The policy mix in a monetary union under alternative policy institutions and asymmetries

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Abstract

In this paper we study the monetary and fiscal policy making in a monetary union when authorities face asymmetries in the countries constructing this monetary union. We analyze this problem in an asymmetric environment using a two-country theoretical model and by introducing two alternative types of national asymmetries : asymmetric shocks and the asymmetric transmission mechanism. The central issue of the paper is the design of the appropriate monetary and fiscal policy institutions. In this respect, we investigate which of the two alternative types of monetary policymakers (country representatives or governors) facing to two alternative types of fiscal policy (decentralized or centralized) contributes to better resolve the problem of the trade-off between credibility and flexibility. Our results show that delegate the monetary policy to a council of union-wide governors with decentralized fiscal policies is the appropriate institutional design that would reduce the inflation bias and stabilize better the regional idiosyncratic shocks in a monetary union in the cases of perfectly asymmetric and perfectly symmetric shocks. In addition, in the case of asymmetric transmission, the monetary union would be better off with a council of monetary policy governors and centralized fiscal policies.

Keywords : EMU, Policy-Mix, Asymmetric shocks, Asymmetric transmission

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1. Introduction

The optimal design of a monetary union among a group of independent countries with asymmetries, such as the European Monetary Union (EMU), is not a matter of monetary policy-making alone, but fiscal policy-making also play an important role. Critics of the current efforts to build a monetary union in Europe recognize that the Maastricht Treaty has no provision for a single fiscal policy to complement the single monetary policy and argue that the success of the EMU will depend on large part on the appropriate design of the monetary and fiscal policy-making. Indeed, since January 1999, national monetary policies of the EMU-member countries are completely centralized in the hands of one central monetary authority, the European Central Bank (ECB). At the same time, however, national central banks continue to exert an important influence on this policy-making process. Thus the European System of Central Banks (ESCB) combines unity of decisions with participation of national central banks in the decision making process and in the implementation of these decisions. On the other hand, national fiscal policies of the EMU-member countries are completely decentralized in the hands of the national governments.

This institutional structure of the EMU reflects late 1980's conventional wisdom according to which monetary policy-making looks after inflation, and governments of EMU-member countries fiscal policies look after local cyclical conditions while monitoring their indebtedness. The basic point in this argument is that, once exchange rate are irrevocably fixed and monetary policy can only be used to stabilize symmetric shocks to all country-members of the monetary union, a system of fiscal spending and taxation must be in place to equilibrate transitory regional cyclical economic instability. According to this argument, the debate over the monetary and fiscal policy-making implications of a monetary union focuses mainly on the effects of transitory idiosyncratic shocks, causing asymmetric effects across the country-members of the monetary union. On the other hand, shocks with symmetric effects across the members of the union would not require exchange rate adjustments, and can be dealt with using the union-wide monetary policy. Thus, monetary policy can still be used to stabilize aggregate shocks that affect all members, but individual countries cannot use monetary policy to respond to idiosyncratic shocks.

In this respect, the optimal design of monetary and fiscal institutions in a monetary union requires the clarification of two issues relative to the conditions under what stabilization policy will be effective in a monetary union: first, the optimal monetary and fiscal policy-making from the point of view of the strategic interaction between the monetary and fiscal policy-makers; second, the distribution of the power over monetary and fiscal policies

between the center of the union and the individual members. In fact, the architecture of the EMU has come about as a compromise between the need to unify the monetary policy-making process in a monetary union and the desire of national policy-makers to be involved in this process. The advantage of the decentralized structure of this system is that it allows for a maximum of information regarding the local economic conditions to filter through in the decision process. The disadvantage is that too much focus on local conditions can paralyze decision-makers when each of them attaches a large weight to economic conditions they originate from.

The purpose of this paper is to examine the monetary and fiscal policy-making in an environment like the EMU. This is characterized by the existence of nation-states with their own idiosyncrasies, monetary policy-makers who take decisions jointly but also keep the interest of their countries and fiscal policies are completely decentralized in the hands of the national governments. From a theoretical point of view, an emerging literature is dealing with the optimal design of central banking institutions[1]. In this literature, Von Hagen and Süppel (1994) assume a federal central bank governed by a council consisting of two alternative types of appointees (governors or country representatives) which is designed to make his decision by a simple majority rule. In this context, the governors desire to stabilize the union's inflation and output, whereas country representatives are concerned with regional economic welfare. They conclude that the country representatives solution leads to an inefficient monetary stabilization policy. On the other hand, in a recent paper, De Grauwe (2000) study the monetary policy-making in monetary union when the monetary authority faces of two type of asymmetries : asymmetric shocks and asymmetric transmission[2]. A general finding is that the degree of asymmetries increases, the effectiveness of stabilization of output is reduced. As a result, when asymmetries increase, the stabilization effort of the central bank declines for given preferences about stabilization. Thus, if the asymmetries (either in chocks or in transmission) are high the central bank will be perceived to be conservative, even though it is not, in terms of its declared preferences. He also finds that the central bank can improve the efficiency of its monetary policies when asymmetries in the transmission exist, by using national information in the setting of optimal policies.

This paper extends the De Grauwe's (2000) analysis in several directions. First, it considers the link between monetary and fiscal policy-making and examines the interplay between

[1] See, among others, von Hagen and Süppel (1994) and Godbillon and Sidiropoulos (2001).

monetary and fiscal policies in a two-country monetary union framework. Second, it considers not only the design of the central bank institutions but also the design of fiscal authority institutions. Third, the relation between the degree of asymmetries and the effectiveness of stabilization is focused on the interaction between monetary fiscal policy, the private sector and the (inflation and budget deficit bias), and thus on the credibility/flexibility trade-off. Forth, within this framework, we analyze the implications of alternative institutional arrangements : centralization versus decentralization.

We assume that the monetary union already exists and that monetary and fiscal policies are decided by the union's monetary and fiscal councils. In addition, the individual countries of the union differ in their economic characteristics. Indeed, individual countries are subject to different shocks and their representatives will have different preferences over monetary and fiscal policies. Therefore, the union's policy-makers may look at monetary and fiscal policies from two different perspectives: a unified one considering union-wide aggregates of output, and prices as the relevant policy targets, and a regional or national one taking regional or national aggregates as targets. In particular, the purpose of this paper is to examine which of the two alternative types of appointment (governors or country representatives) of the fiscal council contributes to efficient stabilization policies.

The paper is organized as follows. Section 2 sets up a model of fiscal-monetary game in a monetary union. Section 3 presents the issues of the policy game between representative monetary authorities and centralized and decentralized fiscal policymakers. Then, section 4 explains the stabilization power of monetary governor facing alternative fiscal decisions making. Section 5, summarizes the main conclusions.

2. A two-country monetary union framework

Consider an monetary union which consists of two countries. The model under consideration is an extended version of the closed-economy framework of Alesina and Tabellini (1987) to a two-country setting by allowing for the monetary and fiscal policy interaction in a monetary union. Our model, in contrast of Alesina and Tabellini (1987), is stochastic rather than deterministic[3], featuring a credibility and flexibility (stabilization) trade-off problem, and

[2] There is a large literature analyzing the importance of asymmetric shocks. See among others, Bayoumi and Einchengreen (1993), Artis and Zhang (1995), Melitz and Zumer (1999). On the other hand, some recent papers (Dornbusch, et al., 1998) analyze the importance of asymmetric transmission mechanism.

