Structural reforms and budget deficits in a monetary union: a strategic approach

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Abstract

This paper explores the interrelations between budget deficits and structural reforms in a monetary union. The analysis considers the international spillovers generated by both policies. We show that efforts to achieve fiscal policy coordination within the Eurozone reduce member countries' incentives to carry out much-needed structural reforms. As a consequence, this cooperation can turn out to be welfare-reducting if it not extended to the implementation of structural reforms.

Keywords: Structural reforms, Budget deficits, Externalities, Coordination.

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1 Introduction

The creation of the European Monetary Union (EMU) has sparked a lively debate on how community institutions should be designed so that they can provide macroeconomic stability

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and stimulate economic growth in the euro zone. Two aspects of this debate have received a great deal of attention due to their special relevance. On the one hand, the convenience of adopting rules that help discipline the fiscal policies implemented by the member states. On the other hand, the design of the right incentives that governments in the union should face so that they implement a sufficient level of structural reforms that make their economies more dynamic and competitive.

The need for coordinating fiscal policies in the EMU was highlighted in the Delors Report (1989), which considered it as a prerequisite for a successful monetary integration. Then, after the commitments reached in the Maastricht Treaty (1991), this political process culminated with the signing of the Stability and Growth Pact (SGP) at the Council of Amsterdam in 1997. This agreement represents the operational response of EU countries to the quest for fiscal coordination in the euro area. It contemplates the possibility of imposing sanctions to the member states whose budget deficits are considered "excessive".

The European Commission has emphasized the need of having an institution as the SGP arguing that when one member country incurs a fiscal deficit it makes the other partners worse-off. As HM Treasury (2004) has pointed out if the cost of unsustainable fiscal policies falls entirely within the country that carries them out, they need not be the concern of area-wide rules. However, they can have adverse spillovers in a monetary union and become a concern for other countries. The existence of such "negative externalities" has found support in a active line of investigation (see, for instance, Artis and Winkler, 1998; Beetsma and Uhlig, 1999; Casella, 1999; Chalk and Tanzi, 2002; Beestma and Jensen, 2003; and Fatás and Mihow, 2003). First, it has been argued that when one member country's deficit increases interest rates go up in the whole EMU, which will lower investment in the area[1] and, therefore, economic growth. On the other hand, since these fiscal imbalances increase the stock of public debt, they can give rise to a sustainability problem. In such scenario, the monetary authorities would come under political pressure to monetize the debt, which could erode the monetary authorities's credibility for fighting inflation[2].

[1] Jurgen Stark (2001, p. 79), one of the fathers of the SGP, wrote: 'The state's absorption of resources which would otherwise have found their way into private investments results in higher long-term interest rates'.

[2] Germany was a great supporter of the SGP fearing that, without the existence of such a fiscal institution,

Having said that, the fundamental criticism received by the SGP is based on the claim that this institution hampers the national fiscal authorities's ability to stabilize their economies in the face of adverse shocks (see, for instance, Bovenberg *et al.*, 1991; Bayoumi and Eichengreen, 1995; Dornbusch, 1997; Engwerda *et al.*, 2002; Enderlein, 2004; Solow, 2004 and De Grauwe, 2007).

The existence of deep differences in opinion on the relative importance attached to the pros and cons of the pact has not helped build a wide consensus on the desirability of this fiscal institution. On the contrary, the SGP has been a source of political frictions among signing countries, specially after Germany and France escaped the sanctions contemplated under the SGP for incurring an excessive budget deficit. This event created a precedent that damaged the credibility of the rules embedded in the pact. As a consequence, a process of redesign of the pact took place. The European Council agreed to fundamental changes to the SGP which made the pact's rules more flexible (ECOFIN(2005)). To wit, even if a country's budget deficit is in violation of the 3 percent rule, the new arrangement allows for a wide range of reasons ("any relevant factors", as it reads) why the member state in question will not be fined. This new approach has been criticized (see, for example, Hefeker, 2005; Deutsche Bundesbank's Monthly Report of April 2005 or Beetsma and Debrun, 2007) on the grounds that it is based on country-specific provisions which make the rules more complex, less transparent and, therefore, ultimately even more difficult to enforce.

As for the second aspect of the debate on the community institutions referred to above, a wide consensus has emerged on the need to implement structural reforms if the union is to achieve the goal stated in the Lisbon Council (2000). Namely, to be the most competitive and dynamic economy in the world[3]. The importance of structural reforms underlies the widespread

the incipient monetary institution could not live up to the anti-inflation credibility enjoyed by the Bundesbank (Hancke, 2003).

[3]In recognition of the importance of this monitoring, the Lisbon Council mandated the development of a set of comprehensive structural indicators to underpin analysis. Subsequent European Councils at Goteborg, Stockholm and Barcelona have developed and refined the initial set of indicators. To embrace the economic reform agenda there are indicators to cover six broad areas: general economic background, employment, innovation and research, economic reform, social cohesion and environment.

perception that EMU economies have had a worse performance than that of the United States[4]. It is also widely accepted that, since structural reforms eliminate market rigidities and correct market failures, they increase the flexibility of the economy, enhance its resilience against economic shocks and ultimately result in a higher long-term growth potential (see, for example, Trichet, 2004).

The aim of our paper is to explore how such reforms are affected by the way in which national fiscal policies are carried out by member states. With the purpose of focusing on the strategic aspects involved, we have adopted a game-theoretic approach.

Our paper is related to the ongoing recent literature that analyzes whether or not the focus on fiscal coordination derived from Maastricht and SGP is consistent with the goal of the Lisbon agenda (see Girardi and Paesani, 2008 for a review). Sapir *et al.* (2004) consider that a tight implementation of the EU fiscal rules supports the Lisbon objectives because the only domestic policy that is available to adjust the home economy is the realization of structural reforms. This optimistic view has been questioned on the grounds that the EU fiscal rules reduce the budgetary room for manoeuvre and the political capital of governments. As a result, these rules may deter the implementation of structural reforms. In this respect, Razin and Sadka (2002) have pointed out that these reforms may, at least initially, worsen budget deficits due to direct budgetary costs. Saint-Paul (2002) and Hughes Hallet *et al.* (2005) consider that a supportive fiscal stance may be needed to obviate the temporary widening output gap associated with reforms. Buti *et al.* (2007) show that, depending on the time horizon of the government, fiscal discipline may strengthen or weaken structural reforms. Finally, Beetsma and Debrun (2004a, 2007) and Ribeiro and Beetsma (2008) show that, insofar as a government with electoral uncertainty is more concerned about the present than the future and reforms give rise to future benefits but present costs, a fiscal pact can help mitigate the deficit bias that arises in this kind of environments. However, this outcome is achieved at the expense of a suboptimal low level of structural reforms.

Our approach is related to Beetsma and Debrun (2004a, 2007) and Ribeiro and Beestma (2008) but differs from the one adopted by these authors mainly in two respects. On the one

[4]In this respect, the International Monetary Fund (2004) has estimated that if the labor markets in Europe were as flexible as the ones in the US, the European GNP would be 10 percent greater.

hand, our analysis is not developed in a closed economy model. On the contrary, we adopt an open economy framework where the externalities generated by fiscal and reforms policies play a key role. On the other hand, in our work governments have the social preferences (i.e., they are benevolent) which implies that our model is absent of exogenous electoral uncertainty.

