

Monetary and Fiscal Policy Games and Consequences of Organisational Differences between the European Union and the Rest of the World

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Abstract

The paper deals with monetary and fiscal policy strategic interactions between the European Union and the rest of the world. We use a three-country Mundell-Fleming model to analyse the policy-makers' responses to a negative global productivity shock. The comparison of non-cooperative equilibria indicates that monetary domination harms social welfare. The Stackelberg game in which governments lead is better and can be seen as a second-best form of internal cooperation. The highest welfare gains stem from the joint setting of policies within each area (that is, from the adjustment of the internal monetary-fiscal mix) : solving the conflict about targets between domestic monetary and fiscal authorities is more important than external cooperation. We also show that welfare is higher all over the world if a fiscal stability pact is firmly applied in Europe, whereas delegating the control of monetary policy to a very conservative central banker is clearly sub-optimal.

Keywords : central bank independence, conservativeness, external and internal cooperation, monetary union, policy-mix, stability pact

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1. Introduction

According to some economists (Emerson et al. [1990]), monetary unification in Europe should facilitate dialogue and cooperation with the rest of the world. Some others think on the contrary that the launch of the euro is likely to complicate international macroeconomic policy coordination (Goodhart [1993], Kenen [1993], Begg et al. [1997]).

The optimistic point of view in Emerson et al. [1990] mainly rests on the idea that the European currency union is likely to increase the costs of non-cooperative behaviour for the United States, because of the removal of the asymmetry linked to the small size and to the high degree of openness of European economies. According to them, the other countries should be more aware of non-cooperation drawbacks and, therefore, take into account the spillovers of their policies. Generally speaking, the distribution of non-cooperation costs will probably become less unequal.

We think however that their analysis oversimplifies many things, especially because it considers the European Monetary Union (EMU) as a single actor and, in this way, supposes the appearance of a G3 at the international level. It is true that the Finance Ministers agreed in 1998 upon a three-handed representation mode in the G7 meetings. But such a simplification does not make sense from a fiscal point of view (Goodhart [1993]). No treaty ensures the coordination of national fiscal policies nor their consistency with the monetary strategy of the European Central Bank (ECB). In view of the fact that fiscal and monetary policies are closely interdependent in their effects on the exchange rate, it is rather difficult to see in the launch of the euro the start of a new international cooperation era with the United States !

Some other arguments justify our scepticism, among which the very high weight that the ECB attaches to inflation in its loss function. The priority given to price stability in Europe might well complicate negotiation and informal agreements in international policy forums¹. More directly, why would not European authorities become as indifferent as the others to monetary spillovers (Kenen [1993], Begg et al. [1997]) ?

The result of the coexistence of one central bank and several governments defending their own interests, and therefore in a relatively weak strategic position *vis-à-vis* the common monetary policy-maker, is that the EMU is an original mosaic as regards economic policy, a complex architecture combining centralised and decentralised powers. In other words, the current European setup raises a two-level coordination problem, between the ECB and the governments of the zone taken together, on the one hand, and among national authorities, on the other hand. The fact that national fiscal players do not share the same objectives, or the same preferences either, leads us to think that the ECB is likely to be even more independent *de facto* than it is *de jure* (Johnson [1994]). From a strategic point of view, the monetary policy-making authority could take advantage of fiscal decentralisation and impose its choices very easily. The fact that several governments face one central bank actually means that each national fiscal decision-maker, taken separately, has less incentives to internalise the monetary reaction to his own policy. The modelling framework used to study the decision-making process inside the EMU has to take into account all those interactions among budgetary and monetary actors².

¹ Even if the Council and the ECB are supposed to share the management of the euro exchange rate (article 109 of the Maastricht treaty), the latter will always have the possibility to stray from general orientations for exchange rate policy formulated by the former if price stability is called into question (Kenen [1993], Bénassy-Quéré et al. [1998]).

² Even if the hypothesis of a negotiated solution must be considered as a benchmark, in a normative approach.

In particular, it is important to consider the divergences subsisting on both sides of the Atlantic in the *internal* economic policy organisation, and so in the strategic interactions among domestic authorities, because these differences may have repercussions on welfare, by influencing budgetary and monetary choices, as well as the payoff distribution in case of cooperation. For instance, the US fiscal policy-maker and European governments may react very differently after a common shock, owing to decentralisation in the EMU (that is, because of the additional non-cooperative game among European budgetary authorities). And this internal, specific conflict will automatically imply different monetary policies on the two sides of the Atlantic.

Our general purpose, in this paper, is to bring out the consequences of those organisational differences. More widely, we want to study, in a game-theoretic framework, the repercussions of the strategic interactions between the ECB and European governments on the world macroeconomic equilibrium, on the one hand, and the spillovers of foreign budgetary and monetary policies on European welfare, on the other hand. We use a three-country model, adapted from Canzoneri and Henderson [1991], in order to bring out the specificity of the asymmetric economic policy organisation in the EMU, by means of a comparison with a third country (representing the rest of the world) in which fiscal powers are centralised. That framework is used to study - on the basis of numerical simulations - the policy-makers' responses to a negative global supply shock, producing both inflation and unemployment.

In the first part, we compare the authorities' losses in a completely non-cooperative setting, by calculating the Cournot-Nash, Stackelberg and consistent conjectural equilibria. The combination of two governments with their own objectives inside the monetary union and a sole fiscal authority in the third country - outside Europe - enables us to underline some divergences about the macroeconomic performance or about the policy-makers' strategic incitements and conjectures. We show, among other things, that monetary leadership leaves governments worse off and harms social welfare. Fiscal leadership is better and works like a second-best form of cooperation among domestic decision-makers.

The second part of the paper is about policy coordination. The separation of fiscal and monetary powers inside each country gives us the possibility to distinguish *internal* cooperation (between the fiscal and monetary authorities of the same economic area) from *external* cooperation (among central banks or governments only) in international policy forums, such as the G7 meetings (Capoen et al. [1994], Villa [1995], Capoen and Villa [1996]). Consequently, we have not only to compare negotiated solutions with non-cooperative equilibria, but also to assess the potential benefits of those two types of cooperation. It appears that external cooperation is always "counterproductive", in the sense that there is at least one non-cooperative equilibrium for which social welfare is higher. Internal cooperation is on the contrary the best solution, because the conflict of interests among domestic authorities is stronger, and the combination of their instruments still more inefficient, as each player seeks to counteract the impact of the other's policy on the variable that is the most important for him. It is therefore important to define in Europe new institutional arrangements which would facilitate dialogue and cooperation between the ECB and national budgetary decision-makers.

We lastly study in the third part the welfare implications of a rigid application of the "Stability and Growth Pact" in the EMU, when only monetary policy is used to react to supply-side shocks, then what happens if monetary policy is left with an "ultraconservative" European central banker (that is, with a very great dislike for inflation). The fiscal stability pact is useful when there is a lack of cooperation, because it limits the inefficiency of the

European (tight money - lax fiscal) policy-mix, which has beneficial spillovers in the rest of the world. As opposed to that, appointing a governor with a very high degree of inflation aversion leaves each country worse off by exacerbating the conflict with the fiscal authority. This points to the risk of an independent central bank weighting price stability too heavily.

2. A few remarks about the model

With the aim of illustrating, the three countries of the model are the United States, Germany and France. The two European countries form a monetary union. The dollar-euro exchange rate is free to float. The size of the German and French economies is half the size of the US economy. So, Europe and the United States are symmetric to one another. The structural parameters for the three countries are equal.

The analytical tool we use here is a standard three-country Mundell-Fleming model, in the tradition of Canzoneri and Henderson [1991]. For the sake of brevity, all the equations are written in the appendix. In this section, we mention the modifications that have been introduced, and present the budgetary and monetary authorities' quadratic loss functions.

The main modification is that we consider fiscal as well as monetary policy. Here, we follow Eichengreen and Ghironi [1997], by supposing that demand in each country depends on public expenditure too (see (A.5a)-(A.5c) in the appendix). Budgetary policy has standard Keynesian effects (that is, government spending cuts are contractionary). Adding fiscal policy raises very important issues in the current European setting. In particular, it allows us to study the risk of policy conflicts between domestic decision-makers and, thus, to distinguish internal cooperation from external cooperation, as said before.

A second difference with the original model of Canzoneri and Henderson [1991] is that the demand for money depends on the domestic nominal interest rate too (see (A.8) in the appendix). The last two authors use a simpler condition for the money-market equilibrium in which only incomes appear, so that employment in each country is directly given by its money growth rate. Introducing the interest rate in the money-market equilibrium equation allows output in each country to depend on foreign budgetary and monetary policies too, which leads to new conflicts among authorities.

Thirdly, we follow Kébabdjian [1996] to consider the current account between Europe and the United States in addition. It essentially depends on the dollar-euro real exchange rate, and varies with incomes in the two areas too (see (A.9) in the appendix).

Each decision-maker sets his policy on the basis of a quadratic objective function, that depends on the deviations of consumer prices (q), employment (n), current account (d), and, for governments, public spending (g) from their no-disturbance equilibrium values (i.e. zero).

