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under a Stability Pact

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Marco Buti, Werner Roeger and Jan in't Veld [(*)]

Abstract

The paper analyses in a simple setting a game between an inflation-conservative central bank and a fiscal authority subject to an upper limit on the budget deficit. It is shown that complementarity or substitutability between the policies and the preference of each authority for the other authority's behaviour crucially depends on the type of shock hitting the economy. If the government attempts to stimulate output beyond its natural level, a "deficit bias" emerges under non-cooperation; under cooperation, the equilibrium is characterised by both a "deficit bias" and an "inflation bias". However, if the government only pursues cyclical stabilisation these biases disappear and there are positive gains from coordinating the policy responses to shocks.

JEL classification : E61, E63, H6

1. Introduction

The completion of Economic and Monetary Union (EMU) - based on the precise mission to the European Central Bank (ECB) to maintain price stability and guidelines for the conduct of national fiscal policies - has prompted a renewed interest on the interplay between monetary and fiscal policies.

The traditional Optimal Currency Areas literature pointed out long ago that, in a monetary union, fiscal policy has to play a more important role in cyclical stabilisation given the loss of national monetary independence. This is particularly the case if shocks are not perfectly correlated across frontiers. Fiscal flexibility, together with budgetary discipline and coordination, has come to be seen as a central pillar fiscal policy in a currency area (European Commission, 1990). The Stability and Growth Pact (SGP) has been the operational response of EU countries to the quest for budgetary discipline in EMU.

Recent theoretical and empirical developments have shed new light on the "old" issue of the interactions between monetary and fiscal authorities. At the theoretical level, much work has been devoted to the rationale for fiscal constraints in a monetary union.

A formal model of the SGP is provided by Beetsma and Uhlig (1999) (see also Beetsma, 2000). In a two-period model of a monetary union, myopic governments who know that they may be replaced at the beginning of the second period issue more debt than a social planner would do. This would constrain monetary policy in the second period. This effect is magnified in a monetary union because the adverse impact on the common monetary policy is diluted. As a result, the incentive to restrain public debt accumulation is reduced and we end up with an overburdened monetary policy. Hence, a pact limiting public debt accumulation increases welfare in a monetary union.

However, Chari and Kehoe (1998) argue that the desirability of imposing fiscal constraints crucially depends of the ability of the single monetary authority to commit to its future policies. Only to the extent that monetary policy cannot commit, there are gains from imposing budgetary constraints. This conclusion is "consistent with the view that the framers of the treaty thought that it is extremely difficult to commit monetary policy and therefore wisely included debt constraints as an integral part of the treaty" (Chari and Kehoe, 1998: 2).

The degree of commitment by the central bank affects the design of stabilisation policies in a monetary union. If the central bank is "strong", fiscal constraints are damaging because they limit the room for manoeuvre by fiscal authorities in responding to shocks. This result is emphasised by Cooper and Kempf (2000). These authors conclude that only if shocks are highly correlated across countries

and the central bank is strongly committed to price stability, then a fiscally constrained monetary union dominates the outcome with multiple currencies. Instead, under idiosyncratic shocks, moving to a fiscally-constrained monetary union would be welfare-reducing: "if the set of policy instruments open to fiscal authorities is sufficiently restricted, then monetary union may not increase welfare. Despite having commitment power, the central bank lacks the tools to stabilize in the presence of country specific shocks that are not perfectly correlated." (Cooper and Kempf, 2000: 27).

The conclusion that a monetary union with a strong central bank and no limits on fiscal policies is optimal has been questioned. Recent contributions have pointed out that "strength" or "weakness" of the central bank is not exogenous to the behaviour of fiscal authorites.

The so-called Fiscal Theory of the Price Level (FTPL) has highlighted that, if government solvency is not guaranteed, monetary policy will not be able to control the price level. In order to ensure stability, fiscal policy has to react sufficiently strongly to a rise in the interest rate in the event of inflationary pressures by increasing the primary surplus. In other words, an "active" monetary policy aiming at keeping inflation in check - as the ECB is mandated to behave - has to go hand in hand with an "active" fiscal policy[1]. Once the FTPL is applied to the EMU institutional set up, however, seemingly different conclusions are drawn. While Sims (1999) considers the Maastricht *cum* SGP rules insufficient to rule out FTPL's doom scenario, Canzoneri and Diba (2001) conclude that the SGP appears far too strict from the point of view of guaranteeing fiscal solvency. The latter authors, in particular, call for shifting the attention from nominal to cyclically-adjusted budget balances in assessing compliance of EMU members with budgetary prudence so as not to hamper fiscal stabilisation.

The ability of budgetary authorities to affect monetary commitment is also explored in a number of recent papers by Dixit and Lambertini (see, Dixit and Lambertini, 2000a, b, c; and Dixit, 2000). In a game theoretic framework, monetary and fiscal authorities minimise a quadratic loss function in inflation and output, but final targets and the weight attributed to them vary (typically the central bank is assumed to be more inflation-conservative). These authors conclude that fiscal discretion "destroys monetary commitment" and, as such, may justify rules imposed on budgetary behaviour. But imposing rules is not sufficient per se: another important conclusion by Dixit and Lambertini is that if

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[1] Some terminological confusion exists in the literature. Such fiscal behaviour is dubbed "active" by Sims (1999), following the original contribution by Leeper (1991), or "Ricardian" according to Woodford (1995). On the contrary, Leith and Wren-Lewis (2000) call such reaction function "passive".

final targets differ (e.g. the central bank is an inflation hawk and the fiscal authority aims at pushing output beyond its natural level), a race between monetary and fiscal policy would lead the equilibrium levels of output and inflation far away form the preferred choices. Hence, agreement on the final targets between monetary and fiscal authorities is paramount to lead to a Nash equilibrium which is close to the authorities preferred choices.

The importance of the difference in objectives of monetary and fiscal authorities is also stressed by Demertzis et al. (1999) and Hughes Hallett and Viegi (2000) who find that, if the two authorities pursue their separate goals independently, a conflict arises. From a political economy viewpoint, the authors point out that the establishment of a conservative central bank - strongly biased in favour of price stability - may increase the chances of left-of-centre governments - mainly output-concerned - being elected. This divergence of preferences would heighten the monetary and fiscal conflicts and, by the same token, increase the gains from coordination.

Quite unrelated to this theoretical developments, an empirical literature has addressed in recent years the issue of how monetary and fiscal authorities "actually" behave.

In a seminal paper, Jacques Mélitz uses pooled data for 19 OECD countries, including 14 EU members (except Luxembourg) over the period 1960 until 1995 (Mélitz, 1997). He finds that monetary and fiscal policy tend to move in opposite directions. In his definition, the two policies are "strategic substitutes": looser fiscal policy promotes tighter monetary policy while tighter monetary policy triggers an expansionary fiscal policy. In other words, the "Sargent and Wallace" scenario of a sustained fiscal boost eventually triggering a monetary relaxation does not find confirmation in the data. As the author points out in a more recent paper, "(t)his negative interaction should be interpreted as saying that tightening (easing) of one instrument means less tightening (easing) of the other. Both instruments may still concurrently be tight (or easy, as the case may be)." (Mélitz, 2000:16).

Evidence of strategic substitutability is also found in Wyplosz (1999): the central bank raises the interest rate when the deficit increases. In other words, "(b)oth (authorities) attempt to keep inflation in check and to conduct counter-cyclical policies, but each does less when the other moves in the same direction" (Wyplosz, 1999:43). The result that fiscal policy tends to relax when monetary conditions become tighter is confirmed by von Hagen et al. (2000) for a panel of 20 OECD countries from 1973 to 1989. These authors, however, find that monetary conditions react positively to a tighter fiscal policy, that implies that the reaction of monetary policy to fiscal policy has the opposite sign from the reaction of fiscal policy to monetary policy.

