Do Asymmetries Matter for European Monetary Policy?

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Abstract

In this paper we analyze the impact of economic and institutional (ECB decision rules) asymmetries on the effectiveness of monetary policy in Euroland. We consider a model where asymmetric shocks and divergent propagation of shocks in output and inflation are potential causes of tensions within the ECB concerning the conduct of common monetary (interest rate) policy. Welfare implications of the alternative decision procedures are discussed.

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1 Introduction

The European Central Bank (ECB) has the sole responsibility for the conduct of monetary policies in Euroland. The Maastricht Treaty provides some general principles about the objectives to be pursued by the ECB and has set the institutional framework within which the ECB will take its decisions. More precisely, the statutes of the ECB were enshrined in the Maastricht Treaty. The principles underlying these statutes are, first, that the primary objective of the ECB is the maintenance of price stability (art. 105), and, second, that in order to achieve this objective, the ECB should be politically independent (art. 107). The Treaty also formulates other objectives to be pursued by the ECB (e.g. high employment) but always adds the proviso that this should not interfere with the primary objective which is price stability.

The decision making body is the Governing Council (GC), which consists of the Governors (Presidents) of the National Banks of the euro-countries, and of the President, the Vice-President and the four Directors of the ECB. Each of the members have one vote. Although the statutes of the ECB mandate the members of the ECB-Council to represent the interests of Euroland as a whole, it is quite likely that there will be occasions when the national representatives will pursue national interests.[1]

One major question that arises in this context is the following. Will the national representatives in the ECB-Council take a union-wide perspective when deciding about monetary policies, or will they give a high weight to national economic conditions when taking these decisions? The question is important. For, if asymmetric shocks and/or adjustment speeds occur frequently in the future EMU, a nationalistic attitude of the ECB Council members, triggered by divergent economic conditions, may lead to frequent conflicts about the appropriate policies to be pursued. One can expect that, although each of the Governors will share similar preferences about inflation and output stabilization, these divergent economic conditions may lead them to take different positions on the desirable stance of monetary policies. When that happens, national viewpoints will loom large in the decision making process. As a result, the decision making process within the ECB will be made difficult.

At the end of the day, however, a common monetary policy must be implemented. The issue of divergent optimal (national) monetary policies thus leads to a need for decision procedures. These procedures will determine the way country-specific desires about monetary policies are aggregated into one common monetary policy. Obviously, the modalities of the decision procedure will matter in this aggregation problem and will also affect macro-economic performance and welfare of the individual countries.

This paper provides a first step in analyzing the effects of decision procedures in the GC on effectiveness of monetary policy and macro-economic stabilization.[2] The paper proceeds in two steps. First, in section 2 we assess empirically the magnitude of the divergence in 'national interests' that may arise and their effects on the desired monetary policy reactions. This we achieve by using the benchmark Rudebusch and Svensson (1999) model for optimal monetary policy in an intertemporal setting. Second, having established the asymmetries in desired optimal monetary policy reactions, we formulate some rules for the decision process

[1] For a more detailed description of the statutes of the ECB see Gros, et al.(1999). See also Begg, et al.(1998) and Gros, et al.(1999) for a discussion of the decentralised nature of the European System of Central Banks.

[2] Recent papers have analyzed similar issues issues relating to workings of the European Central Bank. See Bindseil(1996), Bottazzi and Manasse(1998), Brueckner(1997) and Von Hagen and Sueppel(1994). See also Dornbusch, Favero and Giavazzi(1998) who study problems of voting in the ECB.

within the GC (section 3). Four types of decision procedures will be analyzed: a consensus model, a purely nationalistic rule where all representatives only take into account their national interests, an intermediate case where the national representatives take a nationalistic perspective and the EMU-wide perspective prevails for the ECB representatives and an EMS-rule where German monetary preferences are applied. Effects of the decision procedures on macro-economic stabilization will be discussed in section 4. Finally, section 5 contains a summary of the main findings of the paper.

2 Optimal Policy Rules for Country Representatives

In this section we model central bank behavior, using the model presented in Rudebusch and Svensson (1999).[3] The central bank is assumed to have an explicit target for the goal variables such as an inflation target and output gap target. In order to reach these targets the central banks use the short run interest rate as an instrument. The implicit rule for the instrument (from now on policy rule) can then be derived from the first order condition of the explicit loss minimization. In general, this policy rule will depend on the current economic state of the country and the way the interest rate (over time) affecting the different explicit goal variables, i.e. inflation and output. The interest rate, as determined by the policy rule, will therefore be a function of (1) the preferences of the central bank over the different macro-economic variables, (2) the transmission of interest rates into these goal variables (3) the actual state and structure of the economy and finally (4) the stochastic shocks that alter the state of the economy. Each of these four components is likely to differ across countries such that optimal interest rate rules are likely to be country-specific and therefore a potential cause of tension within the ECB Governing Council[4].

2.1 State space representation

To make the model similar in structure to the one used by central banks we follow Rudebusch and Svensson (1999) in focusing on the following three features: (1) the policy instrument used by the central bank is the short-run interest rate (i), (2) the model is defined in terms

[3] We base our analysis on recent research concerning the use of monetary policy rules in a number of industrial countries (see Taylor (1993) and Clarida, Gali and Gertler (1998)). This research indicates that central banks in industrial countries generally target the rate of inflation and are also concerned about stabilizing the business cycle. The instrument used to perform these tasks is usually the short-term interest rate. This evidence has led Taylor (1993) to conclude that central banks (in particular the US Federal Reserve) raise the short term interest rate when inflation increases and when output grows relative to output capacity, and vice versa. Clarida, Gali and Gertler (1998)) conclude that central banks of the major industrial countries (US, Japan, Germany, England) behave in a similar way, although the weight they attach to inflation and output varies. It is interesting to note that the Bundesbank which is the most outspoken about price stability as the primary objective of monetary policy, in practice attaches considerable importance to output stabilization (see also Bernanke and Mihov (1997), Laubach and Posen (1997), Issing (1996), Neumann (1997), von Hagen (1995) and Peersman and Smets (1999) on this issue).

[4] There is a large literature analysing these asymmetries in Europe. Some, like Bayoumi and Eichengreen (1993) or Bayoumi and Prasad (1997) analyse the asymmetries of shocks. More recently, there has been an upsurge of econometric analysis studying the assymetries in the tranmission mechnanism, of symmetric shocks. See, for example, Dornbusch, Favero and Giavazzi (1998), Ramaswamy and Sloek (1998), Peersman and Smets (1999), Giovannetti and Marimon (1998). Note that other recent studies focus on the likely impact of the differences in asset markets on the monetary transmission mechanism (see Maclennan, Muellbauer and Stephens, 1998) or stress the role of the financial and legal structures as a potential explanation of such asymmetries (see Cecchetti, 1999).

of the output gap and (3) a standard autoregressive Phillips-curve is used. Note that the autoregressive Phillips curve is backward looking instead of the (theoretically) more appealing, forward looking, version. Empirical evidence, however, suggests that the former may, from an empirical point of view, be superior to the latter. For instance, Fuhrer (1997) finds that the backward looking version is much closer to the empirically observed inflation dynamics than the (purely) forward looking version. Recent research by Gali and Gertler (1999) shows that the use of the output gap can be a problem in forward looking specifications of the Phillips curve. Gali and Gertler find that the output gap leads the rate of inflation, a finding which is inconsistent with a forward looking Phillips curve. An additional reason why we did not use a forward looking Phillips curve is tractability. Although theoretical models for forward looking Phillips-curve models (see Svensson (1999, 2000)) and practically feasible estimation techniques exist (see for instance Clarida et al. (1998)) for one country models, we face the situation where monetary policy is the outcome of possibly intricate decision procedures in the GC, involving seventeen agents. Implementation of the forward-looking Phillips-curve would imply explicitly (analytically) solving the decision procedure(s) and their effects on future inflation in each of the countries. Solving such a model for eleven countries is currently infeasible, forcing us to use the backward looking version for which expectations are easily identified.