[3] In this respect see, among other, Beetsma and Bovenberg (1999).

finally, following De Grauwe (2000), considers two alternative types of asymmetries (shocks and transmission mechanism).

2.1. The monetary union economy

As in Alesina and Tabellini (1987), output which is taxed at a rate t, is produced by competitive firms which use labor input as the sole variable input in the production process. Thus, output in both countries is given by the following supply functions :

$$y_t = \bar{y} + a\,(p_t - p_t^e - t_t) + e_t \qquad a > 0 \qquad (1a)$$

$$y_t^* = \bar{y}^* + a^*(p_t^* - p_t^{*e} - t_t^*) + e_t^* \qquad a^* > 0 \qquad (1b)$$

where y is the log of real output, $\bar{y}$ is the equilibrium (natural) level of output,[4] p and p^e denote, respectively, the actual and expected rate of inflation, t is the tax rate on output and e is an aggregate supply shock, distributed normally with zero mean and variance s_e^2. The superscript '*e*' denotes the rational expectation based on information available at the end of the previous period. Variables without asterisk and with asterisk indicate countries 1 and 2 respectively. Asymmetries appear in two forms in this model. One is an asymmetry in the transmission mechanism represented by different values for a and a^* (i.e. the slopes of the short-term supply functions). The other asymmetry is an asymmetry in the national stochastic disturbances, represented by different values for e and e^*. From equations (1a) and (1b), it follows one source of unemployment : high tax rates drive down output and increase unemployment in the two countries.

The representation of the demand side in both countries is deliberately kept simple in this model, consisting only of a quantity equation linking the central bank's policy instrument, the money growth rate, to the rate of inflation. The link between the money growth rate , *m*, and the output price inflation rate in the two countries is given respectively by : $m_t = p_t$ and $m_t^* = p_t^*$. Thus, we assume that the monetary authorities directly set the rate of inflation. In an alternative and complicated version of the model one could introduce an equation linking the inflation rate to another instrument of monetary policy (e.g. the short-term interest rate). Finally, it is assumed that the inflation rate is assumed equal in the two countries, i.e. $p_t = p_t^*$.

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4 For convenience and without loss of generality, the natural level of output $\bar{y}$ ($\bar{y}^*$) is normalized to zero.

In other words, the common monetary authority sets a common monetary policy (or a common inflation rate) that will prevail in the whole union.

The government budget constraints faced by the two countries fiscal authorities are as follows:

$$g_t = t_t + p_t \tag{2a}$$

$$g_t^* = t_t^* + p_t^* \tag{2b}$$

These approximations to the government budget constraints follow Alesina and Tabellini (1987), by abstracting from the intertemporal dimension of the government budget constraint through the assumption that government expenditures are not financed by issuance of public debt.[5] The absence of the public debt can be interpreted as a situation in which the fiscal authorities wish to raise the desired amount of government expenditure in the form of taxes or seigniorage revenues. Government expenditures are determined once tax rates and money seigniorage have been chosen. Unlike Alesina and Tabellini, there is a common money seigniorage for the two countries, which is determined by the overall inflation rate set by the single central bank.

2.2. The policy environment

We assume that the countries are the individual agents whose welfare is maximized. The monetary policy decision process, however, is unified. One way this idea can be formalized is by specifying that the common monetary authority set the common inflation rate of so as to minimize the following loss function :

$$\min_p \tilde{V}_M = g\, V_M + (1-g) V_M^*, \qquad 0 \le g \le 1 \tag{3}$$

where V_M and V_M^* are the loss functions of central banks of the two member-countries of the monetary union. The parameter g can be interpreted as the weight given to country 1 in the decision process. The parameter g may or not be chosen proportional to the size or the population of country 1 relative to country 2, so that more weight is attached to the loss

[5] The nominal government budget constraint can be written : $P_t G_t + (1+r_t) P_t B_{t-1} = P_t T_t + (M_t - M_{t-1}) + P_t B_t$, where G_t is the public expenditure, $T_t = t_t Y_t$ the taxes, M_t is the money supply, B_t the public debt, P_t the price level, Y_t the output level, B_{t-1} the debt issued in period $t-1$ and to be paid in *t*. Assuming $B_{t-1} = B_t = 0$ and dividing both sides by nominal income, $P_t Y_t$, we obtain : $g_t = t_t + (M_t - M_{t-1})/P_t Y_t$, where $g_t = G_t / P_t Y_t$. Finally, using a simplified quantity equation, $M_t = (1/V_t) P_t Y_t$ with $V_t = 1$, we can obtain equation (2), where $m_t = (M_t - M_{t-1})/M_t$ and $p_t = m_t$.

function of the country having a larger population.[6] The national monetary authorities seek to minimize in their countries the deviation of inflation rate from a goal zero, departures of output from non tax distorted output, and deviations of public expenditure from the target government spending :

$$V_M = (1/2)\left(p_t^2 + m(y_t - \bar{y})^2 + f(g_t - \bar{g})^2\right) \quad (4a)$$

$$V_M^* = (1/2)\left(p_t^{*2} + m^*(y_t^* - \bar{y}^*)^2 + f^*(g_t^* - \bar{g}^*)^2\right) \quad (4b)$$

where $m, f > 0$ and $m^*, f^* > 0$, g denotes the ratio of public expenditures over output, $\bar{y}$ and $\bar{g}$ represent respectively output and public expenditures targets of country representatives. Monetary and fiscal policy-makers are assumed to have the same ultimate targets, and the same relative weights attributed to output and public expenditure relative to inflation (m and f), reflecting their different incentives and constraints. The loss weights on output and public spending deviations from target are assumed to depend on the relative size of the countries in terms of their population or output. Both authorities wish to minimize the deviations of inflation and output from a target value, which is normalized to zero for simplicity. In addition, they wish to minimize the deviations of public expenditures from a non-negative target $\bar{g}$ respectively.[7]

In a similar way, the fiscal authorities in both countries choose the tax rates in their respective countries to minimize the following loss functions :

$$\min_t V_F = (1/2)\left(p_t^2 + m(y_t - \bar{y})^2 + f(g_t - \bar{g})^2\right) \quad (5a)$$

$$\min_{t^*} V_F^* = (1/2)\left(p_t^2 + m^*(y_t - \bar{y})^2 + f^*(g_t - \bar{g})^2\right) \quad (5b)$$

Government expenditures are determined residually from the government budget constraints, defined in equation (2). Because the fiscal authorities are subject to electoral discipline, we assume in the remainder of the analysis that the preferences of the fiscal authorities in equation (5) also reflect the underlying social preferences.

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[6] It will be remembered that in the ESCB one country has one vote irrespective of the size. However, because the members of the ECB-Board also have a nationality so that some countries have two votes. It is then assumed that the members of the ECB Board vote national.