In a model *à la* Sibert (1999), we show that, when fiscal and structural reforms policies are not determined in a cooperative way, budget deficits are excessive from the social welfare point of view and the level of reforms is suboptimally low. Under these circumstances we characterize a set of rules that penalize deficits and the non-implementation of reforms in such a way that the efficient outcome is achieved. However, credibility is a requirement for these arrangements to internalize the externalities involved. Therefore, since the realism of this prerequisite is not supported by recent evidence within the EMU, we then consider an alternative setting where this kind of rules are non-existent or, which is equivalent, cannot be enforced.

In this scenario, and given the emphasis that the European Commission has kept on putting on the need for strengthening the coordination of fiscal policies among member states, we analyze the case where budgetary objectives are not determined by rigid rules but through cooperative agreements that take account of the structural reforms and the realizations of the shocks. This kind of coordination could be achieved by means of the decisions made within a strengthened Euro Group[5]. However, we show that this type of *ad hoc* coordination, reduces the incentives to implement structural reforms, which may render fiscal cooperation counterproductive. That is, welfare in the member countries could worsen in comparison with the scenario where budget deficits are decided at the national level. This result emphasizes the need to extend policy coordination to the design of structural reforms, therefore supporting the ongoing consensus in EMU. In the words of Almunia (2004), European Commissioner for Economic and Financial Affairs: 'it is very clear that we need to coordinate more our actions on structural reforms and our efforts to implement the Lisbon agenda. It is also clear that we cannot rely exclusively on one instrument, the Stability and Growth Pact, to coordinate our economic policies'.

This analysis provides an explanation why, despite the widespread view among EMU mem-

[5] The Eurogroup, which had its inaugural meeting in Luxembourg on 5 June 1998, is a subset of ECOFIN. It is made up of finance ministers of the euro states and acts as a forum for coordination within the euro zone.

bers on the need to carry out a sufficiently high level of structural reforms, national governments are behaving as if they had not the right incentives to do so. Moreover, in the present economic context, where member countries seem to be unable to escape the world economy slowdown, the paper highlights the risk of focusing on fiscal policy coordination but delaying important structural reforms.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 is devoted to the results. Section 4 concludes. Computations not included in the text are gathered in the Appendix.

2 The Model

We consider a monetary union, say the EMU, which is made up of two countries ($i = 1, 2$)[6]. The government in each country has the social preferences represented by the following loss function:

$$L_i^S = \sigma \left(\left(\widetilde{\phi} - \phi_i \right) x - d_i \right)^2 + (\alpha d_i + \beta d_j)^2 + \delta \left(\phi_i \right)^2, \tag{1}$$

where $i, j = 1, 2$; $i \neq j$; $\sigma, \widetilde{\phi}, \alpha, \beta > 0$; $\alpha \geq \beta$ and x is a stochastic disturbance with zero mean and finite variance $\left(E\left(x^2 \right) \right)$.

We begin by explaining the first term of expression (1). Country i's economy has an initial level of rigidity inherited from the past, $\widetilde{\phi}$. However, the greater the level of structural reforms implemented in the period of analysis, ϕ_i, the lower the final level of economic rigidity, $\widetilde{\phi} - \phi_i$; and, therefore, the more resilient the economy will become to a common shock which generates an output gap $\left(\widetilde{\phi} - \phi_i \right) x$. On the other hand, once governments have carried out their structural reforms and the realization of the shock is observed, they can make use of the budget deficit, d_i, to stabilize the economies.

The second term of the loss function in (1) refers to the negative effects that own and foreign deficits have on social welfare. We assume that the social cost of own country's deficit is no lower that the other country's ($\alpha \geq \beta$). First, when the public sector incurs indebtedness, it passes a financial burden to future generations without their approval. Second, when the deficit

[6] For simplicity, we confine the analysis to a two-country version, but a generalization to more countries is relatively straightforward.

increases, it causes interest rates to rise at home and abroad[7], lowering investment and economic growth on the whole currency area. Third, the greater the budget deficit the greater the stock of public debt and the higher the risk of facing a sustainability problem. If this problem arose, the monetary authorities would come under political pressure to monetize the debt, which would erode their anti-inflationary credibility.

The third term of (1) represents the costs associated to the implementations of structural reforms. Some studies have highlighted the existence of such costs on the following grounds (see, for instance Sibert, 1999; and Sibert and Sutherland, 2000). First, the uncertainty associated to the future implementation of reforms is an obstacle which prevents firms and consumers from making efficient decisions. Second, changes in tax laws modify the way in which accountancy is put into practice giving rise to "menu costs". Finally, reforms can cause an undesirable income redistribution and lobbies will struggle to protect their status quo. Notice that the positive parameters σ and δ are, respectively, the weights that the government puts on the costs of output variability and reforms (relative to the costs generated by deficits).

We model the interactions between fiscal and reforms policies by considering a multi-stage game. The sequence of events is as follows:

1) Governments decide the levels of reforms (ϕ_i).

2) Nature chooses the realization of the shock (x).

3) Fiscal authorities determine the budget deficits (d_i).

It is worth noting that, in the timing, the determination of reforms comes before the selection of the budgets deficits. This is in accordance with the fact that the implementation of reforms is a much more irreversible process than the determination of the fiscal variables. As a result, budget deficits can be adjusted more easily in the face of economic shocks.

The paper analyzes the case where the realization of the shock x takes a positive value (i.e. generating an economic slowdown in the union). In this scenario, as will be shown in

[7] This reasoning assumes that the Ricardian Equivalence does not hold. In this sense, it is well known that this hypothesis is based on many restrictive assumptions. Therefore, it is no surprise that this postulate has not received considerable empirical support (see, for example, Bernheim, 1989; Seater, 1993; Kandil, 2001; and Brunila, 2002).

the next section, fiscal authorities will run budget deficits with the aim of stabilizing their own economy. The opposite case where x is negative is not considered in the paper. In such scenario governments would end up having fiscal superavits. We do not explore this setting since we focus on the attempts carried out within the EMU to coordinate fiscal policies, and such attempts have never been aimed at preventing superavits in public finances but excessive deficits.

Our paper assumes that the aim of the fiscal policy is to stabilize the economy. In practice, two types of fiscal instruments are available for this purpose. Namely, the automatic stabilizers, designed prior to knowing the realization of the shock, and the discretional measures implemented after this realization becomes common knowledge. It is widely accepted that the countercyclical effect of the automatic stabilizers has an empirical support. However, the stabilizing role of the discretionary component of fiscal policy has generated an active debate. Hemming *et al.* (2002) have surveyed the empirical and theoretical literature on this topic and concludes that fiscal multipliers are overwhelmingly positive but small and Feldstein (2002) shows that discretionary fiscal policy can play a constructive role in a sustained downturn when aggregate demand and interest rates are low and when prices are falling or may soon be falling. In this sense, the present worldwide slowdown is prompting governments to design ambitious discretionary fiscal stimulus packages so as to stabilize their faltering economies.

A conclusion that could be drawn from the timing assumed in the paper is that we just focus on discretionary fiscal policy. However, as will become apparent in what follows, the same results are obtained if we assume that the fiscal policy is based exclusively on automatic stabilizers, namely, budget deficits are state-contingent functions designed prior to realization of the shock.

Throughout the paper, different equilibria will be obtained and evaluated making use of quadratic loss functions. This type of functions is widely used in the literature on international policy coordination (Obstfeld and Rogoff, 1996, chapter 9). On the other hand, Dixit and Lambertini (2003 a,b) and Woodford (2003, chapter 6) have shown that this type of quadratic objective functions builds on microeconomic foundations, since they can be obtained starting from the utility function of a representative agent. In addition, the intuition captured by this type of functions have been emphasized by former vice-president of the FED, Alan Blinder (1998), who pointed out that policymakers employ their instruments in such a way that only

"small" variations in the economic variables take place and for this type of changes any convex objective function is approximately quadratic.

