Would Fiscal Authorities in the EMU prefer to coordinate?

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Abstract

This article studies whether fiscal authorities would prefer to operate like in the current EMU or to coordinate according to the theoretical literature. The EMU approach will lead to higher volatility of interest rates, output, inflation and average budget deficits, but the SGP deficit target will be breached less often.

Keywords: fiscal policy coordination, monetary union, Stability and Growth Pact.

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1. Introduction.

The Stability and Growth Pact (SGP) in the European Monetary Union (EMU) is widely believed to bring about fiscal policy coordination. For instance, the European Union Commission states that "the [European Communities] Treaty provides for policy cooperation through the stability and growth pact".[1] Further, according to Eichengreen and Wyplosz (1998), a rationale for introducing the SGP was related to the advantages of policy coordination: if countries coordinate their fiscal policies, then they take into account the effects of their deficits on each other.

In the theoretical literature, the analysis of a monetary union such as the EMU has been developed as a game between one monetary authority and various fiscal authorities -see, for instance, Beetsma and Bovenberg (1998) and Dixit and Lambertini (2003), among others. A crucial issue in this research with decentralized fiscal authorities has been how to introduce fiscal coordination. Articles that have analysed fiscal policy coordination among EMU countries have traditionally considered that the fiscal authorities minimize a weighted sum of the national governments´ loss functions or that each government takes into account other countries´ output in their loss function (see, among others, Beetsma et al. (2001), Beetsma and Bovenberg (1998), Engwerda et al. (2002), Dixit and Lambertini (2001 and 2003)). Nonetheless, this is not how fiscal authorities behave in the EMU.

In the EMU, fiscal authorities do not explicitly take into account other countries' variables –like their output– and thus, according to the literature, they do not coordinate fiscal policies. In an attempt to enforce policy coordination, the EMU introduced the multilateral surveillance of budget positions in the European Communities Treaty. Multilateral surveillance obliges countries to provide information at regular intervals about their midterm objectives and about developments that might affect their budgetary position. This notion of coordination is similar to the concept of "information sharing" used in the analysis of oligopoly by, among others, Gal-Or (1985), Shapiro (1986),

[1] Communication from the Comission COM(2002) 487.

Vives (1984) and Ziv (1993). Thus, this type of coordination does not involve a minimization of a weighted loss function.

The objective of this article is to study whether fiscal authorities in the EMU would, given the choice, choose to operate like in the current EMU or to coordinate according to the theoretical literature. To that end, we will first compare the outcomes of the actual workings of the EMU (non-coordination) with those of fiscal policy coordination as understood in the literature. In particular, we will look at the outcomes in terms of volatilities of the average deficit, interest rates, outputs and inflation and we will see that different concepts of fiscal coordination will have radically different results. Second, we will proceed to set up a game where the fiscal authorities will choose whether to coordinate according to the literature or not to, and we will see what, if given the choice, would they choose.

The studies that analyse fiscal policy coordination in a monetary union often provide mixed results. Beetsma and Bovenberg (1998) show that fiscal policy coordination restores the strategic position of the fiscal players vis-à-vis the monetary authority and so destroys the disciplinary effect of a monetary union, thereby resulting in higher inflation, taxes and public spending. Beetsma et al. (2001) study two symmetric countries and conclude that when the shocks that hit the economies are highly correlated, fiscal policy coordination is more likely to be welfare decreasing. Dixit and Lambertini (2003) analyse a model with *n*-symmetric countries and conclude that fiscal coordination is not necessary to achieve the desired objectives of output and inflation. It is worth pointing out, however, that this result depends on the assumption that monetary and fiscal authorities share these objectives of output and inflation. Ferré (2005) studies a model with two asymmetric countries and shows that if the monetary and fiscal authorities share the output objective when fiscal authorities coordinate, then the outcome of fiscal policy coordination could bring about instances of higher volatilities of the interest rate and the average deficit in the monetary union. Engwerda et al. (2002), on the other hand, show that under cooperation the externalities of fiscal policies are internalised and the welfare of the fiscal authorities is higher than under non-cooperation. Uhlig (2003), using a symmetric model with *n* countries, concludes that all fiscal authorities would be better off in a cooperative equilibrium.

In this article we will analyse the differences that can arise from interpreting coordination from the EMU approach or from the literature approach. In Section 2 we will introduce the model to be used and the objective functions of the players, that is, the monetary authority and the national fiscal authorities. Section 3 will analyse the reaction functions of the authorities with and without fiscal policy coordination. Section 4 will then follow on to analyse whether, if given the choice, fiscal authorities would choose to coordinate under the literature approach or rather would choose not to cooperate as it is done nowadays in the EMU. Finally, section 5 will conclude.