To what extent, the EMU project has influenced the reaction function of monetary and fiscal authorities? Von Hagen et al. (2000), find evidence of a "Maastricht effect" in the 1990s in the EU: "on average in the EMU member states, fiscal policy in the 1990s was less reactive to cyclical fluctuations of output and changes in monetary policy than it was in earlier times" (von Hagen et al., 2000: 58). A recent report by the European Commission (2000), argues that monetary policy has, on average, loosened since the beginning of the 1990s (albeit starting from a very tight position), thereby supporting the budgetary retrenchment by EU countries to meet the Maastricht criteria for joining EMU[2]. Hence, in Mélitz' definition, monetary and fiscal policies have been strategic substitutes in the last decade in most EU countries[3].

The theoretical literature reviewed above looks at the rationale for budgetary constraints but rarely embodies explicitly EMU and SGP-relevant rules in budgetary behaviour. While a number of studies[4] encompass a cost of "fiscal policy activism", to our knowledge, no paper encompasses the 3% *cum* "close-to-balance" rule of the SGP which would ensure budgetary prudence while leaving room for manoeuvre for fiscal stabilisation. The empirical literature, while providing interesting insights, lacks theoretical foundations and, as such, is of limited usefulness in understanding the reaction function of monetary and fiscal authorities and, especially, in anticipating the type of interactions which will prevail in EMU. As we argue below, strategic substitutability and complementarity between the two policies - and its interpretation in terms of "conflict" or "cooperation" - depend crucially on the typology of shocks hitting the economy and on the objective functions of monetary and fiscal authorities.

Our paper provides a simple analytical setting for assessing the interactions of monetary and fiscal authorities when the latter are subject to upper limits on the budget deficit. A particular emphasis is put on the design of stabilisation policies.

The structure of the paper is as follows. In section 2 we outline a simple model of monetary and fiscal behaviour capturing some of the main features of the

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[2] One should, however, make a distinction between "level" and "direction" of the monetary stance. While monetary policy loosened over the retrenchment period, it remained basically cautious as confirmed by looking at the difference between actual and "Taylor" interest rates. See OECD (1999).

[3] However, this is not true for all countries. As shown in European Commission (1999), tighter monetary policy has gone hand in hand with tight fiscal policy in Italy. This complementarity between the two policies is probably explained by the "double convergence" - on budget deficit and inflation - that Italy had to accomplish to meet the Maastricht requirements.

[4] See, e.g. Aarle et al. (2000), Bennett and Loayza (2000) and Leitmo (2000).

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Maastricht institutional fra   mework. The solution of the game between monetary and fiscal authorities under non-cooperation and cooperation is provided in sections 3 and 4, respectively. Section 5 presents some numerical simulations with the Commission Services' QUEST model on the quantitative relevance of the theoretical findings. Section 6 provides a summing up of the main results and discusses some policy implications.

2. A simple model of monetary and fiscal policy interactions

The Maastricht Treaty and secondary legislation provide a clear assignment of objectives to monetary and fiscal authorities in EMU.

The primary task of the ECB is to maintain price stability. In order to achieve price stability, the single monetary authority is entrusted with both "goal" and "instrument" independence. To the extent that price stability is not jeopardised, the ECB is called upon to support the general economic policies in the Community.

The SGP is the backbone of fiscal policy in EMU. The Pact can be seen as strengthening the procedures introduced by the Maastricht Treaty, at least in relation to the deficit criterion. Its objective is to ensure that fiscal prudence - as embodied in the Treaty fiscal criteria - applies not only in the run up to the single currency, but becomes a permanent feature of the EMU. It demands that the countries of the European Union (EU) aim for "medium-term objectives of budgetary positions close to balance or in surplus". This objective is believed to ensure budgetary discipline whilst preserving a sufficient room for manoeuvre for fiscal stabilisation without infringing the 3% of GDP deficit ceiling.

The model outlined below aims at capturing in simplified fashion some the main features of the Maastricht monetary and fiscal architecture, namely the objectives of price stability and fiscal prudence.

The model encompasses a demand-(IS) equation and a supply-(Phillips curve) equation of standard type determining the value of the output gap, G, and inflation, π :

(1) $G^D = \phi_1 d - \phi_2(i - \pi^e) + \varepsilon_1$

(2) $G^S = \omega(\pi - \pi^e) + \varepsilon_2$

where d is the budget deficit, i is the nominal interest rate, ε_1 is a demand shock and ε_2 is a supply shock. The superscript "e" indicates expected variables. The rest of the world is omitted. The coefficient ω in (2) can be interpreted as the

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degree of labour market flexibility: a high ω implies that an inflation surprise, by lowering real wages, entails a strong rise in supply; on the contrary, a low ω implies that real wages are rigid and supply responds little to unexpected inflation.

The budget deficit is defined as follows:

(3) $d = d_s - \alpha G$

where d_s is the cyclically-adjusted balance and α is the cyclical sensitivity of the budget[5]. The nominal deficit d should not exceed a deficit ceiling: $d \le \bar{d}$.

By replacing (3) in (1) and solving for G and π, we obtain:

(4) $G = \dfrac{1}{1+\phi_1\alpha}\left[\phi_1 d_s - \phi_2(i-\pi^e) + \varepsilon_1\right]$

(5) $\pi = \dfrac{1}{\omega(1+\phi_1\alpha)}(\phi_1 d_s - \phi_2 i + \varepsilon_1) - \dfrac{\varepsilon_2}{\omega} + \left[1 + \dfrac{\phi_2}{\omega(1+\phi_1\alpha)}\right]\pi^e$

The policy rules specify the setting of d_s by fiscal authorities and i by the central bank.

The instrument of fiscal authorities is the cyclically-adjusted budget balance. This formulation implies that, when interest rates move, there occurs an internal compensation between the interest burden and the primary balance. This specification of the fiscal policy rule simplifies considerably the algebra, but misses a potentially important channel of interaction between monetary and fiscal policy via the effect of monetary decisions on interest payments. This effect is quantitatively limited if the stock of public debt is low and/or its maturity is relatively long. It also implies that, in the jargon of the FTPL, that fiscal policy is "active", that is it reacts to a change in monetary policy.

Fiscal policy can be in <u>an unconstrained or a constrained regime</u>. In the first case, the fiscal authority chooses d_s to minimise the following loss function:

(6) $L(FP) = (d_s - d_s')^2 + \theta(G - G')^2$

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[5] Mainstream estimates indicate that the value of α is around 0.5 for the EU and EMU as a whole. However, if varies between 0.3-0.4 for the Mediterranean countries to 0.8-0.9 for the Nordic countries; see, European Commission (2000) and van den Noord (2000). Other studies, however, find considerably lower values of the automatic stabilisers (between 0.1 and 0.2); see, Mélitz (2000).

Equation (6) indicates that the government cares about output and would like to deviate as little as possible from the medium term target d'_s which is consistent with the "close to balance" rule of the SGP. In other words, fiscal authorities have a preferred output target, but policy activism to achieve it is costly.

A crucial choice concerns the preferred output gap: if the fiscal authority simply aims at stabilising the business cycle, G' will be equal to zero. A strict interpretation of the SGP provisions (see, e.g. Buti et al., 1998) would imply setting a sufficiently ambitious budgetary target and just let automatic stabilisers work. This implies θ and $G'=0$. Instead, if the government aims a level of output higher than the natural level (i.e. an unemployment below the natural rate), G' is positive. This formulation seems to us more consistent with actual preferences and institutional arrangements than models in the Barro-Gordon tradition which attribute to the central bank the willingness to reduce unemployment rate below its natural level via surprise inflation[6].

If, in the case of particularly severe shocks or too high medium term target, fiscal policy is constrained, d_s will change so as to satisfy $d = \bar{d}$ for any value of G.

The basic assumption underlying this behaviour is that member countries treat the prospect of infringing the deficit ceiling as one to be strictly avoided. That is, we assume that the cost of risking the triggering of the sanctions procedure of the SGP is regarded by all countries as large. Those costs include not only the formal financial penalties envisaged in the sanctions procedure but also the costs that the market might inflict and the loss of reputation that could be involved. In Eichengreen and Wyplosz (1998)'s words, this implies that the 3% limit is going to be viewed as a "hard" ceiling. The experiences with the implementation of the Pact confirm such indication (see European Commission, 2000, and Buti and Martinot, 2000). As we do not consider situations where political horse trading may imply delaying or not implementing the sanctions, our analysis can be treated as a "full credibility" benchmark.

