DISCUSSION PAPER SERIES

No. 3036

UNION-WIDE AGGREGATES VERSUS NATIONAL DATA BASED MONETARY POLICIES: DOES IT MATTER FOR THE EUROSYSTEM?

Paul De Grauwe and Tomasz Piskorski

INTERNATIONAL MACROECONOMICS

Centre for Economic Policy Research

www.cepr.org

Available online at: **www.cepr.org/pubs/dps/DP3036.asp**

ISSN 0265-8003

UNION-WIDE AGGREGATES VERSUS NATIONAL DATA BASED MONETARY POLICIES: DOES IT MATTER FOR THE EUROSYSTEM?

Paul De Grauwe, Katholieke Universiteit Leuven and CEPR
Tomasz Piskorski, Katholieke Universiteit Leuven

Discussion Paper No. 3036
November 2001

Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

CEPR Discussion Paper No. 3036

November 2001

ABSTRACT

Union-wide Aggregates versus National Data Based Monetary Policies: Does it Matter for the Eurosystem?*

The effectiveness of alternative loss functions assigned to the common central bank of a monetary union is studied. The alternative policy objectives are a function of the degree of aggregation of decision variables. We consider, respectively, the policy based on the union-wide aggregates and the policy based on the national data of the member states. To assess the performance of two alternative policy objectives in the environment of euroland, we derive the implied optimal linear feedback rules using the framework similar to those proposed by Rudebusch and Svensson(1999). The dynamic simulations within the calibrated model of EMU indicate that the policy based on the union-wide aggregates yields stabilization performances that are close to the policy based on the national data of the member states. The main implication of the Paper is that the announced monetary policy strategy of the ECB based on the union-wide aggregates may be a reasonable proxy of the optimal policy rule based on the national data of the member states.

JEL Classification: E10, E30, E40 and E50
Keywords: ECB, EMU, heterogenous monetary union, loss function, optimal linear feedback rules and welfare aggregation

Paul De Grauwe
Centrum voor Economische Studiën
Katholieke Universiteit Leuven
Naamsestraat 69
B-3000 Leuven
BELGIUM
Tel: (32 16) 326794
Fax: (32 16) 326796
Email: paul.degrauwe@econ.kuleuven.ac.be

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=100508

Tomasz Piskorski
Centrum voor Economische Studiën
Katholieke Universiteit Leuven
Naamesestraat 69
B-3000 Leuven
BELGIUM
Tel: (32 16) 324547
Fax: (32 16) 326796
Email: tomasz.piskorski@econ.kuleuven.ac.be

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=156121

* We would like to thank Yunus Aksoy, Alex Cukierman, Mattias Erlandsson, Bert Willems, Kenneth Wallis and participants in the conferences held in Brussels, Maastricht and Milan for helpful comments on an earlier version of the Paper.

Submitted 10 October 2001

NON-TECHNICAL SUMMARY

In this Paper, we analyse the performance of common central bank monetary policies in a monetary union based on the national data of the member states and union-wide aggregates. In order to assess the performance of two alternative policy objectives in the environment of euroland, we derive the implied optimal linear feedback rules using the framework similar to the one proposed by Rudebusch and Svensson(1999). The dynamic simulations within the calibrated EMU model indicate that the policy based on the union-wide aggregates yield very close stabilization performances to the policy based on the national data of the member states. This result holds across different structures of the stochastic disturbances and postulated stabilization preferences, and irrespectively of the significant asymmetries in the calibrated models of the EMU countries.

An important finding is that for most of the countries their respective losses do not change much with a switch from national to aggregate data rule. For some cases, the difference may turn out to be substantial. In general we find that countries which are more responsive to the policy instrument tend to be better off under the *national data* rule than under the *aggregate data* rule. The reverse holds true for less responsive countries. This may lead to potential conflicts among the countries when deciding which policy variables, the national data or union-wide aggregates, should be incorporated into the common central bank loss function.

The main implication of the Paper is that the announced monetary policy strategy of the ECB using union-wide aggregates may be a reasonable proxy of the optimal policy rule using the national data of the member states. Because the welfare differences between the two alternative polices are very small, the *aggregate data targeting* may provide a better framework for the conduct of common monetary policy by being simpler and to some extent by denationalizing the key decision variables.

Several extensions of our framework may be considered in future research. One could consider to what extent the results of the simulations are sensitive to the changes of the parameter values of the calibrated model. This would make it possible to address the question of model uncertainty. In addition it would make it possible to derive the range of parameters of the dynamic model for which the different policy objectives result in a close stabilization performance.

1. Introduction

On January 1, 1999, the third and final stage of European Economic and Monetary Union (EMU) began with the establishment of a currency union encompassing 11 of the 15 member countries of the European Union. For the participating economies, the major change is that they are subject to a centralized monetary policy conducted by the ECB.

On announcing the monetary strategy in October 1998, the ECB expressed its intention to adhere to a strict interpretation of its mandate to guarantee price stability, as expressed in the Maastricht Treaty (art. 105). The Treaty stipulates other objectives of the common monetary policy, however these objectives should not conflict with the primary objective of price stability. The present official view is that in order to pursue its objectives, the ECB should only consider aggregate (i.e. average) data, leaving national idiosyncrasies to the care of national governments. However, the decision making body, (the ECB Governing Council), provides for a large representation of the different national interests. In addition, given the decentralized nature of the Eurosystem, national central banks have a comparative advantage in analyzing national economic conditions. While officially they are interpreting their mission as not being supposed to concern themselves with the country specific economic conditions, this resolve may not be time consistent. For many obvious reasons, countries will remain the unit of economic analysis in Europe.

The objective of the paper is to study the extent alternative ways of aggregation of information on the economic conditions of the member states of the union by the common central bank affect the stabilization effectiveness of the monetary policy. For that purpose we consider two alternative loss functions assigned to the common central bank. The first loss function expresses the policy goals in terms of the national data of the member states. The second one formulates the policy variables in terms of the union-wide aggregates.

We consider two types of asymmetries that characterize the member states' economies. First, the transmission mechanisms of monetary policy, which are defined as the ways in which the policy instrument affects output and inflation, are likely to be different[1]. Second, stochastic disturbances that affect inflation and output are not necessarily synchronized. [2]

---

[1] Econometric evidence points to the asymmetric nature of the monetary transmission mechanism across the EMU countries. See, for example, Clarida et al. (1997), De Grauwe et al. (1999), Dornbusch et al. (1998), Giovannetti and Marimon (1998), Hallett and Piscitelli (1999), Peersman and Smets (1999), Smets (1995).

[2] For evidence of the asymmetries of shocks in the EMU countries, see for example, Bayoumi and Eichengreen (1992), Bayoumi and Prasad (1995).

In what follows, we assume that the central bank acts independently in the pursuit of the predetermined objective function. We consider only monetary policy as a stabilization tool. By ruling-out non-monetary stabilization policies, our analysis establishes a lower bound to the stabilization potential of the monetary union.

To assess the performance of two alternative policy objectives in the environment of Euroland we derive the implied optimal linear feedback rules using the framework similar to those proposed by Rudebusch and Svensson (1999). The dynamic simulations within the calibrated EMU model allows us to compare the stabilization performance of the policy based on the union-wide aggregates with the policy based on the national data of the member states.

The paper is organized as follows. Section 2 formulates the country specific losses and the social loss of the monetary union. Section 3 describes the optimal monetary policy of independent countries. In Section 4, the two alternative loss functions assigned to the common central bank of the monetary union are introduced. The first loss function expresses the policy goals in terms of the national data of the member states. The second one formulates the policy variables in terms of the union-wide aggregates. Section 5 describes the backward-looking macroeconomic framework we make use of in the paper. Section 6 discusses the state space representations of the macroeconomic model and the formulation of the alternative linear feedback rules. In Section 7 the country specific macroeconomic models are calibrated. In Section 8 the comparisons of the stabilization performance of alternative policy rules are undertaken. Finally, Section 9 concludes.

2. Single Country and Monetary Union Social Loss

Single Country Social Loss. We assume, following much of the literature[3], that the intertemporal social loss function of country *i* is given by:

$$L^i = E_t\left(\sum_{j=0}^{\infty}\delta_i{}^j L^i_{t+j}\right) \tag{1}$$

where the period loss function is:

$$L^i_t = (\pi^i_{t+j})^2 + b_i(y^i_{t+j})^2 + d_i(i_t - i_{t-1})^2 \tag{2}$$

In the intertemporal loss function δ_i is a country specific discount factor. In the period loss function, π^i_t and y^i_t stand for deviations of inflation and output of country *i* from its

[3] This specification follows exactly Rudebusch and Svensson (1999).

socially desired level and the natural level, respectively, and $i_t - i_{t-1}$ is the one period change in the level of the nominal interest rate. The parameters b_i and d_i represent, respectively, the country specific relative preferences for output and interest rate stabilization. This specification could be enriched by other factors like variability of the exchange rates, but this is not done here.

Throughout the paper we assume that the preferences across the countries are the same, that is $\exists i \quad \delta_i = \delta$, $b_i = b$ and $d_i = d$. This assumption enables us to focus solely on the asymmetries in the economic structures of the member states.

Monetary Union Social Loss. We assume, following De Grauwe (2000), that the overall loss function of the monetary union of *n* countries is represented by the weighted sum of the member states' utilities given by (1), i.e.:

$$L^U = \sum_{i=1}^{n} \alpha^i L^i \tag{3}$$

where α^i is the weight assigned to country *i* such that $\sum_{i=1}^{n} \alpha^i = 1$, which may be a function of the country specific factors like population or GDP.

We feel that the postulated monetary union loss function given by (3) may provide a good approximation of the environment in the present Euroland. The cultural differences and language barriers are likely to continue affecting labor mobility in Europe by sustaining its high degree of inertia[4]. Therefore, the national representatives in the Governing Council are likely to attach some weight to the own national economic conditions.

3. Monetary Policies of Independent Countries

We assume that the central bank follows a monetary policy rule (implicitly or explicitly). The rule describes the process by which the central bank optimizes its objective function which translates the targeted variables into a welfare measure. We assume that the target for output is the natural output level. Our assumption is based on the view that it is

[4] Empirical studies point to the high degree of inertia in labour mobility between European countries relative to the US regions. See, for instance Eichengreen (1993), De Grauwe (1994), Obstfeld and Peri, (1998).

implausible that the central banks of industrialized countries systematically pursue an output objective that exceeds the natural level of output.[5]

The monetary authority implements its policy by controlling the short-term nominal interest rate. This assumption is related to the fact that most central banks of industrialized economies actually conduct monetary policy in this way. An important implication of the assumption is that the money demand relationship, traditionally referred to by "LM" curve, is no longer relevant. To control the nominal interest rate, the central bank must allow the nominal supply of money to adjust in an endogenous manner, which implies that inflation and output are determined independently of money demand and supply factors.

The optimal monetary policy of the independent central bank of country *i* calls for setting the policy instrument in order to minimize the intertemporal country specific loss function given by (1). Therefore, in the optimum, the loss function of the central bank corresponds to the social loss function. The optimal level of the policy instrument is then specified as:

$$i_t^{opt} = \arg\left(\min_{i_t} E_t \left(\sum_{j=0}^{\infty} \delta_i{}^j L_{t+j}^i \right) \right) \quad (4)$$

4 Common Monetary Policies

4.1 Central Bank of the Monetary Union

The central bank of the union conducts the monetary policy by controlling the common short-term interest rate i^U according to a certain policy rule (implicit or explicit). The rule describes the process by which the central bank attempts to optimize its objective function. We assume that the central bank has the instrument independence, i.e. the ability to use without restrictions its monetary policy instrument to pursue the predetermined objectives. We assume that the member states of the union have already reached a compromise consensus concerning the specification of the loss function (*LF*) assigned to the central bank. Finally, as in the case of the national monetary authority, we assume that the common central bank does not pursue an output objective that is higher than the natural outputs of the member states.

[5] See, Blinder (1997) on this.

4.2 Optimal National Data Policy

Within our framework, and under the assumption that the monetary union already exists, the best the central bank can do is to minimize the loss function (3). The optimal loss function assigned to the central bank is therefore equivalent to the social loss of the monetary union:

$$LF^{NDT} = L^U = \sum_{i=1}^{n} \alpha^i L^i \tag{5}$$

We call the policy based on the postulated union-wide loss function a *national data targeting* (*NDT*) because the central bank follows the objective of maximization of the sum of individual utilities of the member states, which are expressed in national data.

