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Time Inconsistency: An Updated Survey of the Literature*

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ABSTRACT

We provide an updated survey of the literature on time inconsistency, focusing on the key contributions that followed the seminal papers of Kydland and Prescott (1977) and Barro and Gordon (1983a). Starting from the traditional models addressing the time inconsistency problem of monetary policy, we then proceed to analyse the more recent contributions accounting for the important monetary and fiscal policy interactions. We conclude by sketching an encompassing open-economy model summarising the most recent positions concerning the optimal management of fiscal policies.

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I. INTRODUCTION

The approach of early theory of macroeconomic policy dealing with the economic consequences of given policy rules is that knowledge of such consequences and of the policy objectives automatically leads to the selection of the optimal policy rule. Implicit in this approach is the assumption that policymakers are passive agents whose only task is to implement the optimal path once identified. Yet, lack of success of this theory in explaining both the way in which policymaking is carried out in practice and why inflation has been higher in some countries rather than others has gradually changed the focus of economic theory. As a result, a new literature – identified as on *time* or *dynamic inconsistency* – has developed emphasising the analysis of the policy formation process.

We provide an updated survey of the now substantial literature on time inconsistency, focusing on the key contributions that followed the seminal papers of Kydland and Prescott (1977) and Barro and Gordon (1983a). We start by describing the more traditional models addressing the commitment problem of monetary policy, thus proceeding to analyse the more recent contributions internalising the important interactions existing between monetary and fiscal policies. We conclude by sketching an encompassing open-economy model based on microfoundations, which bridges the gap between the latest works on the desirability of fiscal policy co-ordination by Beetsma and Bovemberg (1998) and Levine and Pearlman (1998). We show that, under certain circumstances, their policy implications are in fact not in contrast as generally believed.

The outline of the paper is as follows. Sections II and III introduce the issue of time inconsistency. Section IV illustrates Rogoff's argument in favour of a conservative central banker, while sections V and VI introduce the more recent developments based upon this theory, concentrating in particular on the principal-agent approach formalised by Walsh (1995). Section VII discusses the main limitations of the traditional models of monetary policy, and section VIII analyses the key contributions accounting for the fiscal and monetary policy interactions. Section IX presents an encompassing open-economy model summarising the recent positions concerning the optimal management of fiscal policies. Finally, section X summarises and concludes.

II THE TIME INCONSISTENCY PROBLEM: RULES VERSUS DISCRETION

The concept of time-inconsistency is first formalised in economic theory in 1977 to describe the temptations that policymakers face to deviate from a policy rule that has been previously announced. This field of macroeconomic policy, known also as *rules versus discretion* literature, develops following two premises. The first premise is that current decisions depend not only on the current and past dates of the

world, but also upon expectations of future events. However, since these enter as a constraint in the optimisation problem, an optimal policy rule at the beginning of a time period may no longer remain such at a latter date. When this happens, the policy is said to be *time* or *dynamically inconsistent*. The second premise is that macroeconomic policy is better understood as the outcome of strategic interactions between the government and the private sector of the economy. This means that the optimal decision rule for the fiscal authority depends not only upon its own decisions but also upon those of any other player in the economy. Hence, the maintained assumption that policy decisions are the outcome of a game played among rational agents makes game theory the methodological tool adopted by this modern approach to macroeconomic policy.

Kydland and Prescott (1977) are the first to illustrate the time inconsistency phenomenon. Their argument may be briefly exposed using a simple two period example. Assume that the policy-maker at time *t=1* is to maximise an agreed-upon social objective function

$$U\left(x_1, x_2, y_1, y_2\right) \tag{1}$$

where $x = \left(x_1, x_2\right)$ are policies at time *t=1,2* and $y = \left(y_1, y_2\right)$ are the corresponding sequence of economic agents decisions subject to:

$$y_1 = f_1\left(x_1, x_2^e\right) \tag{2}$$

$$y_2 = f_2\left(y_1, x_1, x_2\right) \tag{3}$$

where x_2^e denotes rational expectations of x_2 formed at time *t=1*. Assuming differentiability, the first order conditions for the optimality of *U* are:

$$\frac{\partial U}{\partial x_1} + \frac{\partial f_1}{\partial x_1}\left[\frac{\partial U}{\partial y_1} + \frac{\partial U}{\partial y_2}\frac{\partial f_2}{\partial y_1}\right] + \frac{\partial f_2}{\partial x_1}\frac{\partial U}{\partial y_2} = 0 \tag{4}$$

$$\frac{\partial U}{\partial x_2} + \frac{\partial f_1}{\partial x_2}\left[\frac{\partial U}{\partial y_1} + \frac{\partial U}{\partial y_2}\frac{\partial f_2}{\partial y_1}\right] + \frac{\partial f_2}{\partial x_2}\frac{\partial U}{\partial y_2} = 0 \tag{5}$$