The Federal Reserve and the European Central Bank control money supply (m) and want to minimise, respectively :

$$L_{\text{Fed}} = \frac{1}{2} \left\{ \gamma_q (q_{\text{US}})^2 + \gamma_n (n_{\text{US}})^2 + \gamma_d (d_{\text{US}})^2 \right\} \quad (1a)$$

$$L_{\text{ECB}} = \frac{1}{2} \left\{ \theta_q (q_{\text{EU}})^2 + \theta_n (n_{\text{EU}})^2 + \theta_d (d_{\text{EU}})^2 \right\} \quad (1b)$$

Welfare losses increase in the deviations of inflation, employment (that is, output) and current account from zero. The parameters γ_q , γ_n and γ_d measure the importance the Fed attaches to price stability, employment and external equilibrium, respectively. θ_q , θ_n and θ_d are the corresponding target weights for the ECB.

Governments control public spending (g). Their preferences are represented by the following loss functions :

$$L_{US} = \frac{1}{2} \left\{ \psi_q (q_{US})^2 + \psi_n (n_{US})^2 + \psi_d (d_{US})^2 + \psi_g (g_{US})^2 \right\} \quad (2a)$$

$$L_G = \frac{1}{2} \left\{ \omega_q (q_G)^2 + \omega_n (n_G)^2 + \omega_d (d_{EU})^2 + \omega_g (g_G)^2 \right\} \quad (2b)$$

$$L_F = \frac{1}{2} \left\{ \omega_q (q_F)^2 + \omega_n (n_F)^2 + \omega_d (d_{EU})^2 + \omega_g (g_F)^2 \right\} \quad (2c)$$

Taking into account the cost of the deviations of public expenditure is a way to capture the idea that fiscal policy is difficult to fine tune and cannot be adjusted as quickly as monetary policy. The higher the parameters ψ_g and ω_g , the less the degree of fiscal activism.

The reduced form of the model is too complicated to obtain analytical solutions, and we must therefore assign numerical values to the different parameters in order to simulate the stabilisation game. We have chosen the following values for the target weights : $\gamma_q = \theta_q = 5$, $\gamma_n = \theta_n = 0.5$ and $\gamma_d = \theta_d = 0.1$ for central banks ; $\psi_q = \omega_q = \psi_d = \omega_d = 0.25$, $\psi_n = \omega_n = 2$ and $\psi_g = \omega_g = 5$ for governments. The target weights are equal on both sides of the Atlantic in order to bring out the specific effects of differences in the internal economic policy organisation. Central banks put relatively more weight on inflation, while governments care relatively more about output, as is commonly assumed in the policy coordination literature.

The higher weight given to the deviations of public spending expresses the limits of fiscal activism (Eichengreen and Ghironi [1997], Ghironi and Giavazzi [1997])³, and means that governments are reluctant to run very expansionary policies, in order not to aggravate their budget deficit⁴, or very tight policies, in view of the attachment to public utility service. Moreover, the higher target weight might illustrate the ceilings on public debt and fiscal deficits in Europe incorporated in the Maastricht treaty, that prevent each participating country from actively using the fiscal instrument, and the desire of reducing public debt in the United States.

As regards the weight of the current account objective, we follow the common idea that the move to monetary union in Europe is likely to bring about much more "benign neglect" *vis-à-vis* the exchange rate (Begg et al. [1997], Bénassy-Quéré et al. [1997]) : since the euro zone is larger and mechanically less open than the constituting member states, it is natural to expect that the ECB will behave much more like the Fed, devoting far less attention to the exchange rate⁵. The implication of reciprocal benign neglect is that monetary and budgetary policies will be predominantly set with a view to domestic objectives everywhere in the world⁶.

³ See Méhitz [1997] and Wyplosz [1999] for some econometric evidence on this point in Europe.

⁴ Since we do not consider tax revenue here, public expenditure (g) can be assimilated to budget deficit.

⁵ Since the European Union and the United States are two relatively closed economic areas (with a degree of openness around 10 %), the current account depends much more on the real exchange rate than on incomes (see (A.9) and (A.13) in the appendix), so that the weight given to the achievement of external equilibrium can be understood as the one given to the dollar-euro real exchange rate stabilisation.

⁶ Except in the case of misalignments and abnormally large swings in competitiveness.

3. Non-cooperative equilibria

In this section, each player is supposed to behave in a non-cooperative way, and to set his policy on the basis of his sole objective function, without considering the consequences of his choice on the other players' welfare. The economic policy interactions between Europe and the United States are always modelled with a Cournot-Nash game. We successively calculate the Cournot-Nash, Stackelberg (with monetary and budgetary leadership) and consistent conjectural equilibria to describe the strategic interactions inside each currency zone.

We analyse the policy-makers' reactions to a positive realisation of x (that is, a symmetric unfavourable productivity shock in the world).

3.1. World-wide Nash equilibrium

The monetary and fiscal reaction functions are found by routine analytics from the first-order conditions of the monetary and fiscal authorities' minimisation problems :

$$m_{US} = 0.068m_{EU} - 0.731g_{US} - 0.646(g_G + g_F)/2 - 1.810x \quad (3a)$$

$$m_{EU} = 0.068m_{US} - 0.731(g_G + g_F)/2 - 0.646g_{US} - 1.810x \quad (3b)$$

$$g_{US} = -0.167m_{US} + 0.008m_{EU} - 0.093(g_G + g_F)/2 + 0.042x \quad (3c)$$

$$(g_G + g_F)/2 = -0.090m_{EU} + 0.004m_{US} - 0.050g_{US} + 0.023x \quad (3d)$$

Other things being equal, a reduction in money supply or an increase in public expenditure in the European Union (the United States) forces the Fed (the ECB) to conduct a more contractionary policy to damp imported inflation down. Central banks mainly react to domestic fiscal decisions, because of their stronger impact on output and employment (see (3a) and (3b)). An increase in money supply and public spending cuts in the EMU (the United States) restrain production abroad, because the dollar (the euro) appreciates against the euro (the dollar), and force the US government (European governments) to increase spending in order to fight unemployment. Governments react to domestic monetary choices above all, due to their stronger spillovers on home employment (see (3c) and (3d))⁷.

In the Cournot-Nash equilibrium (N), each central bank tries to conduct a still more contractionary monetary policy than the other in the hope to export inflation abroad with a real appreciation, while governments increase spending to bolster activity (see table 1, column 2). The fundamental point is that the US fiscal policy is twice as expansionary as European fiscal policies, owing to the non-cooperative game between Germany and France. Each European budgetary player is aware of the beneficial effect of the other player's expansion on home employment, and internalises that information by expanding less than he would in the absence of the other player's response⁸. And neither player takes into account the beneficial impact of his own policy on the other player. As a result, the Nash solution does not exploit the positive externalities associated with budgetary policy enough.

⁷ The US fiscal best-response function (3c) obviously differs from the EMU-wide fiscal reaction function (3d) because of the non-cooperative game between the German and French governments.

⁸ Thus, fiscal policies are strategic substitutes.

	1 passive attitude	2 (N)	3 (ML)	4 (FL)	5 (CCE1)	6 (CCE2)
m_{US}	0	-2.4026x	-2.4554x	-2.0050x	-2.3968x	-2.0113x
m_{EU}	0	-2.3867x	-2.4211x	-2.0028x	-2.3804x	-2.0065x
g_{US}	0	+0.4048x	+0.4131x	+0.0551x	+0.4046x	+0.0555x
$g_G = g_F$	0	+0.2069x	+0.2094x	+0.0278x	+0.1989x	+0.0279x
e_{FC}	0	-0.0728x	-0.0813x	-0.0100x	-0.0757x	-0.0111x
z_{EU}	0	-0.0809x	-0.0853x	-0.0112x	-0.0841x	-0.0116x
q_{US}	+0.94x	+0.5070x	+0.4967x	+0.5118x	+0.5069x	+0.5105x
$q_G = q_F$	+0.94x	+0.5151x	+0.5097x	+0.5130x	+0.5153x	+0.5123x
n_{US}	-0.22x	-1.6004x	-1.6327x	-1.6162x	-1.5999x	-1.6205x
$n_G = n_F$	-0.22x	-1.6273x	-1.6461x	-1.6199x	-1.6279x	-1.6222x
d_{US}	0	-0.0659x	-0.0686x	-0.0091x	-0.0686x	-0.0093x

Table 1. Optimal policies and endogenous variables in the completely non-cooperative regimes

Thus, the European monetary policy is less contractionary than the US one, because the ECB sets its instrument according to public expenditure in Germany and France above all. It results from those differences in the internal economic policy organisation on both sides of the Atlantic that the dollar appreciates against the euro, hence the external deficit of the United States. But internal stabilisation is better in the United States than in the European Union : the more contractionary monetary policy and the more expansionary budgetary policy lead to lower inflation and unemployment rates.

3.2. Stackelberg equilibria

Under the Stackelberg regime, fiscal and monetary authorities no longer act simultaneously. It is now assumed that one player (the Stackelberg leader) has a first-mover advantage when selecting his policy, and takes into account the response of the other player (the follower) to his measures. Thus, the leader chooses its optimal strategy subject to the follower's reaction function, and the follower's committed response is to simply take the leader's policy as given and minimise its loss. We think that the leader-follower policy regime is interesting in as much as it allows to bring out the strategic aspects of the decision-making process, and especially the consequences of the differences in the economic policy architecture on the two sides of the Atlantic.