[7] If $\bar{y} > 0$ and $\bar{g} > 0$, the outcome is the existence of two bias : an inflation bias and a budget deficit bias.

The federal structure of the monetary union raises the question of how to distribute the power over monetary and fiscal policy between the center and the two countries of the union. The decision process in this monetary union is now assumed to be organized according to the four alternative institutional arrangements considered below : [8]

(i) First, we begin with a monetary union in which monetary policy-makers take decisions jointly in a common monetary authority where the members are country *representatives* keeping the interest of their countries and national fiscal policies are uncoordinated and completely decentralized in the hands of the national governments.

(ii) Second, we extend this analysis by introducing fiscal policy-makers who take decisions jointly in a common fiscal authority where the members are country *representatives* minimizing the following common loss function .

(iii) Third, we assume a monetary union in which the members of the common monetary authority are *governors* keeping the interest of the whole union and the fiscal policy-making is uncoordinated and decentralized in the hands of the national governments.

(iv) Fourth, we extend this analysis by introducing fiscal policy-makers who take decisions jointly in a common fiscal authority where the members are country *representatives*.

In the remaining sections, we analyze and we compare the optimal inflation and output stabilization policy-making under the previous alternative institutional arrangements by focusing, first, on the asymmetry of the national shocks (in other words, we assume that both countries in the monetary union experience the same transmission mechanism, i.e. $a = a^*$, but exhibit asymmetric national shocks, i.e. $e \neq e^*$), and then, on asymmetry on transmission process (different slope of Phillips curve, i.e. $a \neq a^*$ and $e = e^*$).

3. A monetary union with a monetary authority of country representatives

In this section, we consider a monetary union in which the monetary policy decision process is assumed to be organized by a common (union-wide) monetary authority composed entirely by country representatives (indicated by *MR*). We assume one monetary representative for each country. All union members have one vote and a proposal may be accepted according to a majority rule of votes. One way this idea can be formalized is the following. Each country representative (or national central bank) computes its loss,

[8] Following von Hagen and Süppel (1994), we distinguish two types of appointees : the country *representatives* and the *governors*. The term '*governors*' is borrowed from the U.S federal system practice.

represented respectively by equations 4a and 4b, given the asymmetric shock it observes in its domestic supply function (i.e. equations 1a and 1b). This loss is then aggregate using equation (3) and by giving the suitable weights.[9] The common monetary authority then computes the first order condition of this aggregate loss function, which determines the optimal inflation rate that will be applied to the whole monetary union. To complete this institutional setting, we consider two alternative scenarios of fiscal policy making by assuming alternatively that national fiscal authorities coordinate or not their fiscal policies in the presence of the common monetary authority.

3.1. Decentralized fiscal policies

In this initial setting, the fiscal authority of each country-member of the monetary union is assumed not to coordinate with either the common monetary authority or the fiscal authority of the other country. Thus the two national fiscal authorities choose the tax rates in their own countries to minimize their loss functions represented respectively in equations (5a) and (5b).

3.1.1 Asymmetry in shocks

We consider here a monetary union where both countries experience the same transmission mechanism ($a = a^*$), but exhibit asymmetric national shocks ($e \neq e^*$). In this institutional setting, the time-consistent ex post optimal solutions under monetary and fiscal discretion for common inflation rate, national tax rates and national outputs are given by :[10]

$$p_{MR} = \frac{2mfa^2}{A_1}\bar{g} - \frac{mfa}{A_1 + B_1}(e + e^*) \tag{6}$$

$$t_{MR} = \frac{f}{A_1}\bar{g} + \frac{mfa(f - ma^2)}{(ma^2 + f)(A_1 + B_1)}e + \frac{C_1}{(ma^2 + f)(A_1 + B_1)}e^* \tag{7a}$$

$$t^*_{MR} = \frac{f}{A_1}\bar{g} + \frac{C_1}{(ma^2 + f)(A_1 + B_1)}e + \frac{mfa(f - ma^2)}{(ma^2 + f)(A_1 + B_1)}e^* \tag{7b}$$

[9] In the following, we will generally set $g = 0.5$ assuming that both countries have the same weight in the decision process.

[10] Time indices have been omitted for notational convenience.

$$y_{MR} = -\frac{fa^2}{A_1}\bar{g} + \frac{D_1}{(ma^2+f)(A_1+B_1)}e - \frac{2mfa^2}{(ma^2+f)(A_1+B_1)}e^* \qquad (8a)$$

$$y^*_{MR} = -\frac{fa^2}{A_1}\bar{g} - \frac{2mfa^2}{(ma^2+f)(A_1+B_1)}e + \frac{D_1}{(ma^2+f)(A_1+B_1)}e^* \qquad (8b)$$

where

$$A_1 = ma^2(1+2f)+f > 0, \quad B_1 = 2mfa^2 > 0,$$

$$C_1 = (ma/A_1)\left(f^2(1+f)+2fma^2(1+3f+f^2)+m^2a^4(1+5f+6f^2)\right) > 0,$$

$$D_1 = (m/A_1)\left(f+2mfa^2(1+f)+m^2a^4(1+4f+4f^2)\right) > 0.$$

Inspection of equation (6) reveals that the aggregate supply shocks ($e+e^*$) are only partially offset by the optimal (discretionary) setting of the country representatives monetary policy. The optimal fiscal policy solution (7a,b) shows that the higher is the supply shocks, the higher is the need to use distortionary taxation to finance public expenditures. Moreover, the solutions show that the higher is the public expenditure target $\bar{g}$, the higher is the need to use distortionary taxation to finance public spending and the higher is the inflation rate in the monetary union. If $f = 0$, that is, if public expenditures does not enter in the authorities loss function, then inflation rate is at his targeted level ($p_{MR} = 0$). Moreover, in the case where output does not enter in the authorities loss functions ($m = 0$), then it is straightforward to show that there is no incentive of monetary authorities to create unexpected inflation. Thus inflation rate is zero. In other words, there is perfect credibility of the monetary authorities because of their independence (in objective) relative to the political business cycles.

This first analysis reveals that the problem of the optimal monetary and fiscal policy choice in this monetary union is the trading off between the *credibility* constraint required for eliminating the inflation bias and the *flexibility* needed for stabilization of the shocks.[11] The question then becomes: Can we design an appropriate institutional arrangement in this monetary union that would overcome this problem? To this question we now turn. More precisely, we turn now to the question of how much stabilization of output there will be when asymmetric shocks occur. In order to do so, we compute the variance of the expressions (6), (8a) and (8 b) : [12]

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[11] In this respect, see Beetsma and Bovenberg (1999).

[12] These results are obtained under the assumption that $s_e^2 = s_{e^*}^2$. A possible justification of this assumption is that the two countries in the monetary union are assumed of equal size. From the solution (6),

$$\text{Var}\, p_{MR} = \left(\frac{mfa}{ma^2(1+4f)+f} \right)^2 2(1+r)s_e^2 \tag{9}$$

$$\text{Var}\, y_{MR} = \text{Var}\, y^*_{MR} = \frac{f^2\left((A_1+f)^2 + B_1^2 - 2r\, B_1(A_1+f)\right)}{(ma^2+f)^2(A_1+B_1)^2} s_e^2 \tag{10}$$

where r denotes the correlation coefficient of the national idiosyncratic shocks e and e^*. Two extreme cases can be distinguished : the case of perfect asymmetry in the national shocks (i.e. $r = -1$), and the case of perfect symmetry in the national shocks (i.e. $r = 1$).