Hence, the *ex ante* optimal (control) policy is obtained by solving the (1)-(5) system in x_1, x_2, y_1, y_2. By contrast, the solution provided by dynamic programming begins in period *2* and starts by evaluating the policy at time two (x_2), given x_1, y_1 and the constraint (3). This means that the first order condition for x_2 is:

$$\frac{\partial U}{\partial x_2} + \frac{\partial f_2}{\partial x_2}\frac{\partial U}{\partial y_2} = 0 \tag{6}$$

Comparing (6) with (5) it is immediately clear that the two expressions are equivalent only if the effect of x_2 upon y_1 is zero ($\partial f_1/\partial x_2 = 0$) or if the direct and indirect effects of y_1 and y_2 on *U* are

exactly offsetting. Kydland and Prescott refer to the policy sequence $\{x_1, x_2\}$ – provided by dynamic programming – as *consistent*, a term that the literature has subsequently changed to *time-consistent*. It follows that:

Definition

A policy is (time) consistent if, for each period of time t, it maximises (1), taking as given previous decisions, and that future policy decisions are similarly selected.

The implications Kydland and Prescott derive from a two period problem similar to the one we have just described are essentially two. First, dynamic programming does not provide an optimal policy sequence since, in general, it does not satisfy the first order condition for the maximisation of *U*. Second, optimal control theory – although powerful and useful technique for analysing dynamic systems – is an inappropriate tool for economic planning even when there is a "well-defined and agreed-upon" fixed social objective function. This derives from the fact that current decisions of economic agents partly depend upon their expectations of future policy actions. Thus, optimal control would be appropriate only if these expectations were invariant to the future policy plan selected. It is important to observe that what we require is not necessarily that agents can forecast the future perfectly, but that they have some knowledge of how policies will be modified as a result of changing economic conditions Secondly, the discretionary or time consistent solution for which policymakers select the best action given the current situation will not typically result in the social objective function being maximised. Conversely, by relying on "simple and easily understood" policy rules, policymakers are able to improve their economic performance[1]. Kydland and Prescott are very clear in this regard. The reason why policymakers should follow rules rather than discretion

> *"... is not that they are stupid or evil but, rather, that discretion implies selecting the decision which is best, given the current situation. Such behaviour either results in consistent but suboptimal planning or in economic instability."* [K.P., JPE 1977, vol. 85, no. 3, p. 487].

The problem of time inconsistency is subsequently popularised in the monetary policy game of Barro and Gordon (1983a). They postulate a supply function for aggregate output, which implies that real output only increases with unanticipated inflation. In such a framework, the policymaker is viewed as attempting to maximise an objective that reflects society's preferences over inflation and output. They show that, although the government in period one may adopt an anti-inflationary policy, it has a clear

[1] Observe that, unlike Friedman's (1948) argument, this does not depend upon ignorance of the magnitude and timings of the effects of policy.

incentive to reverse policy in period two in order to engineer surprise inflation and increase output. Yet, a rational private sector fully understands the government's motive to increase output by creating surprise inflation. As a result, it incorporates a positive mark-up into its inflationary expectations such that they are now sufficiently high so as to give the government a disincentive to further stimulate output. The long-run result is that output remains at its natural rate while inflation becomes much higher then the socially optimal level. An inflation bias is therefore said to arise. This is computed as the difference between the lowest enforceable inflation rate and the ideal rate.

Clearly, the existence of an inflationary bias relies on the assumption that policymakers are not able to commit to a particular action in advance. If a precommitment technology existed, the inflation bias would disappear. At the beginning of the planning horizon the government could in fact commit to a zero-inflation rule and the inflationary expectations would adjust accordingly.