In a Stackelberg equilibrium, monetary leadership (ML) is an usual way to capture the notion of central bank independence (Petit [1989], Hughes Hallett and Petit [1990], Debelle [1996]). In the context of the EMU, an alternative interpretation for Stackelberg leadership of the monetary authority rests on the fact that the ECB deals with several national fiscal policy-makers, which is likely to strengthen the strategic position of the common central bank against each government (van Aarle [1996]). However, the opposite case of fiscal leadership (FL) is conceivable too, and does not call into question central bank independence, in so far as fiscal policy cannot be adjusted as quickly as monetary policy, so that choosing the level of public spending provides the government with a first-mover advantage (Beetsma and

Bovenberg [1998]). In fact, that second equilibrium might be an even more appropriate description of fiscal-monetary interactions in practice than the standard Nash equilibrium, since fiscal policy is typically set on an annual basis, and even usually adopted for several years running. We shall consider the two possibilities in what follows.

3.2.1. Monetary leadership

Suppose in the first place that central bankers are Stackelberg leaders in the EMU and in the rest of the world. Thus, the Fed moving first anticipates that the US government will respond to its policy according to the reaction function (3c), while the ECB internalises the EMU-wide fiscal reaction function (3d). The new monetary best-response functions are then :

$$m_{US} = 0.072m_{EU} - 0.664(g_G + g_F)/2 - 2.142x \quad (4a)$$

$$m_{EU} = 0.070m_{US} - 0.655g_{US} - 1.978x \quad (4b)$$

Compared to (3a) and (3b), the reaction coefficients to the productivity shock x are higher. Monetary policies are more contractionary than in the previous non-cooperative equilibrium (see table 1, column 3). Each central bank knows that fiscal authorities are mainly concerned with employment, and internalises the increase in public spending following any reduction in money supply now. Since the fiscal reaction weakens the impact of monetary policy on prices, each governor is *ex ante* driven to adopt a more aggressive policy in order to control inflation⁹. Consequently, fiscal policies become more expansionary. Thus, monetary leadership intensifies the policy conflict inside each currency zone.

Note that the US monetary policy is more contractionary than the European one again, because the US government reacts more than the German and French policy-makers ($(\partial g_{US})/(\partial m_{US}) = -0.167$ according to (3c), and $(\partial g_{EU})/(\partial m_{EU}) = -0.090$ according to (3d)). The difference is due to the lack of cooperation between the two member countries of the monetary union, which drives each of them to limit the increase in public expenditure.

Thus, monetary leadership strengthens the appreciation of the dollar against the euro, and makes the US external deficit worse. The US and European rates of inflation are lower under that new regime, but unemployment increases. Inflation and output stabilisation is better in the United States again, because the level of public spending remains there much higher.

3.2.2. Fiscal leadership

Now, consider the opposite case of fiscal leadership. The US government knows that the Fed will react to any change in budgetary policy according to the reaction function (3a), while both European governments internalise the reaction function (3b) of the ECB. The budgetary best-response functions become approximatively :

$$g_{US} = -0.001m_{EU} + 0.007(g_G + g_F)/2 + 0.053x \quad (5a)$$

$$(g_G + g_F)/2 = -0.001m_{US} + 0.004g_{US} + 0.026x \quad (5b)$$

⁹ Note that such a reasoning from monetary authorities might be questioned if their objective function included the deviations of public spending too. In fact, central bankers might well become less restrictive if budget deficit stabilisation was heavily weighted in their loss function (see for instance Artus [1999]).

Compared to (3c) and (3d), the sign of the reaction coefficients concerning foreign policies is inverted : at present, governments slightly reduce public spending after any monetary expansion or any budgetary contraction in the rest of the world. Such a change is due to the fact that fiscal players, when leading, worry less about the consequences of any deterioration in competitiveness on home employment, and care more about the spillovers of their instrument on consumer prices.

The main thing is that fiscal policies are much less expansionary than in the Cournot-Nash equilibrium (see table 1, column 4) : governments do not raise public spending as much as in the case of the first game, as they take into account the fact that monetary policy is less stringent when budget deficit is smaller, which in principle should allow to limit the fall in activity, because monetary policy has a bigger impact than budgetary policy on home employment (see (A.12a)-(A.12b) in the appendix : (+ 0.76) against (+ 0.64)).

Note that the reduction in budget deficit with respect to the Cournot-Nash solution is much greater in the United States than in Europe (in fact, the public spending gap between the two currency zones is roughly divided by seven). Of course, this is due to the organisational differences again. The potential gain of the monetary reaction as regards employment is higher in the rest of the world. The strategic incitement of each European government to reduce its budget deficit, in order to alter the common monetary policy, is indeed restricted because of the internal non-cooperative game : *ex ante*, both the German and French authorities only consider the impact of a variation of the value of their sole instrument on the EMU-wide money supply, instead of taking into account the effect of an EMU-wide budget deficit variation. In concrete terms, the fiscal inducement calculated by the US government is given by the partial derivative $(\hat{c}m_{US})/(\hat{c}g_{US}) = -0.731$ (see (3a)), which is twice as big as the inducement calculated by each European player ($(\hat{c}m_{EU})/(\hat{c}g_G) = (\hat{c}m_{EU})/(\hat{c}g_F) = -0.3655$ according to (3b)). The Stackelberg game with fiscal leadership clearly illustrates what we said in introduction : namely, each national authority in the EMU is likely to feel that the effects of its own measures on the trend in monetary policy will tend to be small.

The more pronounced curtailment in public expenditure in the United States limits the dollar's rise against the euro and the US external deficit. However, compared to the first Nash solution, the inflation and output stabilisation measures in the United States turn out to be less effective. As regards home inflation, spending cuts in every country do not offset the less contractionary policy of the Fed. As regards home employment, the limited decrease in money supply does not counteract the initial reduction in public expenditure *ex post*. This contrasts with the situation in the EMU, where the rates of inflation and unemployment are lower under fiscal leadership than in the Nash equilibrium. Thus, the lack of cooperation between Germany and France paradoxically allows to achieve a better stabilisation (by comparison with the results of the first scenario).

3.3. Consistent conjectural equilibria

The traditional Cournot-Nash equilibrium does not really result from a rational behaviour of economic authorities. Under the Cournot assumption, each player assumes when selecting the value of his instrument that the opponent will not react, which is hardly realistic. In fact, in the Cournot game, each decision-maker is wrong in predicting the response of the other. For instance, in our model, it is reasonable to assume that both the Fed and the ECB know in

advance that any monetary contraction will provoke an increase in public expenditure. In the same way, governments are likely to anticipate a monetary easing if public spending decreases. The consistent conjectural equilibrium (CCE) assumes therefore that each agent, in choosing his own strategy, takes the response of the other into account. Nevertheless, the CCE is not necessarily better than the Cournot-Nash solution, because anticipating the reaction of the other can weaken as well as aggravate the conflict of interests, according to the target weights of the loss functions¹⁰.

We shall analyse two consistent conjectural equilibria here, first between the two European governments only (CCE1), then between the fiscal and monetary authorities of each economic area (CCE2). In the last case, an interesting point concerns the differences in the policy-makers' conjectures in Europe and in the United States induced by fiscal decentralisation.

3.3.1. CCE between the two European governments

Each European fiscal player anticipates the response of the other to his own policy and optimises his objective function taking this reaction into account now. We find that both the German and French governments make the conjecture $h = -0.039$: in concrete terms, each national decision-maker estimates that raising his budget deficit by 1 will induce the other to reduce deficit by 0.039 (owing to positive spillovers). The conjectured decrease is slightly smaller than what is indicated in the reaction function in the Cournot-Nash game.

Each European fiscal decision-maker then prefers to reduce his deficit in order to compel the other to increase spending. Since both the German and French authorities have the same reasoning, the level of public expenditure in the EMU is smaller than in the Cournot-Nash equilibrium, hence the less stringent policy of the ECB (see table 1, column 5). Thus, the CCE between the two European governments aggravates their policy conflict, but alleviates the one with the ECB. The new European policy-mix contributes to weakening the euro against the dollar, and so to importing inflation from the United States, which allows the Fed to adopt a less contractionary policy. The spillovers of these policy changes on the US production tend to offset one another, so that the US government's stance is almost unchanged. All in all, compared to the first Nash game, inflation and output stabilisation turns out to be rather less efficient in Europe, and slightly better in the rest of the world (but the differences concerning endogenous variables are minimal). The US external deficit is as large as in the monetary leadership case.