This paper considers two different types of coordination, which have been labeled in this literature as *ex-ante* coordination and *ex-post* coordination (see for instance Beetsma *et al.*, 2001). The former, refers to the case where the economic authorities set rules prior to having observed the realizations of the shocks. The SGP in its initial version would had fallen within this category if the fines it contemplated would had been applied to countries whose deficits exceeded the reference level specified in the agreement. Had it been the case, this community fiscal institution would had been a credible commitment determined prior to stage 1 (stage 0). By contrast, cooperation ex-post is *ad-hoc* and takes place on the basis of the current state of affairs, that is, taking into account previous decisions and the realization of the shock. In our context, this kind of coordination develops in the third stage. The Eurogroup can be viewed as a vehicle for implementing this regime[8]. In the words of Strauss-Kahn (1997), the purpose of the creation of Eurogroup was both political 'to avoid the ECB being regarded as responsible for growth' and economic 'to match increased monetary interdependence by closer economic and budgetary cooperation'. In this sense, Pisani-Ferry (2002) argues that Eurogroup should agree on a set of broad non-binding policy principles outlining the operation of fiscal policy to assist fiscal coordination.

In addition to the ad-hoc reduced form structure of the model, our analysis has two main limitations: (a) it could be argued that the stabilization of demand shocks does not fall under the responsibility of national fiscal authorities but the common central bank; and (b) the model is static. However, the first limitation is not very restrictive in the European context because the conduct of the monetary policy is assigned to an independent central bank whose mandate emphasizes price stability rather than output stabilization. As for the second one, we follow a strand of literature that makes abstraction of the dynamic aspects related to the government

[8] France has been the main proponent of a strong role for this forum, which some view as the key instrument by which France hopes to regain the share of political power over monetary affairs abdicated to Germany prior to the creation of EMU. Many have noted that France appears to regard the Eurogroup as an "embryonic" economic government for Europe (Mcnamara and Meunier, 2002).

intertemporal budget restriction with the aim of concentrating its attention on the strategic aspects of monetary and fiscal policies (see, for instance, Agell *et al.*, 1996; Dixit, 2001; Dixit and Lambertini, 2001; 2003a,b, Beetsma and Debrun, 2004b). Moreover, as stated by Agell *et al.(*1996), if the Ricardian Equivalence is not satisfied, the government intertemporal budget constraint is not relevant. Alternatively, they argue that this restriction is not binding in the short run and, therefore, the strategies of the players involved can be modelled by a multi-stage game as the one outlined above.

3 The Results

We begin by analyzing the determination of budget deficits and structural reforms when both types of policy decisions are determined at the national level. Then, we compare this regime with the benchmark case where a benevolent social planner sets reforms and deficits in both countries (efficient outcome). Next, we characterize a commitment technology that leads to the implementation of the social optimum in a decentralized way. Finally, considering the scenario in which such mechanism is unfeasible in practice -and, therefore, lacks credibility- we study two alternative regimes. In the first one, fiscal authorities of both countries carry out a fiscal coordination *ex-post*. In the second scenario, countries collectively determine the level of their structural reforms.

3.1 Sovereign policies on budget deficits and structural reforms

In this subsection we consider the regime where decisions on budget deficits and structural reforms belong to the national level. This non-cooperative behavior is modeled by making use of the concept of subgame perfect equilibrium. Therefore, we apply backward induction to the game outlined in section 2.

In the last stage, once the level of structural reforms and the realization of the shocks are known, each government selects the size of its budget deficit with the aim of minimizing its country's social loss, taking its counterpart's as given. Formally, each government faces the

following problem:

$$\underset{\{d_i\}}{Min} \quad \sigma\left(\left(\widetilde{\phi}-\phi_i\right)x-d_i\right)^2+\left(\alpha d_i+\beta d_j\right)^2+\delta\left(\phi_i\right)^2,$$

where $i,j=1,2;\ i\neq j$.

From the first-order condition, we obtain the reaction function of the fiscal authorities in each country:

$$d_i=\frac{\sigma x\left(\widetilde{\phi}-\phi_i\right)-\alpha\beta d_j}{\sigma+\alpha^2}. \tag{2}$$

Now, solving simultaneously the reaction functions of the fiscal authorities yields the following Nash equilibrium:

$$d_i=\frac{\sigma\left(\left(\sigma+\alpha^2\right)\left(\widetilde{\phi}-\phi_i\right)-\alpha\beta\left(\widetilde{\phi}-\phi_j\right)\right)x}{\left(\sigma+\alpha^2\right)^2-\alpha^2\beta^2}. \tag{3}$$

Finally, in the first stage, bearing in mind expression (3) and prior to knowing the realization of the shock, governments implement structural reforms without cooperation. That is, the government in country i minimizes the expected value of its country's social loss. Analytically, it solves:

$$\begin{array}{ll}\underset{\{\phi_i\}}{Min} & E\left[\sigma\left(\left(\widetilde{\phi}-\phi_i\right)x-d_i\right)^2+\left(\alpha d_i+\beta d_j\right)^2+\delta\left(\phi_i\right)^2\right]\\ s.t. & d_i=\frac{\sigma\left(\left(\sigma+\alpha^2\right)\left(\widetilde{\phi}-\phi_i\right)-\alpha\beta\left(\widetilde{\phi}-\phi_j\right)\right)x}{\left(\sigma+\alpha^2\right)^2-\alpha^2\beta^2},\end{array}$$

giving rise to the following reaction function:

$$\phi_i=\frac{\left(\left(\sigma+\alpha^2\right)\left(\sigma+\alpha^2-\beta^2\right)\left(\left(\sigma+\alpha^2-\alpha\beta\right)\left(\alpha+\beta\right)\widetilde{\phi}-\sigma\beta\phi_j\right)\right)\alpha\sigma E\left(x^2\right)}{\delta\left(\sigma+\alpha^2-\alpha\beta\right)^2\left(\sigma+\alpha^2+\alpha\beta\right)^2+\sigma E\left(x^2\right)\alpha^2\left(\sigma+\alpha^2\right)\left(\sigma+\alpha^2-\beta^2\right)^2}, \tag{4}$$

which implies that the resulting Nash equilibrium is[9]:

$$\phi_i^N=\frac{\widetilde{\phi}}{1+\frac{\delta(\sigma+\alpha^2-\alpha\beta)(\sigma+\alpha^2+\alpha\beta)^2}{(\alpha+\beta)(\alpha^2+\sigma)\left(\sigma+\alpha^2-\beta^2\right)\sigma E(x^2)\alpha}}>0. \tag{5}$$

Another implication is that the equilibrium level of structural reforms do not reach its ceiling $\left(\phi_i<\widetilde{\phi}\right)$ since we have that the denominator of (5) is positive. Therefore, reforms are insufficient to completely eliminate the output variability caused by adverse shocks. On the other hand,

[9] The superscript "N" appearing in (5) and (6) stands for "Nash equilibrium".

taking into account structural reforms (expression (5)), budget deficits will be (substituting (5) into (3)):

$$d_i^N = \frac{\sigma\left(\left(\sigma+\alpha^2\right)^2-\alpha^2\beta^2\right)\delta\widetilde{\phi}x}{\alpha\sigma E\left(x^2\right)(\alpha+\beta)\left(\alpha^2+\sigma\right)\left(\sigma+\alpha^2-\beta^2\right)+\delta\left(\sigma+\alpha^2-\alpha\beta\right)\left(\sigma+\alpha^2+\alpha\beta\right)^2} > 0. \quad (6)$$

