4

OUT_OF SAMPLE STABILITY, 1997.Q1-2001.Q4

Equation		F-value	Tail probability
Germany	AS	0.89	60.12
	AD	0.67	84.46
France	AS	0.52	95.12
	AD	0.37	99.23
Italy	AS	0.76	75.38
	AD	0.68	83.59

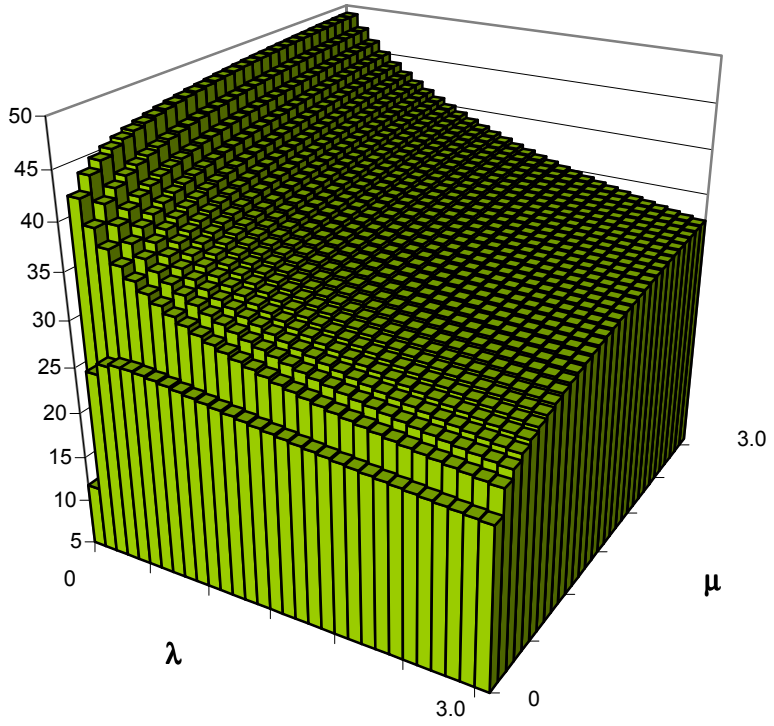
Table 5

PERCENTAGE REDUCTION IN OBJECTIVE FUNCTION, MCIBR vs. AWIBR, STRUCTURES VS. DISTURBANCE CONVERGENCE

		Structures	
		No convergence	Full convergence
Disturbances	No convergence	36.1	3.2
	Full convergence	7.1	0

Fig. 1

Percentage reduction in the optimised loss function, MCIB rule vs. AWIB rule



Percentage reduction in the optimised loss function, MCIB rule vs. AWIB rule
(as a share of overall reduction -- Optimal instrument rule vs. AWIB rules)