4.3 Aggregate Data Policy

The official view of the European Central Bank (ECB), is that in order to derive the optimal policy rule the national macroeconomic data should first be aggregated into euro-wide aggregates In this view the ECB minimizes the following loss function:

$$LF^{ADT} = E_t \left(\sum_{j=0}^{\infty} \delta^j \left((\pi^U_{t+j})^2 + b(y^U_{t+j})^2 + d(i^U_t - i^U_{t-1})^2 \right) \right) \tag{6}$$

where:

$$\pi^E_{t+j} = \sum_{i=1}^{n} \alpha^i \pi^i_{t+j} \tag{7}$$

$$y^E_{t+j} = \sum_{i=1}^{n} \alpha^i y^i_{t+j} \tag{8}$$

In the specification (6) b and d are the union-wide relative preferences for the variability of aggregate output and the common interest rate, which under the imposed assumption of identical preferences are equal to the country specific preferences. We assume that the country specific weights α^i used in constructing the union-wide aggregates correspond to the weights assigned to the countries in the social loss of the monetary union. We call the above procedure an *aggregate data targeting* (*ADT*) as the central bank aims to stabilize the variability of the union-wide aggregates.

4.4. Union-Wide Aggregate Data versus National Data Monetary Policy

Under the assumption that the monetary union already exists, the best the central bank can do is to follow the *national data targeting* rule (5). Still there are many reasons to consider the *aggregate data targeting* policy and compare its stabilization performance to those of the optimal policy.

First, according to the announcements of the common central bank, the aggregate data targeting is the official policy followed by the ECB. Therefore, it is of interest to determine the eventual loss of the stabilization effectiveness induced by the *aggregate data targeting* policy under the assumed social loss function of the monetary union represented by (3).

Second, it is worth considering that the optimal policy, the *national data targeting*, may incur an additional cost, which is not modeled explicitly in the paper. This cost may be related to the technical difficulties related to the implementation of the *national data* rule. Also the rule based on national data may intensify policy conflicts among countries, which is particularly relevant to the decentralized structure of the European System of Central Banks. Therefore, if the welfare differences between the two alternative polices are small, both at the union level as well as at the country level, the *aggregate data targeting* may provide a better framework for the conduct of monetary policy by being simpler and to some extent by denationalizing the key decision variables.

5. A Backward-Looking Model for Policy Analysis

In reality, the central banks' optimization problem cannot be solved without knowledge of the dynamics of the state variables as a function of the policy control variable, and the stochastic disturbance process driving the economy. A class of models, which are widely used for the purpose of policy analysis, is based on a backward-looking specification of the economy. Often, in these types of models, the model specification is reduced to a dynamic aggregate supply equation and an aggregate demand equation[6]. The reduced form of the evolution of inflation and output can then be written in the following vector moving-average form:

$$\begin{bmatrix} \pi_t \\ y_t \end{bmatrix} = A(L)\begin{bmatrix} v_t \\ i_t \end{bmatrix} \tag{9}$$

[6] See, for example, Ball (1999) and Rudebusch and Svensson (1999), among many others.

where *A(L)* is a matrix of lag polynomials (possibly of infinite orders) in the lag operator L, v_t is a vector of stochastic disturbances realized at time *t*, and i_t is a vector of control variables (instruments) set at time *t*.

5.1 Backward-Looking Model of a Single Country

To make the model similar in structure to those used by central banks we follow Rudebusch and Svensson (1999) [7]. More formally, the model consists of an aggregate demand equation and a Philips curve given as:

$$y_{t+1} = \beta_{y1} y_t + \beta_{y2} y_{t-1} - \beta_r (\bar{i}_t - \bar{\pi}_t) + u_t \tag{10}$$

$$\pi_{t+1} = \alpha_{\pi 1}\pi_t + \alpha_{\pi 2}\pi_{t-1} + \alpha_{\pi 3}\pi_{t-2} + \alpha_{\pi 4}\pi_{t-3} + \alpha_y y_t + \varepsilon_t \tag{11}$$

where π_t is the quarterly deviation of inflation from its target consistent with the public expectations in percent (annualized), i_t represents the quarterly short-term deviation of the nominal interest rate from its implied equilibrium level consistent with the natural real interest rate and the inflation target, $\bar{\pi}_t = \frac{1}{4}\sum_{j=0}^{3}\pi_{t-j}$ is four-quarter average inflation, $\bar{i}_t = \frac{1}{4}\sum_{j=0}^{3} i_{t-j}$ is the four-quarter average short-term interest rate, y_t stands for the percentage gap between actual real output and potential real output, and u_t and ε_t are stochastic white-noise disturbances that affect output gap and inflation at quarter *t*.

The model captures the main problems facing the policy-maker in practice. Both output and inflation are subject to unforecastable shocks. Monetary policy that is conducted by controlling the short-term nominal interest rate influences the economy with lags. It takes a period for policy to affect output, and a period for output to affect inflation. Therefore, it takes two periods to affect inflation. This structure captures the stylized fact that monetary policy affects output more quickly than inflation (Ball, 1999).

The model departs from recent models including expectations[8]. While these models have strong theoretical foundations, they fail to fit key facts like the inertia of inflation[9] that appears in the data (Ball, 1999).

---

[7] We decided to use the Rudebusch-Svensson structure of the autoregressive components and thus imposing a fixed number of lags across the countries. Apart from tractability, the reason was not to expand the dimension of the EMU system that we build from the country specific equations. Taylor (1999) and Peersman and Smets (1999) uses the same lag structure to calibrate the EMU models.

[8] See, for example, McCallum and Nelson (1999), and Rotemberg and Woodford (1999).

Following Rudebusch and Svensson (1999), we will derive the optimal rules from the country specific aggregate relationships. Naturally, in reality the central banks base their decision process on a much wider information set than the variables included in the equations (10) and (11), a point which is recognized by Rudebusch and Svensson (1999).

5.2 EMU-11 Model

We limit our attention to the eleven founding members of the Economic and Monetary Union (EMU-11), i.e.: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. We have opted for the approach of building a model of the EMU-11 by constructing separate models of the member economies based on the equations (10) and (11) and then linking them together in a multi-country model to derive the common policy rules.

The best way to implement the *aggregate data targeting* rule would be to first aggregate the relevant macroeconomic time series across economies, and then to estimate a model for the euro area as a whole. However, it is easy to show that imposing that the euro-wide aggregate equations should have the same polynomial order as the national ones will generally result in an incorrect model specification if one assumes that the national aggregate relationships (10) and (11) are correctly specified. In order to avoid this methodological drawback, we decided to assess the performance of the alternative polices using a multicountry model. This allows us to impose a unique information set on the common central bank and it guarantees an internal consistency of performance comparisons.

6. Dynamic Stochastic Linear Regulator and Optimal Liner Feedback Instrument Rules

In the paper, we make use of the optimization framework provided by Rudebusch and Svensson (1999), which is based on the dynamic stochastic linear regulator[10]. We consider the class of linear rules based on the current economic states. A conventional way to describe the dynamics of the economic state is given as:

$$X_t = AX_{t-1} + Bi_{t-1} + v_t \tag{12}$$

[9] For instance, Fuhrer (1997) found that the backward-looking version reproduces much closer empirically observed inflation dynamics compared to the forward-looking one.
[10] See, as a reference, Chow (1970), and Sargent (1987).

where X_t is a vector of economic states variables, A is the matrix of parameters, i_t is a central bank instrument variable, B is the column vector describing how the instrument affects the state variables, and v_t is a vector of exogenous i.i.d. shocks with zero mean and constant variance. The period loss function can be written as:

$$L = Y_t' K Y_t \tag{13}$$

where K is a matrix of preferences attached to the policy goals given by:

$$Y_t = C_x X_t + C_r i_t \tag{14}$$

The optimal linear feedback instrument rule is given in vector form as:

$$i_t = f X_t \tag{15}$$

where f fulfils:

$$f = -(R + B'VB)^{-1}(U' + B'VA) \tag{16}$$

with V satisfying the following Riccati equation:

$$V = Q + Uf + f'U' + f'Rf + M'VM \tag{17}$$

The matrices M, Q, U, and R are defined as:

$$M = A + Bf \tag{18}$$

$$Q = C_x' K C_x \tag{19}$$

$$U = C_x' K C_r \tag{20}$$

$$R = C_r' K C_r \tag{21}$$

6.1 State Space Representation of a Single Country

Following Rudebusch and Svensson (1999), we express the aggregate relationships (10) and (11) of country i in the state-space form (12):

$$X_t^i = A^i X_{t-1}^i + B^i i_{t-1} + v_t^i \tag{22}$$

where:

$$A^i = \begin{bmatrix} \frac{1}{4}\alpha_{\pi 1}^i & \frac{1}{4}\alpha_{\pi 2}^i & \frac{1}{4}\alpha_{\pi 3}^i & \frac{1}{4}\alpha_{\pi 4}^i & \alpha_y^i & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{4}\beta_r^i & \frac{1}{4}\beta_r^i & \frac{1}{4}\beta_r^i & \frac{1}{4}\beta_r^i & \beta_{y1}^i & \beta_{y2}^i & -\frac{1}{4}\beta_r^i & -\frac{1}{4}\beta_r^i & -\frac{1}{4}\beta_r^i \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix}; \tag{23}$$

$$X_t^i = \begin{bmatrix} \pi_t^i \\ \pi_{t-1}^i \\ \pi_{t-2}^i \\ \pi_{t-3}^i \\ y_t^i \\ y_{t-1}^i \\ i_{i-1} \\ i_{t-2} \\ i_{t-3} \end{bmatrix}; \; B^i = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ -\frac{1}{4}\beta_r^i \\ 0 \\ 1 \\ 0 \\ 0 \end{bmatrix}; \; v^i = \begin{bmatrix} \varepsilon_t^i \\ 0 \\ 0 \\ 0 \\ u_t^i \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \tag{24}$$

We assume, following Rudebusch and Svensson (1999), that the countries share the common discount factor, which is set equal to one, i.e. $\delta_i = \delta = 1$[11]. Under this assumption, the country specific intertemporal loss function (1) approaches an infinite sum of the unconditional means of the period loss functions. Consequently, the scaled loss function $(1-\delta_i)E_t\left(\sum_{j=0}^{\infty}\delta_i{}^j L_{t+j}^i\right)$ approaches the unconditional mean of the period loss function that equals the weighted sum of the unconditional variances of the goal variables, namely:

$$E\left(L_t^i\right) = VAR(\overline{\pi}_t^i) + bVAR(y_t^i) + dVAR(i_t - i_{t-1}) \tag{25}$$

In the remaining part of the paper we will use the loss specification (25) to evaluate the stabilization effectiveness of the country specific monetary policies

The state space representation of the country specific loss (25) is given by:

$$L_t^i = Y_t^{i\,/} K^i Y_t^i \tag{26}$$

where Y_t^i is the country specific vector of the goal variables:

$$Y_t^i == \begin{bmatrix} \overline{\pi}_t^i \\ y_t^i \\ i_t - i_{t-1} \end{bmatrix} = C_X X_t^i + C_r i_t \tag{27}$$

where:

$$C_X = \begin{bmatrix} 0.25 & 0.25 & 0.25 & 0.25 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 \end{bmatrix}; \; C_r = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \tag{28}$$

and K^i is a matrix of the stabilization preferences:

$$K^i = diag(1,\; b,\; d) \tag{29}$$

The term *diag(a)* represents the matrix with vector *a* on the diagonal and zeros elsewhere.

The optimal value of the loss under the optimal linear feedback rule (16) is given as:

[11] The irrelevance of the time preferences occurs if the frequency of the central bank's meetings is sufficiently high, see De Grauwe et al. (1999). Alternatively, the monetary authority may treat generations equally by avoiding economic expansions at the expense of future inflationary pressures.

$$E(L_t^i) = trace(V \Sigma_{vv}^i) \tag{30}$$

where $\Sigma_{vv}^i = E\left(v_t^i v_t^{i\,/}\right)$ is a covariance matrix of the disturbance vector and V is defined by (17).

Alternatively, the loss function may be derived from the unconditional covariance-variance matrix of the state vector Σ_{XX}^i given by:

$$vec(\Sigma_{XX}^i) = (I - M \otimes M)^{-1} vec(\Sigma_{vv}^i) \tag{31}$$

where *vec(Z)* denotes the vector of stacked columns vectors of the matrix *Z*, *I* denotes a matrix of ones on the diagonal with zeros elsewhere, *M* is defined as in (18), and $\otimes$ denotes a Kronecker product. The covariance-variance matrix of the goal variables is given by:

$$\Sigma_{YY}^i = C \;\; \Sigma_{XX}^i \; C^{\,/} \tag{32}$$

where:

$$C \; = C_X + C_r \times f_i \tag{33}$$

and f_i is an optimal linear feedback rule (16).