2. The model

Our model will represent a monetary union with one central monetary authority and various fiscal authorities that have a public deficit target, as in the Stability and Growth Pact. The model is a simple one-period, two goods and two country framework, where we assume, for simplicity, that both countries are symmetric in their structural model parameters and we ignore the interaction of this two-country EMU with the rest of the world. The model is described by the following equations, where all variables are country-variables defined in terms of deviations from their long-run values, with the exception of the interest rate (i), which is the monetary union's rate:

$$y^d = \phi d - \varphi(i - \Pi^e) - \partial(\Pi - \Pi^*) + \nu y^* + \varepsilon_1 \quad (1)$$

$$y^{*d} = \phi d^* - \varphi(i - \Pi^{*e}) + \partial(\Pi - \Pi^*) + \nu y + \varepsilon_1^* \quad (2)$$

$$y^s = \omega(\Pi - \Pi^e) + \varepsilon_2 \quad (3)$$

$$y^{*s} = \omega(\Pi^* - \Pi^{*e}) + \varepsilon_2^* \quad (4)$$

$$\Pi - \Pi^* = u \quad (5)$$

$$y \equiv y^d = y^s \quad (6)$$

$$y^* \equiv y^{*d} = y^{*s} \quad (7)$$

Equation (1) represents the domestic economy, where y^d is aggregate demand, d is the budget deficit, i is the nominal interest rate of the monetary union, Π is the inflation

rate, Π^e is the expected inflation and ε_1 is a demand shock. Starred variables represent the foreign economy, so in equation (1), y^* represents foreign output and Π^* represents foreign inflation, and $\Pi - \Pi^*$ represents the real exchange rate. Equation (2) shows the identical expression for the foreign country. Equations (3) and (4) relate domestic and foreign aggregate supply, y^s and y^{*s}, with inflation surprises ($\Pi - \Pi^e$, and $\Pi^* - \Pi^{*e}$) and a supply shock (ε_2 and ε_2^*). All parameters in the equations are positive, and the demand and supply shocks all have zero mean and finite variance.

According to equations (1) and (2), the budget deficit increases aggregate demand and, thus, also increases output. The real interest rate has a negative effect on aggregate demand: a higher real interest rate will lower consumption and investment. The real exchange rate shows the intra-EU competitiveness: if $\Pi - \Pi^* > 0$, the domestic country is losing competitiveness vis-à-vis the foreign country, and this will affect the domestic country's aggregate demand negatively. The higher the foreign income, the more demand there will be for domestic products through trade. Finally, the aggregate demand can be subject to demand shocks –such as those derived from changes in world demand for domestic products. In equations (1) and (2), the parameter ϕ measures the effectiveness of fiscal policy, φ is the real interest rate elasticity of aggregate demand, ∂ measures the sensitivity of output to intra-EU competitiveness and ν is the relative openness of the economy.

Equations (3) and (4) are supply (Lucas) equations where output is affected by inflation surprises and supply shocks. A positive inflation surprise, where inflation exceeds expected inflation, will stimulate production as wages –and other costs– were set too low. The parameter ω can be interpreted as the degree of labour market flexibility. Output will also be affected by supply shocks –like a sudden increase in oil price.

In equation (5), the inflation differential between the two countries, ($\Pi - \Pi^*$), depends on a disturbance (*u*) with zero mean and finite variance. This inflation differential –or competitiveness gap– represents market imperfections: it can reflect differences between national labour markets (like unemployment levels) that give rise to different wage pressures on prices and demand. Finally, equations (6) and (7) define the equilibrium in the domestic and foreign economies, respectively.

The economies of these two countries are connected by a number of channels. Output fluctuations in both economies are partly transmitted to the other country through the trade channel. Domestic fiscal policy will also impact on foreign output through this channel. Price fluctuations in the domestic or foreign economy affect intra-EU competitiveness and therefore output in both economies.

Since the works of Kydland and Prescott (1977) and Barro and Gordon (1983), the literature that looks at the strategic behaviour of monetary and fiscal authorities considers that the policymakers have preferences over some variables that correspond to quadratic loss functions. In this article, the monetary authority will aim to maintain price stability[2] and it will use the nominal interest rate as the instrument of monetary policy. This attempts to reflect the European Central Bank (ECB) operating procedure. As a result, the monetary authority will try to minimise the following objective quadratic loss function:

$$\min_i \frac{1}{2}\left\{\left(\frac{1}{2}\Pi + \frac{1}{2}\Pi^*\right)^2\right\} \tag{8}$$

Expression (8) implies that the monetary authority has a zero average inflation target for the monetary union. By giving the same weight (1/2) to each variable we assume that the two countries are identical in size.