More formally, we assume that inflation (π) is determined by the output gap ($-y$) with a one period lag and past inflation rates:

$$\pi_{t+1} = \sum_{j=1}^{n} \alpha_{\pi,j} \pi_{t+1-j} + \alpha_y y_t + \varepsilon_{t+1}. \tag{1}$$

We decompose output into a permanent and a transitory component and interpret the permanent component of output as the output capacity of an economy. The transitory component y therefore measures the temporary over- or underutilisation of the output capacity. We adapt the standard Rudebusch and Svensson (1999) model to the European situation by explicitly modelling the trade-interactions among countries. More specifically, the output gap is assumed to depend on previous output gaps, a year lagged trade weighted output gaps of the other countries in the EMU $\left(y^*_{t-12}\right)$ and the average real interest rate over the past 12 periods. More formally:

$$y_{t+1} = \sum_{j=1}^{m} \beta_{y,j} y_{t+1-j} + \beta^*_y y^*_{t-12} - \beta_r \left(\bar{i}_t - \bar{\pi}_t\right) + \eta_{t+1}, \tag{2}$$

where $\bar{i}_t$ and $\bar{\pi}_t$ denote a twelve month (moving) arithmetic average of current and past interest and inflation rates

$$\bar{i}_t = 1/\left(12\right) \sum_{i=0}^{11} i_{t-i} \quad \text{and} \quad \bar{\pi}_t = 1/12 \sum_{i=0}^{11} \pi_{t-i} \tag{3}$$

and y^*_t denotes the bilateral trade weighted output gaps of the other EMU-members; This trade weighted output gap for country i is calculated as follows:

$$y^*_t = \sum_{j=1,j\neq i}^{11} w_{i,j}\, y_{j,t} \text{ with } w_{i,j} = \frac{X^i_j}{\sum_{k=1,k\neq i}^{11} X^i_k} \text{ and } X^i_j \text{ export volume from country } i \text{ to } j. \tag{4}$$

Note that equations (1) and (2) imply a particular transmission mechanism in response to changes in the policy instrument. More specifically, a change in the interest rate first affects the output gap and subsequently, with a one period lag, affects the inflation rate indirectly (through the effects of interest rate changes on the output gap). Evidently, the transmission of interest rate changes to output and inflation will be determined by the parameter values $\alpha_{\pi,l}$ and $\beta_{y,j}$ with $l = 1, ..., n$ and $j = 1, ..., m$..[5]

The state of the economy and its dynamics can be summarized by the state space representation of equations (1) and (2). Denoting the state of the economy by X_t, an $(n + m + 2 + 11) \times 1$ vector, stacking consecutively π_t till π_{t-n}, y_t till y_{t-m}, y^*_{t-11} till y^*_{t-12} and i_{t-1} till i_{t-11}, its dynamics can be reformulated as (for a more detailed definition of A and B see appendix A) :

$$X_{t+1} = AX_t + Bi_t + \upsilon_{t+1} \tag{5}$$

Note that the above state space representation is not 'closed'. That is the dynamics of this state space representation depend on the dynamics of the interest rate level, which has not (yet) been modeled explicitly. To close the model we introduce in the next section the interest rate dynamics by deriving the optimal Taylor-rule for interest rates.

2.2 Optimal linear feedback rule

The central bank has as objective to minimize its intertemporal loss function which is defined in terms of the time t expected difference between (yearly) inflation, the output gap $(-y)$ and their targeted values, c_1 and c_2, respectively.[6] Moreover, some degree of interest smoothing is assumed for the central bank. Formally, we assume the following minimization problem:

$$\min_{i_t} \sum_{j=0}^{+\infty} \delta^j E_t \left[(\bar{\pi}_{t+j} - c_1)^2 + \lambda y^2_{t+j} + \nu \left(i_{t+j} - i_{t+j-1} \right)^2 \right]. \tag{6}$$

If the frequency of meetings in the ECB is sufficiently high (say, monthly) such that the discount rate $\delta \to 1$, it can be shown that the above minimization problem can be restated in terms of an unconditional loss function (see Rudebusch and Svensson, 1998):

$$\min_{i_t} E\left[L_t\right] = Var\left[(\bar{\pi}_t - c_1)\right] + \lambda Var\left[y_t\right] + \nu Var\left[\Delta i_t\right]. \tag{7}$$

Again, following Rudebusch and Svensson (1999) we write the target variables, $\bar{\pi}_t$, y_t and $i_t - i_{t-1}$ in function of the state variable X_t (a detailed definition of the matrices C_X and C_i can be found in appendix A):

[5] In order to satisfy the natural rate hypothesis a restriction of the α coefficients of the form

$$\sum_{j=1}^{n} \alpha_{\pi,j} = 1$$

should be imposed. In the empirical section we use the unrestricted coefficient estimates for which the summed coefficients are in most cases reasonably close to and insignificantly different from 1. A formal test for long run neutrality is presented in table 1 in the appendix.

[6] As y_t is being defined as the output gap one can conveniently set c_2 to zero.

$$Y_t = \begin{bmatrix} \bar{\pi}_t \\ y_t \\ i_t - i_{t-1} \end{bmatrix} = C_X X_t + C_i i. \tag{8}$$

The loss function can now be rewritten as[7]:

$$L_t = E\left[Y_t' K Y_t\right], \text{where } K = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \lambda & 0 \\ 0 & 0 & \nu \end{bmatrix}. \tag{9}$$

Given the empirical evidence that central banks base their interest rate policy on current (and previous) values of output and inflation we consider the class of linear feedback rules, that is linear rules based on the current economic states:

$$i_t = f X_t \tag{10}$$

where f denotes a $1 \times (n + m + 2 + 11)$ vector. Using the above relations and substituting the linear feedback rule we obtain the dynamics of the state variable, taking into account the actions of the central bank (on interest rates), as:

$$X_{t+1} = M X_t + v_{t+1},\ M = A + Bf \tag{11}$$

and for the goal variables:

$$Y_t = C X_t,\ C = C_X + C_i f. \tag{12}$$

Note that according to equation (10) the central bank can alter the dynamics of the economic state by conditioning its interest rate policy on the current state of the economy. The optimal linear feedback rule is then defined as that interest rate rule that generates a state-space dynamics that minimizes the loss function (8). Under the assumptions made so far, Rudebusch and Svensson (1999) show that the optimal (linear) policy rule is given by:

$$i_t \equiv f\, X_t = -\left(R + B' V B\right)^{-1} \left(U' + B' V A\right) X_t \tag{13}$$

where the matrix V is defined by:

$$\begin{aligned} V &= Q + Uf + f'U' + f'Rf + M'VM \qquad (14) \\ Q &= C_X' K C_X,\ U = C_X' K C_i \text{ and } R = C_i' K C_i. \end{aligned}$$

Inspection of the optimal linear feedback rule f shows that the desired interest rate levels can diverge across countries for two reasons: either in the feedback coefficients f or economic conditions X_t. First, the economic conditions, as summarized by the state variable, X, can differ and hence require different policy actions. Second, reaction coefficients (the vector f) can differ across countries basically for three reasons. First, the preferences of the central banks can differ (the K matrix). Second, the sensitivity of output to interest rate changes

[7] Note that in what follows we have implicitly deducted the mean from each of the target variables. In the empirical section we deal with this issue by doing the econometric analysis on the demeaned series.