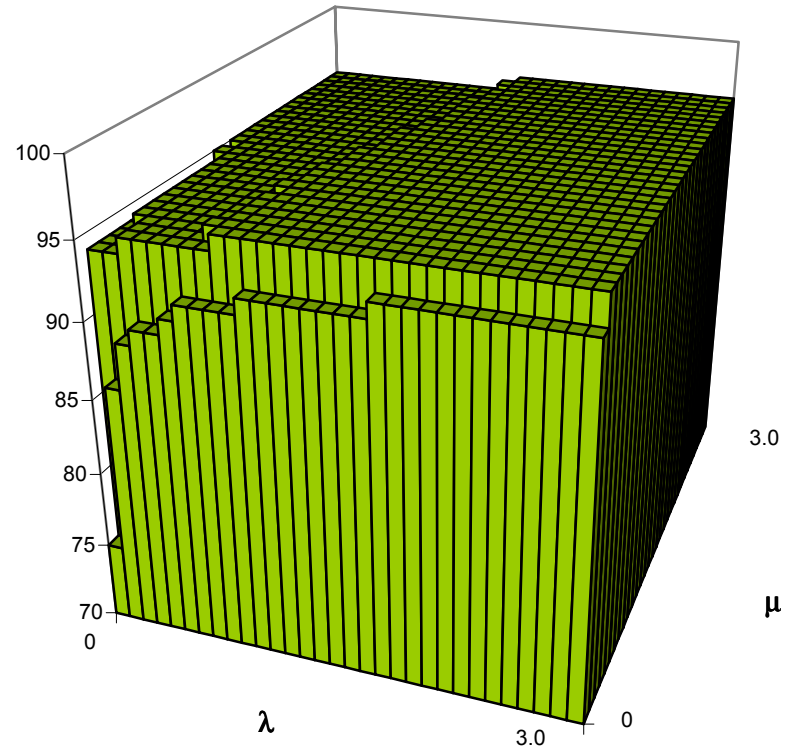
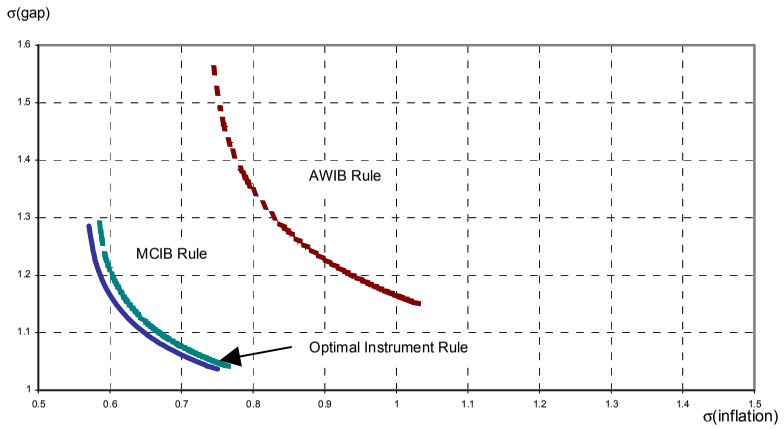