It is also traditional in the literature that the fiscal authority cares more about output stabilisation than price stability (see, for instance, Beetsma and Bovenberg (1998), Dixit and Lambertini (2001) or Uhlig (2003)). In this article we will assume that the fiscal authority cares about output stabilization and not about price stability, but also takes into account the SGP deficit objective. In particular, the fiscal authority would like to deviate as little as possible from a target value $\hat{d}$ for the budget deficit, similarly to, for

[2] In the literature, the monetary authority traditionally targets both inflation and output deviations in a loss function of the type: $\min_i \frac{1}{2}\left\{\alpha\bar{y}^2 + \overline{\Pi}^2\right\}$, with the variables representing average output and average inflation, and with α being the weight placed on output stabilisation. When simulating the EMU, α is set smaller than 1 to represent the fact that the ECB gives a higher weight to stabilising prices than output. In this article we have assumed that α = 0 in order to present less cumbersome expressions, but the results would hold to a more general loss function for the ECB as long as α < 1.

instance, Beetsma et al. (2001), Buti et al. (2001), Dixit and Lambertini (2003) and Ferré (2005). The domestic and foreign fiscal authorities will use their instrument, which will be their budget deficit, to try to minimise the following objective loss functions:

$$\min_{d} \frac{1}{2}\left\{y^2 + \theta(d - \hat{d})^2\right\} \tag{9}$$

and

$$\min_{d^*} \frac{1}{2}\left\{y^{*2} + \theta(d^* - \hat{d})^2\right\}, \tag{10}$$

respectively, where θ represents the weight given by fiscal authorities to the deficit objective. If $\theta < 1$, fiscal authorities would be more concerned with output stabilisation than achieving the deficit target $\hat{d}$, and if $\theta > 1$, the opposite would be true.

The interaction between the monetary authority and the various fiscal authorities will be represented by a game with the following timing. In the first place, the public will set its inflation expectations, which are set rationally. In the second place, the shocks will occur. In the third place, fiscal authorities will choose their budget deficit, and finally, the central bank will set the nominal interest rate *i*. We are interested in the outcomes of stabilisation policies given by the reaction of authorities to shocks; this is why the authorities observe the shocks before they choose their variables.[3] This type of timing has recently been adopted by Beetsma and Bovenberg (1998), Chari and Kehoe (2002), Dixit and Lambertini (2003) and Uhlig (2003), among others, in the analysis of a monetary union with various fiscal authorities. We believe this timing reproduces the actual game in the EMU: the ECB has regular meetings throughout the year whereas budget decisions cannot be adjusted as quickly as monetary policy.

[3] Further, the fact that the authorities can observe their own shocks and the other countries' shocks is a good approximation to the workings of the SGP under the multilateral surveillance.

3. Coordination of fiscal policies.

Sequential games are solved by backward induction, so we will first find the optimal rule for the central bank, independently of whether the fiscal authorities coordinate or not. Once we have found the optimal interest rate rule, we will proceed to find the optimal setting of the fiscal authorities variable: the budget deficit. In this second step we will have to differentiate whether fiscal authorities act like in the EMU or coordinate like in the literature.

Combining equations (1) to (7), we obtain expressions for output and inflation in each country (shown in Appendix 1). The monetary authority will minimise its loss function (8) taking into account these expressions, and the first order condition of this problem will give us:

$$i = \frac{\phi}{\varphi}\left(\frac{d+d^*}{2}\right) + \frac{1}{\varphi}\left(\frac{\varepsilon_1+\varepsilon_1^*}{2}\right) - \frac{(1-\nu)}{\varphi}\left(\frac{\varepsilon_2+\varepsilon_2^*}{2}\right) \qquad (11)$$

The optimal interest rate rule (11) will increase with the average budget deficit and with positive average demand and negative average supply shocks. The higher the deficit in either country, the higher output and inflation in each country will be, and, therefore, the monetary authority will raise the interest rate to fight inflation. A positive demand shock in either country will raise output and inflation in both countries, so the monetary authority will increase the interest rate. A negative supply shock in one country will lower output but raise inflation in that country, so the monetary authority will increase the interest rate. Note that the monetary authority does not react to competitiveness shocks because we have considered countries to be identical in size, and thus the effect of these shocks on average inflation is cancelled out.

The fiscal authorities of each country anticipate the interest rate rule (11) followed by the monetary authority, so they will incorporate this knowledge in their value function. We will consider two possible scenarios: that fiscal authorities operate like in the EMU (non-coordinated), or that they coordinate as considered by the literature. We will first solve the EMU case, and afterwards the literature coordination case.