(the B vector) can differ across countries. And finally, countries can differ in the dynamic adjustment paths of the economy to shocks (the A matrix). So, if individual member-states try to pursue their own optimal economic policies within EMU, (country-specific) differences in economic state, transmission mechanisms and preferences over the three goal variables are a potential source of conflict in the conduct of the European monetary policy.

2.3 Empirical results

In this section we empirically investigate the optimal feedback rules for each of the eleven EMU countries. First, we estimate the macro-model consisting of equations (1) and (2). We use the Akaike Information Criterion in order to determine the lag structures for the aggregate demand supply equations[8]. Subsequently we use the obtained estimates together with some assumptions about the preferences of the central bank (i.e. the matrix K) to compute the optimal feedback coefficients (contained in the vector f).

The sample consists of monthly observations for inflation and industrial production for the period 1979:1 till 1994:09.[9] Interest rates are monthly money market and call money rates (with the exceptions of STF rate for Ireland, average lending rate for Finland and lending rate for Portugal) as reported by the IFS statistics.[10]Monthly inflation series are constructed by taking first differences of (log) CPI data and the output gap was constructed by properly detrending the industrial production series.[11]For reasons of brevity we do not present the estimation results for all countries considered.[12] Table 1 summarizes some of the important features of the estimation results.

Insert Table 1

For our purpose, the presence of asymmetric propagation of shocks is of great importance. Therefore. we estimated the effects of interest rate changes on output and inflation for each of the countries. More specifically, we estimated the reaction of output and inflation to a temporary (twenty-four months) increase of the interest rate by one percent. The results of these estimates can be obtained from the authors. In line with the existing empirical literature we find that both output and inflation decrease as a consequence of the increase in interest rate. Moreover, we find for all countries that the initial output response is larger than that of inflation. Also, the size of responses as well as the propagation of the increase in the interest rate differ considerably across countries.[13] Our results are broadly consistent with those of Ramaswamy and Sloek (1998). In line with their findings, we observe stronger impacts of

[8]Selected lag structures are presented in Table 1.

[9]Lack of data on industrial production for several countries, in particular for Portugal, prevented us from extending the sample to the current time.

[10]We asssume also that Belgian interest rate applies in Luxembourg.

[11]More specifically we used a multiplicative HP filter with a value for λ of 500 000. This amounted to a linear detrending exercise for most countries involved. Only for Ireland we found evidence of a nonlinear trend. The output gap was then constructed by taking the logaritmic transform of the transitory part of the multiplicative HP filter. The resulting series captures very well the business cycle frequency.

[12]Regression diagnostics were reasonable for all estimated equations. No significant signs of remaining autocorrelations were reported. The R^2 for the output equation were relatively high explaining on average about 60% of variation. The R^2 for the inflation regressions were somewhat lower with an average around 40%. See Table 1. Estimation results and eigenvalues for the A matrix are available upon request.

[13]For some countries, notably Belgium and Ireland, we observe the so-called price puzzle (see Fuhrer (1997) and Christiano, Eichenbaum and Evans (1996)). That is, the price response to an increase in the interest rate is perverse, i.e. the price level increases (slightly) in response to an interest rate shock.

changes in monetary policies for some countries such as Belgium, Finland and Germany, than in countries such as France and Spain. However, our results do not suggest a clear division of Euroland in two distinct groups of countries. Despite these differences, Ramaswamy and Sloek's main conclusion of significant differences of the direct impact and the transmission of shocks across countries is corroborated.

In order to construct the optimal feedback rules we need to specify the preferences of the central bank explicitly. We consider five preference configurations $diagK$: (1, 1, .5), (1, .2, .5), (1, 5, .5), (1, 1, 1) and (1, 1, 5).The first preference configuration will serve as our benchmark. Configurations two and three vary the output stabilization concern of the central bank to relatively low and high values respectively. The final two configurations increase the concern of the central bank for interest rate smoothing and financial stability.

Insert Figure 1

Some observations are worth stating regarding the optimal feeback rule coefficients. First, in figure 1 we plot the estimated optimal feedback rules ($f-$vector defined in (12)) for inflation and output for each individual country separately assuming the benchmark preference configuration (1, 1, .5). We find that the initial feedback coefficient of output is considerably higher than the one of inflation, i.e. three to eight times higher depending on the country considered. This is clearly at odds with the standard Taylor rule, prescribing equal feedback coefficients of output and inflation. This finding is, however, qualitatively in line with the findings of Peersman and Smets (1999), who find a factor of three for quarterly data.[14] The sums of the optimal feedback coefficients are presented in table 1. These suggest that the total feedback coefficient of inflation is systematically higher than the total feedback coefficient of output. Second, and in line with the intuition, the output coefficients in the feedback rules tend to increase with the weight on output stabilization (λ). Finally, as can be inferred from table 1, the implementation of the optimal feedback rule by central banks does not lead to hysteresis effects. That is, the state-space representation remains stable after implementation of the optimal feedback rule. This can be inferred from the largest eigenvalue of the matrix M, which determines the dynamics of the state space under the linear feedback rule. As can be seen all maximal eigenvalues are below one.[15]

3 Institutional Framework: ECB Decision Rules

The monetary policy decisions are taken by the GC of the ECB which consists of seventeen representatives. Six members represent the ECB board and are likely to take a euro-wide view. The other eleven members are the governors of the national banks and are appointed by each of the individual member states. There is up till now no clear prescription about the procedures to be followed in the decision process. These procedures are at the discretion of the Council itself. As a result, one can argue that the ECB has instrument independence and although the Maastricht Treaty sets the price stability as the primary objective there is room

[14]Estimating the optimal feedback rule for Germany on quarterly data we obtained coefficients close to the ones of Peersman and Smets, corroborating the relatively large weight on output.

[15]Note that the entries in table 1 are only representative for the preference parameters 1, $\lambda = 1$ and $\nu = .5$. We also tested the stability for the other preference parameters. None of the cases considered yielded eigenvalues larger than 1. In other words for all preference parameters considered, inflation, output and interest rates react only temporarily to demand and supply shocks.

for target independence. In other words, the ECB sets itself goals for inflation and possibly output stabilization, designs its own strategy to meet these goals and moreover is the only one responsible for the design of the voting procedures in the GC as well.

To evaluate the effects of the decision procedures on the conduct of monetary policy we distinguish four procedures. The first one is denoted a nationalistic rule. In this case all the seventeen members of the Council determine the optimal interest rate rule based on the loss function of the country he represents. Thus the optimal interest rate rule d for the representative of country j at time t can be written as:

$$d_{j,t} = i_{j,t} = -\left(R_j + B_j' V_j B_j\right)^{-1} \left(U_j' + B_j' V_j A_j\right) X_{j,t}, \ \ j = 1, ..., 11. \tag{15}$$

The second rule is labelled the consensus rule. In this rule each representative takes a Euro-wide perspective, i.e. s/he takes into account the macro-economic situation of the whole union. We model this by assuming that such a representative would form the desired interest rate (rule) as a weighted average of the desired interest rates of the individual countries:

$$d_{EMU,t} = \sum_{j=1}^{11} w_j d_{j,t}. \tag{16}$$

The weights, w_j $j = 1, ..11$, represent the weight assigned to the country in the general loss function.[16] Equation (16) can be interpreted as a short cut to an Euro-wide optimal policy rule. As Gerlach and Schnabel (1998) show, the weighted average of Euro interest rates can be replicated well by a simple Taylor-rule on Euro aggregates of inflation and output. Therefore, we can interpret equation (16) as an approximation of an optimal linear interest rate rule for euroland as a whole.

The third rule is called the ECB-rule. This is a combination of the previous two rules. More precisely, when this rule applies, we assume that the members of the ECB Board take a Euro-wide perspective, i.e. they apply equation (16), while the eleven national governors take a nationalistic perspective, i.e. they apply equation (15).