Consider first the case of perfect asymmetry in national shocks ($r = -1$). Using equations (9) and (10), we obtain respectively the following inflation and output variability :

$$\text{Var}\, p_{MR} = 0 \quad \text{and} \quad \text{Var}\, y_{MR} = \text{Var}\, y^*_{MR} = \left(\frac{f}{ma^2+f} \right)^2 s_e^2 \tag{11}$$

These results reveal that the common monetary authority of country representatives does not adjust the optimal inflation rate to the perfectly asymmetric shocks that occur in the two countries of the monetary union. On the other hand, since this common monetary authority do not adjust inflation rate so as to accommodate for national asymmetric shocks, the variability of output in both countries is positive. The intuition behind this result is that with perfect asymmetry in national shocks, the national desires about the optimal monetary policy exactly offset each other. Consequently, there is a stalemate in the decision process of the common monetary authority and nothing is done to stabilize output. In the case where output does not enter in the authorities loss functions (i.e. $m = 0$), then it is straightforward to show that the common monetary authority of country representatives behaves as if it is a *super-conservative* central bank because the variability of output is exactly equal to the variability of the underlying shocks : $\text{Var}(y) = \text{Var}(y^*) = s_e^2$. Our results reveal that the output variability is lower than the variability of the underlying shocks because national fiscal authorities stabilize partially these local shocks.

$\text{Var}(p) = \left(\frac{mfa}{A_1+B_1} \right)^2 \left[s_e^2 + s_{e^*}^2 + 2\,\text{cov}(e, e^*) \right]$. Using the equality $\text{cov}(e, e^*) = r\sqrt{s_e^2 \cdot s_{e^*}^2}$, we obtain equations (9) and (10). In this respect, see De Grauwe (2000).

On the other extreme case, where national shocks are perfectly symmetric ($r = 1$), we can find the following results :

$$\text{Var}\, p_{MR} = \left(\frac{2mfa}{ma^2(1+4f)+f} \right)^2 s_e^2 \tag{12a}$$

$$\text{Var}\, y_{MR} = \text{Var}\, y^*_{MR} = \left(\frac{f}{ma^2(1+4f)+f} \right)^2 s_e^2 \tag{12b}$$

The positive variability of inflation rate in equation (12a) means that the common monetary authority of country representatives adjusts the optimal inflation rate to the symmetric shocks that occur in the two countries of the monetary union. Since the common monetary authority adjusts the inflation rate so as to accommodate for shocks, equation (12b) shows that the variability of output becomes positive in the presence of perfect symmetric shocks. Comparison of equations (11) and (12b), reveals that variability of output is greater in the last case than in the case of perfect asymmetric shocks. More generally, we find that the degree of inflation variability and the degree of output stabilization exerted by the monetary and fiscal authorities in this monetary union are positive functions of the correlation of the shocks :

$$\frac{\partial(\text{Var}\, p_{MR})}{\partial r} = \frac{2m^2 f^2 a^2 s_e^2}{(A_1 + B_1)^2} > 0 \quad \text{and} \quad \frac{\partial(\text{Var}\, y_{MR})}{\partial r} = -\frac{2f^2(A_1 + f)B_1 s_e^2}{(m_1 a^2 + m_2)^2 (A_1 + B_1)^2} < 0$$

Consequently, even if the monetary policy country representatives preferences (as given by m and f) do not change, an increase in r increases their output stabilization (or flexibility) effort and induces them to increase the variability of inflation reducing their credibility effort. Conversely, a decline in r leads them to reduce their stabilization efforts and to increase the credibility of their common monetary policy.

3.1.2. Asymmetry in transmission

We focus now on the asymmetry of the transmission mechanism. We will assume that both countries in the monetary union experience symmetric national shocks ($e = e^*$), but exhibit asymmetry of the transmission mechanism (i.e. $a \neq a^*$). Under this assumption, we compute the variance of the inflation rate and the variances of the output in both countries as :

$$\text{Var}\, p_{MR'} = \left(\frac{2mf\tilde{a}}{f + m(1+4f)(\tilde{a}^2 + s_a^2 + a^2 a^{*2})} \right)^2 s_e^2 \qquad (13a)$$

$$\text{Var}\, y_{MR'} = \left(\frac{f^2 + mfa^{*2} + 2mf^2 a^*(a^* - a)}{f + m(1+4f)(\tilde{a}^2 + s_a^2 + a^2 a^{*2})} \right)^2 s_e^2 \qquad (13b)$$

$$\text{Var}\, y^*_{MR'} = \left(\frac{f^2 + mfa^{*2} + 2mf^2 a(a - a^*)}{f + m(1+4f)(\tilde{a}^2 + s_a^2 + a^2 a^{*2})} \right)^2 s_e^2 \qquad (13c)$$

where $\tilde{a} = (1/2)(a + a^*)$ and $s_a^2 = (1/2)\left((a - \tilde{a})^2 + (a^* - \tilde{a})^2\right)$. We define $\tilde{a}$ as the average of the union-wide estimate of the slope of the supply function and we can interpret this variance s_a^2 as a measure of the asymmetry in the transmission process.[13] Equation (13a) shows that, with an increasing asymmetry in the transmission mechanism (increasing s_a^2), the less the common monetary authority adjusts the inflation rate to stabilize the economy. In this respect, monetary policies decided by country representatives and aimed to stabilize output become less effective. Assuming that $a^* > a$ (i.e. more flexibility in the labor market of country 2 than in the labor market of country 1), the numerator of (13b) is greater than the numerator of (13c) and the variance of output is greater in the rigid country than in the flexible country. Indeed, when a symmetric shock hits symmetrically both countries of the monetary union, the stabilizing effect of the monetary and fiscal policy mix will be stronger in flexible country than in the rigid country, since output in the flexible country reacts stronger to prices than in the rigid country. Finally, we find that an increase in the asymmetry of the transmission process (measured by s_a^2) increases the variance in the rigid country and reduces it in the flexible country.[14]

3.2. Centralized fiscal policies

We now assume that the two national fiscal authorities coordinate their fiscal policies in the presence of the common monetary authority. In this respect, the control over taxation and government spending will be assumed centralized at the federal union level rather than at a

[13] A justification of this assumption may be founded on the *Lucas critique* which states that policy changes affect the parameters of the reduced-form models.