6.2 State Space Representation of the EMU-11 Model

We construct the model of the monetary union (EMU-11) from the country specific aggregate relationships given by (10) and (11). In order to shorten the notation it will prove to be very convenient to define the following matrices and vectors for country *i*:

$$XX_t^i = \begin{bmatrix} \pi_t^i \\ \pi_{t-1}^i \\ \pi_{t-2}^i \\ \pi_{t-3}^i \\ y_t^i \\ y_{t-1}^i \end{bmatrix};\; AA^i = \begin{bmatrix} \frac{1}{4}\alpha_{\pi 1}^i & \frac{1}{4}\alpha_{\pi 2}^i & \frac{1}{4}\alpha_{\pi 3}^i & \frac{1}{4}\alpha_{\pi 4}^i & \alpha_y^i & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ \frac{1}{4}\beta_r^i & \frac{1}{4}\beta_r^i & \frac{1}{4}\beta_r^i & \frac{1}{4}\beta_r^i & \beta_{y1}^i & \beta_{y2}^i \\ 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \tag{34}$$

$$D^i = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ -\frac{1}{4}\beta_r^i & -\frac{1}{4}\beta_r^i & -\frac{1}{4}\beta_r^i \\ 0 & 0 & 0 \end{bmatrix};\; BB^i = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ -\frac{1}{4}\beta_r^i \\ 0 \end{bmatrix};\; R = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix};\; vv^i = \begin{bmatrix} \varepsilon_t^i \\ 0 \\ 0 \\ 0 \\ u_t^i \\ 0 \end{bmatrix} \tag{35}$$

$$w\pi = \begin{bmatrix} \frac{1}{4} & \frac{1}{4} & \frac{1}{4} & \frac{1}{4} & 0 & 0 \end{bmatrix} \tag{36}$$

$$wy = [0 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0]$$

$$ww = \begin{bmatrix} w\pi \\ wy \end{bmatrix}$$

$$wi = [-1 \quad 0 \quad 0]$$

The dynamics of the EMU-11 economic state is then given by:

$$X_t^U = A^U X_{t-1}^U + B^U i_{t-1}^U + v_t^U \tag{37}$$

where:

$$A^U = \begin{bmatrix}
AA^{AUS} & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & D^{AUS} \\
Z_6^6 & AA^{BEL} & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & D^{BEL} \\
Z_6^6 & Z_6^6 & AA^{FIN} & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & D^{FIN} \\
Z_6^6 & Z_6^6 & Z_6^6 & AA^{FRA} & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & D^{FRA} \\
Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & AA^{GER} & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & D^{GER} \\
Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & AA^{IRL} & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & D^{IRL} \\
Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & AA^{ITL} & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & D^{ITL} \\
Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & AA^{LUX} & Z_6^6 & Z_6^6 & Z_6^6 & D^{LUX} \\
Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & AA^{NET} & Z_6^6 & Z_6^6 & D^{NET} \\
Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & AA^{POR} & Z_6^6 & D^{POR} \\
Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & Z_6^6 & AA^{SPA} & D^{SPA} \\
Z_6^3 & Z_6^3 & Z_6^3 & Z_6^3 & Z_6^3 & Z_6^3 & Z_6^3 & Z_6^3 & Z_6^3 & Z_6^3 & Z_6^3 & R
\end{bmatrix} \tag{38}$$

and:

$$X_t^U = \begin{bmatrix} XX_t^{AUS} \\ XX_t^{BEL} \\ XX_t^{FIN} \\ XX_t^{FRA} \\ XX_t^{GER} \\ XX_t^{IRL} \\ XX_t^{ITL} \\ XX_t^{LUX} \\ XX_t^{NET} \\ XX_t^{POR} \\ XX_t^{SPA} \\ i_{t-1}^U \\ i_{t-2}^U \\ i_{t-3}^U \end{bmatrix}; \quad B^U = \begin{bmatrix} BB^{AUS} \\ BB^{BEL} \\ BB^{FIN} \\ BB^{FRA} \\ BB^{GER} \\ BB^{IRL} \\ BB^{ITL} \\ BB^{LUX} \\ BB^{NET} \\ BB^{POR} \\ BB^{SPA} \\ 0 \\ 1 \\ 0 \end{bmatrix}; \quad v_t^U = \begin{bmatrix} vv_t^{AUS} \\ vv_t^{BEL} \\ vv_t^{FIN} \\ vv_t^{FRA} \\ vv_t^{GER} \\ vv_t^{IRL} \\ vv_t^{ITL} \\ vv_t^{LUX} \\ vv_t^{NET} \\ vv_t^{POR} \\ vv_t^{SPA} \\ 0 \\ 0 \\ 0 \end{bmatrix} \tag{39}$$

The symbol Z_n^m stands for the matrix of zeros with *m* rows and *n* columns.

As in the single country case, we assume that the countries share the same discount factor equal to one. Under this assumption the intertemporal loss functions (5) and (6) approach the infinite sum of their unconditional one-period means. Then the scaled loss function approaches their one period unconditional means. Consequently, the scaled *national data targeting* loss function equivalent to the union-wide social loss is given by:

$$E\left(L_t^U\right)=E\left(LF_t^{NDT}\right)=\sum_{i=1}^{11}\alpha^i\left(VAR(\overline{\pi}_t^i)+bVAR(y_t^i)++dVAR(i_t^U-i_{t-1}^U)\right) \quad (40)$$

In the same manner, the scaled *aggregate data targeting* loss function equals:

$$E\left(LF_t^{ADT}\right)=VAR(\pi_t^E)+bVAR(y_t^E)+dVAR(i_t^U-i_{t-1}^U) \quad (41)$$

As in the one country case, we will use the scaled monetary union social loss (40) to evaluate the stabilization performance of the alternative policies.

The state space representation of the scaled *national data targeting* loss function is given by:

$$LF_t^{NDT}=Y_t^{NDT\,/}K^{NDT}Y_t^{NDT} \quad (42)$$

where:

$$Y_t^{NDT}=C_X^{NDT}X_t^U+C_r^{NDT}i_t \quad (43)$$

and:

$$C_X^{NDT}=\begin{bmatrix} ww & Z_6^2 & Z_6^2 & Z_6^2 & Z_6^2 & Z_6^2 & Z_3^2\\ Z_6^2 & ww & Z_6^2 & Z_6^2 & Z_6^2 & Z_6^2 & Z_3^2\\ Z_6^2 & Z_6^2 & ww & Z_6^2 & Z_6^2 & Z_6^2 & Z_3^2\\ Z_6^2 & Z_6^2 & Z_6^2 & ww & Z_6^2 & Z_6^2 & Z_3^2\\ Z_6^2 & Z_6^2 & Z_6^2 & Z_6^2 & ww & Z_6^2 & Z_3^2\\ Z_6^2 & Z_6^2 & Z_6^2 & Z_6^2 & Z_6^2 & ww & Z_3^2\\ Z_6^1 & Z_6^1 & Z_6^1 & Z_6^1 & Z_6^1 & Z_6^1 & wi \end{bmatrix} \quad (44)$$

$$K^{NDT}=diag\,(\alpha^{AUS}\quad b\alpha^{AUS}\quad \alpha^{BEL}\quad b\alpha^{BEL}\quad \ldots\quad \ldots\quad \alpha^{SPA}\quad b\alpha^{SPA}\quad d)$$

$$C_r^{NDT}=\begin{bmatrix} Z_1^{22}\\ 1\end{bmatrix}$$

The state space representation of the scaled *aggregate data targeting* is given by:

$$LF_t^{ADT}=Y_t^{ADT\,/}K^{ADT}Y_t^{ADT} \quad (45)$$

where:

$$Y_t^{ADT}=C_X^{ADT}X_t^U+C_r^{ADT}i_t \quad (46)$$

$$C_X^{ADT}=\begin{bmatrix} w\pi\alpha^{AUS} & w\pi\alpha^{BEL} & w\pi\alpha^{FIN} & w\pi\alpha^{FRA} & w\pi\alpha^{GER} & w\pi\alpha^{IRL} & w\pi\alpha^{ITL} & w\pi\alpha^{LUX} & w\pi\alpha^{NET} & w\pi\alpha^{POR} & w\pi\alpha^{SPA} & Z_3^1\\ wy\alpha^{AUS} & wy\alpha^{BEL} & wy\alpha^{FIN} & wy\alpha^{FRA} & wy\alpha^{GER} & wy\alpha^{IRL} & wy\alpha^{ITL} & wy\alpha^{LUX} & wy\alpha^{NET} & wy\alpha^{POR} & wy\alpha^{SPA} & Z_3^1\\ Z_6^1 & Z_6^1 & Z_6^1 & Z_6^1 & Z_6^1 & Z_6^1 & Z_6^1 & Z_6^1 & Z_6^1 & Z_6^1 & Z_6^1 & wi \end{bmatrix}$$

$$K^{ADT}=diag\,(1,\quad b,\quad d)$$

$$C_r^{ADT}=\begin{bmatrix}0\\0\\1\end{bmatrix} \quad (47)$$

We remember that α^i is the weight assigned to the economic conditions of country *i* in the decision process. Throughout the paper we use the country specific weights based on the capital subscription of the member states to the European Central Bank. These weights are a function of the country specific GDP and population.[12]

Once the optimal linear feedback rules (16) are derived, the unconditional covariance-variance matrices of the EMU-11 state vector X_t^U may be found for the national and aggregate data policy rule from:

$$vec(\Sigma_{XX^U}^{NDT}) = (I - M^{NDT} \otimes M^{NDT})^{-1} vec(\Sigma_{vv^U}) \tag{48}$$

$$vec(\Sigma_{XX^U}^{ADT}) = (I - M^{ADT} \otimes M^{ADT})^{-1} vec(\Sigma_{vv^U}) \tag{49}$$

where $\Sigma_{vv^U} = E\left(v_t^U v_t^{U\prime}\right)$ is a covariance matrix of the disturbance vector of the EMU-11 model. M^{NDT} and M^{ADT} are given by (18) with $A = A^U$, $B = B^U$, and respectively: $f = f^{NDT}$ and $f = f^{ADT}$.

The variability of the country specific inflation, output, and the common interest rate under the *national data targeting* policy rule (f^{NDT}) may then be derived from the unconditional covariance matrix of the state vector X_t^U as follows:

$$\Sigma_{YY^{NDT}}^{NDT} = C_{NDT}^{NDT} \Sigma_{XX^U}^{NDT} C_{NDT}^{NDT\prime} \tag{50}$$

where:

$$C_{NDT}^{NDT} = C_X^{NDT} + C_r^{NDT} f^{NDT} \tag{51}$$

and $\Sigma_{YY^{NDT}}^{NDT}$ stands for the covariance matrix of the goal variables Y_t^{NDT} under the *national data targeting* policy rule.

In the similar way, the variability of the country specific inflation, output, and the common interest rate under the *aggregate data targeting* policy rule (f^{ADT}) may then be derived from the unconditional covariance matrix of the state vector of the of the goal variables X_t^U according to:

$$\Sigma_{YY^{ADT}}^{NDT} = C_{ADT}^{NDT} \Sigma_{XX^U}^{ADT} C_{ADT}^{NDT\prime} \tag{52}$$

where:

$$C_{ADT}^{NDT} = C_X^{NDT} + C_r^{NDT} f^{ADT} \tag{53}$$

[12] The weights are Austria: 0.030, Belgium: 0.036, Finland: 0.018, France: 0.213, Germany: 0.310, Ireland: 0.011, Italy: 0.189, Luxembourg: 0.002, Netherlands: 0.054, Portugal: 0.024, and Spain: 0.11.

and $\Sigma_{YY\,ADT}^{NDT}$ stands for the covariance matrix of the goal variables Y_t^{NDT} under the *aggregate data targeting* policy rule.

Similarly, the variability of the union-wide aggregates under the *national data targeting* rule may be derived from the unconditional covariance matrix of the state vector X_t^U as follows:

$$\Sigma_{YY\,NDT}^{ADT} = C_{NDT}^{ADT} \sum\nolimits_{XX^U}^{NDT} C_{NDT}^{ADT\,/} \tag{54}$$

where:

$$C_{NDT}^{ADT} = C_X^{ADT} + C_r^{ADT} f^{NDT} \tag{56}$$

and $\Sigma_{YY\,NDT}^{ADT}$ stands for the covariance matrix of the goal variables Y_t^{ADT} under the *national data targeting* rule.

Finally, the variability of the union-wide aggregates under the *aggregate data targeting* rule may be derived from the unconditional covariance matrix of the state vector X_t^U according to:

$$\Sigma_{YY\,ADT}^{ADT} = C_{ADT}^{ADT} \sum\nolimits_{XX^U}^{NDT} C_{ADT}^{ADT\,/} \tag{57}$$

where:

$$C_{ADT}^{ADT} = C_X^{ADT} + C_r^{ADT} f^{ADT} \tag{58}$$

and $\Sigma_{YY\,ADT}^{ADT}$ stands for the covariance matrix of the goal variables Y_t^{ADT} under the *aggregate data targeting* rule.

Once the variability of the country specific inflation, output, and the common interest rate is derived under a given policy rule, the social loss of the monetary union (40) may be calculated as the weighted sum of the country specific losses. Similarly, once the variability of the union-wide aggregate inflation, output, and the common interest rate is found under a given policy rule, the aggregate data loss specification (41) may be computed. Alternatively, the losses (40) and (41) may be found from the equation (30) with $\sum_{vv}$ now being a covariance matrix of the disturbance vector of the EMU-11 and *V* being a matrix satisfying the Riccati equation used in the derivation of a given union-wide policy rule.