3.3.2. CCE between the fiscal and monetary decision-makers of each area

Now, consider the second CCE. The Federal Reserve and the US government make the conjectures $h_{Fed} = -0.024$ and $h_{US} = -0.730$, respectively: the Fed logically foresees that any increase in money supply will provoke a cut in public spending, and the US government expects a decrease in money supply if its budget deficit goes up. The decentralisation of fiscal powers in Europe necessarily implies different conjectures. We find $h_{ECB} = -0.012$ and $h_G = h_F = -0.365$ (that is, the conjectured variations are divided by two in the EMU). In

¹⁰ The two possibilities will appear here. For the different theoretical aspects and properties of the CCE, as well as some economic examples, see Sterdyniak and Villa [1993].

concrete terms, the ECB estimates that increasing the common money supply by 1 will induce each national fiscal policy-maker to cut public spending by (only) 0.012, while both the German and French governments anticipate that cutting public expenditure by 1 will provoke a rise in money supply by (only) 0.365. Thus, the domestic monetary response anticipated by the US government is twice as big as the reaction expected by European national authorities : this is due to the fact that each member state neglects the impact of the partner's budgetary policy on the trend in monetary policy, as under the previous Stackelberg regime. And the non-cooperative game between the two European member countries explains that the rise in public spending expected by the ECB after a monetary contraction is smaller than the one expected by the Fed (because each European policy-maker would like to take advantage of the fiscal stimuli of the other while limiting his own deficit). Another point to note in this model is that the governments' conjectures correspond to the reaction coefficients in the Cournot-Nash game, whereas central banks expect much smaller fiscal reactions, so that they are less induced to review their strategy¹¹.

Ex ante, anticipating the domestic monetary reaction can lead each budgetary decision-maker either to increase public expenditure more (in order to fight the recessionary effect of the monetary contraction ensuing from the stimulus) or to reduce the budget deficit (because the central banker's response renders any budgetary expansion inefficient). *Ex post*, we are in the second case. Each government takes into account the fact that the monetary policy multiplier is higher than the fiscal policy one as regards output and employment. As under the Stackelberg regime with fiscal leadership, governments run less expansionary policies. Central banks are now induced to contract more because they know that any decrease in money supply will drive fiscal authorities to raise spending, thereby feeding inflation. Thus, monetary policies are slightly harsher than in the previous Stackelberg equilibrium (due to the conjecture), but nevertheless remain less contractionary than in the Cournot-Nash game (because the *ex ante* incentive to contract more in order to control inflation turns out to be completely cancelled by the great cut in public spending).

3.4. Comparison of losses : fiscal leadership as a second best-form of internal cooperation

When no policy-maker reacts, the supply shock x mainly affects central bankers' welfare (see table 2, column 1), given that it produces much more inflation ($+ 0.94x$) than unemployment ($- 0.22x$). Therefore, the policy adjustment leaves central banks better off, but renders fiscal authorities worse off.

Under the Cournot-Nash and monetary Stackelberg leadership regimes, social welfare¹² turns out to be higher in the EMU than in the rest of the world (see columns 2 and 3), because the subsidiarity in fiscal decision-making implies a smaller level of public spending, which limits the negative effects of the policy conflict with the central bank. The Fed is better off than the ECB because the more contractionary US monetary policy stabilises home inflation to a larger extent, but the stronger expansionary bias of fiscal policy renders the US government worse off than European states, though the US unemployment rate is lower.

¹¹ In the Cournot-Nash game, $h_{Fed} = h_{ECB} = 0$ (that is, the central banks' conjectures are inconsistent).

¹² To simplify, social welfare is here understood as the sum of the fiscal and monetary players' losses for each country. In other words, we assume that some groups in the population are better represented by the central bank's function, whereas some others have a welfare function which is closer to that of the government. Such an hypothesis seems to us quite realistic.

	1 passive attitude	2 (N)	3 (ML)	4 (FL)	5 (CCE1)	6 (CCE2)
L_{Fed}	$2.2211x^2$	$1.2832x^2$	$1.2834x^2$	$1.3080x^2$	$1.2825x^2$	$1.3080x^2$
L_{ECB}	$2.2211x^2$	$1.3255x^2$	$1.3270x^2$	$1.3139x^2$	$1.3265x^2$	$1.3140x^2$
L_{US}	$0.1589x^2$	$3.0036x^2$	$3.1240x^2$	$2.6525x^2$	$3.0018x^2$	$2.6664x^2$
$L_G = L_F$	$0.1589x^2$	$2.7888x^2$	$2.8522x^2$	$2.6590x^2$	$2.7827x^2$	$2.6663x^2$
US	$2.3800x^2$	$4.2868x^2$	$4.4074x^2$	$3.9605x^2$	$4.2843x^2$	$3.9744x^2$
EMU	$2.3800x^2$	$4.1143x^2$	$4.1792x^2$	$3.9729x^2$	$4.1092x^2$	$3.9803x^2$

Table 2. Losses in the completely non-cooperative regimes

On the other hand, a federal fiscal architecture yields better results when monetary policy is determined after the event : under the Stackelberg regime with fiscal leadership, the sum of the authorities' losses is smaller in the United States because the two European governments, playing Nash against one another, are not so able as the US government to take advantage of their first-mover situation (see column 4).

The Stackelberg equilibrium in which central banks lead is the worst scenario as regards welfare : monetary leadership stabilises inflation, but the employment loss is larger than under any other regime. Conversely, the Stackelberg equilibrium with fiscal leadership is the best non-cooperative solution from the standpoint of governments, and from a social point of view in each country too¹³. This sequential game can be understood as a second-best form of cooperation with the domestic monetary authority, in the sense that the fiscal player sets his instrument more in accordance with the central banker's interests¹⁴. What the former has to do is to encourage the latter to pursue a less stringent monetary policy. The main credit of this Stackelberg game is that it strengthens fiscal discipline (that is, the deviations of public spending from zero become smaller)¹⁵. This is notably the case for the United States, where the higher inflation and unemployment rates, compared to the Cournot-Nash solution, are more than offset by the more rigorous stance adopted by the government (and by the reduction in trade deficit too).

The two consistent conjectural equilibria yield better results than the Cournot-Nash regime as regards global welfare (see columns 5 and 6). In fact, welfare is little affected with the first CCE, while the second CCE between the fiscal and monetary decision-makers of each area gets closer in its effects to the Stackelberg game with fiscal leadership.

4. Cooperative solutions

In this section, we examine the welfare implications of economic policy coordination, distinguishing the *internal* cooperation problem (between the budgetary and monetary authorities of each currency zone) from the *external* cooperation problem (among central banks or

¹³ It is the case for the ECB too. Only the Fed prefers other equilibria.

¹⁴ More widely, the Stackelberg solution involves a degree of cooperation in that each player assumes a specific role.

¹⁵ We can establish a connection between that result and the analysis in Beetsma and Bovenberg [1998], who show that monetary unification among decentralised fiscal authorities may reduce the inflation bias and the spending bias, in a model with fiscal leadership incorporating commitment problems in the tradition of Barro and Gordon [1983].

governments only, in international policy forums). Such a distinction seems to us very important in the discussion about coordination problems, in the sense that the bigger impact of policy instruments on domestic variables normally implies that the welfare losses resulting from a conflict between the decision-makers of a same country are likely to be higher than non-cooperation costs on a world scale. Therefore, in a normative perspective, the main thing is to know if internal cooperation (inside a country or a currency zone) matters more than international dialogue and negotiation (that is, the G7 meetings).

In the first subsection, we examine the external cooperation cases, between central banks or governments. In the second subsection, we study the effects of internal cooperation, first in the United States only (in order to look if the European Union might take advantage of policy coordination in the rest of the world), then inside the two areas simultaneously.

4.1. External cooperation

4.1.1. Cooperation between central banks

Suppose first that the Fed and the ECB cooperate (case C1), and jointly minimise with respect to m_{US} and m_{EU} , respectively, the average of their loss functions $\frac{1}{2}(L_{Fed}) + \frac{1}{2}(L_{ECB})$ (setting the weights to one half, given that the two currency zones of the model are symmetric to one another)¹⁶. The US and European monetary policies are now respectively defined according to :

$$m_{US} = 0.136m_{EU} - 0.681g_{US} - 0.597(g_G + g_F)/2 - 1.646x \quad (6a)$$

$$m_{EU} = 0.136m_{US} - 0.681(g_G + g_F)/2 - 0.597g_{US} - 1.646x \quad (6b)$$

Central bankers are now aware of the uselessness of competitive policies, and no longer seek to export inflation by manipulating the exchange rate. Cooperation involves a greater increase in money supply in response to any monetary expansion abroad (that is, central bankers no longer try to take advantage of foreign monetary policies). In the same way, the response to the productivity shock x is less aggressive, and the monetary contraction following any fiscal expansion is less strong than before (compare with (3a) and (3b)).

Therefore, compared to the first Nash solution, monetary policies on both sides of the Atlantic become less contractionary, and fiscal authorities increase spending by less (see table 3, column 1).

The appreciation of the dollar against the euro is less strong than under the Cournot-Nash assumption because the differences concerning the optimal values of policy instruments are reduced (of course, the US fiscal policy remains much more expansionary than that of each European player). Monetary cooperation leads to higher inflation rates (spending cuts do not offset the less rigorous stance adopted by central banks), but unemployment is lower than under any non-cooperative regime in Europe as well as in the United States. These employment gains are due to the fact that monetary policies are more altered and have a greater impact on home activity than fiscal policies.

¹⁶ In every case, the decision-makers who do not cooperate always choose the optimal value of their policy instrument according to their reaction function under the Cournot-Nash assumption (see equations (3a)-(3d) above).