[14] In the appendix 1 we provide the demonstration of this result.

national level. In an admittedly simplified manner, this case can be analysed by introducing a federal fiscal authority which might be looked upon as a coalition of the national fiscal authorities designing a common fiscal policy.[15] One way this idea can be formalized is by assuming, in a similar way to the case of the common monetary authority, that the federal fiscal authority seeks to minimize the following loss function :

$$\min_{\tilde{t}} \tilde{V}_F = g\, V_F + (1-g) V_F^* \quad , \quad 0 \le g \le 1 \tag{14}$$

where V_F and V_F^* are the loss functions of the fiscal authorities of the two member-countries of the monetary union. This is different from the insular fiscal policy in which the fiscal authorities chose the tax rates in their own countries to minimize their own loss function. It is assumed here that the federal fiscal authority chose a common output tax rate, $\tilde{t}$. The common monetary authority again chooses the union inflation to minimize its loss function.

3.2.1 Asymmetry in shocks ($e \neq e^*$ and $a = a^*$)

We consider then the scenario in which both monetary and fiscal policies in the monetary union is decided by two common monetary and fiscal authorities composed respectively by monetary and fiscal country representatives (indicated by *MFR*) in the presence of asymmetric shocks. The time-consistent solutions under monetary and fiscal discretion in the presence of a common monetary authority and coordinating fiscal authorities give us respectively the following variances of the inflation rate and the output :

$$\mathrm{Var}\, p_{MFR} = \left(\frac{mfa}{ma^2(1+4f)+f} \right)^2 2(1+r) s_e^2 \tag{15a}$$

$$\mathrm{Var}\, y_{MFR} = \mathrm{Var}\, y^*_{MFR} = \frac{(K_1^2 + K_2^2 + 2rK_1K_2)}{4(A_1+B_1)^2} s_e^2 \tag{15b}$$

where $K_1 = A_1 + B_1 + f$ and $K_2 = A_1 + B_1 - f$. Taking into account equations (15a) and (15b) and the assumption of perfectly asymmetric national shocks ($r = -1$), we obtain :

[15] In this perspective, it might be similar to the current ECOFIN in which the ministers of finance and economic affairs of the EU countries regularly meet to coordinate fiscal and economic policies. As in the case of the ECB, the ultimate policies of the federal fiscal authority are likely to involve an intricate bargaining process between the EU countries.

$$\text{Var}\, p_{MFR} = 0 \quad \text{and} \quad \text{Var}\, y_{MFR} = \text{Var}\, y^{*}_{MFR} = s_e^2 \tag{16}$$

On the other hand, when there is perfect symmetry in the national shocks ($r = 1$), we can establish the following results :

$$\text{Var}\, p_{MFR} = \left(\frac{2mfa}{ma^2(1+4f)+f} \right)^2 s_e^2 \tag{17a}$$

$$\text{Var}\, y_{MFR} = \text{Var}\, y^{*}_{MFR} = \left(\frac{f}{ma^2(1+4f)+f} \right)^2 s_e^2 \tag{17b}$$

The first result in equation (16) means that the monetary authority of country representatives does not adjust the optimal inflation rate to the perfectly asymmetric shocks that occur in the two countries of the monetary union. The second result in equation (16) reveals that there is no stabilization at all, because the variability of output is exactly equal to the variability of the underlying shocks. The intuition behind these results is that with perfect asymmetry, the national desires of the two country representatives about the optimal monetary and fiscal policies exactly offset each other. Therefore, there is a stalemate in the decision process of both monetary and fiscal councils of country representatives and nothing is done. Consequently, the common monetary and fiscal councils of country representatives behave as two *super-conservative* authorities which set the weights on output and government spending stabilization equal to zero (i.e. $m = f = 0$). Equations (17a) and (17b) provide the same results as those obtained in the previous case, equations (12a) and (12b). Therefore, these two institutional arrangements have the same stabilizing features.

3.2.2. Asymmetry in transmission ($e = e^{*}$ and $a \neq a^{*}$)

We focus now on the asymmetry of the transmission mechanism. Under this assumption, we obtain the following variances of the inflation and the output in both countries :

$$\text{Var}\, p_{MFR'} = \left(\frac{2mf(a+a^{*})}{2f+2m(1+4f)(\tilde{a}^2+s_a^2)} \right)^2 s_e^2 \tag{18a}$$

$$\text{Var}\, y_{MFR'} = \left(\frac{2f+m(1+4f)a^{*}(a^{*}-a)}{2f+2m(1+4f)(\tilde{a}^2+s_a^2)} \right)^2 s_e^2 \tag{18b}$$

$$\text{Var}\, y^{*}_{MFR'} = \left(\frac{2f+m(1+4f)a(a-a^{*})}{2f+2m(1+4f)(\tilde{a}^2+s_a^2)} \right)^2 s_e^2 \tag{18c}$$

These equations reveal that with increasing asymmetry in the transmission, monetary and fiscal authorities are less effective in stabilizing output. As a result, they apply less stabilization effort and thus, inflation will be less variable.

4. A monetary union with a monetary authority of union-wide governors

In this section, we examine an alternative institutional arrangement for the monetary policy authority in a monetary union : members of the monetary authority are union-wide governors. Indeed, following von Hagen and Süppel (1994), we can distinguish in a monetary union two types of appointees : the *governors* and the country *representatives*. The members of the council of monetary governors are chosen through a centralized appointment procedure and are assumed to look at optimal monetary policy from a unified perspective considering union-wide aggregates as the relevant policy targets. This also implies that they disregard the national information about inflation and output. In this respect, monetary governors preferences depend on the union-wide inflation and output targets and they minimize the following loss function :

$$\min_{p} \tilde{V}_M = (1/2)\left(p^2 + x\,\tilde{y}^2\right), \quad x \geq 0 \tag{19}$$

where $\tilde{V}_M$ is the loss of the common monetary authority, p is the aggregate union inflation rate, and $\tilde{y}$ is the aggregate union output level defined as : $\tilde{y} = g\,y + (1-g)\,y^*$.[16] The logic of taking a union-wide perspective is that the national supply functions are aggregate into one union supply function as : $\tilde{y} = \tilde{a}(p - p^e - \tilde{t}) + \tilde{e}$, where $\tilde{a}$ is an estimate of the union-wide slope of the short-term supply function, and $\tilde{e}$ is the common union-wide shock in the supply function. We will set $\tilde{a} = ga + (1-g)a^*$ and $\tilde{e} = ge + (1-g)e^*$ with $0 \leq g \leq 1$.

4.1. Decentralized fiscal policies

In the initial setting, we consider a discretionary common monetary authority composed entirely by governors (indicated by *MG*). The fiscal authorities of both countries of the

[16] This contrasts with the optimising procedure we have followed in previous sections, where we assume that the national authorities (representatives) aggregate their national loss functions (using national data) through some common decision making process.

monetary union are assumed not to coordinate their policies with either the common monetary authority of governors or the fiscal authority of the other country.