In order to analyze the optimality of this outcome, we need to determine the levels of structural reforms and budget deficits which would be selected by a benevolent social planner. With this aim, we begin by solving the last stage of this ideal scenario. That is, at the end of the game and knowing the values of the structural reforms and the realization of the shock, the planner would choose the level of the deficits so as to minimize the joint social loss. Formally the problem faced by this supranational authority would be:

$$\underset{\{d_1,d_2\}}{Min} \quad \sum_{i\neq j}\sigma\left(\left(\widetilde{\phi}-\phi_i\right)x-d_i\right)^2+\left(\alpha d_i+\beta d_j\right)^2+\delta\left(\phi_i\right)^2.$$

The solution yields:

$$d_i = \frac{\sigma\left(\left(\alpha^2+\beta^2+\sigma\right)\left(\widetilde{\phi}-\phi_i\right)-2\alpha\beta\left(\widetilde{\phi}-\phi_j\right)\right)x}{\sigma\left(2\alpha^2+2\beta^2+\sigma\right)+\left(\alpha^2-\beta^2\right)^2}. \quad (7)$$

Now, in the first stage the planner would determine the level of reforms that would minimize the expected joint social loss, bearing in mind (7). Namely, the problem to be solved would be:

$$\begin{array}{ll} \underset{\{\phi_1,\phi_2\}}{Min} & E\left[\sum_{i\neq j}\sigma\left(\left(\widetilde{\phi}-\phi_i\right)x-d_i\right)^2+\left(\alpha d_i+\beta d_j\right)^2+\delta\left(\phi_i\right)^2\right] \\ s.t. & d_i = \frac{\sigma\left(\left(\alpha^2+\beta^2+\sigma\right)\left(\widetilde{\phi}-\phi_i\right)-2\alpha\beta\left(\widetilde{\phi}-\phi_j\right)\right)x}{\sigma\left(2\beta^2+\sigma+2\alpha^2\right)+\left(\alpha^2-\beta^2\right)^2}, \end{array}$$

whose result is[10]:

$$\phi_i^O = \frac{\widetilde{\phi}}{1+\frac{\left(\sigma+(\alpha+\beta)^2\right)\delta}{(\alpha+\beta)^2\sigma E(x^2)}} > 0. \quad (8)$$

Substituting (8) into (7) we obtain the efficient levels for deficits:

$$d_i^O = \frac{\sigma\delta\widetilde{\phi}x}{E\left(x^2\right)\sigma\left(\alpha+\beta\right)^2+\left(\sigma+\left(\alpha+\beta\right)^2\right)\delta} > 0. \quad (9)$$

[10] The superscript "O" appearing in (8) and (9) stands for "Optimum". On the other hand, notice that since the denominator of (8) is positive then $\phi_i^o < \widetilde{\phi}$. That is, it is not optimal to completely eliminate the rigidity of the economy since that would be too costly for society.

Result 1: *When decisions on fiscal policy and structural reforms are made at the national level, budget deficits are suboptimally high and the level of reforms is suboptimally low.*

Proof: See Appendix.

The first part of this result is rather straightforward. That is, since deficits generate negative externalities, a prisoners's dilemma arises in the non-cooperative equilibrium, which implies that they are excessive from the welfare point of view (because these externalities are not internalized). However, in order to understand the intuition why structural reforms are suboptimally low we need to realize that they generate positive externalities. In order to do so, first notice that budget deficits are strategic substitutes (using the terminology of Bulow *et al.* (1985)), namely, an increase in the fiscal deficit of country j induces the authorities of country i to reduce its own fiscal deficit (see reaction functions R_i and R_j , derived from (2)). The reason why this is so is that when the foreign country runs a higher budget deficit interest rates in the union increase and so does the risk of a debt monetization. This provides the home country with incentives to run a lower deficit (i.e., to avoid a higher second component in (1)) .

By the same token, structural reforms are also strategic substitutes. When the foreign country implements more reforms its own economy becomes more resilient to shocks. Therefore, it will run lower fiscal deficits generating less (negative) externalities. This will improve home country's welfare. In other words, structural reforms generate positive externalities. Graphically, when country j carries out more reforms its reaction function shifts downwards and the Nash equilibrium moves from N to N'. This decreases its own deficit, leaving more room for using fiscal stabilization in the other country which, therefore, is made better-off. This welfare improvement (i.e. the positive sign of the externalities generated by reforms) is implied by country i's achieving an isoloss curve which is nearer its bliss point.

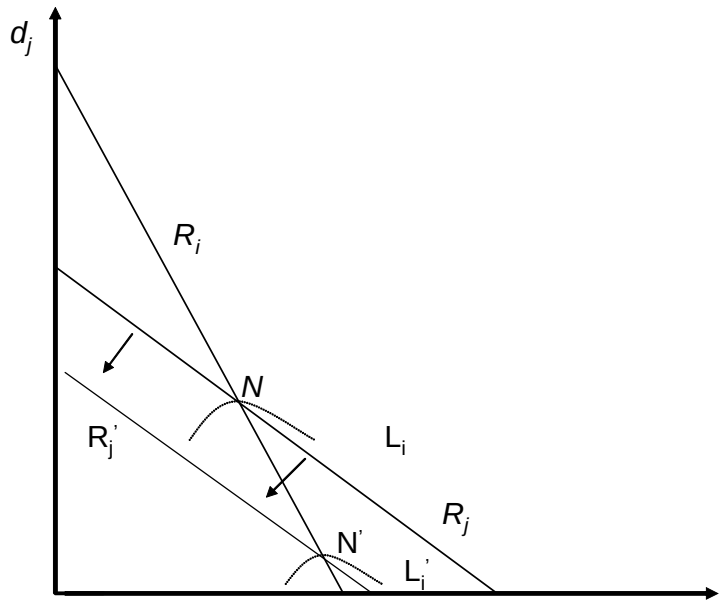

Figure I

Therefore, because reforms generate positive externalities and are costly to implement the absence of coordination leads to a free riding problem. That is, countries carry out a suboptimally low level of reforms because they fail to take into account the beneficial impact of more active reform policy on the other.

It is also worth noting that the above analysis is based in the assumption that decision on the structural reforms are made by benevolent governments, i.e., we set aside the political incentives that increase the cost for the government to carry out structural reforms. Including these opportunistic elements into the analysis would increase the cost of carrying out structural reforms (it would be greater than δ in (1)). In such setting, and taking into account that $\frac{\partial d_i^N}{\partial \delta} > 0$ (from (6)) and $\frac{\partial \phi_i^N}{\partial \delta} < 0$ (from (5)), the outcome would move even further from the optimal one (and in the same direction). That is, these political costs would give rise to even lower reforms. This, in turn, would make the economies more vulnerable to shocks and therefore, more dependent on fiscal stabilization. In other words, budget deficit would be even higher, i.e., they would also be more distant from the optimum level.

Notice also that we assume that the focus of the fiscal policy is the stabilization of the econ-

omy. In practice, fiscal stabilization is a result of the combined effects of automatic stabilizers (designed before the realization of the shock takes place) and discretionary fiscal policy that complements the stabilization carried out by automatic stabilizers. In the timing we assume that fiscal policy is entirely discretional, but notice that our results hold if we assume that the stabilization of the fiscal policy rests exclusively on automatic stabilizers. In such case, fiscal deficits would be state-contingent functions designed prior to realization of the shock (see (3)). Therefore, deficits would be suboptimally high and structural reforms suboptimally low.