	1 (C1)	2 (C2)	3 (C3)	4 (C4)	5 (C5)	6 (C6)
m_{US}	- 2.3566x	- 2.5469x	- 2.9570x	- 2.9023x	- 0.7180x	- 0.5342x
m_{EU}	- 2.3422x	- 2.5469x	- 2.9570x	- 2.9023x	- 2.0377x	- 0.5342x
g_{US}	+ 0.3978x	+ 0.4089x	+ 0.6864x	+ 0.6747x	+ 0.0491x	+ 0.0458x
$g_G = g_F$	+ 0.2034x	+ 0.4089x	+ 0.6864x	+ 0.6747x	+ 0.2008x	+ 0.0458x
e_{EU}	- 0.0711x	0	0	0	+ 0.5134x	0
z_{EU}	- 0.0793x	0	0	0	+ 0.2058x	0
q_{US}	+ 0.5155x	+ 0.5105x	+ 0.5091x	+ 0.5174x	+ 0.8499x	+ 0.8371x
$q_G = q_F$	+ 0.5232x	+ 0.5105x	+ 0.5091x	+ 0.5174x	+ 0.5038x	+ 0.8371x
n_{US}	- 1.5732x	- 1.6122x	- 1.6077x	- 1.5810x	- 0.5644x	- 0.5552x
$n_G = n_F$	- 1.6006x	- 1.6122x	- 1.6077x	- 1.5810x	- 1.5898x	- 0.5552x
d_{US}	- 0.0647x	0	0	0	+ 0.1028x	0

Table 3. Optimal policies and endogenous variables in the cooperative regimes

4.1.2. Cooperation between European governments

Consider the consequences of fiscal cooperation now, and suppose first that only the two European governments coordinate their policies (case C2), in the sense that they minimise the common loss function $\frac{1}{2}(L_G) + \frac{1}{2}(L_F)$ (given that the two member states are identical in all respects). The new European fiscal reaction function is recovered by symmetry according to (3c).

The German and French governments now internalise the fact that an increase in their spending stimulate activity in the neighbouring country, and so raise their budget deficit much more (see table 3, column 2)¹⁷. Consequently, the conflict between the two national budgetary authorities and the common central bank is exacerbated, since the great increase in public expenditure fuels inflation. Fiscal cooperation forces the ECB to pursue a more contractionary monetary policy. The new European policy-mix contributes to weakening the dollar against the euro, so that the Fed is induced to adopt a more rigorous stance too, in order to fight imported inflation. The spillovers of these policy changes on the US production tend to offset one another, so that the US fiscal policy is finally less altered.

Inflation in Europe is lower than under the Cournot-Nash assumption (the increase in public expenditure turns out to be completely offset by the tightened policy of the ECB), but the other countries suffer from higher inflation (since their currency no longer rises against the euro). Unemployment falls in Europe (the increase in public expenditure turns out to be enough to offset the more rigorous stance adopted by the ECB), whereas the further monetary contraction of the Fed strengthens the destabilising impact of the supply shock on output and employment in the United States.

¹⁷ Now, the optimal values of policy instruments are equal in Europe and in the rest of the world, since cooperation between the German and French governments amounts here to considering a federal fiscal architecture in the EMU, so that the organisational differences among the two currency zones are eliminated.

4.1.3. Global fiscal cooperation

When all three fiscal policy-makers cooperate (case C3), they minimise the sum, with weights equal to $\frac{1}{2}$, of the US player's objective function and of the average of the German and French governments' losses, $\frac{1}{2}(L_{US}) + \frac{1}{4}(L_G + L_F)$. The fiscal reaction functions become :

$$g_{US} = -0.150m_{US} - 0.101m_{EU} - 0.173g_{EU} + 0.064x \quad (7a)$$

$$g_{EU} = -0.150m_{EU} - 0.101m_{US} - 0.173g_{US} + 0.064x \quad (7b)$$

Governments react more to any change in foreign economic policies (that is, the US fiscal player raises spending to a bigger extent after any monetary or fiscal tightening in the EMU, and likewise for European fiscal authorities). The increase in public spending following the productivity shock is also bigger than in the non-cooperative case.

Compared to the previous scenario, the increase in public expenditure is dramatically greater, because fiscal authorities within each currency zone now internalise the positive spillovers of their pump-priming measures on activity in the rest of the world (see table 3, column 3). Global fiscal cooperation thus forces the ECB and the Fed to pursue extremely harsh policies, in order to fight the inflationary consequences of domestic and foreign budget deficits¹⁸.

Compared to the case where only the two European governments coordinate their policies, inflation is lower (given that monetary policies are yet tighter), and employment turns out to be higher (due to the large fiscal expansion in every country).

4.1.4. Cooperation between central banks plus global fiscal cooperation

We have envisaged the situation where global fiscal cooperation is coupled with transatlantic monetary cooperation too (case C4). Cooperation between governments involves an increase in public expenditure, and cooperation between central banks leads to less tight monetary policies, as seen before. Consequently, on the one hand, fiscal cooperation fuels inflation and renders coordinated monetary policies harsher than in the case where governments play Nash (see table 3, column 4). On the other hand, monetary cooperation allows to limit the drop in activity, and therefore to discipline governments, so that coordinated fiscal policies are less expansionary than in the case where central bankers play Nash against one another. All in all, employment turns out to be higher than under any non-cooperative regime.

4.2. Internal cooperation

We are now interested in the welfare implications of policy coordination between the fiscal and monetary authorities of the same currency zone. At first glance, given the close interactions of fiscal and monetary policy, a good case can be made out for the cooperative setting of money supply and public spending, which is not incompatible with central bank independence¹⁹.

¹⁸ By the way, the monetary contraction is then maximal, by comparison with the other situations.

¹⁹ As far as we are concerned, we think that defining a specific objective function for the central bank is already a way to

4.2.1. Cooperation between the Fed and the US government

First of all, consider the outcome of a cooperative political process between the US fiscal player and the Federal Reserve (case C5). We suppose that the Fed and the US government now minimise with respect to m_{US} and g_{US} the average loss $\frac{1}{2}(L_{Fed}) + \frac{1}{2}(L_{US})$. The US monetary and fiscal reaction functions become, respectively :

$$m_{US} = 0.058m_{EU} - 0.802g_{US} - 0.604(g_G + g_F)/2 - 0.439x \quad (8a)$$

$$g_{US} = -0.227m_{US} + 0.012m_{EU} - 0.129(g_G + g_F)/2 - 0.063x \quad (8b)$$

On the one hand, cooperating with the US budgetary decision-maker requires the Fed's governor to take more into account the spillovers of his policy instrument on home employment. Therefore, his reaction to the productivity shock is less strong, and any decrease in the budget deficit g_{US} entails a bigger monetary relaxation now. For the same reason, the Fed weights less heavily imported inflation following any monetary contraction or any budgetary expansion in the EMU (compare with (3a)). On the other hand, the US government must care more about the inflationary effect of its budget deficit. This is why the US budgetary policy-maker now curtails spending in response to the supply shock x (given that it produces more inflation than unemployment). The same rationale implies that the curtailment in public expenditure following a monetary relaxation is bigger than in the non-cooperative game, and that the US government weights more imported inflation following any monetary contraction or any fiscal expansion in the EMU (compare with (3c)).

The consequences of internal cooperation in the United States appear very clearly (see table 3, column 5). The new US monetary policy is considerably less contractionary, and the US budget deficit is widely cut down²⁰. Thus, cooperation with the central bank allows to discipline the government strongly. The new US policy-mix automatically contributes to depreciating the dollar, which gives the ECB the opportunity to adopt a less rigorous stance too. In comparison, budgetary policy in France and Germany is altered to a lesser extent, since the spillovers on home employment of the euro's rise and of the new common monetary policy tend to offset one another.

The US price index is *ex post* the highest under that scenario (the positive impact of the spending cut on inflation turns out to be counteracted by the much looser monetary policy adopted by the Fed), but in return the unemployment rate is widely reduced by comparison with all the previous games (given that monetary policy has a greater effect on output). And the US current account now shows a surplus.

European economies benefit from cooperation on the other side of the Atlantic : the euro's rise allows to contain inflation²¹, and the less harsh policy pursued by the ECB allows to achieve a better output stabilisation than in all non-cooperative cases. This is an important result : monetary and fiscal policy coordination in the rest of the world is beneficial from the European standpoint (as will be shown below, in the table 4 giving the values of the loss functions).

capture the notion of its independence, apart from the nature of the policy game. If the governor was really in a weak strategic position *vis-à-vis* the fiscal decision-maker, or completely dependent, there would be no reason to make such a distinction, and the monetary-fiscal mix would be fully determined according to the sole government's loss function, exactly as if there was only one policy-maker.

²⁰ It is even lower than in the Stackelberg game with fiscal leadership.

²¹ The rate of inflation in the EMU is then lower than under any other regime.

4.2.2. Internal cooperation within each area

We lastly assume that the German and French governments jointly define their fiscal policy, and bargain in the same time in an equal position with the European Central Bank for the common monetary policy (case C6). We therefore minimise with respect to m_{EU} , g_G and g_F the sum $\frac{1}{2}(L_{ECB}) + \frac{1}{4}(L_G + L_F)$, so that the new monetary and fiscal reaction functions for the EMU are analogous to the previous ones for the United States (see (8a) and (8b)).