7. A Calibration of the Aggregate Relationships

To compare the performance of alternative policy rules we need to calibrate the country specific aggregate relationships (10) and (11). Following Taylor (1998) we simply estimate the aggregate relationships (10) and (11) for the EMU countries by the OLS to obtain a feel for the magnitude of the differences across the countries.

Our empirical work is based on the quarterly data taken from the IMF International Financial Statistics and the OECD Statistics. The estimations were performed on the period 1984.01-1998.04. We use industrial production from the OECD Statistics as a proxy for output. The output gap was constructed by the log-linear detrending[13] of industrial production. More precisely, we interpret the difference between the logarithmic transform of industrial production and the log-linear trend as a cyclical component of output fluctuations[14]. Quarterly inflations are the country specific quarterly CPI indexes (at annual rate) that were taken from the IMF International Financial Statistics. For the case of Austria, Belgium, France, Germany, Italy, Netherlands, and Spain we use the quarterly call money rates available from the IMF International Financial Statistics as a measure of the short-term nominal interest rates. For the case of Portugal the discount rate from the IMF International Financial Statistics is used as a short-term interest rate. For the case of Ireland we use the call money interbank rate and for Finland the liquidity credit rate taken from the OECD statistics. We assume that the Belgian call money rate applies in Luxembourg.

The interest rates and inflation rates were demeaned prior to estimation such that no constants appear as in the aggregate relationships (10) and (11). This amounts to an assumption that the historical average interest rates and inflation rates are roughly equivalent to the central bank targets consistent with the public expectations.

Naturally, we are aware of the possible drawbacks of our methodology. First, the Lucas critique is particularly relevant to our model given that it is very difficult to predict how the economies will work under the new monetary regime. Not only is the monetary regime changing but many other structural changes are taking place at the same time, which are likely to influence the transmission mechanisms and the structure of stochastic disturbances in the euro area. The problems concerning the change of monetary stance are not only related to the fact that countries experienced different monetary policy regimes and thus differences in credibility prior to the formation of EMU. Our model also imposes that the aggregate relationships will not change despite the fact that the movements of short-term interest rates are now perfectly synchronized in the member countries. The closed-economy specification

[13] We follow Fuhrer and Moore (1995), and Taylor (1993a), among many others, in using output gaps based on a log-linear trend.
[14] The potential outputs were estimated on the 1976:1-1998:4 period to capture the business cycle frequencies.

of the country specific aggregate relationships may also bias the empirical results[15]. In addition, the particular choice of the lag structure implied by the equations (10) and (11) might be insufficient to capture all the dynamics in the countries. Finally, the data heterogeneity resulting from the different national accounting systems and the lack of completely comparable data on the short-term interest rates make the estimated country specific models only roughly comparable. For all these reasons, the results of our statistical exercise should be treated at most as a simple model calibration that gives us a feeling of the magnitude of the plausible differences in the economic structures of the member states.

7.1 A Calibrated Inflation and Output Dynamics

For all countries, the coefficients of the real interest rate variables in the aggregate demand equations exhibit the theoretically anticipated sign. In other words, an increase of the interest rate negatively affects the output gap albeit not always significantly. The same holds for the large majority of the coefficients of the output gap variables in the country specific Philips curves.

For our purpose, the presence of asymmetric propagation of shocks is of great importance. Therefore, we estimated the response of output and inflation to an increase of the nominal interest rate for each of the countries. More precisely, we estimated the reaction of the country specific output and inflation to a one percent temporary increase of the short-term nominal interest rate over the period of one year. The responses of the euro area aggregate output and inflation calculated as the weighted sum of the country specific responses were also studied. Figure 1 displays the results of the simulation exercise for output responses. Figure 2 displays the corresponding responses of inflation.

[Insert Figure 1]

Figure 1 suggests that the size of output responses as well as the propagation of an increase of the interest rate differ considerably across countries. In line with the existing empirical literature, we find that a temporary increase of the short-term interest rate triggers a temporary decline of output.

[Insert Figure 2]

[15] Using the similar framework, Aksoy (1999) found that although the coefficients of real exchange rates in the open-economy type of aggregate demand relationship (10) are general significant and of large size, they do not seem to play the central role in the determination of the Euroland interest rates. This is the consequence of the fact that the country specific shadow exchange rates were found to not diverge substantially from each other.

Figure 2 indicates that the initial response of inflation to a temporary increase of the interest rate is smaller than the response of output. Also here, the size of responses as well as the propagation of an increase in the interest rate differ considerably across the countries. Figure 2 shows that for most of the countries an increase in the interest rate causes a decline in inflation.[16] The simulation exercise corroborates the main conclusion of the empirical literature of the significant differences of the direct impact and the transmission of shocks for output and inflation across the EMU countries.

[Insert Table 1]

We further check the eigenvalues of country specific matrixes *A* (23). Table 1 displays the maximum absolute eigenvalues. We observe that all the maximum absolute eigenvalues of the country specific matrixes are within the unitary circle. This implies that the maximum absolute eigenvalue of the EMU-11 model is also within the unitary circle. Therefore, we conclude that temporary shocks do not have permanent effects on the economies of the member states.

7.2 Stochastic Disturbances

To obtain a feel of the country specific stochastic shocks we use the residuals from the output and inflation equations. Consequently, following Rudebusch and Svensson (1999), we assume that the country specific inflation and output shocks are captured by the residuals of their respective regression. The cross-country correlation coefficients between output and inflation shocks, respectively, are displayed in Table 2 and Table 3.

[Insert Table 2 and Table 3]

It appears from Tables 2 and 3 that the degree of correlation between shocks varies across the countries. As expected, the correlation coefficients between the country specific output and inflation shocks and the cross-country correlation coefficients between output and inflation shocks (not displayed in Tables 2 and 3) are small in magnitude in most cases. Therefore, we assume that the correlation between inflation and output shocks is equal to zero.

It is important to stress that the lack of direct cross-country links in the multi-country model is compensated to some extent by the significant cross-country correlation coefficients. Consequently, the correlation coefficients do not necessarily reflect the existence of

[16] For some countries, namely Austria, France, and Ireland, we observe the so-called price puzzle, that is a positive price response to an increase in the interest rate. See Fuhrer (1997) and Christiano et al. (1996) on this.

symmetry between separate shocks hitting the economies. If cross-country links are sufficiently strong, they may generate systematic comovements of inflation and output, and the correlation coefficients may represent a rapid response of one of the economies to the shock originated in the other one. In that sense, we assume that from the policy perspective it is of a little importance how and where the underlying disturbances have originated.

[Insert Table 4 and Table 5]

Finally, Tables 4 and 5 display the mean squared errors of the residuals from output and inflation regressions that we use as proxies of the variances of the corresponding stochastic shocks. The mean squared errors of the residuals suggest a substantial discrepancy in the magnitude of the variances of the stochastic disturbances across the countries.

8. Stabilization Performance of Monetary Policy Rules

8.1 A Framework for Performance Simulations

In this section, we present a framework that we use for the analysis of performance of the monetary policy rules. We evaluate a performance of the *national* and *aggregate data targeting* rules in the environment of Euroland under the main assumption that the calibrated propagation mechanisms holds.

As we already mentioned, we assume that the preferences are the same across the countries. We consider five types of preferences, i.e.: a low preference output stabilization: (*1, b=0.2, d=0.5*), a medium preference output stabilization: (*1, b=1, d=0.5*), a high preference for output stabilization: (*1, b=5, d=0.5*), a medium preference for interest rate stabilization: (*1, b=1, d=1*), and finally a high preference for interest rate stabilization: (*1, b=1, d=5*).

Given the important uncertainty concerning the character of (a) symmetries in the EMU and the lack of consensus among academics about the direction of eventual change, we evaluate the performance of monetary policy rules within five postulated covariance matrixes of the stochastic disturbances. In all cases the correlation coefficients between output and inflation shocks are set equal to zero. The first four matrixes assume that the country specific variances of shocks will remain identical to those observed in the data as displayed in Tables 4 and 5. The first matrix (*Matrix I*) is characterized by the estimated historical correlation coefficients of the same category of shocks as displayed in Tables 2 and 3. The second matrix (*Matrix II*) assumes that shocks experience zero correlation. The third matrix (*Matrix III*) imposes that inflation shocks are perfectly correlated and that output shocks experience zero correlation. The fourth matrix (*Matrix IV*) assumes that shocks of the same category are perfectly correlated. Finally, the fifth matrix (*Matrix V*) imposes that stochastic disturbances of the same category are perfectly correlated and experience no asymmetry of variance[17].

8.2 Country Specific Optimal Linear Feedback Rules

Before studying the performance of policy rules in the monetary union, we derive the country specific optimal feedback rules corresponding to the case when national central banks enjoy complete independence. The performance of these policy rules, which by definition dominate in terms of welfare those incurred under an EMU-wide interest policy, will be used as a benchmark for comparisons of the stabilization effectiveness of the union-wide policy rules.

[Insert Table 6]

We present the country specific optimal feedback rules in Table 6. The table displays, the sums of the coefficients assigned by the policy rule to the country specific lagged inflation (4 lags), lagged output (2 lags), and lagged interest rate (3 lags). The cross-country comparisons of the policy rules reveal important differences between the country specific coefficients of response. This corroborates the existing empirical evidence of significant differences in the propagation mechanisms across the countries. It suggests that the monetary union will incur an additional cost in terms of stabilization effectiveness even if shocks are perfectly symmetric.

In line with the intuition, we find that an increase in inflation and output causes an overall rise of the nominal interest rate. We observe that the weights attached to output by the policy rules increases with the preference for output stabilization. The coefficients assigned to the interest rates are generally large in magnitude, which implies some degree of inertia in the movements of the interest rates. Finally, the maximum absolute eigenvalues of the country specific matrices M (18) are within the unitary circle which implies that the economic systems with the systematic policy rules are stable.

[17] The average variances are calculated as squared weighted sums of the standard deviations of the country specific output and inflation shocks, respectively (see EMU-11 column in Tables 4 and 5).

8.3 Stabilization Performance of the Country Specific Optimal Policy Rules

We evaluate the performance of country specific optimal feedback rules assuming first that the variances of country specific shocks are equal to their estimates, and second that the country specific variances of the same category of shocks are the same and equal to the squares of the weighted sums of estimated standard deviations of shocks. Table 7 and Table 8 present the stabilization performance of the optimal linear rules. Table 7 displays the results for the estimated variances of shocks. Table 8 presents the results where the country specific shocks of a given category have the same variances. The losses calculated under the assumption of equal variances of shocks enable the cross-country comparisons of maximum stabilization bounds implied by the transmission mechanisms.

[Insert Table 7 and Table 8]

The country specific losses differ remarkably, an additional evidence of observed asymmetries. We find that differences in stabilization performance can lead to differences in welfare of more than four hundred percent. As it emerges from Table 8, the significant differences in the stabilization performance across countries tend to persist under the assumption of equal variances of shocks of the same category. This again indicates that the calibrated models of EMU countries differ remarkably in terms of the implied propagation mechanisms.

The performance of the country specific policy rules will serve us as benchmark to measure the losses implied by the common monetary polices.[18] In addition to the country specific optimal losses, we construct union-wide benchmark losses (indicated by the column EMU-11 in Tables 7 and 8). These union-wide benchmark losses are equal to the weighted sum of the country specific losses, which are calculated under an assumption that the member states implement their own desired interest rates. These benchmarks are of course unrealistic since few countries have the capacity to enjoy full monetary independence. Therefore, they should be treated only as a yardstick to give some perspective to the welfare analysis.

[18] Benchmark 1 cases (BEN1) refer to the losses calculated under the estimated country specific stochastic disturbances. Benchmark 2 (BEN2) cases refer to the losses calculated under the assumption of equal variances of the country specific inflation and output shocks, respectively.

8.4 Union-Wide Common Interest Rate Rules

Table 9 presents the union-wide linear feedback rules implied by the *national data targeting* and *aggregate data targeting* loss functions. The table displays, respectively, the sum of the coefficients assigned by a common policy rule to the country specific lagged inflations, lagged outputs, and lagged common interest rate.

[Insert Table 9]

In line with the intuition, we observe that both policy rules generally attach considerable importance to the economic conditions of larger countries. We find that an increase in inflation and output in any of the countries causes an overall rise of the common interest rate under both policy rules. In the same manner as the monetary independence rules, the union-wide rules attach more weight to the country specific outputs when the preference for output stabilization increases. Similarly to the country specific optimal policy rules, the union-wide rules generally assign a considerable weight to the interest rate coefficients, which implies an inert process for the common interest rate. We also note that all maximum absolute eigenvalues of the multi-country systems with systematic common policy rules are within the unitary circle. Therefore, the union-wide national and aggregate data policy rules do not lead to hysteresis effects in the economies of the member states.

As it emerges from Table 9, there are substantial differences between the coefficients assigned to the country specific economic conditions by the *national data* and *aggregate data targeting* rules across all stabilization preferences considered. We observe that the *national data targeting* rule assigns much more relative importance to the countries that are characterized by more responsive inflation and output to the movements of the interest rate compared to the *aggregate data* rule.