In all the three preceding rules we assume that the decision is taken by majority voting. Since the conditions of the median voter theorem apply, we select the desired interest rate of the representative located in the middle of the distribution of the desired interest rates. It is clear that other voting rules could be analyzed. In particular, the Governing Council may want to avoid applying majority voting so as to base its decisions on a broader consensual basis. We leave the study of this alternative to further research.[17]

Finally, in order to compare our results with a benchmark for the pre-EMU period, we have a fourth rule that we call the EMS-rule. Here, we assume that the desired interest rate of Germany holds as a Euro-wide interest rate.

Before discussing the results, it is useful to point out that the short-cut to a Euro- wide optimal policy rule represented by equation (16) can be given another interesting interpretation. One can write the following:

[16] See Brueckner (1997) for a theoretical analysis on this issue. In the simulations we take the capital share (renormalized as to add up to 1) of every central bank in the ECB as the weight for the country. These weights are assumed to be a function of the countries population and GDP as a fraction of the aggregate EMU population and GDP. The weights are for Austria 0.0299, Belgium 0.0366, Finland 0.0177, France 0.2138, Germany 0.3093, Ireland 0.0106, Italy 0.1896, Luxemburg 0.0019, The Netherlands 0.0542, Portugal 0.0244 and Spain 0.1119.

[17] Issues related to the effects of the constitution of the ECB on macro-economic performance can also be found in Von Hagen (1995, 1998) and Von Hagen and Sueppel (1994).

$$d_{EMU,t} = \sum_{j=1}^{11} w_j d_{j,t} = f_t^E X_t^E,$$

where X^E denotes the appropriately weighted average of the economic states of the different member countries and thus represents the EMU-wide economic state:

$$X_t^E = \sum_{j=1}^{11} w_j X_t^j \ ,$$

and f_t^E denotes the EMU-wide (time varying) linear feedback rule. The k-th element in the feedback rule, $f_{t,k}^E$, is defined as:

$$f_{t,\,k}^E = \frac{\sum_{j=1}^{11} w_j X_{t,\,k}^j \ f_k^j}{\sum_{j=1}^{11} w_j X_{t,\,k}^j} \quad \text{for all } k.$$

In this interpretation the EMU-wide representatives take European aggregated economic conditions, i.e. X_t^E, as the basis for the linear feedback rule. However, in their response to this economic state they aggregate the optimal responses of the individual countries, f^j, using a weighted average which not only takes into account the size of the country, w_j, but also the particular economic conditions of that country, X_t^j. Economic responses are thus weighted using the severity of the economic situation in the country multiplied by the size of the country. Obviously, these weights will vary through time with the variation in the economic conditions.

4 Simulation results

So far, we have modelled the country-specific desired interest rates and the decision procedures. In this section we look into the macro-economic effects of the different voting procedures on the different countries. We analyze the four decision rules listed above: the consensus rule, the ECB rule, the nationalistic rule and the EMS rule.

Some remarks with respect to the simulations are in order. The adjustment paths of inflation and output and the (correlation) structure of the shocks across the union are assumed not to be affected by the creation of EMU. In order to account for the comovements across the member states we use the residuals v_t of the state-space representation (5) for each country. Let S denote the variance-covariance matrix. A particularly useful decomposition of the matrix S is the Cholesky decomposition $S = LL'$,where L is a lower triangular matrix. In the simulations we construct shocks with the same covariance structure as observed in the past. Formally, this covariance structure can be recovered by constructing a vector of shocks $u_t = [u_{1,t}, ..., u_{11,t}]' = L\xi_t$, where ξ is standard normal, $N(0, I)$.

This procedure, of course, leaves us open to the Lucas critique: the new monetary regime is likely to affect the nature of the shocks and the transmission process. There is, however, very little one can do about this, except to wait for years before applying scientific analysis. In addition, we know very little about the question of how EMU will affect asymmetries. It is not even clear whether these will increase or decline. Finally, one can argue, following Peersman and Smets (1999), that the establishment of the ECB is not a totally new environment since a relatively long period of monetary convergence has preceded it.

4.1 Interest rate behavior

In this section we ask the question of how the interest rates desired by each country (i.e. those arising from the optimal interest rate rule) compare with the interest rate decided jointly in the GC for each of the rules considered. Large differences between these desired and decided interest rates are then a clear indication of potential conflicts.

We start by analyzing the correlation pattern between desired and decided interest rates. Table 2 presents the correlation of desired interest rates across countries, Table 3 summarizes the root mean squared error between desired and decided interest rates under alternative rules, and Table 4 contains the statistics about the median voter position.

Insert table 2, 3 and 4.

Some results stand out. First, in the ECB-rule case, i.e. the situation where only the ECB-board members take an EMU-wide perspective, the proposal of the ECB-board will be accepted almost always. This can be deduced from the correlation coefficients between the interest rate desired by the ECB-Board and the decided interest rate, which are higher than 99%. It can also be seen from table 4 which shows the number of times the ECB-board's desired interest rate coincides with the median voter's desired interest rate. We find that this is higher than 94% of the time. This dominating position of the ECB-board in the decision making process follows from the fact that the averaging procedure used by the ECB-board puts the latter almost always right in the middle of the distribution of desired interest rates. Put differently, the ECB-board members who in this decision rule have the same desires and vote the same way, are almost always the median voter. As a result, in a majority voting system, the ECB-board almost always carries the day. So, unless desired interest rates are extremely skewed, the ECB-board's desires as a rule prevail. A corollary to this result is that it makes little difference whether the national representatives take an EMU-wide perspective or a nationalistic perspective. In both cases, the decision is the same, dictated as it is by the ECB-board's desires. It also follows that the consensus-rule and the ECB-rule give (almost always) the same result.

Second, there appears to be a difference in the correlation coefficients of large and small countries (see table 2). In general the correlation coefficients of large countries are significantly higher than those of small countries. (The only exceptions to this rule are Netherlands as a relatively small country and Italy as a relatively large country). The interpretation is as follows. Large countries have a high weight in the averaging procedure followed by the ECB-board. As a result, the euro-average of the desired interest rates will generally be closer to the desired interest rates of the large countries. Some small countries (e.g. the Netherlands) may profit from this effect if their output and inflation shocks correlate well with one (or more) large countries. This result leads to the conclusion that, generally speaking, small countries will experience more frustrations about the interest rate decisions taken in Frankfurt than the large countries.

Third, the correlation coefficients decline when the output stabilization weight, λ, increases. Thus, the more countries wish to stabilize output, the smaller are the correlation coefficients. This result can be given the following interpretation. When national authorities increase their ambition to stabilize output, their desired interest rate will react more to asymmetric shocks. There will, therefore, be a greater spread in the nationally desired interest rates, so that these will correlate less well with the one decided in Frankfurt (the median voter's desired interest rate). Put differently, when national authorities increase their ambitions to stabilize output, they will be more frustrated about decisions taken in Frankfurt. We also find that this degree of frustration (measured by low correlation coefficients) increases most for the small countries. Also, and not surprisingly, as the weight on interest rate stabilization increases, correlations between desired and decided interest rates increase substantially for most countries.

Finally, a relatively clear core-periphery dichotomy appears when one considers the deviation of the decided from the desired interest rate as measured by the RMSE (see table 3). With the exception of Spain, the core countries of EMU tend to have the smaller deviations from the decided interest rates, while the others tend to have substantially larger average deviations between their desired interest rate and the decided (EMU-wide) rate. Note also that table 3 confirms that large core countries' desires tend to be better served than those of the smaller peripheral countries.