Monetary and budgetary policies are obviously the same on both sides of the Atlantic again (see table 3, column 6). On the one hand, the cooperative process among the two European governments implies that they raise spending in order to exploit the positive externalities associated with fiscal policy. On the other hand, taking the common central banker's objective function into account leads each budgetary decision-maker to cut spending in order to contain inflation. *Ex post*, the latter effect gets the upper hand of the former : the German and French budget deficits are widely reduced when comparing with the other solutions²². And the ECB adopts a much looser monetary policy, given that it weights more heavily employment now. These policy changes facilitate price stabilisation in the United States, which allows the Federal Reserve to opt for a still looser policy than before, so that the US government cuts spending.

From the US standpoint, cooperation within the EMU is obviously beneficial : it automatically stops the euro's rise, and so imported inflation, and thus widens the US central banker's leeway, who then has the possibility to protect more home employment. In the EMU, the employment gain is huge, but internal cooperation causes a sharp price increase in return²³.

4.3. Comparison of losses : internal cooperation as the best solution

It emerges from our simulations that the joint setting of fiscal and monetary policy in each currency zone matters much more than international coordination on the occasion of the G7 meetings, because the inefficiency due to policy conflicts among domestic decision-makers is more serious than the one due to a lack of cooperation with the rest of the world.

	1 (C1)	2 (C2)	3 (C3)	4 (C4)	5 (C5)	6 (C6)
L_{Fed}	$1.2834x^2$	$1.3014x^2$	$1.2942x^2$	$1.2941x^2$	$1.8861x^2$	$1.8290x^2$
L_{ECB}	$1.3249x^2$	$1.3014x^2$	$1.2942x^2$	$1.2941x^2$	$1.2669x^2$	$1.8290x^2$
L_{US}	$2.9043x^2$	$3.0497x^2$	$3.7950x^2$	$3.6709x^2$	$0.4162x^2$	$0.4010x^2$
$L_G = L_F$	$2.7000x^2$	$3.0497x^2$	$3.7950x^2$	$3.6709x^2$	$2.6613x^2$	$0.4010x^2$
US	$4.1877x^2$	$4.3511x^2$	$5.0892x^2$	$4.9650x^2$	$2.3023x^2$	$2.2300x^2$
EMU	$4.0249x^2$	$4.3511x^2$	$5.0892x^2$	$4.9650x^2$	$3.9282x^2$	$2.2300x^2$

Table 4. Losses in the cooperative regimes

²² European fiscal policies are less expansionary in the second Stackelberg and consistent conjectural equilibria only.

²³ The inflation rate in the two member states is the highest in this last scenario.

The social welfare gain in case of internal cooperation is the highest owing to the bigger impact of policy instruments on home variables (see table 4, columns 5 and 6). In fact, only governments take advantage of fiscal and monetary policy coordination, since it allows both to achieve a better output stabilisation and to improve fiscal discipline significantly, whereas central banks sustain much larger losses due to the price upsurge, and so prefer other solutions, but the gain obtained by the fiscal player turns out to be quite sufficient to offset the fact that central bankers are worse off²⁴. Since governments and central banks do not share the same preferences, the problem of the process implementation comes up. The fact that the monetary authority suffers larger losses when coordinating monetary and fiscal policy might well hold dialogue up. This points to the risk of conflicting interests between an independent governor, who worries about inflation above all, and society : what citizens would like is not necessarily what the monetary decision-maker prefers...²⁵

The outcomes of external cooperation are not so good. External cooperation is always counterproductive, in the sense that there are non-cooperative equilibria for which social welfare is higher (namely, the Stackelberg solution with fiscal leadership and the consistent conjectural equilibrium between budgetary and monetary authorities).

Transatlantic cooperation among governments is clearly the worst scenario, because it encourages them to pursue much more expansionary policies that compel central banks to respond with sharp contraction. Thus, fiscal cooperation aggravates the inefficiency of the (tight money - lax fiscal) policy-mix. Although the deviations of inflation and employment are lower than when only the two European governments cooperate, the weakening of fiscal discipline is so marked that each fiscal player is far worse off (see columns 2 and 3)²⁶.

The total losses of each currency zone turn out to be lower in the hypothesis of monetary cooperation when comparing with the Cournot-Nash equilibrium (see column 1). Governments are better off since unemployment is then lower. Although inflation goes up, the ECB is also better off, and therefore induced to cooperate with the Fed, but this last one would gain nothing since its losses are practically equal in the two situations (that is, the inflation loss associated with a looser monetary policy offsets the employment gain and the reduction in external deficit in the end).

5. The world-wide repercussions of a fiscal stability pact and of an "ultraconservative" central banker in Europe

The sole differences between the European Union and the United States we have considered in the last two sections were about the nature of the policy game among authorities. Taking into account the specificity of the European institutional arrangements as regards fiscal policy as well as monetary policy allows us to bring other asymmetries out. In this

²⁴ The outcome of that cooperative solution is Pareto-efficient, in the sense that the monetary player cannot be made better off without worsening the situation of the fiscal player.

²⁵ In fact, the monetary authority prefers the case of internal cooperation abroad coupled with a Nash game against the domestic fiscal player, as suggested in our last but one scenario : the ECB's loss is then the lowest because the cooperative game between the Fed and the US government contributes towards price stabilisation in the EMU.

²⁶ Only the ECB's loss diminishes by comparison with any non-cooperative solution. The Fed does not share the ECB's desire for fiscal cooperation because it cannot fully counteract the inflationary effects of increased public expenditure and of the harsher European monetary policy, and because unemployment is then higher than under the global Nash regime.

section, we study the consequences on the world macroeconomic equilibrium of the application of a fiscal stability pact in Europe, on the one hand, and of the appointment of an "ultra-conservative" central banker, on the other hand.

5.1. The fiscal stability pact as a coordination device

The simplest manner of taking the stability pact into account in the model consists in assuming that "the hands of European governments are tied", so that they can no longer maintain production control by changing budgetary policy. That is, we now suppose that the German and French governments must respect the no-deficit rule $g_G = g_F = 0$, so that the ECB alone is in charge of the macroeconomic adjustment in the EMU from now on.

	1 (N) without pact	2 (N) with pact	3 (C1) without pact	4 (C1) with pact	5 (C5) without pact	6 (C5) with pact
m_{US}	- 2.4026x	- 2.2548x	- 2.3566x	- 2.2104x	- 0.7180x	- 0.5860x
m_{EU}	- 2.3867x	- 2.2227x	- 2.3422x	- 2.1813x	- 2.0377x	- 1.8806x
g_{US}	+ 0.4048x	+ 0.4006x	+ 0.3978x	+ 0.3936x	+ 0.0491x	+ 0.0471x
$g_G = g_F$	+ 0.2069x	0	+ 0.2034x	0	+ 0.2008x	0
e_{EU}	- 0.0728x	- 0.1474x	- 0.0711x	- 0.1440x	+ 0.5134x	+ 0.4371x
z_{EU}	- 0.0809x	- 0.1638x	- 0.0793x	- 0.1606x	+ 0.2058x	+ 0.1236x
q_{US}	+ 0.5070x	+ 0.5034x	+ 0.5155x	+ 0.5122x	+ 0.8499x	+ 0.8440x
$q_G = q_F$	+ 0.5151x	+ 0.5198x	+ 0.5232x	+ 0.5276x	+ 0.5038x	+ 0.5084x
n_{US}	- 1.6004x	- 1.5883x	- 1.5732x	- 1.5608x	- 0.5644x	- 0.5600x
$n_G = n_F$	- 1.6273x	- 1.6428x	- 1.6006x	- 1.6162x	- 1.5898x	- 1.6051x
d_{US}	- 0.0659x	- 0.1335x	- 0.0647x	- 0.1310x	+ 0.1028x	+ 0.0362x

Table 5. Optimal policies and endogenous variables in the case of a fiscal stability pact

We recalculate the values of policy instruments and of endogenous variables in the three following cases : (1) Cournot-Nash equilibrium among all authorities (N) ; (2) cooperative equilibrium between the ECB and the Fed (C1) ; (3) cooperative equilibrium between the Fed and the US government (C5).

The impossibility for European governments of using fiscal policy to fight unemployment allows the ECB to adopt a less contractionary policy in each case (see table 5, columns 2, 4 and 6). The new European policy-mix is beneficial from the standpoint of the Fed, since it accentuates the dollar's rise against the euro in the first two games and limits its depreciation in the third one, and then contributes to checking inflation, so that the Fed contracts the money supply by less too. The looser US monetary policy offsets the adverse spillovers of European policies on home employment, which drives the US government to increase spending by less.

For the three games considered, the deviations of inflation and employment in Europe turn out to be bigger when there is no fiscal activism : the fact that public spending no longer

increases does not counteract the impact of the looser ECB's policy on consumer prices and leads to larger activity losses in the same time. On the other hand, the deviations of inflation and employment are lesser abroad when European governments can no longer use budgetary policy to respond to shocks.