The rationale behind the result that the optimal monetary policy assigns considerable weight to the economic conditions of more responsive countries is the following. Reacting to the economic conditions of less responsive economies requires larger shifts of the interest rate compared to those desired by more responsive countries. Therefore, if the central bank would try to optimally react to shocks hitting less responsive economies, the implied shifts of interest rate would induce much larger variability of inflations and outputs in the more responsive countries, and consequently higher overall welfare loss. In addition, output stochastic disturbances induce much larger variability of inflation in more responsive economies because output shocks affect price changes through the slope of the short-term Philips curve, which is larger in more responsive countries. This again leads to an important weight assigned to their economic conditions by the optimal policy rule. In contrast to *the national data targeting*, the optimization of the aggregate data loss calls for the stabilization of the union-wide aggregates that are given by the sum of the country specific inflations and outputs. Consequently, welfare loss induced by misguided policy with respect to the economic conditions of more responsive countries is partially assigned to the less responsive countries, as their data constitute aggregates. As a result the *aggregate data* rule increases the relative importance attached to the shocks of less responsive economies compared to the *national data* rule. This may suggest that more responsive economies to policy instrument will tend to be better off under the *national data* rule while less responsive ones will prefer the *aggregate data* rule. However, it is important to remember that the total loss of a given country under a specific policy will be also determined by other factors such as the relative importance of the country in the decision process or the structure of the covariance matrix of the stochastic disturbances.

8.5 Stabilization Effectiveness of National and Aggregate Data Targeting Rules- A Monetary Union Loss Perspective

In this section, we evaluate the performance of national and aggregate data targeting policy rules in terms of the monetary union loss. Table 10 presents the performance of alternative loss functions across the preferences and covariance matrices of stochastic disturbances. The table displays the expected monetary union losses under the *national data targeting* relative to the benchmark monetary independence weighted losses (*NDT/BEN*), the expected monetary union losses under the *aggregate data targeting* relative to the benchmark monetary independence weighted losses (*ADT/BEN*), and finally the expected monetary union losses under the *aggregate data targeting* relative to the expected monetary union losses under the national data targeting (*ADT/NDT*). It is important to remember, that the *national data targeting* policy rule, which is based on the postulated monetary union loss, will always weakly dominate the *aggregate data targeting* policy rule in terms of the monetary union loss.

[Insert Table 10]

For our purpose, the comparison of performance of the *aggregate data targeting* rule with the *national data targeting* rule, indicated in Table 10 as *ADT/NDT*, is of particular importance. The main result is that the alternative policy objectives yield very similar outcomes from the perspective of the overall monetary union loss. While by definition the *national data* rule weakly dominates other possible specifications in terms of the overall loss, the additional welfare loss induced by the *aggregate data* rule is very small. This result holds across all postulated stabilization preferences and covariance matrices of stochastic disturbances.

As can be inferred from Table 10, the loss of the stabilization effectiveness induced by the common monetary policy is important for some parameters' settings. The results displayed in Table 10 suggests that the highest frustration arises from the common monetary polices associated when the preference for output stabilization is high. We observe that the loss of stabilization effectiveness is to a large extent related to the existence of asymmetries of shocks. If shocks are characterized by zero correlation (*Matrix II*), the loss in the case of a high preference of output stabilization may exceed three hundred percent of its pre-union value. When shocks become more symmetric, the overall relative losses decrease across all preferences and policy objectives. However, even when the country specific stochastic shocks are perfectly correlated (*Matrix IV* and *Matrix V*) the additional loss of stabilization effectiveness may still be important, especially for the case of high preference for output stabilization. This suggests that the differences in the transmission mechanisms across the countries account for an important part of the additional loss induced by the common monetary polices. A closer look at the table reveals that removal of the asymmetry in the magnitude of variances of shocks increases the relative losses. This result implies that the calibrated asymmetries of variances of shocks may have positive welfare effects (compare *Matrix IV* with *Matrix V*) [19].

8.6 Stabilization Effectiveness of National and Aggregate Data Targeting Rules-Country Specific Losses

While so far we have analyzed the performance of alternative policy objectives in terms of the overall loss, in this section we turn our attention to the question of how the overall loss is distributed among the countries. Table 11 presents the country specific losses under the *national data targeting* relative to the losses resulting from the country specific

[19] It can be shown that the asymmetry in variances of shocks may have positive welfare effects. For example, if the asymmetries in the transmission mechanism are present, and the correlation coefficients of shocks are positive, an increase of the variance of shocks that affect economy that is more responsive to policy instrument will increase the overall relative welfare. This follows from the fact that while the more responsive economy has generally lower desire to respond to the same type of shocks than the less responsive one, an increase of the variance of shocks of more responsive economy (up to the point in which the variance becomes too large) will make the individual desires of countries closer to each other.

optimal monetary polices. Table 12 displays the corresponding losses for the *aggregate data targeting* rule.

[Insert Table 11 and 12]

We observe that less preference for output stabilization makes countries better off in relative terms in the case of both policy rules. As it emerges from Tables 11 and 12, the distribution of the overall relative loss among countries is far from being egalitarian. In other words, some countries incur larger relative welfare loss from the participation in the common monetary policy than the others. Generally, smaller countries are found to be much worse off than the larger ones.

[Insert Table 13]

Table 13 compares the stabilization performance of the *aggregate data targeting* rule with the *national data targeting* rule (*ADT/NDT*) in terms of the country specific losses. An important finding is that for most of the countries, the losses do not increase much with a switch from a national to an *aggregate data targeting* rule. However for some countries this switch leads to large welfare losses of up to two hundred percent. Interestingly, the welfare of the more responsive countries to the policy instrument is greater under the *national data targeting* rule across all postulated structures of stochastic disturbances and stabilization preferences compared to the outcome when the *aggregate data* rule is followed. For some less responsive economies the reverse holds true. This result indicates that by assigning more weight to the economic conditions of more responsive economies the *national data targeting* rule improves their welfare compared to the *aggregate data* rule. We also observe that the magnitude of the differences between the country specific losses generated by the two policy rules is the smallest for low output stabilization preference *(1, b=0.2, d=0.5)* and the highest for high output stabilization preference *(1, b=5, d=0.5)*, which holds across all the covariance matrices of the stochastic shocks. The important differences between some of the country specific losses across the two policy rules for high output stabilization preference are likely to be caused by the significant asymmetries in the responses of the country specific outputs to the policy instrument.

[Insert Table 14]

In order to further analyze the stabilization performance of two policy rules Table 14 compares the variability of the common interest rate under the *aggregate data targeting* relative to the *national data targeting*. As it emerges from the table, the *aggregate data* rule leads to higher volatility of the common interest rate compared to the *national data* rule. This result is very intuitive. The aggregate data targeting decreases the relative importance of more responsive countries that prefer small adjustments of the common interest rate. This results in more pronounced policy responses.

8.7 Stabilization Effectiveness of National and Aggregate Data Targeting Rules-Variability of the Union-Wide Aggregates

In this section, we consider the variability of aggregates across the alternative policy objectives. The relative performance of the policy rules in stabilizing the aggregate output and inflation is displayed in Table 15. It is important to remember that the *aggregate data targeting* policy always weakly dominates the *national data targeting* policy in the effectiveness of stabilization of the union-wide aggregates. Therefore, Table 15 presents the losses expressed in terms of aggregates under the *national data targeting* rule relative to benchmark losses of the *aggregate data targeting* rule (*NDT/ADT*).

[Insert Table 15]

We observe that, the performance of the *national data targeting* rule is very close to the *aggregate* data targeting policy. This finding is robust across all stabilization preferences and covariance matrices of the stochastic disturbances. Therefore, if the stabilization of aggregates constitutes the true concern of the central bank (ECB), the *national data targeting* rule will not result in important inefficiencies compared to the *aggregate data targeting* rule.

9. Conclusions

In this paper, we have analyzed the performance of loss functions of the common central bank in a monetary union based on the national data of the member states and union-wide aggregates. In order to assess the performance of two alternative policy objectives in the environment of Euroland, we derived the implied optimal linear feedback rules using the framework similar to the one proposed by Rudebusch and Svensson (1999). The dynamic simulations within the calibrated EMU model indicate that the policy based on the union-wide aggregates yield very close stabilization performances to the policy based on the national data of the member states. This result holds across different structures of the stochastic disturbances and postulated stabilization preferences, and irrespectively of the significant asymmetries in the calibrated models of the EMU countries.

An important finding is that for most of the countries their respective losses do not change much with a switch from national to aggregate data rule. However for some cases, the difference may turn out to be substantial. In general we find that countries, which are more responsive to the policy instrument, tend to be better off under the *national data* rule than under the *aggregate data* rule. The reverse holds true for less responsive countries. This may lead to potential conflicts among the countries when deciding which policy variables, the national data or union-wide aggregates, should be incorporated into the common central bank loss function.

The main implication of the paper is that the announced monetary policy strategy of the ECB using union-wide aggregates may be a reasonable proxy of the optimal policy rule using the national data of the member states. Because the welfare differences between the two alternative polices are very small, the *aggregate data targeting* may provide a better framework for the conduct of common monetary policy by being simpler and to some extent by denationalizing the key decision variables.

Several extensions of our framework may be considered in future research. One could consider to what extent the results of the simulations are sensitive to the changes of the parameter values of the calibrated model. This would make it possible to address the question of model uncertainty. In addition it would make it possible to derive the range of parameters of the dynamic model for which the different policy objectives result in a close stabilization performance.

References:

Aksoy, Y., (1999), Real Exchange Rate and Monetary Policy Effectiveness in EMU, CES DPS 99.20, Katholieke Universiteit Leuven.

Aksoy, Y., De Grauwe, P., Dewachter, H., Do Asymmetries Matter for European Monetary Policy?, forthcoming in the *European Economic Review*.

Ball, L., (1999), Efficient Rules for Monetary Policy, *International Finance*, 2:1, pp. 63-83.

Bayoumi, T., and Eichengreen, B. (1992), Shocking Aspects of European Monetary Unification, CEPR Discussion Paper N° 643.

Bayoumi, T., and Prasad, E., (1995), Currency Unions, Economic Fluctuations and Adjustment: Some Empirical Evidence, CEPR Discussion Paper N° 1172.

Blinder, A. S., (1998), *Central Banking in Theory and Practice*, MIT Press, Cambridge MA.

Chow, G.C., (1970), *Analysis and Control of Dynamic Systems*, New York: Wiley.

Christiano, L.J., Eichenbaum, M., Evans, C., (1996), The Effects of the Monetary Policy Shocks: Some Evidence from the Flows of Funds, *Review of Economics and Statistics*, 78, pp.16-34.

Clarida, R., Gali J., and Gertler, M., (1997), Monetary Policy rules in Practice: Some International Evidence, CEPR Discussion Paper N° 1750.

De Grauwe, P., (1994), *The Economics of Monetary Integration*, Oxford University Press, Oxford.

De Grauwe, P., Dewachter H., and Aksoy, Y., (1999), The European Central Bank: Decision Rules and Macroeconomic Performance, CEPR Discussion Paper N° 2067.

De Grauwe, P., (2000), Monetary Policies in the Presence of Asymmetries, CEPR Discussion Paper N° 2393.

Dornbush, R., Favero, C., and Giavazzi, F., (1998) "Immediate Challenges for the European Central Bank", *Economic Policy*, Vol. 26, pp. 15-64.

Eichengreen, B. (1993), Labour Markets and European Monetary Unification, in P.R. Masson and M.P. Taylor (eds.), *Policy Issues in the Operation of Currency Unions*, Cambridge University Press, Cambridge.

Fuhrer, J.C., and Moore, G.R., (1995), Inflation Persistence, *Quarterly Journal of Economics*, Vol. 110, pp. 127-159.

Fuhrer, J.C., (1997), The (Un)Importance of Forward-Looking Behavior of Price Specifications, *Journal of Money, Credit, and Banking*, Vol. 29, pp. 338-350.

Giovannetti, G., and Marimon, R., (1998), An EMU with Different Transmission Mechanisms, CEPR Discussion Paper N° 2016.

Hallett, H.G., and Piscitelli, L., (1999), EMU in Reality: The Effect of Common Monetary Policy on Economies with Different Transmission Mechanisms, CEPR Discussion Paper N° 2068.

McCallum, B.T., and Nelson, E., (1999), Performance of Operational Policy Rules in an Estimated Semi-Classical Structural Model, in Taylor, J.B. (ed.), *Monetary Policy Rules*, The University of Chicago Press, Chicago.

Obstfeld, M., and Peri, G., (1998), Regional Non-Adjustment and Fiscal Policy, *Economic Policy 26*, April, pp 205-259.

Peersman, G. and Smets, F., (1999), The Taylor Rule: A Useful Monetary Policy Benchmark for the Euro Area, *International Finance*, 2:1, pp. 85-116.