4.1.1. Asymmetry in shocks

We consider again a monetary union where both countries experience the same transmission mechanism (i.e. $a = a^*$), but exhibit asymmetric national shocks (i.e. $e \neq e^*$). In this setting, the time-consistent ex post optimal solutions under monetary and fiscal discretion for common inflation rate, and national output are given by : [17]

$$p^e = \frac{xfa^2}{xfa^2 + ma^2 + f}\bar{g} \tag{20}$$

$$p = \frac{xfa^2}{xfa^2 + ma^2 + f}\bar{g} - \frac{xfa}{2xfa^2 + ma^2 + f}(e + e^*) \tag{21}$$

$$y = -\frac{f}{xfa^2 + ma^2 + f}\bar{g} - \frac{xf^2a^2}{(2xfa^2 + ma^2 + f)(ma^2 + f)}e^* + \Phi e \tag{22a}$$

$$y^* = -\frac{f}{xfa^2 + ma^2 + f}\bar{g} - \frac{xf^2a^2}{(2xfa^2 + ma^2 + f)(ma^2 + f)}e + \Phi e^* \tag{22b}$$

where $\Phi = \dfrac{fa^4(2xfm + m^2 + f^2x^2) + 2f^2a^2(m + xf) + f^3}{(2xfa^2 + ma^2 + f)(ma^2 + f)(xfa^2 + ma^2 + f)} > 0$.

Using these time-consistent optimal solutions for inflation and output, we then examine the question of how much stabilization of monetary union there will be when asymmetric shocks occur. Thus, we compute the variances of the inflation rate and output in both countries and then we analyze the two extreme cases : perfect asymmetry in the shocks ($r = -1$), and the perfect symmetry in the shocks there ($r = 1$). When $r = -1$, we can establish the following results:

$$\text{Var}\, p_{MG} = \left(\frac{fax}{2fa^2x + ma^2 + f}\right)^2 s_e^2 \tag{23a}$$

$$\text{Var}\, y_{MG} = \text{Var}\, y^*_{MG} = \left(\frac{f/(fa^2x + ma^2)}{2fa^2x + ma^2 + f}\right)^2 (2fa^2x + f + ma^2)s_e^2 \tag{23b}$$

[17] We set here $g = 0.5$ assuming that both countries have the same weight in the decision process.

In the other extreme case (when $r = 1$), we can establish the following results :

$$\text{Var}\, p_{MG} = \left(\frac{fax}{2fa^2x + ma^2 + f} \right)^2 s_e^2 \tag{24a}$$

$$\text{Var}\, y_{MG} = \text{Var}\, y^*_{MG} = \left(\frac{f/(fa^2x + ma^2)}{2fa^2x + ma^2 + f} \right)^2 (f + ma^2) s_e^2 \tag{24b}$$

We can consider here the case of an independent monetary council stabilizing the union-wide inflation rate reflected by the assumption that output does not enter into the monetary governors' objective function (that is, $x = 0$). From these solutions it is straightforward to establish the following results : $\text{Var}\, p_{MG} = 0$, $\text{Var}\, y_{MG} > 0$ and $\text{Var}\, y^*_{MG} > 0$. According to these results, there is a perfect credibility of the independent governors' monetary policy. These results reveal that an independent common monetary authority of governors does not adjust the optimal inflation rate to the perfectly asymmetric and symmetric shocks that occur in the two countries of the monetary union. Since the monetary authority of governors do not adjust inflation so as to accommodate for national shocks, the variability of output in both countries is positive.

4.1.2. Asymmetry in transmission

Under the assumption of the asymmetry in the transmission mechanism ($a \neq a^*$) and the symmetry of shocks ($e = e^*$), we obtain in this institutional policy design the following variances of the union-wide inflation rate and the output in the two countries :

$$\text{Var}\, p_{MG'} = \left(\frac{x(a^3 + a^{*3})C_2 + x(a + a^*)D_2}{2xmf(a^4 + a^{*4}) + 4F_1(\tilde{a}^2 + s_a^2)} \right)^2 s_e^2 \tag{25a}$$

$$\text{Var}\, y_{MG'} = \left(\frac{4f(ma^{*2} + f) + fx(a^2 - a^{*2})(ma\,(a - a^*) - 2f)}{xmf(a^4 + a^{*4}) + 2F_1(\tilde{a}^2 + s_a^2)} \right)^2 s_e^2 \tag{25b}$$

$$\text{Var}\, y^*_{MG'} = \left(\frac{fx(a^{*2} - a^2)(2f + ma\,(a - a^*)) - 4f(ma^2 + f)}{xmf(a^4 + a^{*4}) + 2F_1(\tilde{a}^2 + s_a^2)} \right)^2 s_e^2 \tag{25c}$$

where $C_2 = 3mf - af^2a^*$, $D_2 = 4m^2 + ama^*(f + ama^*)$ and $F_1 = 2mf(2 + axa^*) + 2xf^2$. If we consider again an independent common monetary authority of governors stabilizing the union-wide inflation rate (reflected by the assumption $x = 0$), it is straightforward to establish the following results : $\text{Var}\, p_{MG'} = 0$, $\text{Var}\, y_{MG'} > 0$ and $\text{Var}\, y^*_{MG'} > 0$. In other words, equation (25a) shows that, with an increasing asymmetry in the transmission mechanism (increasing s_a^2), an independent common monetary authority of governors does not adjusts the optimal inflation rate to shocks in order to stabilize output in the two countries. On the other hand, equations (25b) and (25c) reveal that with an increasing asymmetry in the transmission mechanism, monetary and fiscal policies are less effective in stabilizing output.

4.2. Centralized fiscal policies

We consider now the case where the two national fiscal authorities coordinate their fiscal policies by creating a federal council of country representatives in the presence of the common monetary authority of governors (designed by *MGFR*). One way this idea can be formalized is by assuming, as previously, that the federal fiscal authority of country representatives seeks to minimize the loss function represented by equation (14) and the monetary governors preferences are presented by equation (19).

4.2.1. Asymmetry in shocks ($e \neq e^*$ and $a = a^*$)

In an initial setting, we assume that both countries experience asymmetric national shocks in the presence of the same transmission mechanism. Moreover, we assume that the two countries may have different weights in the decision process (i.e. $g \neq 0.5$). Under these assumptions, we obtain the following variances of the union-wide inflation rate and of the output when there is perfect asymmetry in the shocks (i.e. $r = -1$) :

$$\text{Var}\, p_{MGFR} = \left(\frac{ax(2gf + 2gma^2 - ma^2 - f)}{2fa^2x + ma^2 + f} \right)^2 s_e^2 \qquad (26a)$$

$$\text{Var}\, y_{MGFR} = \left(\frac{4fxa^2(g-1) - ma^2 - f}{2fa^2x + ma^2 + f} \right)^2 s_e^2 \qquad (26b)$$

$$\text{Var}\, y^*_{MGFR} = \left(\frac{4fxa^2g + ma^2 + f}{2fa^2x + ma^2 + f} \right)^2 s_e^2 \qquad (26c)$$

When there is perfect symmetry in the national shocks (i.e. $r = 1$), we obtain :

$$\text{Var}\, p_{MGFR} = \left(\frac{axf}{2fa^2x + ma^2 + f} \right)^2 s_e^2 \tag{27a}$$

$$\text{Var}\, y_{MGFR} = \text{Var}\, y^*_{MGFR} = \left(\frac{f + ma^2}{2fa^2x + ma^2 + f} \right)^2 s_e^2 \tag{27b}$$

If we consider an independent common monetary authority of governors stabilizing the union-wide inflation rate (reflected by the assumption $x = 0$) in the presence of a federal fiscal council of country representatives, it is straightforward to establish in the two alternative cases (perfectly asymmetric shocks, and perfectly symmetric shocks) the following results : $\text{Var}\, p_{MGFR} = 0$, $\text{Var}\, y_{MGFR} = \text{Var}\, y^*_{MGFR} = s_e^2$. The same results are obtained also in the case of perfect asymmetric shocks if we assume that both countries have the same weight in the decision process (i.e.$g = 0.5$). This means that the monetary union authorities do not adjust the inflation rate so as to accommodate for national shocks and thus variability of output is exactly equal to the variability of the underlying shocks.