	1 (N) without pact	2 (N) with pact	3 (C1) without pact	4 (C1) with pact	5 (C5) without pact	6 (C5) with pact
L_{Fed}	$1.2832x^2$	$1.2651x^2$	$1.2834x^2$	$1.2656x^2$	$1.8861x^2$	$1.8595x^2$
L_{ECB}	$1.3255x^2$	$1.3509x^2$	$1.3249x^2$	$1.3498x^2$	$1.2669x^2$	$1.2903x^2$
L_{US}	$3.0036x^2$	$2.9579x^2$	$2.9043x^2$	$2.8583x^2$	$0.4162x^2$	$0.4084x^2$
$L_G = L_F$	$2.7888x^2$	$2.7347x^2$	$2.7000x^2$	$2.6491x^2$	$2.6613x^2$	$2.6087x^2$
US	$4.2868x^2$	$4.2230x^2$	$4.1877x^2$	$4.1239x^2$	$2.3023x^2$	$2.2679x^2$
EMU	$4.1143x^2$	$4.0856x^2$	$4.0249x^2$	$3.9989x^2$	$3.9282x^2$	$3.8990x^2$

Table 6. Losses in the case of a fiscal stability pact

All in all, the rigid application of a fiscal stability pact in Europe allows to improve social welfare all over the world (see table 6, columns 2, 4 and 6). This pact works in a way as a coordination device among the budgetary and monetary authorities of the EMU, in the sense that the new policy-mix is closer to the one that would be observed if the values of budgetary and monetary instruments were jointly chosen, according to the same objective function, as seen before. Although internal stabilisation turns out to be less efficient in the EMU, and even if the ECB's situation gets worse, the fiscal discipline imposed to the German and French governments renders them better off enough to reduce the total loss. And the budgetary and monetary authorities of the rest of the world benefit also from that arrangement.

5.2. Who benefits from an "ultraconservative" central banker ?

The theoretical arguments in favour of a central banker who attaches a higher weight to price stability than society are well-known, and due to considerations that are absent in the model. Delegating the control of monetary policy to an independent governor, with his own inflation-output trade-off (that is, "conservative"), is one of the most important recommendations of the literature on time inconsistency and commitment problems (Rogoff [1985])²⁷.

We now suppose that the control of the European monetary policy is left to a common central banker whose dislike for inflation is yet greater than before. We recalculate the different equilibrium values for the world-wide Cournot-Nash game (N) with the weights 20, 50 and 100 for price stability in the ECB's loss function. Thus, the limiting case of $\theta_q = 100$ fits the situation where the European monetary decision-maker would be "ultraconservative". Moreover, it is assumed that the progressive increase in the target weight θ_q does not affect the Fed's output-inflation trade-off.

²⁷ It may look somewhat surprising, or even illogical, to consider such a possibility in a model that disregards commitment problems, but the behaviour of the ECB during the last two years leads us to think that the Barro-Gordon model has still a great influence on the Board, even in a world where the credibility problem of authorities hardly arises now...

Of course, the higher the target weight θ_q , the stronger the European monetary contraction (see table 7). Any increase in the level of inflation aversion intensifies the effect of the supply shock on employment and so compels the German and French governments to pursue yet more expansionary fiscal policies. In fact, the appointment of a central banker whose inflation aversion is still higher amounts in a way to giving a first-mover advantage to the monetary player, as in a Stackelberg game (see section 3 beyond), in the sense that he can impose a tighter policy to fiscal authorities.

	1 $\theta_q = 5$	2 $\theta_q = 20$	3 $\theta_q = 50$	4 $\theta_q = 100$
m_{US}	- 2.4026x	- 2.5825x	- 2.6477x	- 2.6734x
m_{EU}	- 2.3867x	- 3.7751x	- 4.2775x	- 4.4764x
g_{US}	+ 0.4048x	+ 0.4119x	+ 0.4144x	+ 0.4154x
$g_G = g_F$	+ 0.2069x	+ 0.3309x	+ 0.3758x	+ 0.3936x
e_{EU}	- 0.0728x	+ 0.3899x	+ 0.5573x	+ 0.6236x
z_{EU}	- 0.0809x	+ 0.0988x	+ 0.1638x	+ 0.1896x
q_{US}	+ 0.5070x	+ 0.5137x	+ 0.5162x	+ 0.5171x
$q_G = q_F$	+ 0.5151x	+ 0.2053x	+ 0.0932x	+ 0.0488x
m_S	- 1.6004x	- 1.6225x	- 1.6305x	- 1.6337x
$n_G = n_F$	- 1.6273x	- 2.5928x	- 2.9421x	- 3.0805x
d_{US}	- 0.0659x	+ 0.0210x	+ 0.0525x	+ 0.0649x

Table 7. Optimal policies and endogenous variables for several degrees of conservatism of the ECB

The combination of a more and more harsh monetary policy and of more and more expansionary national budgetary policies in Europe - as θ_q rises gradually - feeds inflation in the United States, and so forces the Federal Reserve to run a more and more contractionary policy too. On the other hand, the more the European Central Bank penalises inflation in its objective function, the more the European policy-mix stimulates activity in the United States. The US government reacts far less to any increase in the ECB's degree of conservativeness, because the spillovers of the European policy-mix and of the Fed's policy on home employment tend to offset one another.

When the ECB becomes more conservative than the Fed (that is, from $\theta_q = 20$ in our simulation), the euro rises against the dollar, even if the US budgetary policy remains more expansionary, and the European current account shows a growing deficit. Of course, the appointment of a governor with a very high degree of inflation aversion allows to achieve a far better price stabilisation in Europe, despite the significant increase in public expenditure in each member state, but that result is obtained to the detriment of employment. The more expansionary budgetary policies in Germany and France cannot counteract the monetary tightening implemented by the ECB, so that the unemployment rate grows fast with its degree of "Rogoff-conservativeness".

The US inflation and unemployment rates are increasing with the ECB's weight on inflation. The Fed does not manage to offset the adverse spillovers of the European policy-mix on consumer prices, although it runs a more and more contractionary policy, so that the United States imports more and more inflation as θ_q rises gradually. Besides, the tighter US

monetary policy produces more unemployment, even if the European policy-mix improves competitiveness abroad, and the US government's policy is not expansionary enough to counteract that destabilising effect.

	1 $\theta_q = 5$	2 $\theta_q = 20$	3 $\theta_q = 50$	4 $\theta_q = 100$
L_{Fed}	$1.2832x^2$	$1.3180x^2$	$1.33090x^2$	$1.33600x^2$
L_{ECB}	$1.3255x^2$	$1.7860x^2$	$2.18580x^2$	$2.37850x^2$
L_{US}	$3.0036x^2$	$3.0897x^2$	$3.12160x^2$	$3.13440x^2$
$L_G = L_F$	$2.7888x^2$	$7.0016x^2$	$9.01050x^2$	$9.87740x^2$
US	$4.2868x^2$	$4.4077x^2$	$4.45250x^2$	$4.47040x^2$
EMU	$4.1143x^2$	$8.7876x^2$	$11.1963x^2$	$12.2559x^2$

Table 8. Losses for several degrees of conservatism of the ECB

Thus, any increase in the degree of inflation aversion of the European monetary authority makes things worse (see table 8). Indeed, every player suffers larger losses. Putting a still higher weight on price stability is harmful, not only from the standpoint of governments, but also from the standpoint of central banks. In particular, the loss of a European central banker endowed with a rather progressive temperament (that is, who tries to follow a pragmatic approach - a balance between the fear of inflation and a concern for growth - when running monetary policy) is smaller than that of a governor worrying about inflation only. In fact, the less conservative the ECB, the better the macroeconomic performance, because the policy-mix will then be closer to the one achieved in case of internal cooperation. The clear conclusion is that the European Central Bank cannot disregard employment, and that it should be inspired by the Federal Reserve's behaviour, which allowed this last one to enjoy considerable credibility.

6. Conclusion

In this paper, we have addressed the issue of monetary and fiscal policy interactions between the European Union and the rest of the world. The responses of central banks and governments to an aggregate supply disturbance have been simulated by means of a game-theoretic three-country model. Taking fiscal policy into account allowed us to focus on the consequences of the coexistence of several governments defending their own interests within the EMU on the game with foreign countries and, thus, to bring out the welfare disparities across the world due to the maintenance of fiscal sovereignty for each participating country. The separation of budgetary and monetary powers allowed to compare the outcomes of internal cooperation with those of external cooperation too.

We have first calculated different equilibria in a wholly non-cooperative setting. Fiscal decentralisation in Europe implies not inconsiderable differences concerning the macroeconomic performance as well as the decision-makers' strategic incitements, when they lead in a Stackelberg game, or in the hypothesis of a consistent conjectural equilibrium. In particular, it was shown under the Stackelberg regime with fiscal leadership - which may be a more

realistic depiction of the actual relationship among authorities - that the lack of cooperation among national authorities in the EMU leads to the weakening of each individual player's influence on the common monetary policy. The additional non-cooperative game between European governments is then all the more harmful since fiscal leadership is the best solution when central banks act in isolation and take as given the governments' policy choices. This Stackelberg regime is a second-best form of internal cooperation : once the central bank's reaction function is known to fiscal authorities, these last ones can anticipate that a less expansionary policy from them will lead to a looser monetary policy. Thus, fiscal leadership allows to discipline governments, thereby producing a gain in welfare. Conversely, monetary Stackelberg leadership is the worst scenario, because it strengthens the conflict with the fiscal player and entails a yet more inefficient (lax fiscal - tight money) policy-mix.