Rudebusch, G.D., and Svensson, L.E.O., (1999), Policy Rules for Inflation Targeting, in Taylor, J.B. (ed.), *Monetary Policy Rules*, The University of Chicago Press, Chicago.

Sargent, T. L., (1987), *Dynamic Macroeconomic Theory*, Mass: Harvard University Press.

Smets, F., (1995), Central Bank Macroeconomic Models and the Monetary Policy Transmission Mechanisms, in BIS (ed.), *Financial Structure and Monetary Policy Transmission Mechanisms*, Basle: BIS.

Taylor, J.B., (1993a), *Macroeconomic Policy in the World Economy: From Econometric Design to Practical Operation*, New York: W.W. Norton.

Taylor, J.B., (1993b), Discretion versus Policy Rules in Practice, *Carnegie-Rochester Conferences Series on Public Policy*, Vol. 39, pp. 195-214.

Taylor, J.B., (1999), Robustness and Efficiency of Monetary Policy Rules as Guidelines for Interest Rate Setting by the European Central Bank, *Journal of Monetary Economic*s, 43 (3), pp. 655-679.

Figure 1

Response of Output to a Temporary One Percent Increase of
Nominal Interest Rate over the Period of One Year

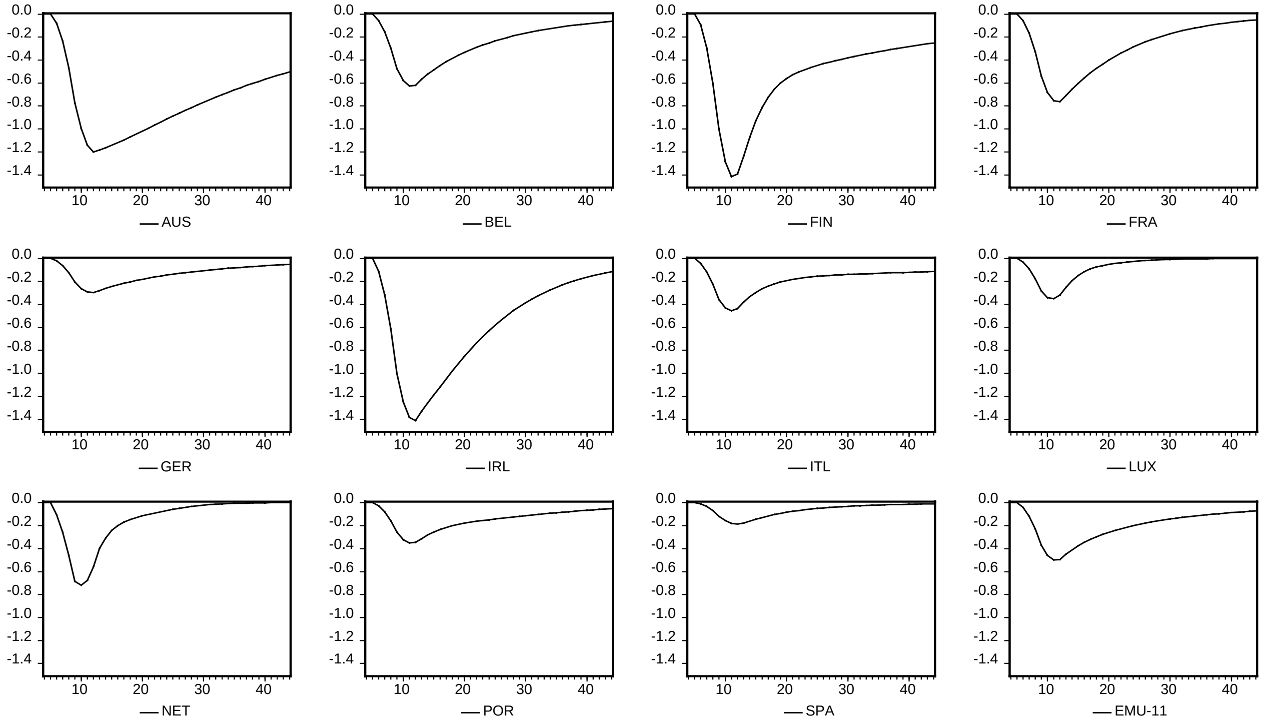

Figure 2

Response of Inflation to a Temporary One Percent Increase of
Nominal Interest Rate over the Period of One Year

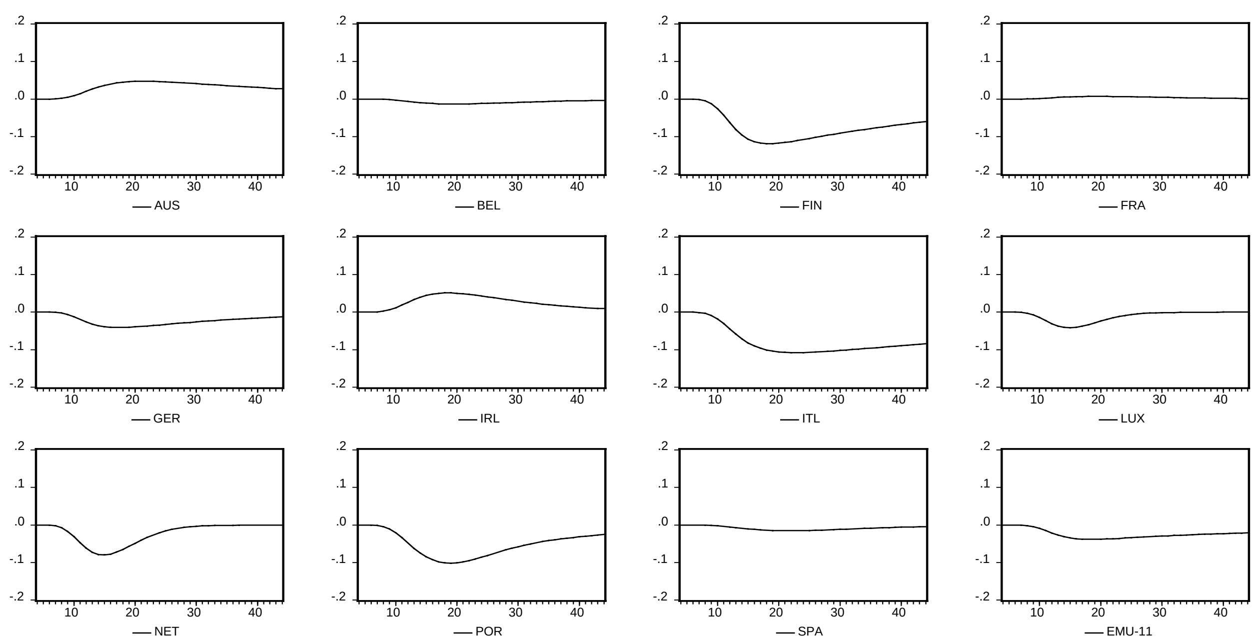

Table 1
Maximum Eigenvalues of Matrices A

AUS	BEL	FIN	FRA	GER	IRL	ITL	LUX	NET	POR	SPA	EMU-11
0.970	0.934	0.971	0.915	0.950	0.916	0.986	0.804	0.814	0.947	0.924	0.986

Table 2
Correlation between Residuals from Output Equations

	AUS	BEL	FIN	FRA	GER	IRL	ITL	LUX	NET	POR	SPA
AUS	1.00	0.13	0.03	0.22	0.28	-0.08	0.07	-0.04	0.14	0.14	0.24
BEL	0.13	1.00	0.24	0.12	0.24	0.26	0.07	0.21	-0.16	0.28	0.24
FIN	0.03	0.24	1.00	0.06	-0.12	0.06	-0.12	-0.09	-0.32	-0.01	-0.11
FRA	0.22	0.12	0.06	1.00	0.50	0.00	0.34	0.16	0.24	0.07	0.36
GER	0.28	0.24	-0.12	0.50	1.00	-0.16	0.25	0.15	0.16	0.21	0.31
IRL	-0.08	0.26	0.06	0.00	-0.16	1.00	0.15	-0.13	-0.01	0.10	0.12
ITL	0.07	0.07	-0.12	0.34	0.25	0.15	1.00	0.24	0.11	0.34	0.23
LUX	-0.04	0.21	-0.09	0.16	0.15	-0.13	0.24	1.00	-0.03	0.09	0.13
NET	0.14	-0.16	-0.32	0.24	0.16	-0.01	0.11	-0.03	1.00	0.14	-0.08
POR	0.14	0.28	-0.01	0.07	0.21	0.10	0.34	0.09	0.14	1.00	0.06
SPA	0.24	0.24	-0.11	0.36	0.31	0.12	0.23	0.13	-0.08	0.06	1.00

Table 3
Correlation between Residuals from Inflation Equations

	AUS	BEL	FIN	FRA	GER	IRL	ITL	LUX	NET	POR	SPA
AUS	1.00	0.40	-0.08	-0.06	0.27	0.06	0.15	0.27	0.54	0.04	0.23
BEL	0.40	1.00	0.20	0.54	0.44	0.33	0.26	0.57	0.45	0.10	-0.18
FIN	-0.08	0.20	1.00	0.44	0.12	-0.01	0.13	0.25	-0.07	-0.05	-0.04
FRA	-0.06	0.54	0.44	1.00	0.35	0.11	0.30	0.43	0.08	0.08	-0.12
GER	0.27	0.44	0.12	0.35	1.00	0.13	0.30	0.54	0.31	-0.09	0.07
IRL	0.06	0.33	-0.01	0.11	0.13	1.00	0.12	0.20	0.20	0.17	-0.03
ITL	0.15	0.26	0.13	0.30	0.30	0.12	1.00	0.44	0.12	0.22	0.16
LUX	0.27	0.57	0.25	0.43	0.54	0.20	0.44	1.00	0.38	0.11	-0.02
NET	0.54	0.45	-0.07	0.08	0.31	0.20	0.12	0.38	1.00	-0.06	-0.03
POR	0.04	0.10	-0.05	0.08	-0.09	0.17	0.22	0.11	-0.06	1.00	0.44
SPA	0.23	-0.18	-0.04	-0.12	0.07	-0.03	0.16	-0.02	-0.03	0.44	1.00

Table 4
Mean Squared Residuals: Output Equation

AUS	BEL	FIN	FRA	GER	IRL	ITL	LUX	NET	POR	SPA	EMU-11
1.74	4.86	2.54	0.86	2.38	5.21	2.83	5.26	3.00	3.53	1.82	2.12

Table 5
Mean Squared Residuals: Inflation Equation

AUS	BEL	FIN	FRA	GER	IRL	ITL	LUX	NET	POR	SPA	EMU-11
0.29	0.21	0.19	0.12	0.47	0.22	0.14	0.31	0.15	1.20	0.41	0.27

Table 6

Optimal Linear Feedback Rules of Single Countries

	AUS	BEL	FIN	FRA	GER	IRL	ITL	LUX	NET	POR	SPA
					Preferences: (*1, b=0.2, d=0.5*)						
Σf_{π}	0.557	0.402	0.799	0.437	0.244	0.627	0.746	0.188	0.407	0.324	0.234
Σf_{y}	0.442	0.335	0.253	0.338	0.359	0.373	0.324	0.143	0.151	0.370	0.247
Σf_{i}	0.346	0.546	0.276	0.491	0.696	0.284	0.598	0.709	0.528	0.642	0.787
$\max\lvert eig(M)\rvert$	0.747	0.796	0.887	0.821	0.839	0.722	0.881	0.806	0.835	0.845	0.848
					Preferences: (*1, b=1, d=0.5*)						
Σf_{π}	0.908	0.672	1.130	0.743	0.394	1.021	0.791	0.401	0.736	0.498	0.349
Σf_{y}	0.876	0.741	0.536	0.737	0.787	0.752	0.621	0.371	0.353	0.694	0.627
Σf_{i}	0.026	0.286	-0.107	0.208	0.526	-0.076	0.396	0.504	0.217	0.476	0.647
$\max\lvert eig(M)\rvert$	0.734	0.795	0.893	0.821	0.789	0.726	0.918	0.798	0.835	0.857	0.841
					Preferences: (*1, b=5, d=0.5*)						
Σf_{π}	1.371	1.058	1.620	1.160	0.655	1.533	1.016	0.746	1.218	0.787	0.554
Σf_{y}	1.646	1.520	1.073	1.492	1.695	1.416	1.306	0.915	0.783	1.457	1.499
Σf_{i}	-0.413	-0.088	-0.615	-0.190	0.265	-0.563	0.063	0.183	-0.249	0.190	0.431
$\max\lvert eig(M)\rvert$	0.735	0.794	0.894	0.821	0.795	0.727	0.927	0.795	0.835	0.859	0.840
					Preferences: (*1, b=1, d=1*)						
Σf_{π}	0.750	0.537	0.928	0.601	0.295	0.844	0.613	0.285	0.561	0.373	0.261
Σf_{y}	0.656	0.531	0.387	0.532	0.552	0.560	0.435	0.241	0.242	0.486	0.417
Σf_{i}	0.177	0.411	0.076	0.343	0.612	0.094	0.508	0.608	0.372	0.572	0.717
$\max\lvert eig(M)\rvert$	0.733	0.795	0.893	0.821	0.802	0.725	0.918	0.802	0.836	0.859	0.843
					Preferences: (*1, b=1, d=5*)						
Σf_{π}	0.458	0.299	0.556	0.345	0.140	0.513	0.325	0.111	0.263	0.175	0.121
Σf_{y}	0.323	0.232	0.172	0.236	0.230	0.269	0.181	0.082	0.093	0.203	0.151
Σf_{i}	0.453	0.631	0.413	0.584	0.760	0.406	0.701	0.782	0.637	0.737	0.835
$\max\lvert eig(M)\rvert$	0.782	0.805	0.892	0.822	0.864	0.755	0.916	0.820	0.841	0.874	0.864