Finally, our analysis rests on the assumption that external effects of the budget deficits are negative. This view underpins the rules embedded in the SGP. However, it has been argued that a higher external demand via own budget deficit gives rise to a positive spillover that could overcome the negative external effects (see Beestma *et. al* (2001, p. 64-65)). In our model that would imply that these external effects are positive (i.e. $\beta < 0$). This would affect the nature of the conflict among government described here. Notice that, in such a case, budget deficits and structural reforms would be strategic complements. That is, reaction functions would be upward sloping in both the (d_i, d_j) and the $\left(\phi_i, \phi_j\right)$ spaces (see (2) and (4)). Therefore the conclusion in Result 1 would be reversed. First, budget deficits would be suboptimally low (each country would fail to take into account the positive effects of its deficit on its neighbor) and an institution fostering high deficits would be called for (just the opposite of the SGP). And second, the level of reforms would be suboptimally high, which would require rules that run counter the Lisbon Council view.

Our paper does not follow this latter route but assumes that fiscal deficits generate negative externalities, which rationalizes the proposals for coordination in fiscal and reforms policy within the union.

3.2 Optimal commitment technology

We now analyze an scenario in which such externalities are internalized by a coordination *ex-ante*. This type of cooperation is based on agreements among countries that determine a set of "rules of the game". This institutional framework creates the right incentives so that the efficient outcome is achieved, even though national policies are determined in a non-cooperative

fashion.

In order to determine such a commitment technology[11], we continue to assume that the sequence of events is the one described in section 2, with the only exception that we now introduce a new stage at the very beginning of the game. In such a "stage 0" (that comes before stage 1) an international principal sets some penalizations on budget deficits (t) and on the non-implementation of reforms (g). More precisely, the objective function of each government becomes:

$$L_i^S = \sigma\left(\left(\widetilde{\phi} - \phi_i\right)x - d_i\right)^2 + (\alpha d_i + \beta d_j)^2 + \delta\left(\phi_i\right)^2 + t\left(d_i\right)^2 + g\left(\widetilde{\phi} - \phi_i\right)^2.$$

Applying backward induction to this enlarged game we obtain the following proposition:

Proposition 1: *When policies are decided at the national level, the efficient outcome is achieved if the penalization rates on deficits and on the non-implementation of structural reforms are, respectively,* $t = \beta(\alpha + \beta)$ *and* $g = \frac{\beta^2(\alpha+\beta)\sigma^2 E\left(x^2\right)\alpha}{\left(\sigma+\beta^2+\alpha^2\right)\left(\sigma+(\alpha+\beta)^2\right)^2}$.

Proof: See Appendix.

Proposition 1 shows that the coordination failure can be resolved through institutional arrangements modeled as "quadratic contracts" *à la* Jensen (2000) that penalize deviations from the optimal policy mix. Therefore, it would be optimal for the European Commission to apply rules that influence the course of fiscal policy and the implementation of structural reforms. However, in the case of the EMU, it could be argued that the enforcement of such rules is not credible given the absence of a full-fledged political union. In fact, the final decision on the actions to be taken against countries which renege on commitments ultimately depends on councils, some of whose components are representatives of the sovereign states that did not honored the agreements. Therefore, such rules would be more credible if their enforcement were

[11] The rationalizations of macroeconomic institutions have been most usually based on the existence of a time-inconsistency problem in monetary policy. However, other arguments for providing institutional solutions are the need for coordinating: a) economic policies among countries (Persson and Tabellini, 1995; and Jensen, 2000); and b) monetary and fiscal policy within one economic area (Agell *et al.*, 1996; Beetsma and Bovenberg, 1997; Debrun, 2000; and Dixit and Lambertini, 2003a).

assigned to the European Commission or some independent committee. As a result, in the subsequent subsections we explore other settings in which this kind of rules aimed at achieving a cooperation *ex-ante*, even if they exist, lack credibility which implies that they are not operative.

3.3 Fiscal coordination ex-post

We now consider the case where fiscal cooperation takes place without setting rigid rules as the ones implied by the SGP in its initial version. On the contrary, we assume that this coordination occurs *ex-post,* that is, in the last stage of the game. In that moment, structural reforms have been implemented and the realizations of the shocks have been observed. In the context of the EMU this kind of coordination could be achieved by means of a strengthened Euro Group.

In this case, and considering that cooperation is not extended to the implementation of structural reforms, when deciding the level of such reforms each governments solves in the first stage (bearing in mind (3)):

$$\begin{array}{ll} \underset{\{\phi_i\}}{Min} & E\left[\sigma\left(\left(\widetilde{\phi}-\phi_i\right)x-d_i\right)^2+(\alpha d_i+\beta d_j)^2+\delta\left(\phi_i\right)^2\right] \\ s.t. & d_i=\frac{\sigma\left(\left(\alpha^2+\beta^2+\sigma\right)\left(\widetilde{\phi}-\phi_i\right)-2\alpha\beta\left(\widetilde{\phi}-\phi_j\right)\right)x}{\sigma\left(2\beta^2+\sigma+2\alpha^2\right)+\left(\alpha^2-\beta^2\right)^2}. \end{array}$$

The solutions yields:

$$\phi_i=\frac{\widetilde{\phi}}{1+\frac{\delta\left(\sigma+(\alpha-\beta)^2\right)\left(\sigma+(\alpha+\beta)^2\right)}{\sigma E(x^2)(\beta+\alpha)\left(\alpha^3-\beta\alpha^2+\sigma\alpha-\beta^2\alpha+\beta^3\right)}}>0. \tag{10}$$

As a consequence, in the third stage budget deficits will take the following value (substituting (10) into (3)):

$$d_i=\frac{\sigma\delta\widetilde{\phi}\left((\alpha-\beta)^2+\sigma\right)x}{\sigma E\left(x^2\right)(\alpha+\beta)\left((\alpha+\beta)(\alpha-\beta)^2+\alpha\sigma\right)+\delta\left(\sigma+(\alpha+\beta)^2\right)\left(\sigma+(\alpha-\beta)^2\right)}>0. \tag{11}$$

Result 2: *In the regime of fiscal coordination ex-post the levels of reforms and budget deficits are, respectively, lower and greater than in the social optimum.*

Proof: See Appendix.

The intuitive explanation of this result is as follows. The only difference between the regime of fiscal cooperation *ex-post* and the one which achieves the social optimum is the way in which the first stage is played. That is, in the former scenario structural reforms are determined in a non-cooperative fashion whereas in the latter such reforms are implemented with cooperation. For this reason, only the former regime will fail to internalize the externalities generated by reforms. As a consequence, since these spillovers are positive, in the regime of fiscal cooperation *ex-post* the level of reforms will be lower than in the social optimum. This means that in the former scenario the level of rigidity of the economy will be higher making it more vulnerable to adverse shocks. That is, if a disturbance creates an economic downturn, the need to incur a budget deficit will be greater in the case in which cooperation is only achieved in the last stage.

Now we compare the regime of fiscal coordination *ex-post* with the scenario where all players act in a non-cooperative fashion.

Result 3: *In the regime of fiscal coordination ex-post, budget deficits and the levels of structural reforms are lower than in the scenario where both policies are determined at the national level.*

Proof: See Appendix.