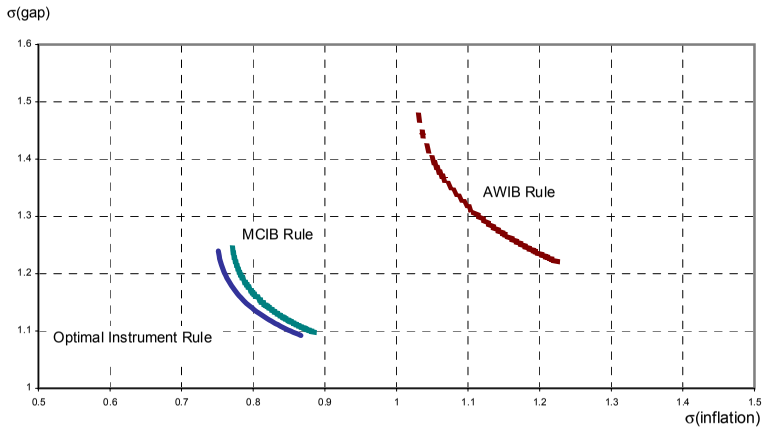
Fig. 2

Inflation - output gap optimal frontiers

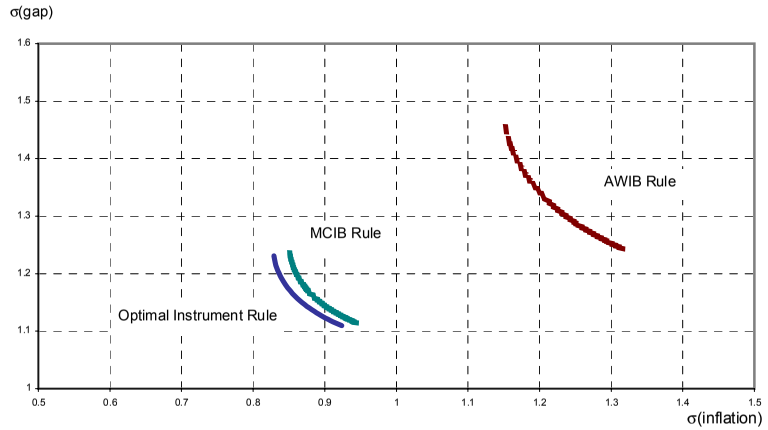
(a) μ=0.1



(b) μ=1



(c) μ=2



(d) μ=3

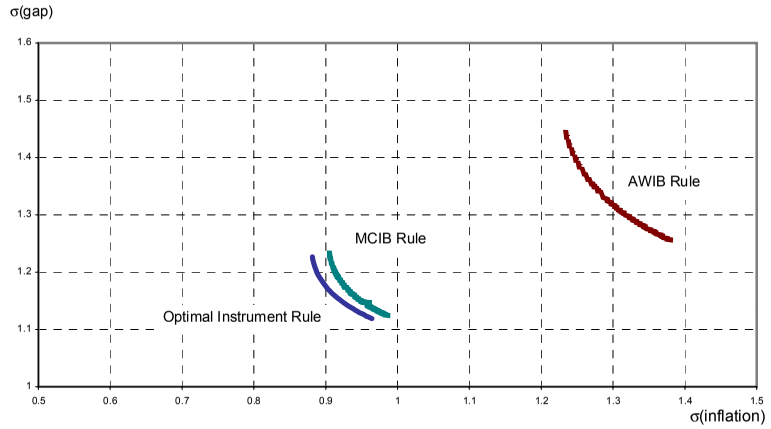