The monetary authority aims at maintaining price stability. It is also assumed that the central bank faces a cost in changing the interest rate. This is consistent with the assumption that, as supported by recent evidence, the central bank smoothes out the interest rate[7]. As a consequence, it minimises the following loss function:

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[6] A positive output gap target in L(FP) may also reflect the shorter time horizon of the governments relative to that of the central bank.
[7] For a summary of the evidence, see Clarida et al. (1999) and Favero and Rovelli (2000).

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(7) $L(CB) = \pi^2 + \beta(i - i_o)^2$

where i_o is the historical interest rate. In equation (7), without loss of generality, the inflation target has been set to zero.

The lack of an output stabilisation term in $L(CB)$ simplifies the algebra but does not change qualitatively the results if we maintain that inflation stabilisation has a substantially higher weight than output stabilisation in the central bank preferences.

A justification for interest rate smoothing is that, in the case of conflict between inflation and output stabilisation, the central bank moves slowly towards the required interest rate level. In this case, the smoothing term in (7) can be seen partly as a way to take care of output stabilisation by the central bank[8]. It will be shown later that interest rate smoothing is crucial to maintain a role for fiscal stabilisation in the case of demand shocks.

Equation (7) attempts to capture an inherently dynamic behaviour such as interest rate smoothing within an a-temporal setting. Our formulation implies that, at each point in time, if the inflation rate is off target, the interest rate is changed to close the gap, but only partly. Hence, following a shock, the interest rate converges gradually towards a value that is consistent with the inflation target. What we are looking at below is a situation in which the adjustment has been completed and the interest rate has reached its equilibrium level. We show that this equilibrium level depends on the preferences of fiscal authorities. What we examine in the next sections is the reaction of monetary and fiscal variables to shocks starting from a position of long run equilibrium.

Given the demand and supply equations and the behavioural rules of fiscal and monetary authorities, the Nash and the cooperative solution are presented in sections 3 and 4, respectively.

3. Nash equilibrium

Unconstrained fiscal policy

In the unconstrained regime, minimisation of (6) gives the following expression for d_s:

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[8] A number of empirical analyses find that the weight of output stabilisation in the reaction function of central banks in Europe is very low. For recent estimates, see, von Hagen et al. (2000).

$$(8) \quad d_s = \frac{(1+\phi_1\alpha)\left[(1+\phi_1\alpha)d_s' + \theta\phi_1 G'\right] + \theta\phi_1\left[\phi_2(i-\pi^e) - \varepsilon_1\right]}{(1+\phi_1\alpha)^2 + \theta\phi_1^2}$$

The structural budget balance is raised when monetary policy tightens while it reacts negatively to a rise in expected inflation and to positive demand shocks.

Solving the central bank' minimisation problem gives the following expression of i:

$$(9) \quad i = \frac{i_o\beta\omega^2(1+\phi_1\alpha)^2 + \phi_2\left[\phi_1 d_s + \phi_2\pi^e + \varepsilon_1 - (1+\phi_1\alpha)\varepsilon_2\right]}{\beta\omega^2(1+\phi_1\alpha)^2 + \phi_2^2}$$

An expansionary fiscal policy leads to monetary tightening. The interest rate is increased in the event of a positive demand shock and is reduced in the event of a positive supply shock.

The interplay between monetary and fiscal behaviour is illustrated in Graph 1 which pictures the reaction functions in the policy instruments space. Both reaction functions are positively sloped. The slope of fiscal authorities' reaction function (FP) is higher than that of monetary authorities (CB)[9].

Graph 1: FP and CB's reaction functions

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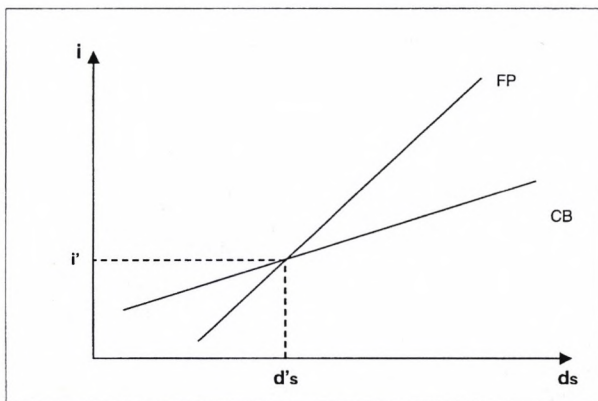
[9] The expressions of the slope of FP and CB are, respectively:

$$\frac{(1+\phi_1\alpha)^2 + \theta\phi_1^2}{\theta\phi_1\phi_2} \quad \text{and} \quad \frac{\phi_1\phi_2}{\beta\omega^2(1+\phi_1\alpha)^2 + \phi_2^2}$$

The difference between the two slopes is always positive. This implies that an expansionary fiscal policy coupled with a restrictive monetary policy results in a higher budget deficit and a higher interest rate (instead of the opposite, as would be the case if CB were steeper than FP).

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The Nash equilibrium is determined by the intersection of the two reaction functions.

Since the central bank does not pursue an output objective, it does not face a dilemma between output and inflation. Hence, in equilibrium, it can always meet its inflation target provided that it sets the appropriate interest rate. The equilibrium interest rate, i', is obtained from equation (8), under the assumption of no shocks and $\pi^e = \pi = 0$:

$$(10) \qquad i' = \frac{\phi_1}{\phi_2}\left(d_s' + \frac{\theta\phi_1 G'}{1+\phi_1\alpha}\right)$$

where the term in brackets is the level of the budget balance prevailing in equilibrium. In absence of shocks, the central bank meets the inflation target while there exists a "deficit bias" if $G' > 0$. The intuition for this result is similar to that of the classic Barro-Gordon inflation bias for monetary policy: fiscal authorities keep stimulating demand in the attempt to push output beyond its natural level until the cost of further increasing the deficit brings it too far from target. Clearly, a Maastricht-type ceiling reduces the equilibrium budget deficit via a lower structural target (d_s'). It is easy to show that, if the budget deficit does not enter FP, the system is unstable as the government keeps stimulating the economy (while being always frustrated in equilibrium). From this perspective, the SGP helps anchoring the system and prevent a "passive" fiscal policy from bringing about the FTPL insolvency scenario[10].

The authorities' reaction functions shift in response to shocks. In the case of a negative demand shock (such as a fall in private consumption), FP moves to the right and CB shifts down. The new equilibrium is a lower interest rate while the change in the budget deficit is ambiguous. However, under normal values of the parameters, one may expect a rise in the budget deficit. In the case of a supply shock (such as an oil price rise), monetary and fiscal policies move in the opposite direction: the interest rate goes up to keep inflation under control and, as a response, the budget deficit expands to prop up output. The new equilibrium is characterised by a higher interest rate and a higher budget deficit. Hence, the likelihood of the budget deficit exceeding the target and shifting fiscal policy into the constrained regime is higher under supply shocks.

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[10] In equilibrium, the model does not feature an inflation bias because the monetary stance, in spite of interest rate smoothing, will be sufficiently tight to prevent the expansionary fiscal policy from endangering the inflation target. However, if e.g., there is a change in government preferences, during the path towards the new equilibrium interest rate, inflation can deviate from target.