3.1 The European Monetary Union approach.

Under the EMU approach, each authority will be concerned with the variables of its own country. In this case, each authority will minimise the original loss functions (9) and (10), taking into account the interest rate rule (11). Therefore, the optimal rule for each authority will be:[4]

$$d = \partial\psi(u) - \frac{\psi}{2}(\varepsilon_1 - \varepsilon_1^*) - \frac{\phi}{4\theta(\nu+1)}(\varepsilon_2 + \varepsilon_2^*) + \hat{d} \tag{12}$$

$$d^* = -\partial\psi(u) + \frac{\psi}{2}(\varepsilon_1 - \varepsilon_1^*) - \frac{\phi}{4\theta(\nu+1)}(\varepsilon_2 + \varepsilon_2^*) + \hat{d} \tag{13}$$

We can see from equations (12) and (13) that the individual budget deficit of each country will, with respect to the deficit target: (i) increase the higher is the competitiveness gap with the other country, (ii) decrease if the country experiences a positive demand shock, as this increases the country's output, (iii) decrease with positive supply shocks, as these will have a positive effect on output, and (iv) increase if the other country experiences a positive demand shock. Taking the demand shocks together, $(\varepsilon_1 - \varepsilon_1^*)$, the deficit will increase if the difference between the domestic and foreign demand shock is negative, in an attempt to compensate for being "worse off".

3.2 The literature approach.

We will now consider the case where fiscal authorities coordinate in the way that has been dealt with in the literature, that is, they take into account the other country's loss function. When the fiscal authorities coordinate in this sense, they choose fiscal policies so as to minimise the weighted loss function:

[4] We have simplified the expression by making $\psi = \frac{\phi}{\phi^2 + 2\theta(1+\nu)^2}$

$$\min_{d,d^*}\left\{\rho\left[y^2+\theta(d-\hat{d})^2\right]+(1-\rho)\left[y^{*2}+\theta(d^*-\hat{d})^2\right]\right\}=$$
$$=\min_{d,d^*}\left\{\frac{1}{2}\left[y^2+\theta(d-\hat{d})^2\right]+\frac{1}{2}\left[y^{*2}+\theta(d^*-\hat{d})^2\right]\right\} \quad (14)$$

For simplicity we have assumed that both countries have equal weight in the cooperative loss function (ρ = ½).[5] Each fiscal authority will minimise the loss function taking into account the interest rate rule followed by the monetary authority in (11). The corresponding optimal rules are:

$$d=2\partial\psi(u)-\psi(\varepsilon_1-\varepsilon_1^*)+\hat{d} \quad (15)$$

$$d^*=-2\partial\psi(u)+\psi(\varepsilon_1-\varepsilon_1^*)+\hat{d} \quad (16)$$

We can see from equations (15) and (16) that the individual budget deficit of each country will, with respect to the deficit target, increase the higher is the competitiveness gap with the other country, decrease if the country experiences a positive demand shock, and increase if the other country experiences a positive demand shock. Note that, however, in this case, the individual deficit of each country does not react to supply shocks, as both governments are now taking into account the effect of their own deficit onto each other's output. For example, with a negative supply shock, under literature coordination, fiscal authorities realise that if they react to the shock by raising the deficits, the outcome in terms of domestic and foreign output will be worse because of the monetary authority's counter-reaction raising the interest rate, so they do not react.

3.3 Comparison of the results.

If we compare the EMU approach (expressions 12 and 13) with the literature approach (expressions 15 and 16), we find that fiscal authorities under the literature coordination are individually more active in reaction to competitiveness gaps and demand shocks, but they do not react to supply shocks. Demand shocks have similar effects on output and

[5] Therefore, we will assume that, as countries are identical in size, they divide this loss equally.

inflation, so there is no conflict of interests between the monetary authority and the fiscal authorities, but there is a conflict for the fiscal authorities. If there is a positive differential demand shock ($\varepsilon_1 - \varepsilon_1^* > 0$), both fiscal authorities would like to see the difference between domestic output and foreign output reduced. However, the instrument available to fiscal authorities will affect both outputs in the same way. For instance, the domestic authority will decrease the deficit and this will lower both domestic output and (less) foreign output. In order to achieve a reduction in the output differential, they have to be more active than under the EMU approach, where they would only care about their own output. A similar argument would apply for competitiveness shocks.

Supply shocks, on the other hand, have opposite effects on output and inflation, and therefore there is a conflict of interests between the monetary authority and the fiscal authorities. If there is a negative supply shock, as inflation will rise, the monetary authority will carry out a contractionary monetary policy and raise the interest rate; fiscal authorities, on the other hand will see output falling and so they would like to raise their deficits in expansionary fiscal policies. As they raise their deficits, the monetary authority will set up a higher interest rate. If they coordinate as in the literature, as both authorities care about each other's output, they realise that it is better not to work against the monetary authority. On the contrary, if they coordinate as in the EMU, as each government cares only about its own output, they will each raise their deficit.