Table 7
Stabilization Performance of Linear Feedback Rules: Single Country Optimal Monetary Policies
Benchmark 1 (*BEN1*): Estimated Variances of the Stochastic Disturbances

	AUS	BEL	FIN	FRA	GER	IRL	ITL	LUX	NET	POR	SPA	EMU-11
Preferences: (*1*, *b=0.2*, *d=0.5*)												
$VAR(\overline{\pi_t})$	1.43	1.87	2.16	1.26	1.84	1.50	4.41	1.88	1.11	9.86	5.29	
$VAR(y_t)$	6.36	13.14	10.18	3.26	12.01	14.07	9.14	17.23	4.18	13.59	15.80	
$VAR(i_t - i_{t-1})$	0.62	0.75	0.67	0.24	0.84	1.01	1.01	0.36	0.14	1.80	0.76	
Loss	3.01	4.88	4.53	2.03	4.66	4.82	6.74	5.51	2.01	13.48	8.83	4.96
Preferences: (*1*, *b=1*, *d=0.5*)												
$VAR(\overline{\pi_t})$	1.44	1.87	2.16	1.26	1.76	1.50	4.81	1.83	1.09	9.61	5.24	
$VAR(y_t)$	4.90	10.88	8.39	2.61	9.84	11.36	7.30	15.80	3.94	12.02	13.27	
$VAR(i_t - i_{t-1})$	1.99	2.94	2.43	0.86	3.13	3.58	1.87	1.94	0.41	3.93	3.39	
Loss	7.33	14.22	11.77	4.30	13.17	14.66	13.05	18.60	5.24	23.60	20.21	11.66
Preferences: (*1*, *b=5*, *d=0.5*)												
$VAR(\overline{\pi_t})$	1.44	1.86	2.15	1.26	1.70	1.50	4.96	1.78	1.08	9.36	5.20	
$VAR(y_t)$	3.88	9.10	6.78	2.12	7.96	9.34	6.20	14.05	3.69	10.16	10.75	
$VAR(i_t - i_{t-1})$	6.84	11.56	10.33	3.23	12.37	13.30	6.84	10.90	1.71	13.68	15.86	
Loss	24.27	53.14	41.21	13.45	47.67	54.84	39.40	77.47	20.38	66.99	66.89	39.26
Preferences: (*1*, *b=1*, *d=1*)												
$VAR(\overline{\pi_t})$	1.43	1.87	2.18	1.26	1.80	1.50	4.95	1.86	1.10	9.86	5.28	
$VAR(y_t)$	5.46	11.80	9.14	2.86	10.80	12.42	7.74	16.50	4.06	12.97	14.42	
$VAR(i_t - i_{t-1})$	1.19	1.63	1.31	0.49	1.70	2.07	1.04	0.88	0.23	2.21	1.69	
Loss	8.08	15.30	12.64	4.62	14.30	15.99	13.73	19.24	5.39	25.04	21.38	12.48
Preferences: (*1*, *b=1*, *d=5*)												
$VAR(\overline{\pi_t})$	1.43	1.88	2.25	1.26	1.90	1.50	5.43	1.91	1.13	10.55	5.38	
$VAR(y_t)$	7.18	14.33	11.07	3.60	13.40	15.52	8.83	17.93	4.38	15.71	17.09	
$VAR(i_t - i_{t-1})$	0.38	0.41	0.34	0.14	0.39	0.59	0.28	0.13	0.06	0.57	0.30	
Loss	10.53	18.25	15.04	5.57	17.25	19.98	15.67	20.47	5.83	29.13	23.99	14.64

Table 8
Stabilization Performance of Linear Feedback Rules: Single Country Optimal Monetary Policies
Benchmark 2 (*BEN2*): No Asymmetry in Variances of the Stochastic Disturbances

	AUS	BEL	FIN	FRA	GER	IRL	ITL	LUX	NET	POR	SPA	EMU-11
						Preferences: (*1*, *b=0.2*, *d=0.5*)						
$VAR(\overline{\pi_t})$	1.33	2.43	3.06	2.94	1.13	1.84	7.95	1.54	1.90	2.58	3.58	
$VAR(y_t)$	7.71	5.78	8.54	8.05	10.69	5.81	8.02	6.98	2.97	8.16	18.45	
$VAR(i_t - i_{t-1})$	0.72	0.40	0.67	0.58	0.74	0.51	1.33	0.17	0.19	0.83	0.82	
Loss	3.23	3.79	5.10	4.84	3.64	3.26	10.22	3.02	2.59	4.63	7.68	5.55
						Preferences: (*1*, *b=1*, *d=0.5*)						
$VAR(\overline{\pi_t})$	1.33	2.43	3.07	2.95	1.07	1.85	8.78	1.52	1.88	2.43	3.53	
$VAR(y_t)$	5.96	4.76	7.01	6.45	8.77	4.63	5.61	6.38	2.79	7.22	15.51	
$VAR(i_t - i_{t-1})$	2.37	1.39	2.14	2.10	2.76	1.60	1.75	0.84	0.41	2.10	3.89	
Loss	8.48	7.89	11.15	10.44	11.22	7.28	15.26	8.32	4.88	10.70	20.98	12.24
						Preferences: (*1*, *b=5*, *d=0.5*)						
$VAR(\overline{\pi_t})$	1.45	2.64	3.33	3.21	1.10	2.02	9.96	1.62	2.03	2.47	3.79	
$VAR(y_t)$	4.83	4.07	5.79	5.35	7.25	3.89	4.76	5.79	2.67	6.24	12.85	
$VAR(i_t - i_{t-1})$	8.46	5.32	8.97	8.16	11.22	5.73	5.55	4.60	1.39	8.12	18.86	
Loss	29.83	25.62	36.75	34.02	42.98	24.31	36.55	32.89	16.07	37.71	77.46	40.56
						Preferences: (*1*, *b=1*, *d=1*)						
$VAR(\overline{\pi_t})$	1.33	2.43	3.09	2.94	1.10	1.85	8.97	1.53	1.89	2.55	3.56	
$VAR(y_t)$	6.63	5.17	7.64	7.07	9.62	5.08	5.91	6.68	2.88	7.77	16.84	
$VAR(i_t - i_{t-1})$	1.41	0.80	1.20	1.21	1.49	0.97	1.04	0.39	0.26	1.14	1.91	
Loss	9.37	8.40	11.93	11.23	12.21	7.89	15.92	8.60	5.03	11.46	22.32	13.08
						Preferences: (*1*, *b=1*, *d=5*)						
$VAR(\overline{\pi_t})$	1.33	2.44	3.18	2.94	1.18	1.84	9.66	1.56	1.94	2.85	3.66	
$VAR(y_t)$	8.69	6.37	9.32	8.89	11.91	6.45	6.71	7.30	3.22	9.26	19.91	
$VAR(i_t - i_{t-1})$	0.44	0.23	0.35	0.34	0.34	0.33	0.34	0.06	0.09	0.28	0.33	
Loss	12.22	9.95	14.25	13.55	14.79	9.92	18.07	9.16	5.58	13.49	25.23	15.39

Table 9
Union-Wide Linear Feedback Rules
National Data Targeting (*NDT*) and Aggregate Data Targeting (*ADT*)

Preferences:	(*1, b=0.2, d=0.5*)		(*1, b=1, d=0.5*)		(*1, b=5, d=0.5*)		(*1, b=1, d=1*)		(*1, b=1, d=5*)	
	NDT	*ADT*	*NDT*	*ADT*	*NDT*	*ADT*	*NDT*	*ADT*	*NDT*	*ADT*
AUS Σf_π	0.068	0.021	0.139	0.037	0.250	0.058	0.108	0.030	0.057	0.017
AUS Σf_y	0.039	0.013	0.086	0.029	0.171	0.058	0.064	0.022	0.030	0.010
BEL Σf_π	0.013	0.016	0.024	0.027	0.037	0.043	0.019	0.021	0.011	0.011
BEL Σf_y	0.012	0.012	0.027	0.027	0.057	0.057	0.020	0.019	0.009	0.008
FIN Σf_π	0.035	0.018	0.057	0.030	0.086	0.047	0.045	0.023	0.025	0.013
FIN Σf_y	0.009	0.004	0.022	0.010	0.048	0.022	0.015	0.007	0.006	0.003
FRA Σf_π	0.103	0.112	0.189	0.188	0.293	0.296	0.154	0.149	0.088	0.081
FRA Σf_y	0.084	0.069	0.195	0.161	0.407	0.340	0.140	0.114	0.060	0.048
GER Σf_π	0.039	0.066	0.055	0.102	0.085	0.160	0.043	0.079	0.022	0.041
GER Σf_y	0.060	0.115	0.125	0.244	0.253	0.502	0.090	0.175	0.040	0.076
IRL Σf_π	0.020	0.009	0.037	0.017	0.060	0.027	0.029	0.013	0.016	0.007
IRL Σf_y	0.010	0.004	0.021	0.009	0.044	0.019	0.016	0.007	0.007	0.003
ITL Σf_π	0.172	0.104	0.149	0.125	0.181	0.179	0.115	0.098	0.060	0.053
ITL Σf_y	0.068	0.056	0.102	0.113	0.197	0.241	0.072	0.079	0.031	0.033
LUX Σf_π	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.001	0.000	0.000
LUX Σf_y	0.000	0.000	0.000	0.001	0.001	0.002	0.000	0.000	0.000	0.000
NET Σf_π	0.020	0.020	0.036	0.043	0.054	0.082	0.027	0.031	0.013	0.013
NET Σf_y	0.008	0.006	0.019	0.016	0.047	0.038	0.013	0.010	0.005	0.004
POR Σf_π	0.005	0.007	0.006	0.010	0.009	0.016	0.005	0.008	0.003	0.004
POR Σf_y	0.006	0.008	0.010	0.016	0.019	0.034	0.007	0.011	0.003	0.005
SPA Σf_π	0.006	0.025	0.006	0.029	0.007	0.038	0.005	0.023	0.003	0.012
SPA Σf_y	0.009	0.034	0.022	0.077	0.046	0.166	0.015	0.054	0.006	0.022
Σf_{i^U}	0.554	0.601	0.306	0.369	-0.060	0.027	0.428	0.482	0.643	0.680
$\max\lvert eig(M)\rvert$	0.982	0.982	0.984	0.983	0.984	0.983	0.984	0.983	0.984	0.983

Table 10
Stabilization Performance of National Data Targeting (*NDT*) and Aggregate Data Targeting (*ADT*)
Monetary Union Losses

Shocks			Matrix I		
Preferences	(*1, b=0.2, d=0.5*)	(*1, b=1, d=0.5*)	(*1, b=5, d=0.5*)	(*1, b=1, d=1*)	(*1, b=1, d=5*)
NDT/BEN1	1.72	2.17	2.74	2.05	1.78
ADT/BEN1	1.77	2.28	2.92	2.13	1.84
ADT/NDT	1.02	1.05	1.07	1.04	1.03
Shocks			Matrix II		
Preferences	(*1, b=0.2, d=0.5*)	(*1, b=1, d=0.5*)	(*1, b=5, d=0.5*)	(*1, b=1, d=1*)	(*1, b=1, d=5*)
NDT/BEN1	1.83	2.35	3.00	2.21	1.90
ADT/BEN1	1.88	2.45	3.17	2.29	1.96
ADT/NDT	1.03	1.04	1.06	1.04	1.03
Shocks			Matrix III		
Preferences	(*1, b=0.2, d=0.5*)	(*1, b=1, d=0.5*)	(*1, b=5, d=0.5*)	(*1, b=1, d=1*)	(*1, b=1, d=5*)
NDT/BEN1	1.55	1.83	2.18	1.75	1.57
ADT/BEN1	1.59	1.93	2.36	1.83	1.63
ADT/NDT	1.02	1.05	1.08	1.05	1.03
Shocks			Matrix IV		
Preferences	(*1, b=0.2, d=0.5*)	(*1, b=1, d=0.5*)	(*1, b=5, d=0.5*)	(*1, b=1, d=1*)	(*1, b=1, d=5*)
NDT/BEN1	1.26	1.40	1.61	1.35	1.25
ADT/BEN1	1.29	1.48	1.76	1.42	1.29
ADT/NDT	1.02	1.06	1.10	1.05	1.03
Shocks			Matrix V		
Preferences	(*1, b=0.2, d=0.5*)	(*1, b=1, d=0.5*)	(*1, b=5, d=0.5*)	(*1, b=1, d=1*)	(*1, b=1, d=5*)
NDT/BEN2	1.34	1.48	1.65	1.43	1.33
ADT/BEN2	1.37	1.55	1.78	1.49	1.36
ADT/NDT	1.02	1.05	1.08	1.04	1.03