In order to obtain the expression of the output gap and inflation in the event of demand and supply shocks, we cross substitute from (8) and (9) and, after replacing i' from (10), we plug solution for d_s and i in (4) and (5). Under rational expectations, we obtain:

(11) $\qquad G = \dfrac{\beta\omega^2(1+\phi_1\alpha)\varepsilon_1 + \phi_2^2\varepsilon_2}{\phi_2^2 + \beta\omega^2\left[(1+\phi_1\alpha)^2 + \theta\phi_1^2\right]}$

(12) $\qquad \pi = \dfrac{\beta\omega\{(1+\phi_1\alpha)\varepsilon_1 - \left[(1+\phi_1\alpha)^2 + \theta\phi_1^2\right]\varepsilon_2\}}{\phi_2^2 + \beta\omega^2\left[(1+\phi_1\alpha)^2 + \theta\phi_1^2\right]}$

Equations (11) and (12) show the fundamental role played by interest rate smoothing. If, contrary to the assumption above, β is set equal to zero, all demand-side parameters disappear from the solution. This implies that the central bank can offset perfectly any demand shock. The intuition is straightforward: as the output gap and inflation move in the same direction, the central bank faces no dilemma and, via a sufficiently strong response of interest rates, is able to close the output gap and preserve at the same time its inflation target. If β is positive, the central bank faces a cost in changing the interest rate. Hence, demand shocks are not fully smoothed and fiscal stabilisation comes back into play. Under $\beta = 0$, supply shocks feed through unsmoothed while the inflation target is always met[11].

The impact of structural parameters and policy preferences on the output gap and inflation are summarised in table 1.

The sign of the partial derivatives are as expected. In particular, a high degree of interest rate smoothing - implying a low response of monetary policy to shocks - is destabilising in the case of demand shocks while it is output-stabilising and inflation-destabilising in the case of supply shocks. A high preference for output stabilisation by fiscal authorities helps stabilising output and inflation in the event of demand shocks, but is inflation-destabilising in the case of supply shocks.

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[11] If G appears explicitly in CB's loss function, demand shocks are still fully offset. However, supply shocks will imply a deviation of inflation and output gap from the target values reflecting the conflicting objectives of price and income stabilisation. See, Artis and Buti (2000b).

Table 1: Influence of policy parameters and preferences on G and π

		ϕ_1	ϕ_2	α	θ	β
ε_1	G	+/-	-	+/-	-	+
	π	+/-	-	+/-	-	+
ε_2	G	-	+	-	-	-
	π	+	-	+	+	+

A positive (negative) sign indicates that a rise in the variable leads to an amplification (smoothening) of the shock.

As shown in the table, high automatic stabilisers (α) and high effectiveness of fiscal policy (ϕ_1) may not lead to overall higher stabilisation in the case of demand shocks. This seemingly counterintuitive result occurs if monetary policy is very effective. In such a case, the combination of a higher response by the budget deficit and a lower reaction by the interest rate (due to interest rate smoothing), may imply a lower overall degree of stabilisation. While theoretically interesting, under normal values of the parameters, higher budgetary stabilisers and a more effective fiscal policy can be expected to lead to higher output stabilisation.

The above results help highlight the preference of each authority for the behaviour of the other authority. This can be obtained by replacing the solution for the G, π , d_s and i in the FP and CB loss functions (equation (6) and (7), respectively) and cross differentiating for the monetary and fiscal parameters. While the algebra is messy, the conclusions are fairly straightforward.

The central bank would like to see higher fiscal stabilisation in the event of demand shocks because that will allow to achieve lower deviations of inflation from target for given changes in the interest rate (or, conversely, attain the same degree of inflation stabilisation with a smaller variation of the interest rate from its equilibrium level). On the contrary, monetary authorities would prefer lower fiscal stabilisation in the event of supply shocks because that will result in lower changes in inflation and interest rates. The preference of fiscal authorities on monetary behaviour depends on the assumptions on the target level of the output gap. If the government pursues "pure" output stabilisation (i.e. $G'=0$), it would like to see high monetary stabilisation in the case of demand shocks (that is high ϕ_2 and low β) and low monetary stabilisation in the case of supply shocks.

Hence, each authority would like the other to do <u>more</u> in the case of demand shocks and <u>less</u> in the case of supply shocks.

The conclusions are less straightforward if the government aims at a positive output gap ($G'>0$). The above results apply in the case of negative shocks and large positive shocks. However, as highlighted in table 2, in the case of positive but small shocks, the government preference for monetary response is different. Let us consider first a positive demand shock bringing the output gap close to G'. In such a case, the government would benefit from a weak response by the central bank (occurring if the preference for interest rate smoothing, β, is large) because this will allow the output gap to remain in the neighbourhood of G'. In the case of a positive small supply shock shifting the output gap towards but still below G', the fiscal authority would like to see a strong monetary response because higher inflation stabilisation will imply a further increase in the output gap (thereby bringing G closer to G').

These result are relevant for the discussion of the cases of "fiscal dominance" and "monetary dominance" in section 4.

Table 2   Preference of the fiscal authority for monetary reaction

Shock	Negative	Positive small	Positive large
ε_1	small β, large ϕ_2	large β, small ϕ_2	small β, large ϕ_2
ε_2	large β, small ϕ_2	small β, large ϕ_2	large β, small ϕ_2

Constrained fiscal policy

In the above analysis, we have assumed that the budget balance is sufficiently far from the deficit ceiling so as fiscal policy is unconstrained. However, if, following a severe negative shock, the nominal deficit hits the deficit ceiling, we shift to a fiscally-constrained regime[12]. In such a case, the fiscal reaction function simply becomes:

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[12] Clearly, the likelihood of shifting to a constrained regime depends on the medium term deficit target of the fiscal authorities. If the latter are highly risk averse and want to avoid at

(13) $d_s = \bar{d} + \alpha G$

This implies that the discretionary part of the budget moves to compensate for the effect of the automatic stabilisers and thus all fiscal stabilisation is forsaken. The reaction function of the fiscal authority is negatively sloped and, unlike the unconstrained regime, it shifts to the left in the case of a negative demand shock.

Under a constrained fiscal policy, the solution of G and π is the following:

(14) $G = \dfrac{\beta\omega^2\varepsilon_1 + \phi_2^2\varepsilon_2}{\phi_2^2 + \beta\omega^2}$

(15) $\pi = \dfrac{\beta\omega(\varepsilon_1 - \varepsilon_2)}{\phi_2^2 + \beta\omega^2}$

Compared to the unconstrained regime, we have lower output and inflation stabilisation in the event of demand shocks[13] and lower output stabilisation and higher inflation stabilisation in the event of supply shocks.

4.   Cooperative equilibrium

In the cooperative solution the two policy instruments, d_s and i, are chosen so as to minimise the joint loss function of fiscal and monetary authorities :

(16) $L(FPCB) = \eta\left[(d_s - d_s')^2 + \theta(G - G')^2\right] + (1 - \eta)\left[\pi^2 + \beta(i - i')^2\right]$

where $0 \le \eta \le 1$ gives the « bargaining power » of the two policy authorities : a large (small) η indicates a strong (weak) fiscal authority.

Given the cumbersome algebra, we illustrate the main results under simplifying assumptions on a number of parameters.

An important result is that, if fiscal policy pursues "pure" output stabilisation (i.e. $G' = 0$), under no shocks the Nash and the cooperative equilibria are the same (namely $G = \pi = 0$). However, if the government targets a positive output

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all costs an 'excessive deficit', they may set a medium-term target which is able to withstand all shocks - regardless of their severity - without exceeding the deficit ceiling. This approach is behind the calculations of the so-called "minimal benchmarks" which, on the basis of past business cycle experience, allow a sufficient safety margin under the 3% of GDP deficit ceiling. See, European Commission (1999, 2000) and Artis and Buti (2000 a and b).

[13] This holds under normal values of the parameters. See discussion above on the special case of a higher fiscal stabilisation resulting in an overall lower macroeconomic stabilisation.

gap ($G'>0$), the equilibrium solution is characterised by a « deficit bias » and an « inflation bias ». Under the assumption $\phi_1 = \beta = 0$, the expression of the inflation bias is the following :

(17) $\quad \pi = \dfrac{G'\omega\eta\theta}{\phi_2(1-\eta)}$

Clearly, the inflation bias is a positive function of the bargaining power of the fiscal authority and the output gap target. The reason is that, via the combined loss function, the central bank encompasses the fiscal policy target of a positive output gap. Therefore, as in the classic Barro-Gordon result, the central bank stimulates the economy until the (temporary) output gains would be compensated by the additional costs of a further rise in inflation (and, in the general case, by the cost of shifting the interest rate away from its equilibrium value).