Fig. 3

Percentage of cases in which the MCIBR outperforms the AWIBR by at least 20 per cent
(1,000 drawings from distribution of residuals)

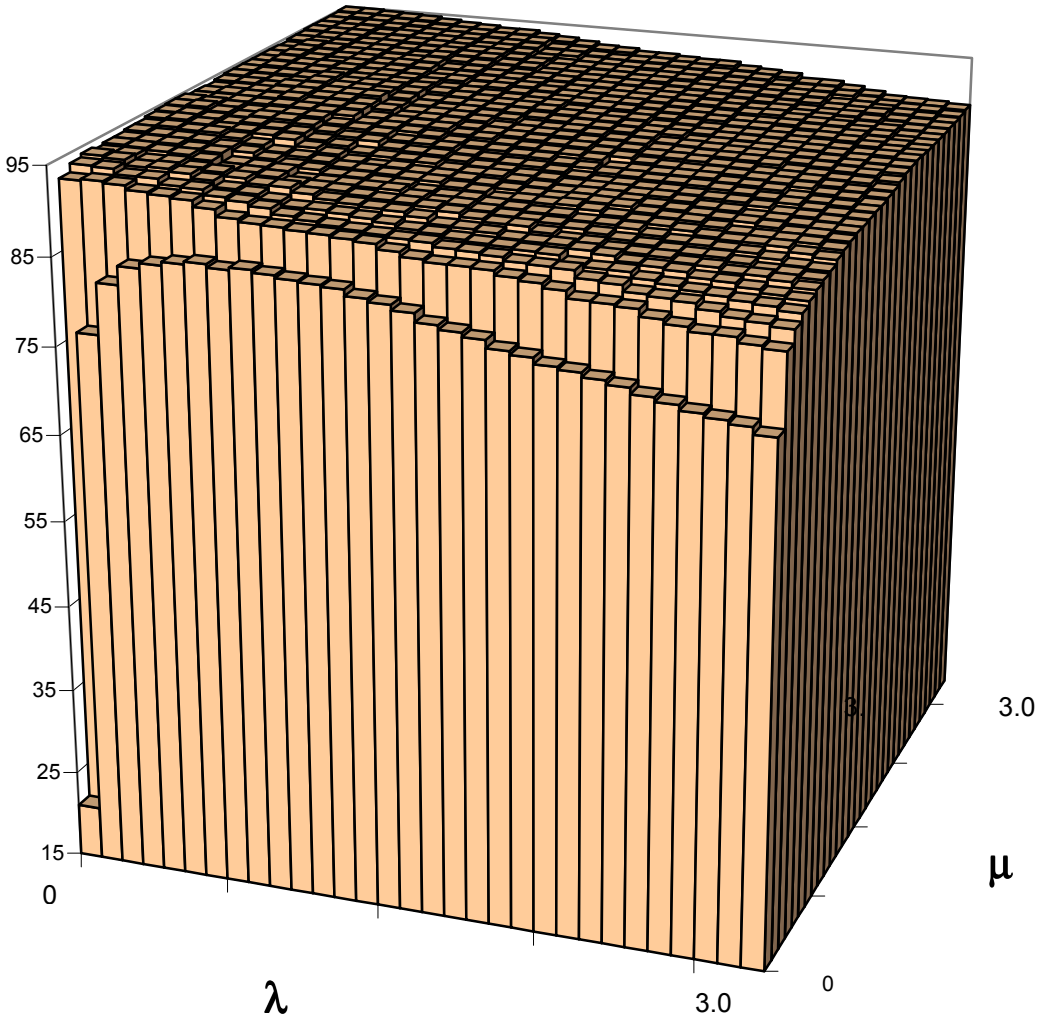
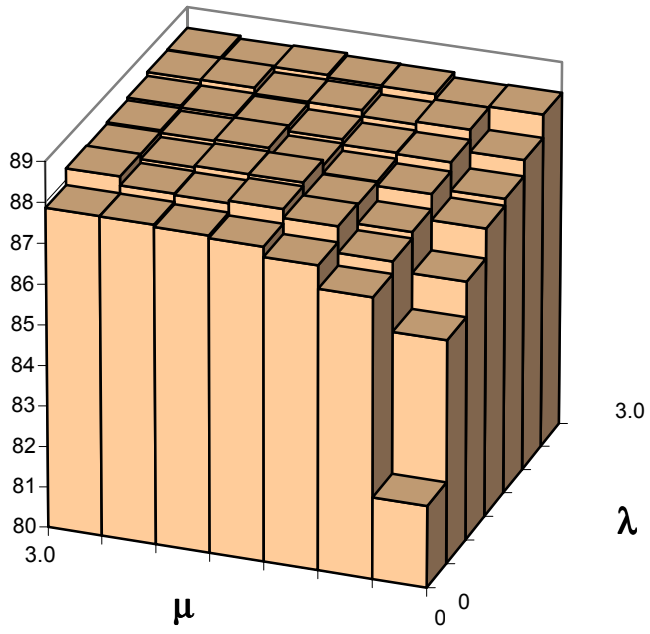