We obtain this conclusion because the two regimes referred to in Result 3 just differ in the way the last stage develops. That is, in comparison with the non-cooperative fiscal policy scenario, in the cooperative one lower deficits are expected -so as to collectively rein in the negative externalities of deficits. Therefore, this triggers a lower level of structural reforms. Why? Because one of the reasons why reforms are implemented is that, costly though they are, they reduce the incentives to run budgets deficits so as to diminish them and their negative effects on welfare (expressed by the second term in (1))

To end up this subsection we present the following proposition which questions the convenience of the regime in which cooperation is carried out just in the last stage of the game:

Proposition 2: *Implementing fiscal coordination ex-post can be counterproductive.*

Proof: See Appendix.

Result 3 and the expression for society's objective function in (1) help understand why we obtain Proposition 2. To wit, comparing the case of fiscal coordination *ex-post* with the scenario in which no stage develops in a cooperative fashion, the former regime has two advantages but one drawback. As for the pros, on the one hand, since in the former case deficits are lower their negative effect on welfare is smaller (second term, $(\alpha d_i + \beta d_j)^2$, in (1)); and, on the other hand, the fact that the structural reforms are implemented to a lesser extent in the cooperation *ex-post* scenario implies that the cost of carrying them out is reduced (third term, $\delta (\phi_i)^2$, in (1)). However, this cooperative regime has a clear-cut disadvantage which can be more easily understood with an inspection of the first term in (1) ($\sigma \left(\left(\widetilde{\phi} - \phi_i \right) x - d_i \right)^2$). Namely, since reforms are reduced, economies become less flexible and more vulnerable to adverse shocks. Furthermore, with a more passive fiscal policy its anticyclical role is hampered.

To sum up, the drawback associated to the regime of coordination *ex-post* can more than offset its advantages in comparison with the scenario where no cooperation takes place.

3.4 Cooperative implementation of structural reforms

Finally, in this subsection, we consider a context where countries's coordination efforts are concentrated only on structural reforms policy. In this respect, Eichengreen and Wyplosz (1998), Eichengreen (2004) and Pichelmann and Roeger (2004) consider that trying to coordinate fiscal policies is a nuisance since it deviates attention from the most important challenge of the European authorities, namely, coordinating their structural reforms policies. Notwithstanding the progress made in the Amsterdam Council (1999), the main responsibility for carrying out reforms in capital, labor and products markets still lies with the member states. The Lisbon Strategy provides a mechanism for coordination in areas as labor markets: the called open method of coordination (OMC). The OMC is based on a voluntary participation of the member states and is not armed with any legal sanctions, it can only use informal means of enforcement. The only pressures on countries can be exerted through mutual information and assessment.

This setting implies, in our framework, that only the first stage develops in a cooperative

fashion. Therefore, the problem faced by governments in that stage is:

$$\begin{array}{ll} \underset{\{\phi_1,\phi_2\}}{Min} & E\left[\sum_{i\neq j}\sigma\left(\left(\widetilde{\phi}-\phi_i\right)x-d_i\right)^2+\left(\alpha d_i+\beta d_j\right)^2+\delta\left(\phi_i\right)^2\right] \\ s.t. & d_i=\frac{\sigma\left(\left(\sigma+\alpha^2\right)\left(\widetilde{\phi}-\phi_i\right)-\alpha\beta\left(\widetilde{\phi}-\phi_j\right)\right)x}{\left(\sigma+\alpha^2\right)^2-\alpha^2\beta^2}, \end{array}$$

whose solution is:

$$\phi_i=\frac{\widetilde{\phi}}{1+\frac{\delta\left(\sigma+\alpha^2+\alpha\beta\right)^2}{\sigma E(x^2)(\beta+\alpha)^2(\alpha^2+\sigma)}}. \tag{12}$$

As a consequence substituting (12) into (3) deficits are:

$$d_i=\frac{\sigma\delta\widetilde{\phi}x}{\sigma E\left(x^2\right)\left(\alpha+\beta\right)^2\frac{\alpha^2+\sigma}{\sigma+\alpha^2+\alpha\beta}+\left(\sigma+\alpha^2+\alpha\beta\right)\delta}. \tag{13}$$

Result 4: When cooperation applies just to the implementation of structural reforms, not only such reforms but also budget deficits are suboptimally high.

Proof: See Appendix.

The intuition behind this result is as follows. The social optimum can be interpreted as the regime in which cooperation occurs in the first and final stages of the game. Therefore, if such cooperation does not apply to the last stage, fiscal authorities will not internalize the negative externalities of deficits which, as a result, will be suboptimally high. In this context, if governments collectively determine structural reforms they will aim at creating the appropriate incentives so that this fiscal imbalances are reduced. This will be achieved by implementing a high level of reforms, which will increase beyond the social optimum.

Now we compare the regime in which cooperation only applies to reforms with the scenario where all the stages of the game develop in a non-cooperative way.

Result 5: Comparing the regime where structural reforms are collectively implemented but fiscal policies are determined at the national level with the scenario in which both policies are determined in a non-cooperative fashion, in the former, social welfare and the level of reforms are higher but budget deficits are lower.

Proof: See Appendix.

The explanation why we obtain this result is as follows. To begin with, note that since in both regimes the last stage develops in the same (non-cooperative) way, in the case where structural reforms are collectively implemented, choosing the level of such reforms corresponding to the other scenario is an available option. However, since structural reforms generate positive externalities, their complete internalization in the cooperative regime implies that their level -and, therefore, welfare- will be higher than in the case where reforms are decided at the national level. This higher level of reforms makes economies less rigid and, as a consequence, more resilient to adverse disturbances. Therefore, when such shocks take place the need for making use of budget deficits as a means of stabilizing the economy is less important and, as a result, fiscal imbalances will be smaller. However, social welfare would improve even more if cooperation is applied not only to the design of reforms but also to the implementation of fiscal policies since, in this scenario, all the externalities involved would be internalized.

4 Conclusions

The formation of the EMU have prompted a deep interest among academics and practitioners in how fiscal community institutions should be designed so that the negative externalities generated by budget deficits in the member countries are reduced without undermining the stabilizing role of fiscal policy. On the other hand, a wide consensus has emerged on the need to implement to structural reforms if the economies of the union are to increase their competitiveness and dynamism in line with the goals set by the Lisbon Council (2000).

The aim of this paper has been to explore the interrelations between the implementation of structural reforms and determination of fiscal polices in the context of the EMU. With this purpose it has made use of game theory in order to focus on the strategic aspects involved.

In a setup in which budget deficits and structural reforms are decided on a national level, we have characterized a set of rules that achieve the social optimum by penalizing member countries' fiscal imbalances and the non-implementation of their reforms. However, the empirical evidence casts doubts on the enforceability of such commitment. More specifically, the precedent set by

France and Germany have undermined the credibility of this European institution because these two countries have not been fined, in spite of not having abided by the pact

These developments have led us to consider an alternative setting where fiscal rules are non-existent or, which is equivalent, they do not represent a credible commitment. In this context and bearing in mind the emphasis put by the European Commission on the need to somehow coordinate fiscal policies in the union we have studied a regime where member countries determine their budget deficits by cooperating *ex-post*, that is, taking into account the level of reforms previously implemented and the shocks hitting the economy. In practice, the institution through which this kind of "ad hoc" cooperation would be achieved is the Euro Group. In this sense, we have shown that if fiscal policy is collectively determined in this way and this coordination does not extend to the implementation of structural reforms, incentives to carry out such reforms will decrease. As a result fiscal cooperation *ex-post* can turn out to be counterproductive. That is, social welfare could be lower than in the scenario where deficits are determined at the national level.