Note that if the countries experienced identical symmetric demand shocks ($\varepsilon_1 = \varepsilon_1^*$) or identical asymmetric shocks ($\varepsilon_2 = -\varepsilon_2^*$) then the deficits set up by the fiscal authorities under EMU or under coordination would be the same, as the countries are identical in size. In the first case, this is explained by the fact that fiscal authorities react to the differential impact of demand shocks. If demand shocks are the same, then there is no need to intervene. Supply shocks, on the other hand, affect inflation and output in opposite ways, so fiscal authorities try to counteract the monetary authority's reaction. When the shocks are identical but opposite in sign, the central bank will not change the interest rate, so there is no difference to the reaction if fiscal authorities coordinate or if they do not.

It is interesting to point out that under coordination according to the literature, fiscal authorities are individually more active in reaction to competitiveness gaps and demand shocks than under non-coordination, and thus, there will be more instances where the deficit target established by the SGP will be breached under coordination compared to non-coordination. For instance, in the presence of a positive competitiveness gap shock ($u > 0$), the fiscal authority from the domestic country will increase more the deficit under coordination than under non-coordination, therefore having a higher chance of breaching the limit $\hat{d}$.

In order to look at the volatility of deficits and interest rates, it is helpful to calculate the average deficits. The average deficit under the EMU approach ($\bar{d}_{EMU}$) is:

$$\bar{d}_{EMU} = \hat{d} - \frac{\phi}{4\theta(\nu+1)}(\varepsilon_2 + \varepsilon_2^*) \tag{17}$$

and with the literature coordination ($\bar{d}_{LIT}$) is:

$$\bar{d}_{LIT} = \hat{d} \tag{18}$$

The average deficit in the monetary union will be more volatile under the EMU approach than with literature coordination in the presence of supply shocks. Individually, fiscal authorities under coordination are more active with respect to the shocks that affect their economies in opposite ways (competitiveness shocks and differential demand shocks), and so their deficits move in opposite ways, not increasing the volatility of the average deficit. Nonetheless, under coordination, countries do not react to supply shocks and thus the average deficit is less volatile.

Furthermore, if we look at the interest rate rule (11), we can see that the interest rate depends on the average deficit of the union. The more volatile the average deficit, the more volatile the interest rate will be. Therefore, interest rates will be more volatile when fiscal authorities operate like in the EMU than when there is coordination as it has been dealt with by the literature.

It is also interesting to compare what are the individual output and inflation in each country under the two cases analysed. The actual expressions for output and inflation under the EMU approach and under the literature coordination are shown in Appendix 2. These expressions indicate that, even though on average output and inflation coincide in the two cases, the actual magnitude of output and inflation in each country is different. We find that output and inflation in each country will be more volatile under the EMU than under literature coordination in the presence of competitiveness shocks and demand shocks.[6] This higher volatility of output and inflation under the EMU is in accordance with the empirical evidence: the relevant economic fundamentals in most euro area economies have diverged from the euro area average and so are more volatile. According to Enderlein (2004), in the first 6 years of the SGP's life, it becomes quite clear that persistent patterns of inflation and output gap differentials have developed.

There are some interesting implications from the results obtained here. Even with the limitations of a static model, the results are clear. One of the arguments for introducing the SGP was related to the advantages of policy coordination. However, it is not clear what is understood by fiscal policy coordination. As pointed by Beetsma et al., (2001), the way and the circumstances under which fiscal coordination among EMU Member States should be organised have received relatively little attention in the literature. The literature approach has considered that countries take into account the other countries´ outputs in their minimising behaviour. This approach delivers less volatility of interest rates, output, inflation and average deficits, but it is obviously a game theory approach that is very difficult to implement in practice. The European Monetary Union has adopted an easier approach to implement in practice, that of "peer-pressure", and according to the model used here, this approach seems to deliver more volatile interest rates, output, inflation and average deficits. Therefore, what is understood by fiscal policy coordination in a monetary union can have radically different results in terms of the volatility of key economic variables. Further, in terms of complying with the deficit target of the SGP, it has been shown that fiscal policy coordination, in the presence of competitiveness shocks and of differential demand shocks will bring about higher

[6] For supply shocks the volatility would be the same. This is due to the fact that there are two opposing effects under the EMU approach: if there is, for instance, a negative supply shock, deficits will be raised by both fiscal authorities, but the monetary authority will raise the interest rate even more (on account of the supply shock and on account of the higher deficits).

individual deficits and thus the deficit target will be breached in more occasions under coordination.