III SOLUTIONS TO THE TIME INCONSISTENCY PROBLEM

The fact that discretionary monetary policy gives rise to an inflation bias naturally raises the question of what can be done to avoid or at least mitigate this problem. A number of alternative solutions have been proposed.

A first potential solution to the credibility problem comes from Giavazzi and Pagano (1988). They argue that a high inflation country may enhance the credibility of its own monetary policy by pegging its exchange rate to the currency of a low inflation country. The convergence of inflation rates during the 1980s in Europe through the Exchange Rate Mechanism (ERM) suggests that this particular approach may have been quite effective for some time. Unfortunately, the main problem with this solution is that fixing the exchange rate is not always feasible given the difficult task of finding suitable low-inflation countries to peg the currency against. An additional problem is that such arrangements are always vulnerable to speculative attacks, especially when capital controls are being relaxed. The 1992-1993 crisis of the ERM remains a well-known example.

In a completely different context, a number of authors (including Fisher and Summers (1989), Devereux (1987)) have argued that monetary time-inconsistency can be overcome by indexing labour contracts to the price level. Their argument is that with wage indexation the Phillips curve becomes steeper, and the government is less tempted to create unanticipated inflation, since this now has to rise to a much higher level to achieve the same reduction in unemployment.

An alternative and more popular approach, however, is offered by the so called 'reputational literature'. Barro and Gordon (1983b) have in fact extended their previous analysis (B&G, 1983a) to

examine whether reputational considerations can restore the credibility policy-makers need to pursue time-inconsistent policies. The basic idea is that if the game is repeated over time a government might have incentives – namely poor reputation as reflected in an upward revision of inflationary expectations – to persist with a low inflation policy. The assumption is that, whenever private agents observe an inflation rate different from the one they anticipated, they will expect the policymaker to act only in accordance with his short run incentives for some time in the future. Agents will therefore raise their inflationary expectations. Hence a trigger strategy can be assumed to be put in place to create a trade-off for the policymaker. He gets a current benefit by driving up inflation above its expected value, but he has got to balance this against the cost of higher inflation in the future. This implies that the computation of the lowest enforceable inflation rate requires the policymaker making two calculations. On the one hand, he has to compute the gain from reneging on any policy announcement. This involves weighting up the cost of higher inflation and moving away from the ideal inflation rate against the gain of generating surprise inflation and moving nearer to the target level of output. This first calculation is what Barro and Gordon refer to as *temptation*. On the other hand, the second calculation involves comparing the cost of being able to pursue the same inflation policy rule in the next period as opposed to being forced to follow the higher discretionary inflation rate. The discounted value by which the cost of discretionary policy exceeds the policy rule is referred to as *enforcement*. The outcome of such a cost and benefit calculation is that a range of announced inflation rates can be an equilibrium. Such a range crucially depends on how heavily the policymaker discounts the future and on how long the reversion of high inflationary expectations last. Yet, the important fact remains that endogenisation of future costs (deriving from reneging on promised policies) by the policymaker helps him relax his short-run incentive constraint. As a result:

> *"... some monetary rules, but generally not the ideal one, can be enforced by the policymaker's potential loss of reputation... .Specifically, the outcomes are superior to those under discretion - where no commitments are pertinent - but inferior to those under the ideal rule"* [Barro and Gordon, JME 1983b, pp. 99-100]

While the framework set up by Barro and Gordon illustrates the potential role of reputation in monetary policy, it does present two major weaknesses. The first is the implicit requirement that all the private agents somehow co-ordinate on a particular strategy for revising their inflationary expectations whenever the policymaker deviates from the expected inflation rate. The second is that such revisions are assumed to occur whenever private agents face a broken promise by the policymaker, however small and in whichever direction. Al-Nowaihi and Levine (1996), however, shed some light on this last criticism. Adopting a weaker notion of renegotiation, they introduce the concept of "chisel-proof credibility" by asking whether the public will still be willing to punish if the central bank cheats just a little. They show

that the lowest inflation rate that can be supported in this case is positive but still inferior to the discretionary rate.