4.2 Welfare Analysis

The ultimate objective of the monetary authorities is to minimize the loss functions as specified in equation (6). In this section we analyze how well the monetary authorities do this in the different decision rules. We, therefore, substituted the simulated output, inflation and interest rates into the loss functions and computed the average losses for each country, together with the contribution of each of the three variables in these losses. As before, we consider five cases concerning stabilization preferences: the standard case ($\lambda = 1$, $\upsilon = .5$), the low output stabilization case ($\lambda = 0.2, \upsilon = .5$), the high output stabilization case ($\lambda = 5, \upsilon = .5$) and two cases of increasing interest rate stabilization ($\lambda = 1, \upsilon = 1$) and ($\lambda = 1, \upsilon = 5$).

We add a benchmark to measure the losses. In this benchmark, each country is able to implement its own desired interest rate. This implies, of course, that each country maintains its monetary independence, i.e. that it does not take part in EMU. This is, of course, a very unrealistic benchmark since few countries have the capacity to enjoy full monetary independence, as defined here. We use this as a yardstick to give some perspective to the welfare analysis. In addition, we compare the losses generated under EMU with those obtained in the EMS. This comparison provides for a better evaluation of the welfare losses under EMU than the comparison of EMU with complete monetary independence.

Insert tables 5 and 6

In table 5 we show the results of the standard case (the cases of low and high stabilization parameter configurations are available upon request)[18] and in Table 6 we present results for relative losses across alternative decision rules . A first result to note is that the losses are higher in a monetary union compared to the benchmark of absence of monetary union. The differences, however, tend to be limited especially when the stabilization parameter λ is not

[18] Note that we do no longer present the case of the consensus rule separately. Given the discusssion in the previous section, it is obvious that all relevant values will almost exactly coincide with those reported under the heading ECB-rule. Results for the consensus rule are available upon request.

too high (the low and standard cases). With a high output stabilization parameter, these differences in the losses also become higher. This has to do with the fact that with a high stabilization preference individual countries' optimal interest rates are very much influenced by asymmetric output shocks. In a monetary union they find it more difficult to pursue their stabilization desires. As a result, losses increase.

A second result relates to the comparison between the ECB-rule and the nationalistic rule. The ECB-rule is welfare improving compared to the nationalistic rule. In general we find cases in which an ECB-rule leads to lower losses than the nationalistic rule, i.e. is a better rule to minimize the variability of output, inflation and the interest rate. There are, however, also cases where the opposite holds as for example Finland. This in a sense is not really surprising. The difference between the ECB-rule and the nationalistic rule boils down to a difference in the way in which information is processed. In the nationalistic rule each decision maker uses his own national information about output and inflation, and then votes. Majority rule then determines the outcome. In the ECB-rule some participants (the ECB-board) aggregate the national data on output and inflation, while others (the governors) use the "raw" national data. They then vote using the same majority rule. It is not a-priori obvious which of the two methods of aggregating national information is the most efficient, i.e. minimizes the losses of the individual countries. Put differently, the difference between the ECB-rule and the nationalistic rule boils down to a difference in the way national preferences are aggregated. These different aggregation procedures affect the effective voting power of the participants. Both rules stabilize output and inflation in approximately the same way. The nationalistic rule, however, generates in general a higher interest rate volatility. As a result, the losses generated under the nationalistic rule are systematically higher than those obtained under the ECB-rule.

A third result relates to the welfare implications of a switch from the EMS regime to EMU as presented in Table 6. Not surprisingly, the results show that, except for Austria, Finland and Germany, irrespective of their preferences all countries are better off moving from the EMS to EMU.[19] An interest rate dictated by the preferences of the German economic policymakers frustrates the other member states in their desire to stabilize output, inflation and interest rate. This result, however, only holds as long as the ECB-rule applies. Under the nationalistic rule, the superiority of EMU over EMS clearly depends on stabilization preferences.

Insert figure 2

Finally in figure 2, we further analyze how the move from the nationalistic rule to the ECB-rule affects welfare of different countries. The two decision rules differ in the effective voting power they confer to individual countries.[20] Therefore, on the vertical axis we set out the ratio of the voting power of a country under the ECB rule and the voting power

[19] Note that although the generated country specific 'Cholesky filtered' shocks for output and inflation are identical across scenarios, the relative losses of Germany in the case of the benchmark and EMS rule do not exactly match. This is just because in the simulations we do take into account the 'foreign' business cycle developments after interest rate changes in the two alternative scenarios. Whereas in the benchmark rule all countries can choose for their desired interest rate, in the EMS rule German desired interest rate applies which affects the business cycles in other countries that in turn affects the German business cycle through equation (2).

[20] We assume that the voting power under the ECB-scenario is given by the capital shares of the countries in the ECB, i.e. the weights used in the aggregation procedure in equation (15).

under the nationalistic rule. On the horizontal axis we set out the ratio of the losses under the ECB rule and under the nationalistic rule. We observe a negative relation, i.e. countries that gain (loose) voting power when moving from nationalism to ECB-rule in general improve (decrease) their welfare. We thus find that voting procedures clearly matter for welfare of the EMU-members.

5 Conclusions

In this paper we analyzed how different decision procedures in the Governing Council of the ECB affect economic conditions and welfare in the different member states, when shocks and transmission processes are asymmetric. In order to do so, we derived the optimal interest rates for each member state based on the optimal linear feedback rules as proposed by Rudebusch and Svensson (1999). We then applied majority rule assuming different procedures about the way the members of the Council use national versus euro-wide aggregates. Our results can be summarized as follows.

First, when majority voting is used, the ECB can effectively control the GC and thus the monetary policy in EMU. That is, when all the ECB-board members take the same position on the desired interest rate based on a euro-wide perspective, then the ECB-board's desires almost always prevail. The national governors then have a very small influence on the outcome when they take a nationalistic perspective, i.e. when their desired interest rate depends only on national economic conditions. This result has to do with the fact that the desires of the national governors tend to offset each other when asymmetries in the shocks or in the transmission process are high. This may lead to some frustration (measured by the difference between nationally desired interest rates and the decided interest rate) among these national central bankers. We also find that this frustration is typically larger for small countries.

Second, we find that when countries increase their desire to stabilize output they are increasingly frustrated about the decisions taken in Frankfurt. This result can be given the following interpretation. When national authorities increase their ambition to stabilize output, their desired interest rate will react more to asymmetric shocks. There will, therefore, be a greater spread in the nationally desired interest rates, so that these will correlate less well with the one decided in Frankfurt (the median voter's desired interest rate).

Third, welfare is in general improved by having an ECB-board take a euro-wide perspective (the "ECB-rule") compared with a regime in which all members of the Governing Council take a nationalistic view (the "nationalistic rule") or an EMS regime where Germany sets monetary policy. In general, we find that the ECB-rule leads to lower losses, i.e. is a better rule to minimize the variability of output, inflation and the interest rate, than the nationalistic rule and than the EMS-rule. The superiority of the ECB-rule is most pronounced with respect to the EMS-rule. This is not surprising. In the EMS-rule only information about German economic conditions is used to set the optimal interest rate of all the member states. This is generally a less efficient rule than a policy rule that uses information of all the countries in the system.

This paper has many limitations which invite further research. For instance, in the estimation of inflation and output equations we neglected the real exchange rate as a possible cause of output and inflation movements. Obviously this external source of economic fluctuations may be of considerable importance for small open economies. Incorporating the real exchange rate along the lines of Peersman and Smets (1999) seems an interesting way to account for these external forces. However, it would also increase the dimension of the state space considerably, which is large already in the current setting. We plan to pursue this route of research in the near future.

Second, the optimal desired interest rate for Euroland as a whole has not been derived explicitly. Instead we assumed that a proxy for this variable was given by the weighted average of the desired interest rates of the member-states. The optimal desired interest rate could theoretically be obtained in much the same way as the national desired interest rates. Here the curse of dimensionality strikes again. At the end of the day, however, we would like to argue that the approach we took is a reasonable approximation for the ECB optimal linear feedback rule. Finally, we have only considered majority voting. Our results indicate that the use of majority voting can create significant conflicts between member-states in an environment characterized by asymmetric shocks. Therefore, the ECB may want to use other decision rules in which consensus plays a greater role. We hope to pursue this line of research in the future.