Fig. 4

Percentage of cases in which the MCIBR outperforms the AWIBR
(random drawings from distribution of estimated parameters)



Percentage of cases in which the MCIBR outperforms the AWIBR by at least 20 per cent
(random drawings from distribution of estimated parameters)

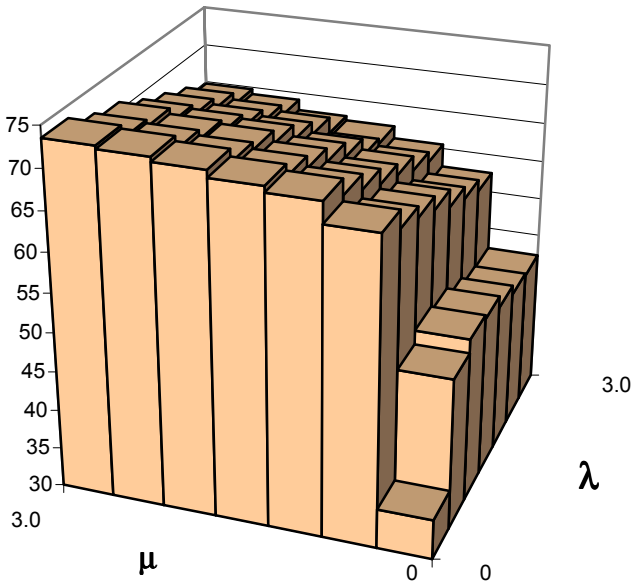
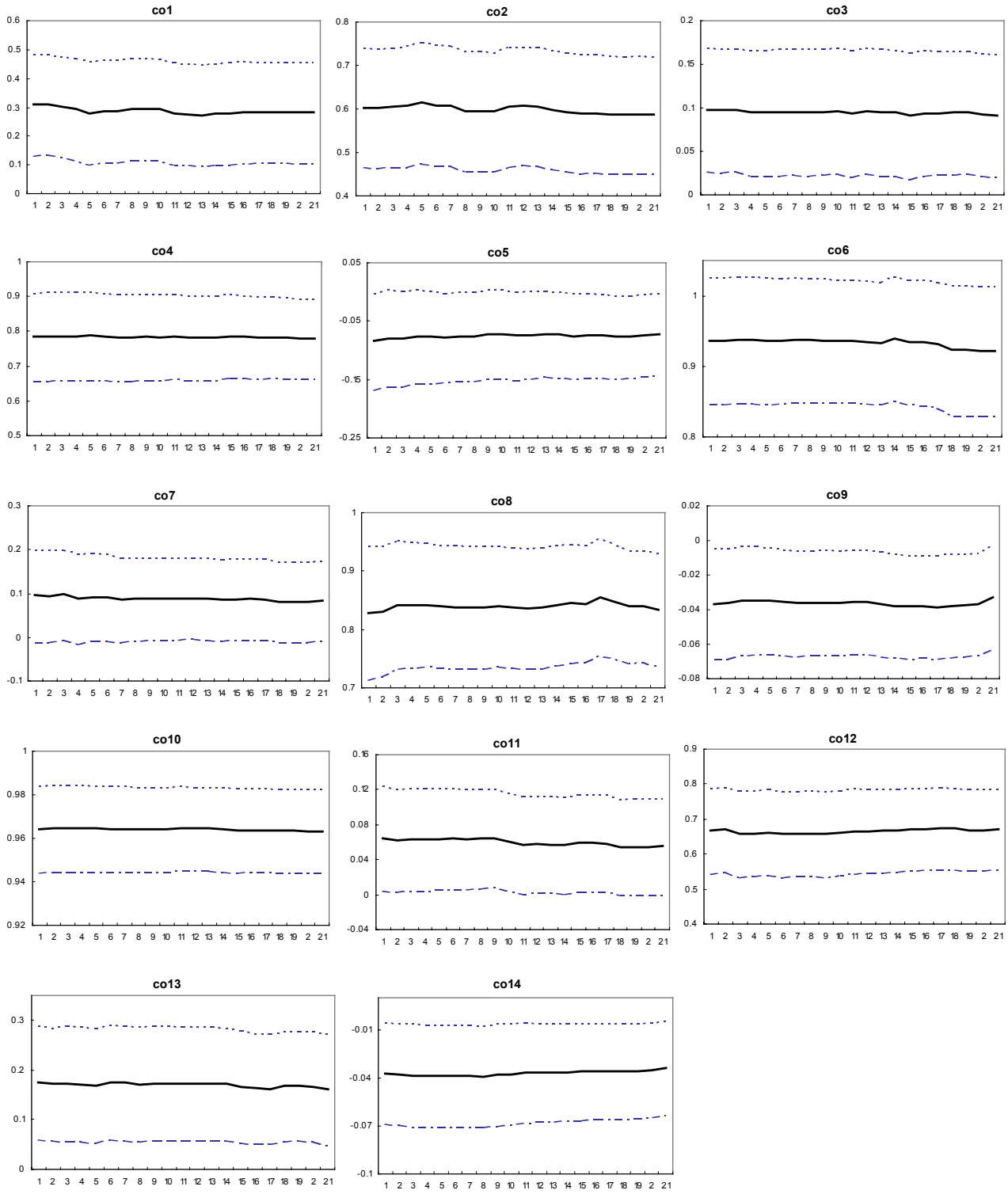


Fig. 5

RECURSIVE ESTIMATES OF MODEL COEFFICIENTS, 1996.Q4 – 2001.Q4



Legenda: co1: coeff. of German inflation (lag 1) in German AS curve; co2: coeff. of German inflation (lag 4) in German AS curve; co3: coeff. of German output gap (lag 1) in German AS curve; co4: coeff. of German output gap (lag 1) in German AD curve; co5: coeff. of real interest rate in German AD curve; co6: coeff. of French inflation (lag 1) in French AS curve; co7: coeff. of French output gap (average of lags 2-5) in French AS curve; co8: coeff. of French output gap (lag 1) in French AD curve; co9: coeff. of real interest rate in French AD curve; co10: coeff. of Italian inflation (lag 1) in Italian AS curve; co11: coeff. of Italian output gap (lag 1) in Italian AS curve; co12: coeff. of Italian output gap (lag 1) in Italian AD curve; co13: coeff. of German output gap in Italian AD curve; co14: coeff. of real interest rate in Italian AD curve