IV THE CONSERVATIVE CENTRAL BANKER'SOLUTION

The discussion of rules versus discretion also encompasses the topic dealing with the viability and sustainability of independent central banks as an alternative solution to the time inconsistency problem. In this regard, the seminal contribution remains the one by Rogoff (1985). He investigates the effects of delegating monetary policy to an independent authority concluding that:

> *"... it can be entirely rational for a society to structure its central bank in such a way that the monetary authorities have an objective function very different from the social welfare function. Whenever a distortion causes the time consistent rate of inflation to be too high, the society can be made better off by having the central bank place 'too large' a weight on inflation rate stabilisation".* [Rogoff, Q.J.E. 1985, vol. 100, p. 1184]

Rogoff's argument can be illustrated by using a stripped down version of the Barro-Gordon model[2].

Let output be given by a supply equation in which only unexpected changes in the money stock have real effects:

$$y^s = p - p^e + e \quad , \quad e \sim N\left(0, s_e^2\right) \tag{7}$$

where p and p^e are, respectively, actual and expected inflation and e is an aggregate productivity disturbance. The principal feature of the model is the assumption that, because of tax and labour market distortions, the equilibrium level of output is below the socially optimal level. Denoting with $\hat{y}$ the target level of output and with *b* the positive difference between this and the natural rate, we further assume that the government preferences can be summarised as:

$$L_{FA} = \left(y - \hat{y}\right)^2 + ap^2 \tag{8}$$

where *a* is the relative weight the government places on inflation stabilisation versus output stabilisation. The first term in (8) captures the idea that the government is dissatisfied with the market-determined level of output, while the second term represents the cost of inflation. As in Kydland and Prescott, the government is unable make binding commitments to low inflation and is motivated to generate unexpected inflation in order to expand economic activity. In order to construct the discretionary equilibrium, we need to derive the Nash non co-operative solution by backwards induction. This gives the well-known result:

$$p = \frac{b}{a} - \frac{e}{1+a} \tag{9}$$

The first term is the inflationary bias, while the second represents the monetary response to unexpected disturbances. This discretionary equilibrium satisfies the following two conditions. Firstly, private sector expectations are on average correct, in the sense that p^e is always the optimal forecast of actual inflation. Secondly, although it is at the discretion of the government to fool the private sector through an inflation surprise, the latter sets its inflationary expectations sufficiently high so that the marginal cost of inflating equals the marginal gain from increasing output. Hence the government is not motivated to inflate further. Observe that, if the fiscal authorities were able to commit to a policy rule, than a simple rule of zero inflation would eliminate the inflationary bias whilst still allowing flexible responses to shocks. In our specific case, the optimal policy rule would have the following form:

$$p^* = -\frac{e}{1+a} \tag{10}$$

So far we have quite simply formalised the issues that have been illustrated in section II. Using a framework very close to the one we have just described, Rogoff suggests to mitigate the time inconsistency featured in (9) by appointing an 'independent' central banker, which places a greater weight on inflation stabilisation than the government does. Formally, this is equivalent to letting the central banker's loss function be:

$$L_{CB} = (y - \hat{y})^2 + (a + c)p^2 \tag{11}$$

where c is the endogenously determined extra weight placed on inflation stabilisation. Under this modified setting, the equilibrium rate of inflation can be shown to be:

$$p = \frac{b}{a+c} - \frac{e}{1+a+c} \tag{12}$$

Comparing the first two terms of (12) and (9) it is clear that, for any $c > 0$, the inflationary bias with a conservative central banker is lower than the bias delivered under a discretionary equilibrium. It is also clear, however, that a trade-off between commitment and flexibility is established. In fact, if increasing c reduces the time consistent average inflation, the same increase also reduces the stabilisation part of inflation that aims to mitigate the impact of the supply shock on output. In fact, as c approaches infinity, the counter-cyclical feedback coefficient in (12) approaches zero and the result is that the central bank ends up responding completely inappropriately to shocks.

The next step in Rogoff's analysis is to compute the optimal degree of central bank independence. This is given by the point where the benefits of reducing the inflationary bias outweigh the costs of

[2] The macroeconomic model underlying our subsequent analysis is deliberately stylised because we wish to highlight the gaming aspects of monetary policy rather than the technicalities of the transmission mechanism.

responding inappropriately to supply shocks. Rogoff proves that the expected value of the government's loss function is convex in c and that there exists a positive optimal value of it that minimises this function. To see this intuitively, suppose that $c = 0$. Then, the central bank would be stabilising the economy optimally on the one hand, but the economy would be suffering from inflationary bias on the other hand. Hence, it would be possible for a government, by raising the central bank's weight on inflation stabilisation, to achieve a first order stabilisation gain at a second order stabilisation cost. At the other extreme, if c goes to infinity, then the inflationary bias would be eliminated but the loss due to output variability would be very high. Thus, for a very large c the marginal cost of reducing c is small relative to the stabilisation gain. Hence, it is optimal for the government to choose an agent to head the central bank who places a greater, but *not infinitely greater*, weight on inflation stabilisation than the government does.