4. Would fiscal authorities prefer to coordinate like in the literature?

So far we have compared the outcomes in terms of volatilities of the average deficit, the interest rate, outputs and inflation in the cases where the fiscal authorities operate like in the EMU or coordinate like in the literature. We will now analyse whether, if fiscal authorities could choose, they would prefer to operate like in the EMU or they would prefer to coordinate. To this end, we will look at the payments –i.e., the value of the loss function– for each country if they do not coordinate and if they do coordinate like in the literature. There will be a simultaneous game where each authority will choose its instrument at the same time as the other authority, which can be illustrated in the following payoff matrix:

Table 1. Matrix of payments

		Fiscal authority of country 2 (foreign)	
		Not to Coordinate	Coordinate
Fiscal authority of country 1 (domestic)	Not to Coordinate	(L_{1nn}, L_{2nn})	(L_{1nc}, L_{2nc})
	Coordinate	(L_{1cn}, L_{2cn})	(L_{1cc}, L_{2cc})

The payments for each authority are summarised by L (value of the loss function), followed by 1 or 2 (representing the fiscal authorities of the domestic country or the foreign one, respectively) and followed by either *n* (not to coordinate fiscal policies) or *c* (coordinate according to the literature) for authority 1 (domestic) and 2 (foreign). In this way, L_{1nn} represents the payment that authority 1 would obtain if she and fiscal authority 2 both did not coordinate, and L_{1nc} represents the payment that authority 1 would obtain if she did not coordinate but authority 2 did.

We have solved different games in order to be able to compare the payments in each case. [7] In particular, the cases solved in the previous section illustrate the cases where

both play non-cooperatively like in the EMU (L_{1nn}, L_{2nn}) and where both "play literature" (L_{1cc}, L_{2cc}), and in these cases we have obtained that $L_{1cc} < L_{1nn}$, and that $L_{2cc} < L_{2nn}$ when there are either –and only- competitiveness shocks, differential demand shocks, supply shocks, or when there is a negative correlation between the competitiveness shocks and the difference of the demand shocks ($u(\varepsilon_1 - \varepsilon_1^*) < 0$). Therefore, fiscal authorities would strictly prefer to coordinate their policies than not to coordinate them under each of the three types of shocks considered. But, if fiscal authorities agreed to coordinate in the EMU, would they respect the agreement or would they have incentives to deviate from it?

In order to be able to see whether fiscal authorities would choose to stick to an agreement to coordinate or would actually cheat on it, we have solved two more games: where authority 1 coordinates and authority 2 does not (L_{1cn}, L_{2cn}), and where authority 1 does not coordinate and authority 2 does (L_{1nc}, L_{2nc}). To find the solution of the game illustrated in Table 1, we have to compare the payments for the authorities under different scenarios. For instance, authority 1 will prefer not to coordinate if (i) the loss for fiscal authority 1 if both authorities do not coordinate is smaller than the loss authority 1 obtains when she does coordinate and authority 2 does not ($L_{1nn} < L_{1cn}$), and (ii) the loss for fiscal authority 1 if she does not coordinate and authority 2 coordinates is smaller than the loss authority 1 obtains when both authorities coordinate ($L_{1nc} < L_{1cc}$). This implies that the strategy not to coordinate would be a dominant strategy for authority 1, which would be chosen independently of authority 2's choice. An identical analysis could be made for authority 2.

In the presence of only demand shocks both countries have a dominant strategy to coordinate, and therefore there is a unique Nash equilibrium where both end up coordinating ($L_{1cc,}$ L_{2cc}). Even though the individual deficits are more volatile, the lower volatility of output more than compensates for the higher volatility of the deficits, and so the losses are lower.

[7] The values of the loss function in each case can be obtained from the author upon request.

In the presence of only supply shocks or only competitiveness shocks, there are two possible Nash equilibria:[8] either fiscal authority 1 does not coordinate and the other one does ($L_{1nc,}$ L_{2nc}) or the other way around ($L_{1cn,}$ L_{2cn}). In this case, even though the outcome of both coordinating is preferred to the one were both do not coordinate, one of the countries could achieve lower losses by not coordinating if the other one did. In the presence of only competitiveness shocks, this result is due to the fact that, when both coordinate, even though the variability of output is lower than when they do not, there is a higher variability of the deficits. If one country coordinates but the other one does not, as the central bank does not react to competitiveness gaps, then the latter can achieve lower variability of the deficit and of the output, and so its losses are reduced.

In the presence of only supply shocks, when both authorities coordinate, there is less variability of deficits than if they do not coordinate and identical variability of outputs. If one of the fiscal authorities does not cooperate, then it will be able to lower the volatility of its output and achieve a lower loss.