APPENDIX A

Here we present the matrix A, containing the autonomous dynamics of the state space in more detail. First, introduce the following notation: e_j denotes a $1 \times (n+m+2+11)$ vector with all elements equal to zero but the j-th which equals one; $e_{i:j}$ a $1 \times (n+m+2+11)$ vector with 1/12 as element from row i up till row j and zeros elsewhere. The state space itself is constructed by stacking inflation output trade and interest rate variables into the state vector X. The matrix A summarizes the dynamics.The presentation of vectors and matrices below follows following notation: the first column specifies the variable in the matrix. The second column denotes the row in which the value enters.

$$X_t = \begin{bmatrix} \pi_t & 1 \\ \pi_{t-1} & 2 \\ \vdots & \downarrow \\ \pi_{t-n+1} & n \\ y_t & 1 \\ y_{t-1} & 2 \\ \vdots & \downarrow \\ y_{t-m+1} & m \\ y^*_{t-11} & 1 \\ y^*_{t-12} & 2 \\ i_{t-1} & 1 \\ \vdots & \downarrow \\ \vdots & \downarrow \\ i_{t-l} & l \end{bmatrix} \qquad A = \begin{bmatrix} \sum_{j=1}^{n} \alpha_{\pi,j} e_j + \alpha_y e_{n+1} & 1 \\ e_1 & 2 \\ \vdots & \downarrow \\ e_n & n \\ \beta_r e_{1:11} + \sum_{j=1}^{m} \beta_{y,j} e_{n+j} + \beta^*_y e_{n+m+1} - \beta_r e_{n+m+4:n+m+2+l} & 1 \\ e_{n+1} & 2 \\ \vdots & \downarrow \\ e_{n+m} & m \\ 0.999 e_{n+m+1} & 1 \\ e_{n+m+1} & 2 \\ e_0 & 1 \\ e_{n+m+4} & \downarrow \\ \vdots & \downarrow \\ e_{n+m+2+l} & l \end{bmatrix}$$

Note that we have imposed an autoregressive coefficient on the trade-weighted business cycle component of about .999. This value was obtained as the average of country by country AR model estimation.

The vector B is a vector containing zeros except for the element for y_{t-1} and the i_{t-1} where the coefficients are respectively $-\beta_r/12$ and 1. Finally we model the demand and supply shocks in the vector v.

$$B=\begin{bmatrix} 0 & 1 \\ 0 & 2 \\ \vdots & \downarrow \\ 0 & n \\ -\frac{\beta_r}{12} & 1 \\ 0 & 2 \\ \vdots & \downarrow \\ 0 & m \\ 0 & 1 \\ 0 & 2 \\ 1 & 1 \\ \vdots & \downarrow \\ \vdots & \downarrow \\ 0 & l \end{bmatrix} \quad and\, v_t = \begin{bmatrix} \varepsilon_t & 1 \\ 0 & 2 \\ \vdots & \downarrow \\ 0 & n \\ \eta_t & 1 \\ 0 & 2 \\ \vdots & \downarrow \\ 0 & m \\ 0 & 1 \\ \vdots & 2 \\ \vdots & 1 \\ 0 & 2 \\ \vdots & \downarrow \\ \vdots & \downarrow \\ 0 & l \end{bmatrix} \tag{17}$$

Rewriting the target variables in terms of the state space:

$$Y_t = \begin{bmatrix} \bar{\pi}_t \\ y_t \\ i_t - i_{t-1} \end{bmatrix} = C_X X_t + C_i i_t, \text{where}\, C_X = \begin{bmatrix} e_{1:12} \\ e_{n+1} \\ -e_{n+m+3} \end{bmatrix} \text{ and } C_i = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \tag{18}$$

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Table 1: Statistical Summary

	AUS	BEL	FIN	FRA	GER	IRE	ITA	LUX	NET	POR	SPA
Eigenvalues											
M matrix	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
$\Sigma\alpha_{\pi,j}$	0.68	0.89	0.76	0.84	0.72	0.71	0.88	0.70	0.78	0.82	0.86
$\Sigma\beta_{y,j}$	0.84	0.79	0.76	0.87	0.82	0.87	0.54	0.91	0.64	0.87	0.84
F Test	2,57*	1,98*	4,03*	9,85*	1.59	8,42*	5,25*	4,77*	2,86*	0.34	1,80*
Σf_{π}	0.46	0.67	1.52	1.65	0.76	0.61	1.44	0.75	0.20	0.77	0.18
Σf_y	0.38	0.47	-0.17	0.20	0.24	0.59	-0.02	0.89	-0.15	0.43	-0.23
$Sf_{\Delta i}$	0.50	0.24	0.39	0.81	0.55	0.70	-0.08	0.41	0.91	0.24	0.98
R^2 eq:π	0.20	0.46	0.40	0.75	0.24	0.30	0.78	0.46	0.45	0.39	0.36
R^2 eq:y	0.72	0.65	0.90	0.80	0.77	0.59	0.72	0.71	0.42	0.81	0.78
Lag Lenghts											
π (Akaike)	12	13	20°	31°	14°	29	13	24	16°	11	15
y (Akaike)	11	11	31°	11°	11°	13	34	24	16°	13	18

* indicates that the hypothesis of long term neutrality is rejected in the 95% interval
° indicates that the lag length as suggested by the AIC is applied and A and M matrices are stable. Otherwise we chose the lags in the close neighbourhood.

Table 2: Correlations between Desired and Decided Interest Rates (%)

	AUS	BEL	FIN	FRA	GER	IRE	ITA	LUX	NET	POR	SPA	ECB
(λ=0.2,ν=0.5)												
EMS	96	90	26	94	100	93	49	25	98	51	98	40
ECB	87	80	23	90	93	84	49	3	97	59	97	100
NAT	92	80	37	92	93	86	20	-8	99	54	99	-
(λ=1,ν=0.5)												
EMS	77	60	24	89	100	64	27	27	94	23	93	57
ECB	56	51	10	89	83	39	42	-11	91	57	86	100
NAT	68	48	27	90	69	51	19	13	94	41	92	-
(λ=5.0,ν=0.5)												
EMS	54	41	14	79	100	46	35	32	90	6	86	70
ECB	37	53	14	70	74	23	33	10	76	27	67	100
NAT	45	47	20	79	51	43	21	23	85	24	77	-
(λ=1.0,ν=1.0)												
EMS	89	73	40	94	100	79	42	46	96	18	96	64
ECB	73	65	25	92	89	59	52	17	95	40	95	100
NAT	87	58	42	95	87	69	41	34	98	51	98	-
(λ=1,0,ν=5.0)												
EMS	98	97	61	99	100	95	33	76	99	77	99	34
ECB	94	90	41	98	97	82	75	48	99	77	98	100
NAT	97	93	73	99	97	89	17	46	99	79	99	-

Table 3: Root Mean Squared Error between Desired and Decided Interest Rates (%)