We conclude this section with a note. The Barro-Gordon (1983 a,b) and Rogoff (1985) seminal papers are usually cited when discussing the case for central bank independence. Yet, it is important to observe that the policy implications of these works are rather different. Barro and Gordon argue that the inflationary bias under discretion makes a case for a monetary rule. In their initial non-stochastic equilibrium, the optimal rule would fix the money stock or money growth rate. Once uncertainty is introduced and the level of output is affected by shocks, it is optimal to set up a feedback rule, in which monetary policy responds optimally to shocks. This would be a rule without discretion, but there would be no need for an independent central bank. If fact, it would only require a technical institute to implement this rule. Conversely, Rogoff's solution to the need for flexibility for monetary policy to respond to shocks is to install a conservative central banker with the discretion to respond to shocks and the conservatism to keep the mean rate of inflation low. Hence, the optimal central banker is chosen by trading off the reduction in mean inflation secured by conservatism against the less than optimal trade-off between inflation and output variability produced by the same conservatism.

V RECENT EXTENSIONS OF ROGOFF'S CONSERVATIVE CENTRAL BANKER

Rogoff's seminal contribution has been quite influential as it is evidenced by the number of researchers who have used it as an analytical framework for investigating further the macroeconomic effects of delegating monetary policy to an independent authority.

A first development originates from the observation that in the rather rigid framework devised by Rogoff the government is quite simply unable to override a decision taken by an autonomous central bank. Lohmann (1992) relaxes this assumption using a model of delegation in which the monetary

authority sets the inflation rate while allowing for a flexible escape clause implemented in extreme situations. The set-up is similar to that in Rogoff except for an additional term in the government's loss function. This extra term is an endogenously determined cost that the government pays when it *ex post* overrides the central bank's monetary policy decision. The timing of events is described as follows: Firstly, the government appoints an inflation adverse authority to run monetary policy and also sets the cost of overriding a central banker. Then the private sector sets nominal wages. Finally the shock is realised and the central bank sets the inflation rate. The government either accepts this inflation rate or it chooses the option to override the central bank and reset a higher inflation rate. In the latter case, the government achieves an output gain at the expense of paying a cost for overriding the central bank. Lohmann shows formally that the optimal strategy for the central bank is to avoid being overridden by announcing an inflation rate that makes the government indifferent between overriding the central bank and not doing so. Lohmann's conclusion is that an arrangement that implies delegation of monetary policy to the central bank and a government retaining the option to override the central bank's decision when needed dominates the central banking arrangement proposed by Rogoff.

A second development of Rogoff's analysis consists in the introduction of a welfare function representing the preferences of a heterogeneous population. Waller (1992) derives heterogeneity from a two-sector – competitive versus non-competitive – labour market structure. Although the loss functions in the two sectors are identical, output variability in the non-competitive sector is higher than in the competitive sector due to nominal wage rigidities. Thus, a central banker, optimally chosen to minimise the social loss function defined as a weighted average of the two sectors loss function, may not be regarded optimal for either of the two sectors. In fact, if the non competitive sector were allowed to choose the central banker, it would choose a less inflation-averse central banker relative to the competitive sector's choice, since it suffers a larger increase in output variability than does the competitive sector. Along the same line of reasoning, the competitive sector would be willing to accept a more conservative central banker than it is socially optimal. Waller's main insight is that the decision to appoint a conservative central banker is not as straightforward as indicated by Rogoff. In an economy with more than one sector and with political parties representing these sectors, the choice of a conservative banker may in fact be subject to partisan influences.

A similar point is made by Alesina and Grilli (1993) within the context of EMU. Using a variant of Rogoff's model, they show how different member countries may disagree over the conduct of the monetary policy formulated by a common central bank (ECB). This is due to the fact that, during the transition to a political union, different countries will have their own national loss functions and quite plausibly, the effects of common monetary policies will be evaluated on the basis of these national loss functions. Hence, while monetary policy is set by the ECB, each member country will assess the effects of

common policy according to its national loss function. It follows that a policy, optimally chosen by a common central banker to stabilise the variance of European output, may not be optimal for a country with a larger variance of national output. For such a member country, the ECB will be too conservative in the sense that it is not stabilising enough. This may yet again give rise to disagreement over the choice of the Governor of the ECB.