4.2.2. Asymmetry in transmission ($e = e^*$ and $a \neq a^*$)

Finally, under the assumptions of asymmetry in the transmission mechanism and the symmetry in shocks, we can obtain the following variances of the union-wide inflation rate and the output:

$$\text{Var}\, p_{MGFR'} = \frac{1}{2}\left(\frac{x(a^3 + a^{*3}) + x(a + a^*)(4f - ama^*)}{2f(1 + axa^*) + 2(m + xf)(\tilde{a}^2 + s_a^2)} \right)^2 s_e^2 \tag{28a}$$

$$\text{Var}\, y_{MGFR'} = \left(\frac{(a - a^*)(ma^* + xf(a + a^*)) - 2f}{2f(1 + axa^*) + 2(m + xf)(\tilde{a}^2 + s_a^2)} \right)^2 s_e^2 \tag{28b}$$

$$\text{Var}\, y^*_{MGFR'} = \left(\frac{(a - a^*)(ma^* + xf(a + a^*)) + 2f}{2f(1 + axa^*) + 2(m + xf)(\tilde{a}^2 + s_a^2)} \right)^2 s_e^2 \tag{28c}$$

These results show that, with an increasing asymmetry in the transmission mechanism, an independent monetary authority of governors (i.e.) does not adjust the inflation rate so as to accommodate for national shocks. That is, if $x = 0$, it is straightforward to establish the following results : $\text{Var}\, p_{MGFR'} = 0$, $\text{Var}\, y_{MGFR'} > 0$ and $\text{Var}\, y^*_{MGFR'} > 0$ Assuming that $a^* > a$ the variance of output is greater in the rigid country than in the flexible country, so that, $\text{Var}\, y_{MGFR'} > \text{Var}\, y^*_{MGFR'}$. For example, when a symmetric shock hits symmetrically both countries, the stabilizing effect of the monetary and fiscal policy mix will be stronger in flexible country than in the rigid country, since output in the flexible country reacts stronger to prices than in the rigid country.

5. Comparison of the alternative institutional policy-mix arrangements

The question arising here is which is the appropriate institutional policy design that would better resolve the trade-off between the inflation bias (credibility) and the output stabilization (flexibility) in a monetary union. To investigate the appropriate policy design (or the optimal policy mix), we evaluate and compare the performances of the four previous alternative institutional arrangements : monetary country representatives or monetary union-wide governors with and without coordinating fiscal authorities. In this respect, we focus our analysis on the variability of inflation and output in the following special cases: perfectly asymmetric shocks, perfectly symmetric shocks, and asymmetric transmission .

5.1. Perfectly asymmetric shocks

Consider first the case in which individual countries are affected by perfectly asymmetric shocks. Comparing first the performances of an institutional design in a monetary union constituting by a monetary authority of country representatives in the presence of a decentralized fiscal policies (designed by *MR*) with the performances of an institutional design constituting by a monetary authority of country representatives in the presence of centralized fiscal policies (designed by *MFR*), we obtain the following results : $\text{Var}\, p_{MR} = \text{Var}\, p_{MFR} = 0$, $\text{Var}\, y_{MR} < \text{Var}\, y_{MFR}$ and $\text{Var}\, y^*_{MR} < \text{Var}\, y^*_{MFR}$. Comparing next the performances of an institutional design constituting by a monetary authority of union-wide governors in the presence of a decentralized fiscal policies (designed by *MG*) with the performances of an institutional design constituting by a monetary authority of union-wide governors in the

presence of a centralized fiscal policies (designed by *MGFR*), we obtain the following results: $\text{Var}\, p_{MG} = \text{Var}\, p_{MGFR} = 0$, $\text{Var}\, y_{MG} < \text{Var}\, y_{MGFR}$, $\text{Var}\, y^*_{MG} < \text{Var}\, y^*_{MGFR}$. Finally, following these results a comparison of inflation and output variances among the four previous institutional arrangements (*MR, MG, MFR* and *MGFR*) may be summarized in Table 1.

Table 1 : Comparison of solutions under perfectly asymmetric shocks($r = -1$)

Union-wide inflation	Output in country 1	Output in country 2
$\text{Var}\, p_{MR} = \text{Var}\, p_{MG} = 0$	$\text{Var}\, y_{MG} < \text{Var}\, y_{MR} < s_e^2$	$\text{Var}\, y^*_{MG} < \text{Var}\, y^*_{MR} > s_e^2$
$\text{Var}\, p_{MFR} = \text{Var}\, p_{MGFR} = 0$	$\text{Var}\, y_{MFR} = \text{Var}\, y_{MGFR} = s_e^2$	$\text{Var}\, y^*_{MFR} = \text{Var}\, y^*_{MGFR} = s_e^2$

The comparison of the results of the four cases indicates that the institutional arrangement where a common monetary authority constituting by union-wide governors exist in the presence of decentralized national fiscal policies (*MG*) is the appropriate institutional design in the case of perfectly asymmetric shocks. This institutional design reduce the inflation bias and his variance ($\text{Var}\, p_{MG} = 0$) and better stabilize the output in the case of asymmetric shocks ($\text{Var}\, y_{MG} < \text{Var}\, y_{MR} < s_e^2$). Noting that these results are obtained under the assumption of the independence of the monetary council of union-wide governors (i.e.$x = 0$), and under the following assumption : $(ma^2 + f)/(ma^2)^2 < 1$. [18] Consequently, with this institutional design we obtain the best trade-off between credibility and flexibility in a monetary union.

5.2. Perfectly symmetric shocks

Consider now the case in which monetary union countries are affected by perfectly symmetric shocks. A summary of the comparisons among the different institutional regimes is illustrated

[18] When we set $a = 1$, this last condition may be transformed as : $m > 1$. This means that the relative weight attributed to the output stabilization is significantly high in the loss functions of the local fiscal authorities.

in Table 2 . These results are provided under the assumption of independence of the monetary authority of union-wide governors (i.e. $x = 0$).