	AUS	BEL	FIN	FRA	GER	IRE	ITA	LUX	NET	POR	SPA
(λ =0.2, ν =0.5)											
EMS	1.0	1.7	12.2	1.3	0.0	1.3	4.5	5.3	0.7	5.4	0.6
ECB	0.8	1.0	12.1	1.1	0.6	0.9	1.9	4.2	0.4	5.1	0.4
NAT	0.8	1.2	8.6	1.1	0.8	1.0	3.3	4.5	0.4	5.2	0.4
(λ=1.0,ν=0.5)											
	AUS	**BEL**	**FIN**	**FRA**	**GER**	**IRE**	**ITA**	**LUX**	**NET**	**POR**	**SPA**
EMS	2.3	3.0	16.2	1.7	0.0	3.2	6.6	6.0	1.3	11.0	1.4
ECB	1.9	2.0	13.4	1.3	1.3	2.9	2.2	5.7	0.8	10.1	1.0
NAT	1.9	2.3	8.8	1.3	1.8	2.9	4.1	5.4	0.8	10.1	1.1
(λ=5.0,ν=0.5)											
	AUS	**BEL**	**FIN**	**FRA**	**GER**	**IRE**	**ITA**	**LUX**	**NET**	**POR**	**SPA**
EMS	5.9	7.6	30.3	4.0	0.0	7.3	12.8	10.4	2.8	24.5	3.6
ECB	4.6	3.9	25.4	3.0	3.2	6.5	5.4	8.5	1.8	21.7	2.7
NAT	4.7	5.3	15.9	3.0	4.5	6.5	9.2	8.9	2.1	21.7	3.0
(λ=1.0,ν=1.0)											
	AUS	**BEL**	**FIN**	**FRA**	**GER**	**IRE**	**ITA**	**LUX**	**NET**	**POR**	**SPA**
EMS	1.5	2.2	10.4	1.1	0.0	2.0	4.2	4.0	0.9	7.0	0.9
ECB	1.2	1.3	9.6	0.8	0.9	1.7	1.7	3.5	0.5	6.3	0.6
NAT	1.2	1.9	7.2	0.8	1.2	1.8	3.3	3.8	0.5	6.2	0.6
(λ=1.0,ν=5.0)											
	AUS	**BEL**	**FIN**	**FRA**	**GER**	**IRE**	**ITA**	**LUX**	**NET**	**POR**	**SPA**
EMS	0.6	1.1	3.8	0.4	0.0	1.0	3.8	1.9	0.4	2.6	0.4
ECB	0.5	0.6	5.9	0.3	0.3	0.7	0.9	1.4	0.2	2.6	0.2
NAT	0.5	0.8	2.8	0.3	0.4	0.8	2.5	1.7	0.2	2.5	0.2

Table 4: Median Voters (%)

	AUS	BEL	FIN	FRA	GER	IRE	ITA	LUX	NET	POR	SPA	ECB
(λ=0.2,ν=0.5)												
ECB	0.33	0.27	0.07	0.13	0.53	0.07	0.27	0.00	0.40	0.00	0.60	0.97
NAT	5.47	3.40	1.00	8.13	14.27	5.80	4.40	1.00	27.00	1.27	28.27	-
(λ=1.0,ν=0.5)												
ECB	0.47	0.13	0.00	0.33	0.00	0.00	0.07	0.07	0.20	0.07	0.20	98.47
NAT	5.73	4.87	3.53	17.67	11.47	3.13	8.47	1.73	27.20	0.67	15.53	-
(λ=5.0,ν=0.5)												
ECB	0.40	0.20	0.00	0.73	0.13	0.20	0.13	0.40	0.33	0.00	0.53	96.93
NAT	5.27	5.47	3.67	20.07	13.67	4.53	7.73	3.13	21.00	2.00	13.47	-
(λ=1.0,ν=1.0)												
ECB	0.27	0.20	0.07	0.60	0.33	0.07	0.13	0.00	0.20	0.00	0.73	97.40
NAT	6.07	4.20	2.40	16.20	12.33	4.67	6.13	2.20	24.60	0.73	20.47	-
(λ=1.0,ν=5.0)												
ECB	0.27	0.53	0.07	1.47	1.13	0.27	0.13	0.13	0.67	0.20	0.60	94.53
NAT	5.67	3.20	2.33	24.80	13.87	3.80	1.80	1.27	26.13	1.27	15.87	-

Table 5: Losses in % (λ=1.0, ν =0.5)

	AUS	BEL	FIN	FRA	GER	IRE	ITA	LUX	NET	POR	SPA
Benchmark											
Inflation	0,001	0,001	0,002	0,002	0,002	0,001	0,001	0,006	0,001	0,040	0,003
Output	0,091	0,109	0,081	0,057	0,060	0,213	0,043	0,153	0,093	1,154	0,135
Desired r	0,015	0,014	0,021	0,009	0,012	0,023	0,007	0,029	0,003	0,243	0,007
Decided r	-	-	-	-	-	-	-	-	-	-	-
Loss	0,099	0,117	0,094	0,064	0,068	0,225	0,047	0,174	0,096	1,315	0,142
ECB Rule											
Inflation	0,001	0,001	0,058	0,003	0,003	0,001	0,003	0,039	0,001	0,161	0,003
Output	0,111	0,132	1,424	0,063	0,074	0,252	0,072	0,317	0,093	1,839	0,144
Desired r	0,009	0,007	0,022	0,005	0,008	0,013	0,005	0,024	0,003	0,142	0,003
Decided r	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003
Loss	0,113	0,135	1,484	0,067	0,079	0,254	0,077	0,357	0,095	2,001	0,149
Nationalistic Rule											
Inflation	0,001	0,001	0,028	0,003	0,004	0,001	0,008	0,036	0,001	0,154	0,003
Output	0,117	0,140	0,648	0,062	0,080	0,254	0,174	0,305	0,093	1,824	0,144
Desired r	0,009	0,007	0,016	0,006	0,009	0,013	0,006	0,024	0,004	0,141	0,004
Decided r	0,047	0,047	0,047	0,047	0,047	0,047	0,047	0,047	0,047	0,047	0,047
Loss	0,142	0,164	0,699	0,088	0,107	0,278	0,205	0,365	0,117	2,002	0,171
EMS Rule											
Inflation	0,001	0,001	0,084	0,003	0,002	0,001	0,011	0,039	0,001	0,184	0,003
Output	0,109	0,148	2,048	0,063	0,061	0,247	0,398	0,333	0,092	1,973	0,150
Desired r	0,013	0,011	0,033	0,012	0,012	0,019	0,011	0,031	0,010	0,144	0,012
Decided r	0,012	0,012	0,012	0,012	0,012	0,012	0,012	0,012	0,012	0,012	0,012
Loss	0,117	0,155	2,137	0,072	0,069	0,254	0,416	0,379	0,099	2,163	0,160

Table 6: Relative Losses (%)