Electoral uncertainty is an additional element that Alesina and Gatti (1995) use to extend Rogoff's model. They develop a framework where output variability can be decomposed in two parts. The first is the economic variability that is due to nominal and real shocks that monetary policy aims to stabilise. The second part of output variability is political, introduced to the economy by electoral uncertainty. Alesina and Gatti show that an independent central banker who is chosen before the outcome of elections but who implements monetary policy right after the election date, has two benefits: it reduces the inflationary bias, but also eliminates politically induced output variability since monetary policy is not under the direct control of governments with different preferences. The elimination of policy-induced output variability may compensate for the increased economic variability caused by the fact that an independent central bank does not try enough to stabilise supply shocks. This of course strengthens the case for central bank independence, especially in countries experiencing particularly severe political business cycles.

Along the same lines but in a more public finance framework, van der Ploeg (1992) makes a case for delegating monetary policy to an ultra-conservative central banker, namely to someone who cares only about price stability. This is due to the fact that, in an economy with nominal wage contracts and nominal public debt, a government has a temptation to create unanticipated inflation in order to erode the real value of debt service and hence to cut distortionary taxes. Under discretion, this results into an inflation bias and in a suboptimal government revenue mix relying too much on seignorage revenue and too little on taxation. Van der Ploeg shows that a fully independent central bank committed to price stability yields a higher welfare than a dependent central bank. He also shows that a fully independent central bank is more likely to be preferred when the stock of outstanding nominal government debt is high, when a large proportion of wages is not indexed and when the extent of the black economy and collection costs of conventional taxes are insignificant.

VI THE PRINCIPAL-AGENT APPROACH

One of the most promising contributions to the recent literature on central bank independence comes from Walsh (1995). His main innovation is to adopt a principal agent framework in an attempt to analyse the incentives a central banker faces in a standard monetary policy game. In a principal-agent framework, the *principal* (government) delegates control over inflation to an *agent* (central bank). The principal's task is to offer the agent a contract providing the incentives to enact the policy desired by the

principal. The positive aspect of the contract is that it does not modify the central bank's preferences about output stabilisation. Hence, it completely eliminates the *credibility vs. flexibility* trade-off Rogoff's proposal suffers from. The issue then becomes choosing a suitable contract, which can be taken as credible by the private sector.

The set-up is the natural rate model examined in section III. However, in contrast to the Rogoff's approach of viewing the central banker as a more inflation averse than the rest of society, in Walsh's theoretical framework the government offers the governor of the central bank a state-contingent wage contract and his objective is to maximise the budget transfer from the government which in turn depends on inflation and unemployment. Formally, let the central bank's objective function be:

$$L_{CB} = \left(y - \hat{y}\right)^2 + a\left(p - \hat{p}\right)^2 \tag{13}$$

where $\hat{p}$ and $\hat{y}$ are the target levels of inflation and output respectively. Aggregate supply and output is given by the Lucas supply function:

$$y = \bar{y} + \left(p - p^e\right) + e \tag{14}$$

where e is, as before, an aggregate supply shock with zero mean and finite variance, $\bar{y}$ is the equilibrium level of output in the absence of supply shocks, and p, p^e are the actual and expected inflation rates, respectively. As it is often the case in monetary policy games, it is assumed that the market determined level of output $\bar{y}$ is below the target level of output $\hat{y}$ ($\hat{y} = \bar{y} + k; k > 0$). The informational structure assumes that, firstly, expectations about inflation are formed, secondly, the monetary authority observes a signal q about e and it finally sets the inflation rate based on this. The signal is private information of the central bank. Suppose now that monetary policy is delegated to an independent central banker who chooses the inflation rate in order to maximise his utility given by $U = t - L_{CB}$, where t is a monetary transfer payment from the government conditional on the central bank performance as specified in the contract. Given the incentives and constraints faced by the government and the central bank, the interactions between the two can be regarded as a standard principal-agent problem. More specifically, the agent sets the inflation rate to maximise his expected utility, conditional on the realisation of q The principal's problem is to design a transfer function t that enforces the central bank to choose $p = p(q)$ so that $E\left(t - L_{CB}\right) \geq 0$. The transfer function $t(p)$ implements the optimal policy $p(q)$ if this maximises $E\left[t(p) - L_{CB}\right]/q$ for all q. Intuitively, the government's objective is to design a contract that eliminates the inflationary bias while leaving the central bank free to respond to q.