Table 11
Stabilization Performance of National Data Targeting (*NDT*)
Country Specific Relative Losses (*NDT/BEN*)

	AUS	BEL	FIN	FRA	GER	IRL	ITL	LUX	NET	POR	SPA
Preferences						(*1*, *b=0.2*, *d=0.5*)					
Matrix I	6.15	1.62	4.07	1.63	1.44	3.68	2.10	1.09	1.42	1.46	1.14
Matrix II	6.18	1.81	3.98	1.88	1.54	3.48	2.27	1.10	1.39	1.52	1.17
Matrix III	4.58	1.32	3.44	1.76	1.24	2.51	1.92	1.03	1.47	1.30	1.09
Matrix IV	2.49	1.04	1.34	1.37	1.18	1.49	1.43	1.01	1.35	1.13	1.05
Matrix V	3.75	1.08	1.38	1.06	1.27	2.56	1.55	1.07	1.35	1.16	1.07
Preferences						(*1*, *b=1*, *d=0.5*)					
Matrix I	8.60	2.09	5.70	2.11	1.79	5.11	2.66	1.17	1.64	1.93	1.37
Matrix II	8.60	2.44	5.50	2.61	1.96	4.72	2.93	1.20	1.61	2.03	1.42
Matrix III	5.71	1.52	4.51	2.25	1.47	2.92	2.31	1.04	1.71	1.58	1.23
Matrix IV	2.51	1.09	1.53	1.49	1.38	1.38	1.57	1.01	1.48	1.30	1.18
Matrix V	3.57	1.04	1.77	1.04	1.42	3.20	1.92	1.04	1.68	1.20	1.19
Preferences						(*1*, *b=5*, *d=0.5*)					
Matrix I	11.88	2.60	7.70	2.74	2.22	6.69	3.31	1.29	1.88	2.59	1.71
Matrix II	11.88	3.09	7.34	3.57	2.48	6.11	3.71	1.33	1.84	2.76	1.80
Matrix III	7.56	1.71	5.80	2.88	1.74	3.44	2.72	1.07	1.93	1.96	1.47
Matrix IV	3.02	1.14	1.82	1.71	1.63	1.40	1.73	1.04	1.62	1.54	1.39
Matrix V	4.04	1.01	2.29	1.01	1.59	4.17	2.42	1.01	2.05	1.25	1.36
Preferences						(*1*, *b=1*, *d=1*)					
Matrix I	7.77	1.95	5.24	2.00	1.67	4.64	2.54	1.13	1.58	1.82	1.30
Matrix II	7.79	2.27	5.10	2.45	1.82	4.31	2.80	1.16	1.56	1.91	1.34
Matrix III	5.20	1.47	4.22	2.14	1.39	2.76	2.24	1.03	1.66	1.51	1.19
Matrix IV	2.29	1.07	1.46	1.44	1.32	1.36	1.54	1.01	1.44	1.26	1.13
Matrix V	3.23	1.04	1.66	1.04	1.35	2.94	1.88	1.06	1.63	1.17	1.14
Preferences						(*1*, *b=1*, *d=5*)					
Matrix I	5.92	1.66	4.28	1.76	1.43	3.61	2.27	1.07	1.44	1.58	1.17
Matrix II	5.98	1.90	4.24	2.09	1.53	3.41	2.48	1.09	1.42	1.64	1.20
Matrix III	4.09	1.36	3.57	1.89	1.24	2.40	2.06	1.02	1.52	1.36	1.10
Matrix IV	1.85	1.05	1.30	1.33	1.20	1.33	1.47	1.01	1.38	1.16	1.06
Matrix V	2.52	1.04	1.43	1.04	1.23	2.38	1.77	1.09	1.51	1.12	1.07

Table 12
Stabilization Performance of Aggregate Data Targeting (*ADT*)
Country Specific Relative Losses (*ADT/BEN*)

	AUS	BEL	FIN	FRA	GER	IRL	ITL	LUX	NET	POR	SPA
Preferences						(*1, b=0.2, d=0.5*)					
Matrix I	7.51	1.65	4.62	1.74	1.31	4.28	2.20	1.10	1.56	1.46	1.13
Matrix II	7.60	1.83	4.26	1.98	1.40	3.76	2.45	1.11	1.45	1.53	1.15
Matrix III	5.86	1.29	3.87	1.99	1.16	2.82	1.95	1.03	1.64	1.26	1.07
Matrix IV	3.41	1.02	1.79	1.66	1.12	1.84	1.40	1.01	1.53	1.10	1.04
Matrix V	4.03	1.12	1.79	1.11	1.18	3.20	1.59	1.08	1.48	1.09	1.05
Preferences						(*1, b=1, d=0.5*)					
Matrix I	13.67	2.22	7.39	2.66	1.58	6.62	2.55	1.19	2.06	1.92	1.34
Matrix II	13.79	2.56	6.56	3.27	1.73	5.65	2.88	1.22	1.84	2.05	1.40
Matrix III	10.32	1.45	5.91	3.24	1.30	3.82	2.12	1.03	2.22	1.47	1.18
Matrix IV	5.64	1.02	2.64	2.50	1.24	2.21	1.42	1.01	2.01	1.20	1.13
Matrix V	5.98	1.24	3.01	1.23	1.28	5.86	1.83	1.09	2.27	1.10	1.14
Preferences						(*1, b=5, d=0.5*)					
Matrix I	20.75	2.80	10.58	3.79	1.90	9.07	3.08	1.31	2.56	2.58	1.65
Matrix II	20.76	3.30	9.11	4.84	2.14	7.57	3.54	1.36	2.21	2.79	1.76
Matrix III	15.80	1.60	8.20	4.82	1.47	4.88	2.38	1.04	2.78	1.77	1.37
Matrix IV	8.83	1.02	3.74	3.65	1.38	2.73	1.49	1.01	2.49	1.34	1.29
Matrix V	8.52	1.37	4.58	1.35	1.37	9.10	2.23	1.05	3.21	1.11	1.27
Preferences						(*1, b=1, d=1*)					
Matrix I	12.13	2.07	6.68	2.47	1.49	5.91	2.44	1.15	1.95	1.82	1.28
Matrix II	12.30	2.38	6.02	3.02	1.62	5.10	2.75	1.17	1.76	1.93	1.32
Matrix III	9.09	1.42	5.39	2.98	1.25	3.52	2.06	1.03	2.10	1.43	1.15
Matrix IV	4.85	1.02	2.37	2.30	1.20	2.06	1.40	1.01	1.90	1.17	1.10
Matrix V	5.19	1.21	2.68	1.21	1.24	5.16	1.80	1.10	2.13	1.09	1.11
Preferences						(*1, b=1, d=5*)					
Matrix I	8.77	1.74	5.22	2.07	1.31	4.40	2.18	1.09	1.68	1.58	1.16
Matrix II	9.01	1.97	4.86	2.46	1.40	3.91	2.42	1.10	1.55	1.65	1.19
Matrix III	6.51	1.34	4.30	2.42	1.16	2.86	1.91	1.03	1.80	1.31	1.08
Matrix IV	3.30	1.02	1.84	1.87	1.12	1.77	1.37	1.02	1.68	1.11	1.04
Matrix V	3.60	1.15	2.04	1.16	1.16	3.70	1.71	1.13	1.82	1.07	1.05

Table 13
Comparison of the Stabilization Performance of Aggregate Data Targeting (*ADT*) versus National Data Targeting: Country Specific Relative Losses (*ADT/NDT*)

	AUS	BEL	FIN	FRA	GER	IRL	ITL	LUX	NET	POR	SPA
Preferences					(*1*, *b=0.2*, *d=0.5*)						
Matrix I	1.22	1.02	1.13	1.07	0.91	1.16	1.05	1.01	1.10	1.00	0.99
Matrix II	1.23	1.01	1.07	1.05	0.91	1.08	1.08	1.01	1.04	1.00	0.99
Matrix III	1.28	0.97	1.13	1.13	0.93	1.13	1.02	1.00	1.11	0.97	0.98
Matrix IV	1.37	0.98	1.34	1.21	0.94	1.23	0.98	1.00	1.14	0.97	0.99
Matrix V	1.08	1.04	1.30	1.05	0.93	1.25	1.03	1.01	1.10	0.94	0.98
Preferences					(*1*, *b=1*, *d=0.5*)						
Matrix I	1.59	1.06	1.30	1.26	0.88	1.30	0.96	1.02	1.26	1.00	0.98
Matrix II	1.60	1.05	1.19	1.25	0.88	1.20	0.98	1.02	1.14	1.01	0.98
Matrix III	1.81	0.96	1.31	1.44	0.89	1.31	0.92	0.99	1.30	0.94	0.96
Matrix IV	2.25	0.94	1.72	1.68	0.89	1.60	0.91	0.99	1.36	0.92	0.96
Matrix V	1.67	1.19	1.70	1.19	0.90	1.83	0.96	1.04	1.35	0.92	0.96
Preferences					(*1*, *b=5*, *d=0.5*)						
Matrix I	1.75	1.08	1.37	1.38	0.85	1.36	0.93	1.02	1.36	1.00	0.96
Matrix II	1.75	1.07	1.24	1.36	0.86	1.24	0.95	1.02	1.20	1.01	0.98
Matrix III	2.09	0.93	1.41	1.67	0.84	1.42	0.88	0.97	1.44	0.90	0.93
Matrix IV	2.92	0.90	2.05	2.14	0.85	1.95	0.86	0.97	1.54	0.87	0.93
Matrix V	2.11	1.36	2.00	1.34	0.86	2.18	0.92	1.04	1.57	0.88	0.93
Preferences					(*1*, *b=1*, *d=1*)						
Matrix I	1.56	1.06	1.27	1.23	0.89	1.28	0.96	1.02	1.23	1.00	0.98
Matrix II	1.58	1.05	1.18	1.23	0.89	1.18	0.98	1.02	1.13	1.01	0.99
Matrix III	1.75	0.97	1.28	1.39	0.90	1.27	0.92	1.00	1.26	0.94	0.97
Matrix IV	2.12	0.95	1.63	1.60	0.91	1.51	0.91	1.00	1.32	0.93	0.97
Matrix V	1.60	1.16	1.62	1.16	0.91	1.75	0.96	1.04	1.31	0.93	0.97
Preferences					(*1*, *b=1*, *d=5*)						
Matrix I	1.48	1.05	1.22	1.17	0.92	1.22	0.96	1.01	1.17	1.00	0.99
Matrix II	1.51	1.04	1.15	1.18	0.91	1.15	0.98	1.01	1.09	1.01	0.99
Matrix III	1.59	0.98	1.21	1.28	0.93	1.19	0.93	1.01	1.18	0.96	0.98
Matrix IV	1.78	0.98	1.41	1.41	0.94	1.33	0.93	1.01	1.22	0.95	0.98
Matrix V	1.43	1.11	1.43	1.11	0.94	1.56	0.96	1.03	1.20	0.96	0.98

Table 14

Comparison of the Stabilization Performance of Aggregate Data Targeting (*ADT*) versus National Data Targeting: Relative Variability of the Common Interest Rate (*ADT/NDT)*

	(*1, b=0.2, d=0.5*)	(*1, b=1, d=0.5*)	(*1, b=5, d=0.5*)	(*1, b=1, d=1*)	(*1, b=1, d=5*)
Matrix I	1.33	1.77	1.90	1.72	1.55
Matrix II	1.31	1.87	2.02	1.81	1.63
Matrix III	1.24	1.46	1.52	1.44	1.37
Matrix IV	1.15	1.41	1.50	1.37	1.25
Matrix V	1.06	1.32	1.41	1.28	1.15

Table 15

Comparison of the Stabilization Performance of Aggregate Data Targeting (*ADT*) versus National Data Targeting: Relative Losses due to Variability of the Union Wide Aggregates (*NDT/ADT)*

	(*1, b=0.2, d=0.5*)	(*1, b=1, d=0.5*)	(*1, b=5, d=0.5*)	(*1, b=1, d=1*)	(*1, b=1, d=5*)
Matrix I	1.07	1.19	1.36	1.17	1.11
Matrix II	1.14	1.34	1.63	1.30	1.21
Matrix III	1.04	1.09	1.15	1.08	1.05
Matrix IV	1.02	1.06	1.12	1.05	1.03
Matrix V	1.02	1.05	1.11	1.04	1.03