(λ =0.2, ν =0.5)											
	AUS	BEL	FIN	FRA	GER	IRE	ITA	LUX	NET	POR	SPA
BEN/EMS	96	57	4	99	89	92	7	45	93	59	97
BEN/ECB	92	82	4	108	97	101	28	61	98	61	102
BEN/NAT	47	49	7	50	47	61	10	48	51	59	66
EMS/ECB	96	144	100	109	110	110	428	137	106	104	105
EMS/NAT	49	86	187	51	53	67	152	107	55	100	67
ECB/NAT	51	60	187	47	48	61	35	78	52	96	64
(λ =1.0, ν =0.5)											
	AUS	BEL	FIN	FRA	GER	IRE	ITA	LUX	NET	POR	SPA
BEN/EMS	85	76	4	89	98	89	11	46	97	61	89
BEN/ECB	87	87	6	95	86	89	61	49	100	66	95
BEN/NAT	70	71	13	72	64	81	23	48	82	66	83
EMS/ECB	103	115	144	107	88	100	541	106	104	108	107
EMS/NAT	82	94	306	82	65	91	202	104	84	108	94
ECB/NAT	80	82	212	76	74	91	37	98	82	100	87
(λ=5.0, ν =0.5)											
	AUS	BEL	FIN	FRA	GER	IRE	ITA	LUX	NET	POR	SPA
BEN/EMS	64	54	5	80	96	80	11	49	90	51	85
BEN/ECB	77	91	7	87	84	83	45	60	95	57	93
BEN/NAT	72	68	16	76	59	79	19	54	84	56	85
EMS/ECB	121	167	142	108	87	104	410	121	106	110	109
EMS/NAT	112	126	341	95	61	99	175	109	94	108	99
ECB/NAT	93	75	241	87	70	96	43	90	89	98	91
(λ =1.0, ν =1.0)											
	AUS	BEL	FIN	FRA	GER	IRE	ITA	LUX	NET	POR	SPA
BEN/EMS	86	70	3	96	94	80	7	54	94	62	99
BEN/ECB	96	85	7	112	77	86	55	58	145	77	118
BEN/NAT	83	82	6	102	79	84	24	62	98	71	98
EMS/ECB	111	122	235	117	82	108	765	107	154	123	119
EMS/NAT	96	119	186	106	84	106	335	115	104	113	100
ECB/NAT	86	97	79	91	103	98	44	107	68	92	84
(λ =1.0, ν =5.0)											
	AUS	BEL	FIN	FRA	GER	IRE	ITA	LUX	NET	POR	SPA
BEN/EMS	94	65	11	97	90	90	5	53	91	92	88
BEN/ECB	99	89	5	104	105	101	50	68	99	91	98
BEN/NAT	96	78	18	103	96	97	11	57	99	90	98
EMS/ECB	106	136	43	108	116	112	1,011	129	108	99	112
EMS/NAT	102	120	165	106	107	107	225	108	108	98	112
ECB/NAT	97	88	387	99	92	96	22	84	100	99	100

Figure 1: Optimal Output Gap (dashed line) and Inflation (solid line) Feedback Coefficients (λ=1, ν=0.5)

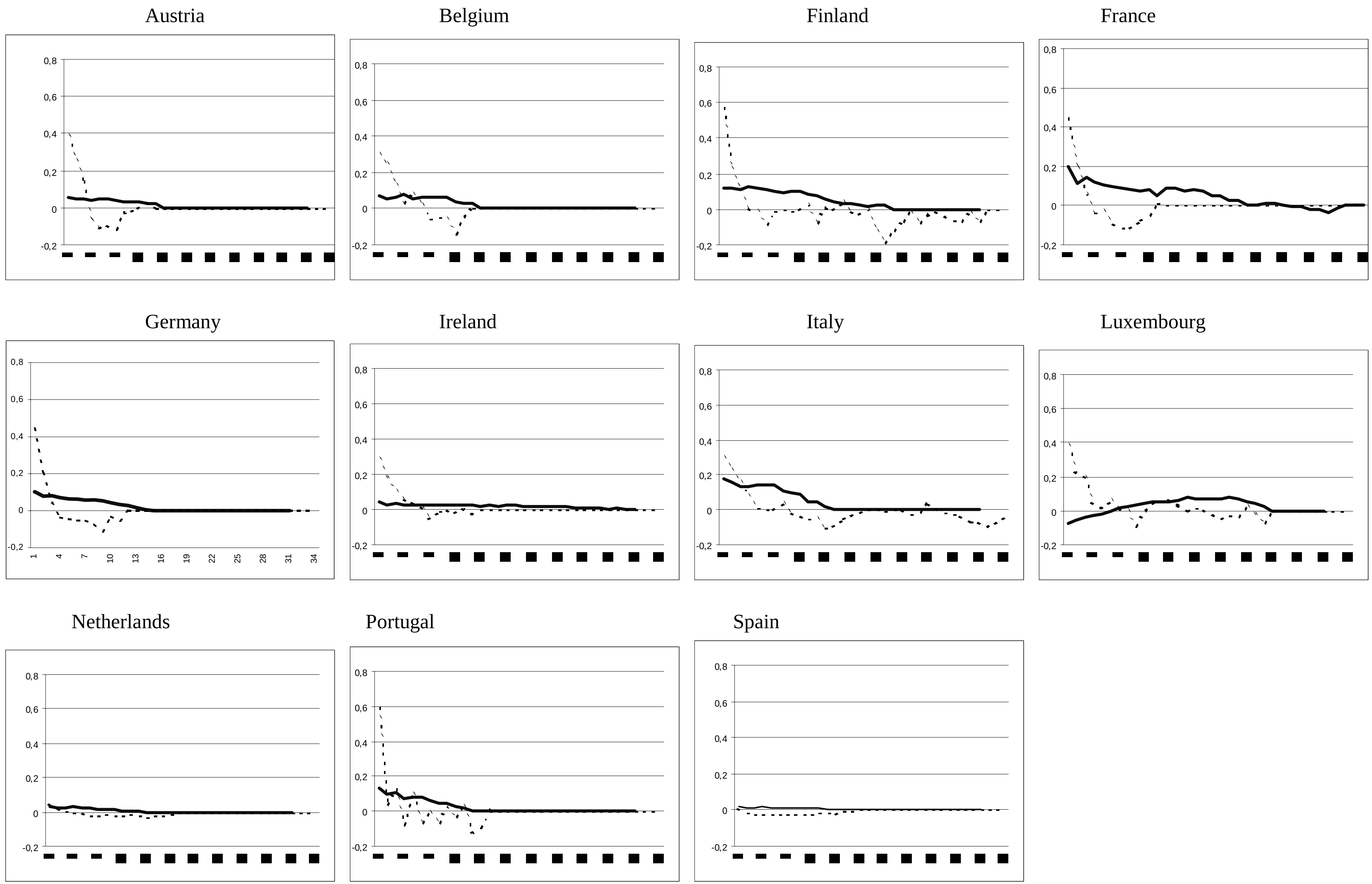
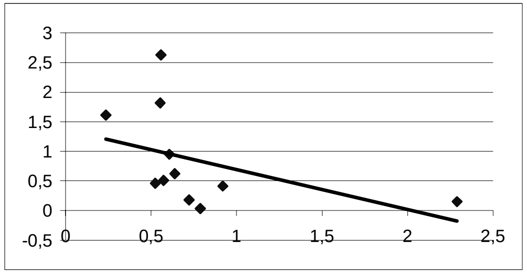
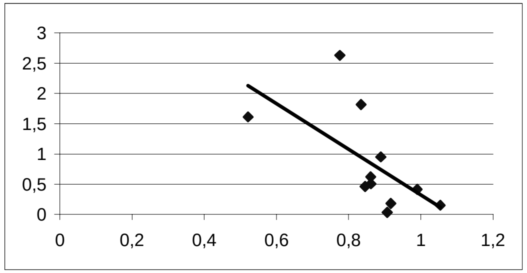


Figure 2: Voting Power and Relative Losses

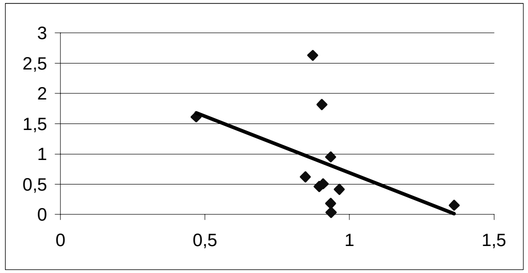
(λ=0.2, ν=0.5)



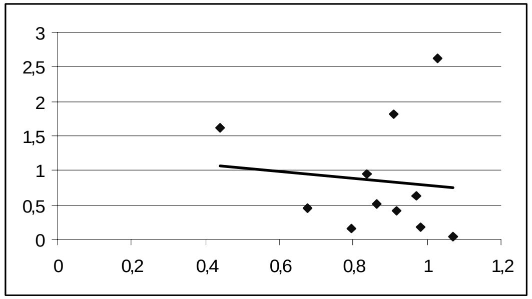
(λ=1.0, ν=0.5)



(λ=5.0, ν=0.5)



(λ=1.0, ν=1.0)



(λ=1.0, ν=5.0)