We can also consider what happens in cases were there are two shocks that occur simultaneously and are correlated.[9] If there are only competitiveness and supply shocks, and there is a positive correlation between the competitiveness shock and supply shocks ($u(\varepsilon_2 + \varepsilon_2^*) > 0$), then there is a unique Nash equilibrium were country 1 coordinates and country 2 does not ($L_{1cn,}$ L_{2cn}). Consider, for example, that $u > 0$ and that $(\varepsilon_2 + \varepsilon_2^*) > 0$. In this case, country 1 would like to increase its deficit in reaction to the competitiveness gap but would like to reduce its deficit in reaction to the supply shock, with the latter effect dominating.[10] Country 2, on the other hand, would like to reduce the deficit on both accounts. Here both countries want to apply a restrictive policy in order to reduce output, but country 1 less than country 2, and thus country 1 prefers to coordinate so that output is reduced by less, but country 2 prefers not to coordinate and affect output by more. If the correlation between the competitiveness shock and the

[8] Note that there are two Nash equilibria in pure strategies. A unique Nash equilibrium would exist in mixed strategies, but in this case it would be dependent upon what particular values were given to the different parameters of the model.

[9] Only one case is presented as in the other cases where shocks are correlated there are no equilibria (in pure strategies).

[10] The magnitude of $\frac{\partial d}{\partial u}$ is smaller than the magnitude of $\frac{\partial d}{\partial(\varepsilon_2 + \varepsilon_2^*)}$.

supply shocks was negative ($u(\varepsilon_2 + \varepsilon_2^*) < 0$), then the unique Nash equilibrium would be (L_{1nc}, L_{2nc}), that is, fiscal authority 1 would not coordinate and fiscal authority 2 would.

It is interesting to note that, even though the outcome of both fiscal authorities coordinating is generally better than both not coordinating, when authorities can choose, the coordination outcome does not occur too often. There is only one case were both authorities will choose to coordinate (when facing differential demand shocks), and there are, on the other hand, several outcomes where one of the authorities will prefer not to coordinate. This is an interesting result if we consider whether an agreement between fiscal authorities in the EMU to coordinate would hold. As shown, fiscal authorities would have strong incentives not to coordinate –or, in the terminology of game theory, they would prefer to cheat on the agreement to coordinate, particularly when there are differences between countries' competitiveness and in the presence of supply shocks.

5. Conclusion

In this article we have analysed the setting of fiscal policies under the approach followed by the European Monetary Union through the SGP and compared it with the coordination approach traditionally studied by the theoretical literature. We have found that the approach followed by the EMU delivers more volatile interest rates, output, inflation and average budget deficits than the literature coordination. Further, we have also analysed what would fiscal authorities choose –to operate like nowadays in the EMU or to coordinate like in the literature, if they were given the choice. The results, which are dependant on the type of shocks hitting the economies, show that there would be several occasions where one of the countries would choose not to coordinate (in the words of the game theory literature, it would prefer to cheat on the agreement to cooperate). In particular, fiscal authorities would honour the coordination agreement under differential demand shocks. However, they would have an incentive to deviate in the presence of supply shocks (like a rise in the oil price) and in the presence of different evolutions of their competitiveness, circumstances which occur in the EMU

countries. Therefore, if fiscal authorities were to agree on coordinating their policies in the EMU, it would be necessary to introduce some mechanisms or binding agreements that would make deviations from the agreement less attractive.

Further, if fiscal authorities agreed to coordinate in the EMU, this would be accompanied by more active fiscal policies in the presence of demand shocks that affected countries differently and in the presence of competitiveness shocks, compared to the actual arrangement in the EMU. This, in turn, would involve more cases where fiscal authorities would set up a deficit above the deficit ceiling established by the SGP.

There are obviously some restrictions in the analysis carried out in this article. In the first place, we have used a static model that is played only once. In reality, fiscal authorities interact with each other through time, so an interesting extension would be to consider a multi-period setup. Secondly, in terms of complying with the deficit target of the SGP, it has been shown that, at the individual level, if there is fiscal policy coordination, there will be more instances of breaching the deficit target than under non-coordination. Nonetheless, the actual functioning of the SGP involves the possibility of being sanctioned for exceeding the deficit target of 3% of GDP. In the model considered in this article fiscal authorities have an objective for their deficit but the possibility of being penalised has not been explicitly introduced. That would introduce a restriction that could alter the behaviour of authorities when reacting to shocks, particularly under fiscal policy coordination. This is certainly an interesting extension of the analysis of fiscal policy coordination in the EMU.

Finally, in this article we have also illustrated that the outcomes associated with the two alternative concepts of fiscal policy coordination in a monetary union can be dramatically different. Therefore, it seems crucial to devote more research to clarify what should be understood by fiscal policy coordination and how could this coordination be achieved and implemented in a monetary union.