In order to examine some of the mechanisms at work, it is useful to consider two extreme cases of cooperation: « fiscal dominance » ($\eta=1$) and « monetary dominance » ($\eta=0$).

Under fiscal dominance, the government uses both policy instruments to minimise its own loss function. Since deviating from the output target is costly, it will set d_s equal to the deficit target[14] and use i for stabilisation purposes.

If the government pursues « pure » stabilisation ($G'=0$), in equilibrium the output gap is zero but, in absence of a nominal anchor, the inflation rate is undetermined. If the government pursues a positive output gap ($G'>0$), it will keep lowering i in the attempt to push output beyond its natural level. Since i cannot be lowered below zero, from equation (1) we obtain :

(18) $\quad \dfrac{\phi_1}{\phi_2}d_s' - \dfrac{(1+\phi_1\alpha)G'}{\phi_2} + \pi^e + \dfrac{\varepsilon_1}{\phi_2} = 0$

Hence, in « equilibrium », the inflation rate is the following :

(19) $\quad \pi = -\dfrac{\phi_1}{\phi_2}d_s' + \dfrac{(1+\phi_1\alpha)}{\phi_2}G'$

Under monetary dominance, the interest rate is kept fixed at its equilibrium level and the budget deficit is used by the central bank to achieve the inflation target. If the central bank sets a sufficiently low fiscal target, fiscal policy will never be

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[14] In fact, given the availability of the interest rate to stabilise output, the government can set d_s at its « true » preference and not at the SGP-compatible level.

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constrained. Output and inflation will be stabilised perfectly under demand shocks while supply shocks will show up in an equivalent change in the output gap with no impact on inflation.

Table 3 summarises the main results of the analysis. Inflation and output under monetary dominance are identical to the Nash solution without interest rate smoothing ($\beta = 0$), with the difference that it is the fiscal instrument and not the interest rate that is used to stabilise inflation. In the case of demand shocks, monetary dominance and fiscal dominance provide more macroeconomic stabilisation than Nash. The reason is that, unlike the Nash solution, one policy instrument (i under fiscal dominance and d_s under monetary dominance) can be used freely to offset perfectly the shock.

Table 3 Output and inflation stabilisation under various regimes

	Monetary dominance	Fiscal dominance ($G' = 0$)	Nash ($\beta > 0$)	Nash ($\beta = 0$)
G	ε_2	0	$\dfrac{\beta\omega^2(1+\phi_1\alpha)\varepsilon_1+\phi_2^2\varepsilon_2}{\phi_2^2+\beta\omega^2\left[(1+\phi_1\alpha)^2+\theta\phi_1^2\right]}$	ε_2
π	0	$\pi^e-\dfrac{\varepsilon_2}{\omega}$	$\dfrac{\beta\omega\left\{(1+\phi_1\alpha)\varepsilon_1-\left[(1+\phi_1\alpha)^2+\theta\phi_1^2\right]\varepsilon_2\right\}}{\phi_2^2+\beta\omega^2\left[(1+\phi_1\alpha)^2+\theta\phi_1^2\right]}$	0

What conclusions can be drawn on the incentives of monetary and fiscal authorities to cooperate ?

Clearly, if the government aims at attaining a positive output gap, there is no incentive for an inflation-conservative central bank – as the ECB is mandated to be - to engage in cooperation because it would have to accept an inflation bias in equilibrium. Notice however that, in general, there is a trade-off between the inflation and the deficit bias because the use of the interest rate to stimulate demand would partly take the place of the rise in the deficit. To the extent that, under non-cooperation, a high deficit bias leads to a unsustainable accumulation of public debt, the central bank would face an unpalatable choice between

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higher inflation now (to reduce the deficit bias) and (debt monetisation and hence) higher inflation in the future.

If the government pursues « pure » cyclical smoothing, under no shocks, the Nash equilibrium and the cooperative equilibrium both imply $G = 0$ and $\pi = 0$. Hence, the incentives for cooperation depend on welfare gains and losses in response to shocks.

Under demand shocks, as both policies move in the same direction the gains from cooperation are ambiguous. This is illustrated in graph 2 which pictures the policy reactions to a negative demand shock. Both policies are restrictive and the new Nash equilibrium is E'. The Bliss points for the two authorities are indicated by B_{FP} and B_{CB}: ideally, as discussed before, each authority would prefer the whole stabilisation be borne by the other authority. The line between the two Bliss points is the contract coordination line. As shown in the graph, E' is very close to such line, indicating that any gain from coordination for both authorities, even if positive, is necessarily minor and could be even negative if the coordination process involves "transaction costs".

Graph 2   Negative demand shock
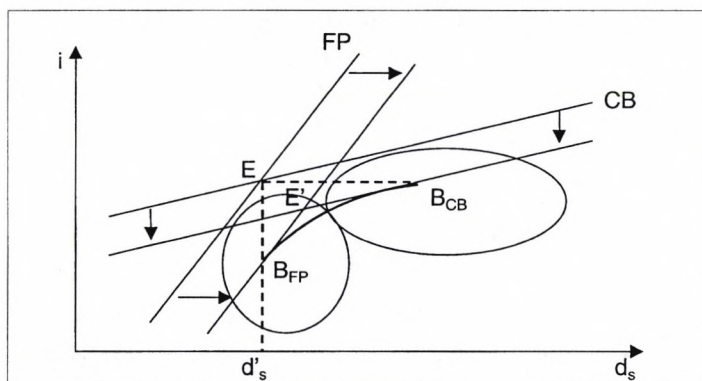
In the case of supply shocks, since under Nash the two policy instruments move in opposite directions, there are unambiguous gains from cooperation. This can be easily understood since, in the non-cooperative solution, part of the change in the interest rate occurs in order to offset the change in the opposite direction in the budget deficit. This additional change in the interest rate, K, is given by :

$$(20) \quad K = - \frac{\phi_1^2 \phi_2 \varepsilon_2}{(1 + \phi_1 \alpha)\left\{\phi_2^2 + \beta \omega^2 \left[(1 + \phi_1 \alpha)^2 + \theta \phi_1^2\right]\right\}}$$

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This result is illustrated in Graph 3 which shows the policy reactions to a negative supply shock. Given the policy preferences of the central bank, the latter would like fiscal policy to turn restrictive to keep inflation under control. Conversely, the government would like to see no change in the interest rate so that all the shock will feed through into higher inflation[15]. Instead, under no cooperation, each authority moves in the opposite direction to that hoped for by the other authority. As shown in the graph, the degree of output and inflation stabilisation implied by non-cooperation could be achieved at lower values of both policy instruments[16]. Given interest rate smoothing in CB and the deficit target in FP, this implies a welfare gain for both authorities. Cooperation also implies a lower likelihood to shift in the fiscally-constrained regime.

Graph 3: Negative supply shock
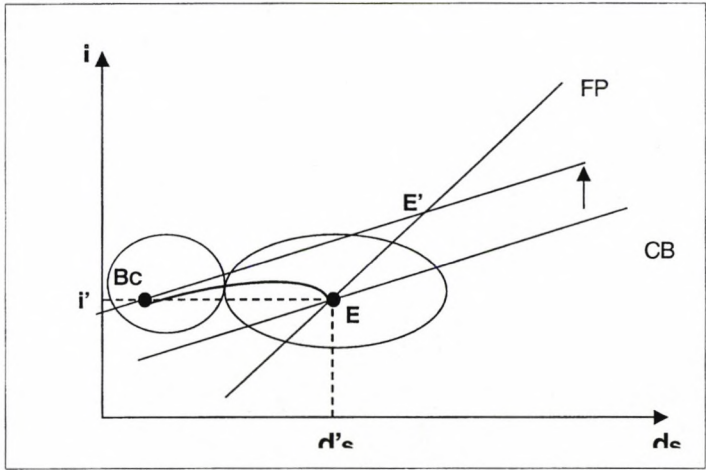
The empirical investigation in Section 5 provides support for these conclusions.