Table 2 : Comparison of solutions under perfectly symmetric shocks($r = 1$)

Union-wide inflation	Output in country 1	Output in country 2
$\text{Var}\, p_{MR} = \text{Var}\, p_{MFR} > 0$	$\text{Var}\, y_{MR} = \text{Var}\, y_{MFR} > 0$ and $\text{Var}\, y_{MFR} < \text{Var}\, y_{MG}$	$\text{Var}\, y^*_{MR} = \text{Var}\, y^*_{MFR} > 0$ and $\text{Var}\, y^*_{MFR} < \text{Var}^*\, y_{MG}$
$\text{Var} p_{MG} = \text{Var} p_{MGFR} = 0$	$\text{Var}\, y_{MG} < \text{Var}\, y_{MGFR} = s_e^2$ $\text{Var}\, y_{MFR} < \text{Var}\, y_{MGFR} = s_e^2$	$\text{Var}\, y^*_{MG} < \text{Var}\, y^*_{MGFR} = s_e^2$ $\text{Var}\, y^*_{MFR} < \text{Var}\, y^*_{MGFR} = s_e^2$

In the first line, we report the results of the comparison between the performances of an institutional regime constituting by a monetary authority of country representatives with a decentralized fiscal policies (*MR*) and the performances of an institutional regime constituting by a monetary authority of country representatives with a centralized fiscal policies (*MFR*). In the second line, we report the results of the comparison between an institutional regime constituting by a monetary authority of union-wide governors with a decentralized fiscal policies (*MG*) and the performances of an institutional design constituting by a monetary authority of union-wide governors with a centralized fiscal policies (*MGFR*). The comparison of these results indicates that, in the case of perfectly symmetric shocks in a monetary union, the regime where a common monetary authority constituting by union-wide governors exist in the presence of decentralized national fiscal policies (*MG*) is the appropriate institutional design. This institutional regime reduce the inflation bias and his variance ($\text{Var}\, p_{MG} = 0$) and better stabilize the output in the case of symmetric shocks ($\text{Var}\, y_{MG} < \text{Var}\, y_{MGFR} = s_e^2$). Consequently, with this institutional design we obtain the best trade-off between credibility and flexibility in a monetary union.

5.3. Asymmetric transmission

Consider finally the case in which monetary union countries are affected by an asymmetric transmission mechanism . A summary of the comparisons among the different institutional

regimes is illustrated in Table 3 . These results are provided under the assumption of independence of the monetary authority of union-wide governors (i.e.$x = 0$).

Table 3 : Comparison of solutions under asymmetric transmission ($a^* > a$)

Union-wide inflation	Output in country 1	Output in country 2
$\text{Var}\, p_{MR'} > 0$ $\text{Var}\, p_{MFR'} > 0$ $\text{Var}\, p_{MR'} < \text{Var}\, p_{MFR'}$	If $m = 0$ and $f \leq 1$: $\text{Var}\, y_{MR'} \leq \text{Var}\, y_{MFR'}$ If $f = 0 : \text{Var}\, y_{MR'} \leq \text{Var}\, y_{MFR'}$	If $m = 0$ and $f \leq 1$: $\text{Var}y^*_{MR'} \leq \text{Var}y^*_{MFR'}$ If $f = 0 : \text{Var}y^*_{MR'} \leq \text{Var}y^*_{MFR'}$
$\text{Var}\, p_{MG'} = 0$ $\text{Var}\, p_{MGFR'} = 0$	$\text{Var}\, y_{MG'} > 0$ $\text{Var}\, y_{MGFR'} > 0$ $\text{Var}\, y_{MG'} > \text{Var}\, y_{MGFR'}$	$\text{Var}\, y^*_{MG'} > 0$ $\text{Var}\, y^*_{MGFR'} > 0$ $\text{Var}\, y^*_{MG'} > \text{Var}\, y^*_{MGFR'}$

These results reveal that the institutional policy regime of a monetary council of union-wide governors with centralized national fiscal policies (*MGFR*) is the appropriate institutional design in the case of asymmetric transmission process. This institutional regime reduce the inflation bias and his variance ($\text{Var}\, p_{MGFR'} = 0$) and better stabilize the output ($\text{Var}\, y_{MGFR'} < \text{Var}\, y_{MR'}$). These results are obtained under the assumption of the independence of the monetary council of governors ($x = 0$), and under the following assumption concerning the width of the transmission asymmetry : $a^* - a \geq (ma^2 - f)/ma^*$.

6. Conclusion

This paper explores the policy performances of alternative institutional regimes through which fiscal policy interact with monetary policy in a monetary union, such as the EMU. Indeed, the federal structure of a monetary union raises the question of how to distribute the power over monetary and fiscal policies between the center and the member countries of the union. The central issue of the paper is the design of the appropriate monetary and fiscal institutions by comparing alternative arrangements to distribute this power and evaluating their performances. In this respect, we investigate which of the two alternative types of appointment (country representatives or governors) of the union-wide monetary and fiscal authorities contributes to reduce the inflation (credibility) and increase the output stabilization effort of authorities (flexibility).

The optimal design of monetary and fiscal institutions depends on the preferences of the member countries , on the stochastic shocks hitting the countries of the union and their respective slopes of the supply functions representing the asymmetry in the transmission mechanism. We focus our analysis on the variability of inflation and output in the following special cases: perfectly asymmetric shocks, perfectly symmetric shocks, and asymmetric transmission. The results of this paper reveal that delegate the monetary policy to a council of union-wide governors with decentralized fiscal national policies is the appropriate institutional design that would reduce the inflation bias and stabilize better the regional idiosyncratic chocks in a monetary union in the cases of perfectly asymmetric and perfectly symmetric shocks. In addition, in the case of asymmetric transmission mechanism, the monetary union would be better off with a council of monetary policy governors and centralized fiscal policies because with this institutional design we obtain the best trade-off between credibility and flexibility in a monetary union.

In general, this paper reviewing the policy-mix problem in a monetary union, offers some analytical aspects relative to the EMU's new situation. Indeed, the institutional policy-mix designed by an independent ECB combined with decentralized fiscal policies in the European Monetary union seems to be the appropriate institutional solution.

Appendix 1 : *Derivation of the effect of the variations of* a *on the variance of output*

Using equation (28a) and the definitions of the union-wide slope of the supply function $\tilde{a} = (1/2)(a + a^*)$ and the variance $s_a^2 = (1/2)\left((a - \tilde{a})^2 + (a^* - \tilde{a})^2\right)$ reported in our text, we can write:

$$\text{Var}(y) = \left(\frac{\Omega_1 + \Omega_2 (a^* - a)}{\Omega_3 + \Omega_4 (a^2 + a^{*2})} \right)^2 s_e^2$$

where $\Omega_1 = m_2^2 + m_1 m_2 a^{*2} > 0$, $\Omega_2 = 2 m_1 m_2^2 a^* > 0$, $\Omega_3 = m_2^2 + A_2 a^{*2} > 0$ and $\Omega_4 = 2B_2 > 0$.

Deriving then Var (y) in respect to a, we obtain :

$$\frac{\partial \text{Var}(y)}{\partial a} = - \frac{2\left(\Omega_1 + \Omega_2 (a^* - a)\right)\left(\Omega_2 \Omega_4 (a^* - a) + \Omega_2 \Omega_3 (\Omega_1 + \Omega_2 a^*)\right)}{\left(\Omega_3 + \Omega_4 a^2 + \Omega_4 a^{*2}\right)^3} s_e^2 < 0$$

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