This analysis rationalizes the widespread view that, despite the consensus about the importance of carrying out more structural reforms (as agreed in the Lisbon Council), member countries seem not to be facing the right incentives to do so. This issue is particularly relevant in the present context where countries in the EMU are not escaping the worldwide economic slowdown. In this sense, the paper highlights the risk of focusing on fiscal policy coordination but delaying important structural reforms.

Finally, the search of technologies that guarantee that cooperative commitments are fully met by all member countries is an important challenge faced by the union. Even though the EU has its own laws and institutions, member states abide by them only when they are perceived in their own individual interests. In fact, the community rules suffer from an important implementation problem, namely, they cannot be enforced. There is still a long way to go and it is going to be a bumpy road. The first step could be to get a SGP credible enough to achieve more fiscal coordination. As for the structural reforms, the tool of coordination in the Lisbon agenda is the so-called Open Method of Coordination (OMC). It is essentially a forum for benchmarking and exchange of best practices among governments, with some commitments and some good

intentions, but no binding instruments. In other words, the OMC is even much weaker than the tools used to obtain fiscal coordination within the EMU. Despite the fact that Member States are not capable of coordinating among themselves they continue to be reluctant to delegate more power to the European Commission or any independent institution.

As long as the union succeeds in overcoming a Europe governance with many government, the goals set in Lisbon, namely, to make Europe "the most dynamic and competitive economy in the world" will keep on being what Alesina and Perotti (2004) have called 'a myriad of meaningless pompous statements'.

Finally, there is an important aspect that should not be overlooked and that this paper has put forward. To wit, the dangers associated to a coordination which just focuses on the determination of budget deficits. In this sense, this study has shown that this collective action can be counterproductive if member countries fail to extend it to the implementation of structural reforms.

5 Appendix

Proof of Result 1

To begin with, as far the structural reforms are concerned, computing the difference between the denominators in equations (5) and (8) one finds:

$$\frac{\left(\sigma\left(\sigma+2\alpha^2+\alpha\beta\right)+\alpha\left(\alpha+\beta\right)\left(\alpha^2+\beta^2\right)\right)\delta\beta}{\alpha E\left(x^2\right)\left(\alpha+\beta\right)^2\left(\alpha^2+\sigma\right)\left(\sigma+\alpha^2-\beta^2\right)}. \tag{14}$$

The positive sign of expression (14) implies that, when fiscal and structural reforms policies are determined at the national level, the level of such reforms is suboptimally low.

In order to compare budget deficit in both scenarios we rearrange (6) in this way:

$$d_i = \frac{\sigma\delta\widetilde{\phi}x}{\frac{\alpha\sigma E(x^2)(\beta+\alpha)(\alpha^2+\sigma)\left(\sigma+\alpha^2-\beta^2\right)+\delta(\sigma+\alpha^2-\alpha\beta)(\sigma+\alpha^2+\alpha\beta)^2}{\left(\sigma^2+2\sigma\alpha^2+\alpha^4-\alpha^2\beta^2\right)}}. \tag{15}$$

Now, subtracting the denominator of (15) from the one in (9) yields:

$$\frac{\left(\delta\left(\sigma+\alpha^2+\alpha\beta\right)\left(\sigma+\alpha\left(\alpha-\beta\right)\right)+E\left(x^2\right)\sigma\left(\alpha^2\left(\alpha^2-\beta^2\right)+2\sigma\alpha^2+\sigma\beta\alpha+\sigma^2\right)\right)\beta\left(\alpha+\beta\right)}{\sigma^2+2\sigma\alpha^2+\alpha^2\left(\alpha^2-\beta^2\right)}. \tag{16}$$

Expression (16) is positive because $\alpha \geq \beta$ (see section 2) and therefore $(\alpha - \beta) \geq 0$ and $\left(\alpha^2 - \beta^2\right) \geq 0$. Then, we conclude that, when decisions on fiscal policies and reforms are decided at a national level, deficits are suboptimally high. ∎

Proof of Proposition 1

In the last stage, each government solves:

$$\underset{\{d_i\}}{Min} \quad \sigma\left(\left(\widetilde{\phi}-\phi_i\right)x - d_i\right)^2 + (\alpha d_i + \beta d_j)^2 + \delta\left(\phi_i\right)^2 + t\left(d_i\right)^2 + g\left(\widetilde{\phi}-\phi_i\right)^2,$$

which yields the following Nash equilibrium:

$$d_i = \frac{\sigma\left(\left(\sigma+\alpha^2+t\right)\left(\widetilde{\phi}-\phi_i\right) - \alpha\beta\left(\widetilde{\phi}-\phi_j\right)\right)x}{\left(\sigma+\alpha^2\right)^2 - \left(\alpha\beta\right)^2 + t\left(t+2\sigma+2\alpha^2\right)}. \tag{17}$$

Now, since in the first stage reforms will be optimal (expression (8)) the budget deficit will be (substituting (8) into (17)):

$$d_i = \frac{\sigma\left(\sigma+(\alpha+\beta)^2\right)\delta\widetilde{\phi}x}{\left(\sigma+\alpha^2+t+\alpha\beta\right)\left(\left(\alpha+\beta\right)^2\sigma E\left(x^2\right) + \left(\sigma+(\alpha+\beta)^2\right)\delta\right)}. \tag{18}$$

Therefore, for deficits are to achieve optimal levels, their "penalizing rate" (t) must be such that the following condition holds (from (9) and (18)):

$$\frac{\sigma\delta\widetilde{\phi}x}{E\left(x^2\right)\sigma\left(\alpha+\beta\right)^2 + \left(\sigma+(\alpha+\beta)^2\right)\delta} = \frac{\sigma\left(\sigma+(\alpha+\beta)^2\right)\delta\widetilde{\phi}x}{\left(\sigma+\alpha^2+t+\alpha\beta\right)\left(\left(\alpha+\beta\right)^2\sigma E\left(x^2\right) + \left(\sigma+(\alpha+\beta)^2\right)\delta\right)},$$

whose solution is:

$$t = \beta\left(\alpha+\beta\right). \tag{19}$$

This is precisely the value of t referred to in Proposition 1. As a consequence, in the first stage, each government faces the following problem:

$$\underset{\{\phi_i\}}{Min} \quad E\left[\sigma\left(\left(\widetilde{\phi}-\phi_i\right)x - d_i\right)^2 + (\alpha d_i + \beta d_j)^2 + \delta\left(\phi_i\right)^2 + t\left(d_i\right)^2 + g\left(\widetilde{\phi}-\phi_i\right)^2\right]$$

$$s.t. \qquad \begin{cases} d_i = \frac{\sigma\left(\left(\sigma+\alpha^2+t\right)\left(\widetilde{\phi}-\phi_i\right) - \alpha\beta\left(\widetilde{\phi}-\phi_j\right)\right)x}{\left(\sigma+\alpha^2\right)^2 - \left(\alpha\beta\right)^2 + t\left(t+2\sigma+2\alpha^2\right)}, \\ t = \beta\left(\alpha+\beta\right), \end{cases}$$

whose solution leads to the Nash equilibrium:

$$\phi_i = \frac{\widetilde{\phi}}{1 + \frac{\delta\left(\beta^2+\alpha^2+\sigma\right)\left((\alpha+\beta)^2+\sigma\right)^2}{E(x^2)\sigma(\beta+\alpha)Z_1+g\left(\beta^2+\alpha^2+\sigma\right)\left((\alpha+\beta)^2+\sigma\right)^2}}, \tag{20}$$

where:

$$Z_1 = \left(\beta^2+\alpha^2\right)(\beta+\alpha)^3 + \sigma\left(\sigma(\beta+\alpha) + \beta\left(2\beta^2+3\beta\alpha+4\alpha^2\right)+2\alpha^3\right).$$