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[15] Notice that FP's reaction function is not directly affected by the supply shock. This implies that the original equilibrium under no shocks (E in graph 3) remains the preferred position for the fiscal authority. Under more general assumptions on the IS equation or FP preferences (including an inflation term), FP's reaction function would shift to the right and so would the new Nash equilibrium.. Obviously, the conclusions in the text remain unchanged.

[16] It is easy to show that the Stackelberg solution entails values of the policy variables intermediate between Nash and cooperation. See, Bennett and Loayza (2000).

5. Illustration of policy interactions with the QUEST model

The present section attempt to provide some quantitative evidence on the some of the effects derived in sections 3 and 4. We use a 2-country version of the DG ECFINs QUEST model to capture the quantitative importance of fiscal-monetary policy interactions. The model we use can be characterized as a modern version of a neoclassical Keynesian synthesis model. This means behavioural equations of households and firms are derived from explicit dynamic optimisation problems subject to budget constraints and adjustment costs. Monetary policy is effective because of sluggish price adjustment in the goods market due to price adjustment costs of monopolistically competitive firms (see, for example Rotemberg (1982, 1996) and Hairault and Portier (1992)) and the nominal wage response is delayed because of overlapping one year contracts[17].

Both the fiscal authorities and the monetary authorities set their policy instruments to minimize their respective loss functions. As the empirical model used here is a dynamic model, the focus is on the impact responses of the shocks, to stay close to the theoretical analysis above. This implies that both the fiscal authorities as well as the monetary authorities face a high rate of time preference, optimise their respective responses over the short run and discount the medium to long term effects more heavily. Another difference with the theoretical model is that here the policy response of the monetary authorities is not formulated in terms of interest rates but in terms of the money supply. This is inconsequential since both instruments are linked via a stable money demand equation in the model. The instrument for the fiscal authorities is government expenditure g.

The underlying utility function correspond to the specification in the theoretical section. In particular we assume that fiscal policy does not care about inflation and monetary policy puts zero weight on output stabilisation. Also in order to mimic as closely as possible the stabilisation motive of both policy makers we assume a high discount rate. Monetary policy sets the money supply m so as to minimize the following loss function

$$(21) \quad L(CB_t) = \sum_{i=t}^{\infty} \delta^i \left(\pi_i^2 + \beta(i_i - i_{i-1})^2 \right)$$

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[17] For a description of the basic structure of the model and its parameter values, see Roeger, in't Veld and Woehrmann (2001). The version used here allows for overlapping wage contracts and sluggishness in prices with firms facing quadratic price adjustment costs per unit of output (see Roeger (1999))

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where δ is the rate of time preference, π_t is inflation, i_t the nominal interest rate and β the weight given to interest rate smoothing. The fiscal authorities set their instrument, government consumption g, to minimize the following loss function

$$(22) \quad L(FP_t) = \sum_{i=t}^{\infty} \delta^i \left\{ \left(Y_i - \overline{Y} \right)^2 + \gamma (d - \overline{d})^2 \right\}$$

where $Y - \overline{Y}$ is the output gap, $d - \overline{d}$ the deficit deviation from target and γ the weight given to the deficit target. Here we deviate from the theoretical model by explicitly specifying a debt rule which guarantees fiscal solvency.

$$(23) \quad \Delta g_t = f_1 \left(b_0 - B_t / Y_t \right) - f_2 \Delta (B_t / Y_t)$$

In order to simplify the optimisation problem faced by fiscal policy, the parameters f_1 and f_2 of that rule are not set optimally but only act as a constraint on a government which accepts responsibility for budget sustainability. This is a mild form of the SGP and captures the "close-to-balance" rule. However, the debt rule as specified in this paper will not automatically guarantee that fiscal policy will meet the deficit target for all shocks. In cases where the deficit target is violated in the experiments conducted below we will both look at an unconstrained as well as a constrained optimisation problem.

Non cooperation

Given the dynamic complexity as well as non linearity of the model it is impossible to derive explicit decision rules for monetary and fiscal policy. Here we briefly describe how the reaction functions are derived in this paper.

Let T_t be a vector of target variables, X_t a vector of instruments, S_t a vector of state variables and ε_t a vector of exogenous shocks, then in a linear approximation, the target variables can be expressed as follows

$$(24) \quad T_t = a_s S + a_x X_t + a_\varepsilon \varepsilon_t$$

In general the instruments, when set optimally, will be related to both the state of the economy and exogenous shocks

$$(25) \quad X_t = b_s S_t + b_\varepsilon \varepsilon_t$$

and the parameters will be complicated functions of both the structural parameters of the model and the preferences of policy makers. To find the optimal policy response it is easier if X_t can be expressed as a function of the shocks only. Using the fact that for any covariance stationary process there exists

a moving average representation, the state variables can be expressed as a moving average of current and past shocks

(26) $S_t = c(L)\varepsilon_t$.

This can be used to express the instruments as functions of shocks only as follows

(27) $X_t = d(L)\varepsilon_t$.

Optimisation therefore requires selecting parameters such that the fiscal and monetary objective function is minimised. Computationally this is a complicated problem since the dimension of the parameter set is not known a priori. In order to economize on the search we assume that the MA process can be approximated by an ARIMA representation, which, in the case of the monetary policy rule only involves lagged money and current shocks. In the case of fiscal expenditure, the response is restricted to current innovations, besides the response implied by the sustainability constraint. Thus the general form of the rules over which we optimize is given by

(28) $m_t = m_{t-1} + c_2\varepsilon_1 + c_3\varepsilon_2$

(29) $g_t = \overline{g} - f_1(b - b_0) - f_2\Delta b + f_3\varepsilon_1 + f_4\varepsilon_2$

Given the standard money demand equation in the model, this rule can be rewritten in terms of an interest rate rule as follows

(28a) $\Delta i_t = \dfrac{1}{\varphi}(\Delta y_t + \Delta\pi_t) - c_2\varepsilon_{1t} - c_3\varepsilon_{2t}$

where φ denotes the semi-interest elasticity of real balances with respect to nominal interest rates. As can be seen from this expression, the optimal rule comes close to a Taylor rule formulated in first differences and equal weights given to both output growth deviations from trend[18] and inflation. However, according to the optimal rule the central bank takes into account the source of the shock. In the case of a positive/negative demand shock it will increase/lower interest rates more than implied by changes in GDP and inflation while in the case of a positive/negative supply shock monetary policy will be less/more restrictive than implied by the Taylor rule.

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[18] Notice, since all variables in the model are defined in efficiency units, the growth rate of y must be interpreted as deviation from its long run trend as defined by the growth rate of TFP and population.

For the demand and supply shocks we assume that the demand shock is a temporary shock to consumption, ex-ante 1 per cent of GDP in the first quarter, which is phased out in following quarters. The supply shock is a persistent technology shock, of similar magnitude of 1 per cent of GDP. Since a persistent technology shock leads to a new long run level of potential GDP, the question therefore arises whether fiscal policy[19] should target the historic or future potential output. We assume in this analysis that fiscal policy targets the historic level of potential output. Given the high discount rate, the government is mainly interested in short run stabilisation. An immediate move towards the new potential output target would be counterintuitive, since the short run perspective of the government would force fiscal policy to adjust output strongly towards the new lower level. This would be inconsistent with the notion that the output gap term in the utility function represents an output smoothing motive for fiscal policy. Finally it must be noted that for less persistent supply shocks the first year response of the model economy would not differ qualitatively from a permanent shock. For the given specifications of the loss functions and for the types of shocks considered here, the following monetary and fiscal reaction functions for the Nash equilibrium are obtained in the unconstrained regime :

$$(30) \quad g_t = \overline{g} - 0.04(b - b_0) - 0.05\Delta b - 0.3\varepsilon_1 - 3.0\varepsilon_2$$

$$(31) \quad m_t = m_{t-1} - 0.000125\varepsilon_1 + 0.025\varepsilon_2$$

Graphs 4 and 5 illustrate the fiscal and monetary reaction functions under negative demand and supply shocks respectively and Table 4 gives the corresponding welfare looses for both authorities under the Nash solution.