Appendix 1. Expressions for output and inflation.

$$y = \frac{-\delta}{1+\nu}u + \frac{\phi}{1-\nu^2}(d+\nu d^*) + \frac{1}{1-\nu^2}(\varepsilon_1 + \nu\varepsilon_1^*) - \frac{\varphi}{1-\nu}i$$

$$y^* = \frac{\delta}{1+\nu}u + \frac{\phi}{1-\nu^2}(d^*+\nu d) + \frac{1}{1-\nu^2}(\varepsilon_1^* + \nu\varepsilon_1) - \frac{\varphi}{1-\nu}i$$

$$\Pi = \frac{-\delta}{(1+\nu)\omega}u + \frac{\phi}{(1-\nu^2)\omega}(d+\nu d^*) + \frac{1}{(1-\nu^2)\omega}(\varepsilon_1 + \nu\varepsilon_1^*) - \frac{1}{\omega}\varepsilon_2 - \frac{\varphi}{(1-\nu)\omega}i$$

$$\Pi^* = \frac{\delta}{(1+\nu)\omega}u + \frac{\phi}{(1-\nu^2)\omega}(d^*+\nu d) + \frac{1}{(1-\nu^2)\omega}(\varepsilon_1^* + \nu\varepsilon_1) - \frac{1}{\omega}\varepsilon_2^* - \frac{\varphi}{(1-\nu)\omega}i$$

Appendix 2. Expressions for output and inflation under the EMU approach and under coordination.

(a) Output and inflation under EMU coordination.

$$y = \frac{-2(1+\nu)\delta\theta}{\phi^2 + 2\theta(1+\nu)^2}u + \frac{(1+\nu)\theta}{\phi^2 + 2\theta(1+\nu)^2}(\varepsilon_1 - \varepsilon_1^*) + \frac{1}{2}(\varepsilon_2 + \varepsilon_2^*)$$

$$y^* = \frac{2(1+\nu)\delta\theta}{\phi^2 + 2\theta(1+\nu)^2}u - \frac{(1+\nu)\theta}{\phi^2 + 2\theta(1+\nu)^2}(\varepsilon_1 - \varepsilon_1^*) + \frac{1}{2}(\varepsilon_2 + \varepsilon_2^*)$$

$$\Pi = \frac{-2(1+\nu)\delta\theta}{(\phi^2 + 2\theta(1+\nu)^2)\omega}u + \frac{(1+\nu)\theta}{(\phi^2 + 2\theta(1+\nu)^2)\omega}(\varepsilon_1 - \varepsilon_1^*) - \frac{1}{2\omega}(\varepsilon_2 - \varepsilon_2^*)$$

$$\Pi^* = \frac{2(1+\nu)\delta\theta}{(\phi^2 + 2\theta(1+\nu)^2)\omega}u - \frac{(1+\nu)\theta}{(\phi^2 + 2\theta(1+\nu)^2)\omega}(\varepsilon_1 - \varepsilon_1^*) + \frac{1}{2\omega}(\varepsilon_2 - \varepsilon_2^*)$$

(b) Output and inflation under the literature coordination.

$$y = \frac{-(1+\nu)\delta\theta}{\phi^2 + \theta(1+\nu)^2}u - \frac{(\phi^2 - \theta(1+\nu)^2)}{2(\phi^2 + \theta(1+\nu)^2)(1+\nu)}(\varepsilon_1 - \varepsilon_1^*) + \frac{1}{2}(\varepsilon_2 + \varepsilon_2^*)$$

$$y^* = \frac{(1+\nu)\delta\theta}{\phi^2 + \theta(1+\nu)^2}u + \frac{(\phi^2 - \theta(1+\nu)^2)}{2(\phi^2 + \theta(1+\nu)^2)(1+\nu)}(\varepsilon_1 - \varepsilon_1^*) + \frac{1}{2}(\varepsilon_2 + \varepsilon_2^*)$$

$$\Pi = \frac{-(1+\nu)\delta\theta}{(\phi^2+\theta(1+\nu)^2)\omega}u - \frac{(\phi^2-\theta(1+\nu)^2)}{2(\phi^2+\theta(1+\nu)^2)(1+\nu)\omega}(\varepsilon_1-\varepsilon_1^*) - \frac{1}{2\omega}(\varepsilon_2-\varepsilon_2^*)$$

$$\Pi^* = \frac{(1+\nu)\delta\theta}{(\phi^2+\theta(1+\nu)^2)\omega}u + \frac{(\phi^2-\theta(1+\nu)^2)}{2(\phi^2+\theta(1+\nu)^2)(1+\nu)\omega}(\varepsilon_1-\varepsilon_1^*) + \frac{1}{2\omega}(\varepsilon_2-\varepsilon_2^*)$$

Note that, in the two cases, the average output and average inflation coincide:

$$\bar{y} = \frac{1}{2}(\varepsilon_2+\varepsilon_2^*)$$

$$\overline{\Pi} = 0$$

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