Fig. 6

Percentage reduction in the optimised loss function, MCIB rule vs. AWIB rule
Convergence in parameters of AS and AD equations

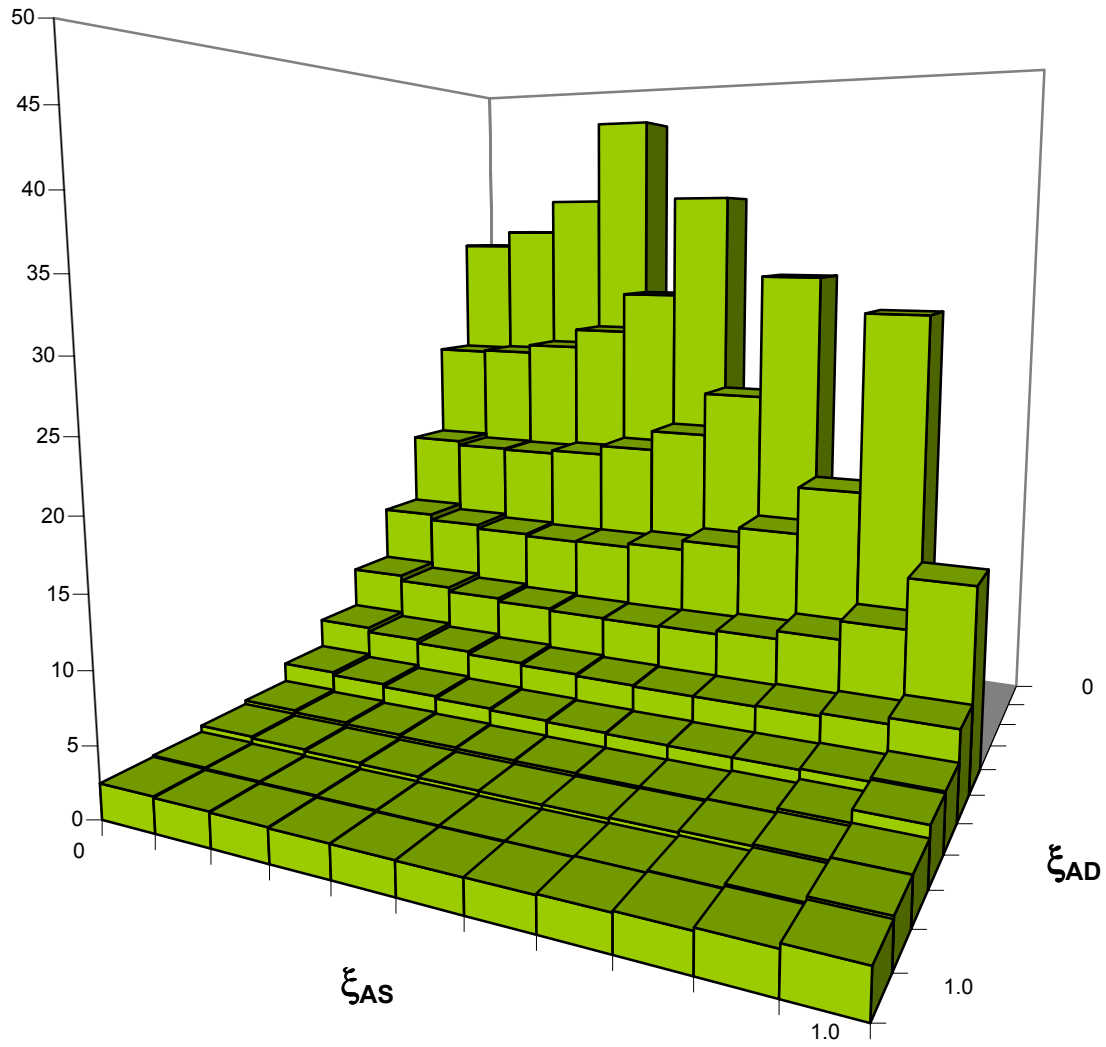


Fig. 7

Percentage reduction in the optimised loss function, MCIB rule vs. AWIB rule
Convergence in disturbances of AS and AD equations