The response parameter for a demand shock is negative. In the case of a negative consumption shock, $\varepsilon_1 < 0$, the fiscal authorities respond by raising expenditure to boost output. The monetary authorities respond by offsetting the deflationary impact of this shock and raise the money supply and reduce interest rates, which will also stimulate domestic demand. Thus, under demand shocks, both policies move in the same direction and if one authority does more, the other has to do less. This is illustrated in Graph 4 which depicts the optimal settings of the respective response parameters for the monetary and fiscal authorities under this particular shock. On the vertical axis, the size of the monetary reaction is given, where a smaller negative value represents a smaller monetary expansion or higher interest rates. The horizontal axis gives the absolute value of the fiscal response parameter and a larger parameter implies a larger increase in government expenditure and a larger deficit. If the response of the fiscal authorities becomes stronger and they raise expenditure by more, the monetary authorities can reduce the size of the monetary loosening. Thus, in

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[19] Notice, monetary policy does not target output at all.

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Chart 3, the CB reaction function is upward sloping. If the central bank reacts more strongly to the negative demand shock and raises the money supply by more, that will help to prop up output again and the fiscal authorities will have to do less. Thus the FP reaction curve is also upward sloping. The FP reaction curve is steeper than the CB curve, consistent with the analysis in section 3 (footnote 10).

In case of a negative supply shock, $\varepsilon_2 < 0$, monetary and fiscal policies go in opposite directions. The response parameter for a supply shock is positive in the monetary reaction function. Monetary policy contracts to offset the inflationary impact of this negative technology shock and the central bank raises interest rates. The fiscal authorities respond by increasing government expenditure to prop up output (i.e. negative coefficient). The policy responses now move output and inflation in opposite directions . The CB reaction reduces output even further and fiscal policy responds by raising expenditure even more. Hence in Graph 5 the FP reaction curve is upward sloping. If the fiscal authorities react more strongly and increase expenditure, than the monetary authorities will react to the additional inflationary pressure by a further monetary tightening. Thus the CB curve is also upward sloping.

The Nash solution is then determined by the intersection of the CB and FP reaction curves. The policy parameters and their corresponding welfare losses are given in Table 4.

In case of the demand shock, fiscal and monetary authorities are able to stabilise output and inflation. The rise in the deficit remains small and well within the limits of the SGP. However, under the particular supply shock given here, the Nash equilibrium in this optimisation game, with this inflation-conservative central bank that stabilises inflation immediately, implies a large response of the fiscal authorities. The optimal fiscal response in this setting would mean that the deficit would exceed the SGP limit of 3%. The 3% deficit limit under this shock implies the fiscal response parameter could not exceed the range of 2-3.5 as indicated by the dotted line in Graph 5.

Table 4: Policy responses under negative supply and demand shocks

	Negative Supply shock (1% of GDP)		Negative Demand shock (1% of GDP)	
a. Nash optimal response :				
Fiscal policy parameter	$f_4 = -3.0$		$f_3 = -0.30$	
Monetary policy parameter	$c_3 = 0.025$		$c_2 = -0.000125$	
	FP:	CB:	FP:	CB:
	47.40755	0.06552	0.01081	0.00029
Effect on:				
GDP	-1.40		0	
Inflation	0.14		0	
Deficit	3.8		0.11	
b. Nash optimal response – constrained fiscal policy:				
Fiscal policy parameter	$f_4 = -2.0$			
Monetary policy parameter	$c_3 = 0.025$			
	FP:	CB:		
	46.19591	0.04868		
Effect on :				
GDP	-1.48			
Inflation	0.10			
Deficit	2.76			

Note: Monetary reaction function: $m_t = m_{t-1} + c_2\varepsilon_1 + c_3\varepsilon_2$

     Fiscal reaction function: $g_t = \overline{g} - f_1(b - b_0) - f_2\Delta b + f_3\varepsilon_1 + f_4\varepsilon_2$

Thus, the SGP constrained optimum lies far to the left of the Nash solution with a lower fiscal response to the shock and an also slightly lower monetary response. As shown in Table 4, the implied output gap in the constrained case is larger than under the Nash (FP loss exceeds that under the Nash) while inflation

is lower (CB loss smaller). In terms of welfare losses, CB gains a lot from the deficit constraint and the CB loss is reduced to a quarter of that under the Nash solution, while the additional loss of FP is relatively small.
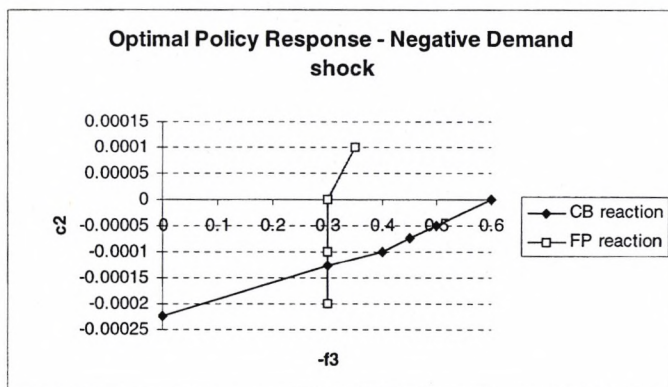
Cooperation

Under demand shocks, monetary and fiscal policies move in the same direction and from the theoretical analysis it is not unambiguously evident whether both parties would gain from cooperation. It was shown above that the fiscal and monetary authorities are able to stabilise output and inflation in this scenario and the respective welfare losses are relatively small. With the deficit entering the FP loss function, a larger fiscal policy response increases the fiscal welfare losses and no improvement relative to the Nash solution can be achieved where both parties would be better off.

In case of a negative supply shock, both parties are unambiguously better off under cooperation. Policies move in opposite directions and part of the monetary tightening occurs in order to offset the effects of the fiscal expansion and vice-versa (see eq. 20). Thus both authorities can gain from reacting less. When the fiscal authorities reduce the size of the expansion and the central bank tightens less, both FP and CB are better off. In Graph 5, there is a whole region below and to the left of the Nash outcome where both FP and CB gain from coordination. The example given here raises the deficit to 1.5 per cent of GDP. Both CB and FP benefit from coordination, but relative to the unconstrained Nash outcome, the gain for CB is largest, as the fiscal response is reduced by most. It is important to bear in mind that these results of positive gains from coordination hold only under these specific scenarios. It is assumed in this exercise that fiscal authorities do not target an output level beyond the natural level and no inflation bias arises.

Table 5: Example of welfare improving policy coordination under negative supply shock

Fiscal policy parameter	$f_4 = -1.0$	
Monetary policy parameter	$c_3 = 0.02$	
	FP:	CB:
	39.96268	0.04230
Effect on :		
GDP	-1.35	
Inflation	0.16	
Deficit	1.51	

Graph 4 : Optimal Policy responses – Negative Demand shock

Optimal Policy Response - Negative Demand shock

c2

0.00015					
0.0001					
0.00005					
0					
-0.00005	0.1	0.2	0.3	0.4	0.5	0.6
-0.0001					
-0.00015					
-0.0002					
-0.00025					

-f3

◆ CB reaction
□ FP reaction

Graph 5 : Optimal Policy responses – Negative Supply shock
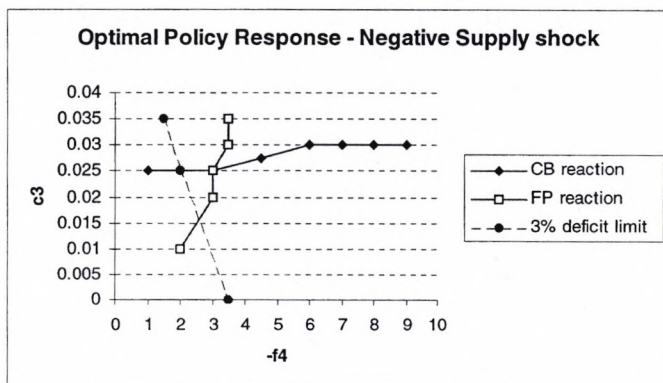
Optimal Policy Response - Negative Supply shock

c3

0.04										
0.035										
0.03										
0.025										
0.02										
0.015										
0.01										
0.005										
0	1	2	3	4	5	6	7	8	9	10

-f4

◆ CB reaction
□ FP reaction
● 3% deficit limit

Note: Monetary reaction function: $m_t = m_{t-1} + c_2 \varepsilon_1 + c_3 \varepsilon_2$

Fiscal reaction function: $g_t = \overline{g} - f_1(b - b_0) - f_2 \Delta b + f_3 \varepsilon_1 + f_4 \varepsilon_2$

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6. Conclusions

This paper has looked at the interactions between monetary and fiscal authorities, when fiscal policy is constrained by upper limits on the budget deficits, as in EMU.