Different cooperative situations have been next analysed. Our numerical simulations support the idea of fostering internal cooperation between the fiscal and monetary authorities of each currency zone rather than international dialogue in the G7 meetings, since welfare losses are then much lower. The internal coordination of monetary and fiscal policies yields a first-order gain in welfare, by disciplining governments (that is, by reducing the expansionary bias of fiscal policies) and by stabilising employment simultaneously, even if inflation is higher *ex post*. Such a solution, however, raises the issue of its implementation (especially in the EMU, owing to the numerous decision-makers), since the price upsurge ensuing from it leaves central banks worse off, but that problem goes beyond the scope of the present paper, that fits into a normative perspective.

Conversely, cooperation among governments or central banks only turns out to be always counterproductive, because there remains other externalities not taken into account : the problem is that a too partial cooperative process (that is, when the monetary and fiscal authorities of each area play Nash against one another) entails still more aggressive reactions from the other players, that finally harm welfare.

We have lastly explored how the rigid application of a fiscal stability pact and how the appointment of an ultraconservative governor in the EMU affect welfare. Two conclusions emerge. First, a strait-jacket for fiscal policy is beneficial and enhances welfare, although inflation and unemployment are then higher in each participating country, because the expansionary bias of governments and so the cost associated with an active use of their instrument vanish. Moreover, the rest of the world also benefits from such an arrangement, as foreign central banks run looser monetary policies, so that the policy-mix in the other countries is finally less inefficient than the one that would otherwise have been observed. Second, delegating the control of monetary policy to a governor *à la* Rogoff, who is extremely attached to price stability, is clearly sub-optimal and has negative consequences all over the world, because it violently exacerbates the policy conflict with fiscal authorities.

Appendix

The three-country model

All variables represent deviations from zero-disturbance equilibrium values and are expressed in logarithms (except in the case of interest rates). The subscripts "US", "G" and "F" refer to the US, German and French economies, respectively. Average European variables are denoted by "EU".

Output (y) in the country j ($j = \text{US, G, F}$) is an increasing function of employment (n) and a decreasing function of a world productivity shock x , which is identically and independently distributed with zero mean (a positive value for x is an adverse shock, producing both inflation and unemployment):

$$y_j = (1 - a)n_j - x \quad (\text{A.1})$$

Labor demand is derived from the standard profit maximisation condition. Denoting the nominal wage as w and the product price as p , and omitting unimportant constants, we have:

$$n_j = \frac{p_j - w_j - x}{a} \quad (\text{A.2})$$

Consumer price indices (q) are weighted averages of the prices of US, German and French goods:

$$q_{\text{US}} = (1 - \beta)p_{\text{US}} + \frac{\beta(p_{\text{G}} + e_{\text{G}})}{2} + \frac{\beta(p_{\text{F}} + e_{\text{F}})}{2} \quad (\text{A.3a})$$

$$q_{\text{G}} = \frac{(1 - \beta)p_{\text{G}}}{2} + \frac{(1 - \beta)(p_{\text{F}} + e_{\text{F}} - e_{\text{G}})}{2} + \beta(p_{\text{US}} - e_{\text{G}}) \quad (\text{A.3b})$$

$$q_{\text{F}} = \frac{(1 - \beta)p_{\text{F}}}{2} + \frac{(1 - \beta)(p_{\text{G}} + e_{\text{G}} - e_{\text{F}})}{2} + \beta(p_{\text{US}} - e_{\text{F}}) \quad (\text{A.3c})$$

The nominal exchange rates e_{G} and e_{F} are the dollar prices of the Deutschmark and the French franc (an increase in e_{G} or e_{F} means that the dollar depreciates against one of the other currencies).

z_{G} and z_{F} are the dollar-Deutschmark and the dollar-franc real exchange rates, respectively:

$$z_{\text{G}} = e_{\text{G}} + p_{\text{G}} - p_{\text{US}} \quad (\text{A.4a})$$

$$z_{\text{F}} = e_{\text{F}} + p_{\text{F}} - p_{\text{US}} \quad (\text{A.4b})$$

Demand for all goods depends on output, competitiveness (real exchange rate), real interest rates (r) and government spending (g):

$$2y_{\text{US}} = 2(1 - \beta)\varepsilon y_{\text{US}} + \beta\varepsilon(y_{\text{G}} + y_{\text{F}}) + \delta(z_{\text{G}} + z_{\text{F}}) - 2(1 - \beta)\nu r_{\text{US}} - \beta\nu(r_{\text{G}} + r_{\text{F}}) + 2\eta g_{\text{US}} + (1 - \eta)(g_{\text{G}} + g_{\text{F}}) \quad (\text{A.5a})$$

$$y_{\text{G}} = \frac{(1 - \beta)\varepsilon(y_{\text{G}} + y_{\text{F}})}{2} + \beta\varepsilon y_{\text{US}} - \delta z_{\text{G}} - \frac{\delta(z_{\text{G}} - z_{\text{F}})}{2} - \frac{(1 - \beta)\nu(r_{\text{G}} + r_{\text{F}})}{2} - \beta\nu r_{\text{US}} + \frac{\eta(g_{\text{G}} + g_{\text{F}})}{2} + (1 - \eta)g_{\text{US}} \quad (\text{A.5b})$$

$$\begin{aligned}
y_F = & \frac{(1 - \beta)\varepsilon(y_G + y_F)}{2} + \beta\varepsilon y_{US} - \delta z_F - \frac{\delta(z_F - z_G)}{2} \\
& - \frac{(1 - \beta)v(r_G + r_F)}{2} - \beta v r_{US} + \frac{\eta(g_G + g_F)}{2} + (1 - \eta)g_{US}
\end{aligned} \tag{A.5c}$$

The real interest rate in the country j ($j = US, G, F$) is (with i the nominal interest rate, and “+ 1” indicating the expected value of a variable tomorrow on the basis of information available today) :

$$r_j = i_j - (q_j)_{+1} + q_j \tag{A.6}$$

Uncovered interest parity holds :

$$i_{US} = i_G + (e_G)_{+1} - e_G \tag{A.7a}$$

$$i_{US} = i_F + (e_F)_{+1} - e_F \tag{A.7b}$$

The no-speculative bubbles condition (i.e. $(e_G)_{+1} = (e_F)_{+1} = 0$) is laid down to calculate the reduced form of the model.

In each country ($j = US, G, F$), the demand for money balances increases with the level of output and falls with the interest rate :

$$m_j - p_j = y_j - \lambda i_j \tag{A.8}$$

where m is the money supply.

The trade balance (d) between the European Union and the United States depends on incomes and on the dollar-euro real exchange rate ($d_{EU} < 0$ fitting an European trade deficit) :

$$d_{US} = -d_{EU} = \beta\varepsilon(y_{EU} - y_{US}) + \delta z_{EU} \tag{A.9}$$

with $y_{EU} = (y_G + y_F)/2$ and $z_{EU} = (z_G + z_F)/2$.

The values that we assign to the structural parameters in order to simulate the stabilisation game are the following : $\alpha = 0.3$; $\beta = 0.1$; $\varepsilon = 0.8$; $\delta = 0.8$; $v = 0.4$; $\eta = 0.9$ and $\lambda = 0.6$ (with $1 - \alpha$ the elasticity of output with respect to employment, β the propensity to import, ε the marginal propensity to consume, δ the elasticity of demand with respect to real exchange rates, v the elasticity of demand with respect to *ex ante* real interest rates, η the fraction of its expenditure that each government devotes to goods produced in its own region, and λ the elasticity of money demand with respect to the interest rate).

The reduced form equations are :

$$e_{EU} = 0.35(m_{US} - m_{EU}) - 0.34[g_{US} - (g_G + g_F)/2] \tag{A.10a}$$

$$z_{EU} = 0.11(m_{US} - m_{EU}) - 0.40[g_{US} - (g_G + g_F)/2] \tag{A.10b}$$

$$q_{US} = 0.24m_{US} - 0.02m_{EU} + 0.15g_{US} + 0.17(g_G + g_F)/2 + 0.94x \tag{A.11a}$$

$$q_G = q_F = 0.24m_{EU} - 0.02m_{US} + 0.15(g_G + g_F)/2 + 0.17g_{US} + 0.94x \tag{A.11b}$$

$$m_{US} = 0.76m_{US} - 0.04m_{EU} + 0.64g_{US} + 0.44(g_G + g_F)/2 - 0.22x \tag{A.12a}$$

$$m_G = m_F = 0.76m_{EU} - 0.04m_{US} + 0.64(g_G + g_F)/2 + 0.44g_{US} - 0.22x \tag{A.12b}$$

$$d_{US} = -d_{EU} = 0.04(m_{US} - m_{EU}) - 0.33[g_{US} - (g_G + g_F)/2] \tag{A.13}$$

We find between the two currency zones the standard spillovers of an increase in money supply or of a spending cut through the exchange rate channel (that is, an appreciation of the foreign currency, which leads to disinflation and bolsters activity). Note that monetary policy has a bigger impact than fiscal policy both on prices and employment in each area. Locking the nominal exchange rate between

the Deutschmark and the French franc implies the equalisation *ex ante* of the inflation and unemployment rates in the two member states (but this does not mean the absence of intra-European fiscal externalities). This is because the pattern of government spending is identical across the EMU : as a consequence, differences in fiscal policies do not affect the intra-European exchange rate.

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