Therefore, the "penalization rate" g must satisfy (equating (20) and (8)):

$$\frac{\widetilde{\phi}}{1+\frac{\widetilde{\phi}}{1+\frac{\delta\left(\beta^2+\alpha^2+\sigma\right)\left((\alpha+\beta)^2+\sigma\right)^2}{E\left(x^2\right)\sigma(\beta+\alpha)Z_1+g\left(\beta^2+\alpha^2+\sigma\right)\left((\alpha+\beta)^2+\sigma\right)^2}}} = \frac{\widetilde{\phi}}{1+\frac{\left(\sigma+(\alpha+\beta)^2\right)\delta}{(\alpha+\beta)^2\sigma E(x^2)}},$$

whose solution is:

$$g = \frac{\beta^2(\alpha+\beta)\sigma^2 E\left(x^2\right)\alpha}{\left(\sigma+\beta^2+\alpha^2\right)\left(\sigma+(\alpha+\beta)^2\right)^2}. \tag{21}$$

This is precisely the value of g appearing in Proposition 1. ∎

Proof of Result 2

First, we show that the cooperation fiscal *ex-post* implies that structural reforms are suboptimally low. The reason is that the difference between the denominator in (10) and (8) is the following positive expression:

$$\frac{\beta\left(\sigma+\beta^2+2\alpha\beta+\alpha^2\right)\delta}{E\left(x^2\right)(\beta+\alpha)^2\left((\beta+\alpha)(\alpha-\beta)^2+\sigma\alpha\right)}. \tag{22}$$

Second, in order to prove that in this regime deficits are suboptimally high we rewrite expression (11) as:

$$d_i = \frac{\sigma\delta\widetilde{\phi}x}{\frac{\sigma E(x^2)(\alpha+\beta)\left((\alpha+\beta)(\alpha-\beta)^2+\alpha\sigma\right)+\delta\left(\sigma+(\alpha+\beta)^2\right)\left(\sigma+(\alpha-\beta)^2\right)}{\left((\alpha-\beta)^2+\sigma\right)}}. \tag{23}$$

Thus, subtracting the denominator in (23) from the one in (9) one finds:

$$\frac{\sigma^2 E\left(x^2\right)\beta(\alpha+\beta)}{\sigma+(\alpha-\beta)^2}. \tag{24}$$

Since (24) is positive, in the regime of fiscal cooperation *ex-post* deficits are suboptimally high. ∎

Proof of Result 3

First, in the regime of fiscal cooperation *ex-post* the levels of structural reforms are lower than in the scenario where both policies are determined at the national level since, subtracting the denominator of (5) from the one in (10), one finds the following positive expression:

$$\frac{\left(\sigma\left(\sigma\left(2\alpha-\beta\right)+2\alpha\left(2\alpha+\beta\right)\left(\alpha-\beta\right)\right)+\alpha\left(\alpha^{2}-\beta^{2}\right)\left(\alpha\left(2\alpha-\beta\right)+\beta^{2}\right)\right)\delta\beta^{2}}{\alpha E\left(x^{2}\right)\left(\alpha+\beta\right)\left(\alpha^{2}+\sigma\right)\left(\sigma+\alpha^{2}-\beta^{2}\right)\left(\left(\alpha+\beta\right)\left(\beta-\alpha\right)^{2}+\alpha\sigma\right)}. \tag{25}$$

Second, in the former regime deficits are lower since the difference between the denominators in (23) and (15) is the following positive amount:

$$\frac{\beta\left(\delta\left(\alpha+\beta\right)\left(\sigma+\alpha^{2}+\alpha\beta\right)\left(\sigma+\alpha^{2}-\alpha\beta\right)\left(\left(\alpha-\beta\right)^{2}+\sigma\right)+E\left(x^{2}\right)\sigma\left(\alpha+\beta\right)Z_{2}\right)}{\left(\sigma+\alpha^{2}+\alpha\beta\right)\left(\sigma+\alpha^{2}-\alpha\beta\right)\left(\left(\alpha-\beta\right)^{2}+\sigma\right)}, \tag{26}$$

where $Z_{2}=\alpha^{2}\left(\alpha+\beta\right)\left(\alpha-\beta\right)^{3}+\sigma\left(\alpha\left(2\alpha+\beta\right)\left(\alpha-\beta\right)^{2}+\sigma\left(\alpha^{2}-\alpha\beta+\beta^{2}\right)\right)$. ∎

Proof of Proposition 2

The following example proves that this proposition holds. For the case where $\sigma=\beta=\delta=1$ and $\alpha=2$, the difference between the expected values of country i's social loss with coordination *ex-post* (obtained by substituting (10) and (11) into (1)) and without any coordination (calculated by plugging (10) and (11) into (1)) is:

$$\frac{36\left(15z+7\right)\widetilde{\phi}^{2}z\left(225z+287\right)-9\left(185z+238\right)\widetilde{\phi}^{2}z\left(25z+42\right)-325\widetilde{\phi}^{2}z^{2}\left(307+240z\right)}{25\left(3z+4\right)^{2}\left(40z+49\right)^{2}}, \tag{27}$$

where $z=E\left(x^{2}\right)$. The fact that expression (27) is positive when $z>7.438$ implies that the cooperation *ex-post* can be counterproductive. ∎

Proof of Result 4

First, when cooperation applies just to the implementation of structural reforms such reforms are suboptimally high since, subtracting the denominator in (12) from the one in (8), we obtain this positive expression:

$$\frac{\delta\beta^{2}}{E\left(x^{2}\right)\left(\alpha+\beta\right)^{2}\left(\alpha^{2}+\sigma\right)}. \tag{28}$$

Second, in this regime budget deficits are excessive from the social welfare point of view, since the denominator in (9) exceeds the one in (13) by the following amount:

$$\frac{\beta\left(\delta\beta^{2}\alpha+E\left(x^{2}\right)\sigma\beta^{2}\alpha+\sigma\delta\beta+2\delta\beta\alpha^{2}+2\sigma E\left(x^{2}\right)\beta\alpha^{2}+\delta\sigma\alpha+\delta\alpha^{3}+E\left(x^{2}\right)\sigma\alpha^{3}\right)}{\sigma+\alpha^{2}+\alpha\beta}, \tag{29}$$

and expression (29) is positive. ∎

Proof of Result 5

To begin with, when structural reforms are collectively determined their level is higher than in the scenario where both policies are determined at the national level. This is so because the difference between the denominator in (5) and (12) is the following positive expression:

$$\frac{\beta\delta\left(\sigma+\alpha^2+\alpha\beta\right)^2}{\left(\alpha+\beta\right)^2\left(\sigma+\alpha^2\right)\left(\sigma+\alpha^2-\beta^2\right)E\left(x^2\right)\alpha}. \tag{30}$$

Now, deficits in the former regime are lower since, subtracting the denominator of (15) from the one in (13) , one finds this function of the parameters:

$$\frac{\beta\left(\sigma\beta+\alpha^2\beta+\sigma\alpha+\alpha^3\right)\sigma^2E\left(x^2\right)}{\left(\sigma+\alpha^2+\alpha\beta\right)\left(\sigma+\alpha^2-\alpha\beta\right)}, \tag{31}$$

which is positive. ∎

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