Conflicts between monetary and fiscal policy arise when the central bank's objective function differs from that of fiscal authorities. This is generally assumed in the literature. In particular it is assumed that the fiscal authority has less incentive to stabilise inflation, while inflation stabilisation is the most important goal of the central bank. Also different degrees of output stabilisation as well as different output targets can be consistent with the objectives of both authorities. In this paper it has been assumed that the central bank adheres to strict inflation control and attaches zero weight to output stabilisation, however the central bank also tries to smooth nominal interest rates. The latter element is introduced since, first, there is sufficient empirical evidence in its favour and, second, it restricts the power of monetary policy with respect to neutralising demand shocks and allows for more interesting policy interactions.

For fiscal policy it is assumed that the government does not care about inflation but only about output stabilisation (around a level which can be higher than the natural rate). The SGP introduces an additional constraint on fiscal policy. This constraint is introduced in the model via the objective function which penalises deficits which deviate from the "close-to-balance" target of the SGP. The government does not necessarily choose a deficit target that would (for given stabilisers) never violate the Maastricht threshold because it faces a trade off between the loss of utility in normal times from a deficit that is set lower than required under solvency and the cost of violating the 3% limit by not setting the target low enough in case of large negative shocks.

Because of this trade-off, fiscal policy will - depending on the size of shocks - operate under two different regimes. Under the fiscally-unconstrained regime, the government chooses instruments in order to maximise its objective function. Under the fiscally-constrained regime, the choice of the fiscal instrument is dictated by the Maastricht deficit limit.

Within this theoretical framework, we analysed how do parameters of fiscal and monetary policies and the preferences of the central bank affect the response of output and inflation to shocks.

The main results of the theoretical analysis are summarised hereafter.

Under *non-cooperation,* demand shocks affect output and inflation only insofar as the central bank smoothes the interest rate. The central bank prefers high

fiscal stabilisation under demand shocks and low fiscal stabilisation under supply shocks; conversely, the government would like to see low interest rate smoothing under demand shocks and high smoothing under supply shocks. Given the move of policies in opposite directions, under negative supply shocks there is a higher likelihood to shift into the fiscally-constrained regime. If fiscal authorities target a positive output gap, there is a "deficit bias" in equilibrium. However, under non-cooperation, since the central bank does not aim at pushing output beyond its natural level, there is no "inflation bias".

Under *cooperation,* if fiscal authorities pursue a positive output gap, there is in equilibrium an "inflation bias" and a "deficit bias", though the latter is lower than under Nash. If the government only pursues "pure" cyclical stabilisation, the gains from cooperation are ambiguous and necessarily small under demand shocks, but there are positive gains from coordination under supply shocks. This implies that, provided that the objective of the government is output stabilisation around its natural level, policy coordination may be looked at as an insurance against future shocks.

Our simulations with the QUEST model lend support to these theoretical predictions. It is shown that the Nash solution, under a sufficiently severe negative supply shock, implies a violation of the deficit threshold. The simulations also confirm that there are positive gains from coordinating the policy response to supply shocks.

These results help to shed light on a number of issue which have been raised in the academic and policy debate.

It has been shown that the substitutability or complementarity between monetary and fiscal policies crucially depends on the type of shocks hitting the economy. In the event of supply shocks, the two policies move in opposite direction : a loosening (tightening) of fiscal policy goes hand in hand with a tightening (loosening) of monetary policy. Hence there is a clear conflict between the two arms of macroeconomic policy. The empirical observation, however, of a policy substitutability does not imply necessarily a conflict. For instance, as mentioned above, a relaxation of monetary policy during periods of budgetary consolidation – as in the EU during the 1990s - may actually imply "implicit" coordination: by helping to cushion the output losses due to the budgetary retrenchment, the expansionary monetary policy facilitates the task of fiscal authorities[20]. Under demand shocks, both policies move in the same

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[20] The SGP has been interpreted by Allsopp and Vines (1996, 1998) as a "commitment technology" by EMU members to bring a monetary relaxation which would reduce the costs of consolidation. As argued in EC (1999) and Buti and Martinot (2000), confirmation of the commitment to fiscal prudence contributed to trigger an accommodating monetary response by the ECB in the first year of EMU.

direction, but if one does more, the other one does less. In this case, there exists a sort of "distributional" conflict between monetary and fiscal authorities on how to share the burden of stabilisation.

Our results may provide a rationale for the traditional central banks' aversion for "ex ante" coordination of macroeconomic policies. This reluctance was expressed forcefully in a recent speech by Otmar Issing, chief economist of the ECB (Issing, 2000): « (N)ot much can be expected from attempts to coordinate these macroeconomic policies ex ante (…). On the contrary, such attempts give rise to the risk of confusing the specific roles, mandates and responsibilities of the policies in question. ». And later : « if there is already an *efficient* initial assignment of responsibilities in place, which does take into account the individual policy-makers' objectives and actions, calls for policy coordination (…) would not be necessary. To put it simply, an efficient initial assignment of objectives and responsibilities will largely substitute the need for coordinated policies later on. ».

As shown above, if fiscal authorities target an output beyond the natural level, under cooperation, an inflation bias will arise in equilibrium. This is likely to put off any incentive for policy coordination by an inflation-conservative central bank, whatever the possible gains from it in responding to shocks. However, if budgetary authorities only pursue cyclical stabilisation, the Nash and the cooperative solutions are identical under zero shocks and no deficit or inflation biases arise in equilibrium. Hence, under no shocks, there are "no risks" from cooperation for the central bank. Therefore, the benefits of coordination have to be assessed by looking at the response to shocks under Nash and cooperation. Our analysis points to gains from coordinating monetary and fiscal policies in response to shocks. If policy coordination is viewed as insurance against future shocks, there seems to be good case for entering into a contract between monetary and fiscal authorities to provide an optimal response to shocks.

Obviously, this conclusion does not consider other factors such as the existence of "transactions" costs of implementing coordination or the fact that supply shocks – especially if long lasting - should be dealt with via structural reforms and microeconomic adjustment rather than macroeconomic stabilisation. To the extent that central bank's reluctance in engaging in coordination is justified by "suspicion" on the real objectives of fiscal authorities, "soft coordination" helping to understand each other's targets, identify the type of shocks, achieve a common view on the output gap, would certainly be beneficial. It could also pave the way to stronger forms of coordination down the road.

The analysis in this paper is subject to obvious limitations, starting with the extremely simplified structure of the model and policy preferences. We look at

an a-temporal equilibrium and do not explore the dynamics of the response to shocks or to changes in policy preferences. For instance, an inter-temporal trade-off may arise between inflation bias and deficit bias. Also, having chosen the interest-inclusive budget balance - instead of the primary balance - as a control variable has cut off an important channel of policy interactions. In the empirical section, the way in which the reaction functions of monetary and fiscal authorities have been derived deserves further investigation. Finally, as the analysis encompasses only one fiscal authority, one should be cautious in deriving direct policy conclusions for EMU.

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