Walsh has shown the optimal policy can be implemented by the following transfer function:

$$t(p) = t_0 - 2k\left(p - \hat{p}\right) \tag{15}$$

(15) states that the central banker is penalised for deviations of actual inflation above target inflation $\hat{p}$ and rewarded for actual inflation rates below such a target. Notice that the penalty is linear in actual inflation, which means that the marginal cost of increasing inflation is the same for all realisations of q .

If the work of Walsh sets the stage for the contractualist research agenda, Svensson's inflation targets bridge the gap with the reality of monetary policy-making. Svensson (1995) in fact observes that if the central banker puts a lower average inflation target than the rest of society does and its preferences over inflation and output are quadratic, this is formally equivalent to adding a linear cost to inflation, as in the Walsh model above. Moreover, he shows that the trade-off between average inflation and output variability arising in Rogoff's model only follows from the particular parameterisation of preference differences, namely that the central bank puts more weight on stabilising inflation than the rest of society does. Svensson's proposal is therefore to assume that the central banker is given a lower average inflation target than the rest of society. In such a case, average inflation can be reduced without any increase in output variability. Lossani *et al.* (2000) believe there are two alternative interpretations of this result. If the central bank may be held accountable, a target is a non-distortionary performance-based contract. Alternatively, Svensson's proposal may be viewed as a suggestion that monetary policy be delegated to a genuinely conservative central banker, that is, a banker who implements non-distortionary responses to shocks but prefers an average rate of inflation lower than the socially optimal one.

VII CONTROVERSIAL ISSUES

Several issues arise at this point. The first regards the distinction between discretionary and rule-based behaviour. How do we decide whether a central bank's behaviour should be classified as discretionary or rule-based? Within a simple model one could calculate the settings implied by each type of behaviour, or simply observe whether inflation exceeds its target value on average. Yet, such steps are not possible for an outside observer, since he does not possess knowledge of the bank's true target values -much less the response coefficients that would be implied by each type of behaviour given the implicit model of the economy. Taylor (1993) explicitly addresses this problem in practice, recognising that no actual central bank would be likely to follow literally a simple formula for its instrument settings, but contending that the distinction could be of importance nevertheless.

Clearly, being systematic is a necessary condition for the rule-like behaviour, but even those central bankers who defend discretionary behaviour do not think of it as unsystematic. Accordingly, McCallum (1993) argues that being systematic it is not sufficient and points out that even discretionary behaviour can be accurately represented by the systematic application of a simple formula. The needed additional criterion, McCallum suggests, is that

"... the monetary authority must also design the systematic response pattern (so as) to take account of the private sectors expectational behaviour" [McCallum 1993, JME]

This leads us back to the main point that central banks have to avoid temptations to re-optimise over time.

A second and perhaps more controversial issue is whether it is actually feasible for a independent central bank to behave in a rule-like fashion. A number of economists (including Taylor (1983), Taylor (1993), McCallum (1995) and Prescott (1977)) have in fact suggested that, since there is no tangible "commitment technology" to guarantee that future choices will be made similarly, independent central banks are inevitably destined to behave in a discretionary fashion, making a fresh optimisation calculation each period. One of the strongest explicit statements of this position is made by Chari, Kehoe, and Prescott (1989) as follows:

"... we should emphasise that in no sense can societies choose between commitment [and] time-consistent [i.e. discretionary] equilibrium. Commitment technologies are like technologies for making shoes in an Arrow-Debreu model -they are either available or not" [Chari, Kehoe, and Prescott, 1989, FRB Minneapolis, p. 303]

Moreover, Lapavitsas (1997) observes that the 'independent' central bank of the theoretical models is not a central bank at all. It is, rather, a social planner armed with a single instrument of economic policy, fiat money, in pursuit of the aim of price stability. With this in mind, 'independence' acquires a meaning: it is, above all, the independence of the social planner from the executive branch of the state, i.e. the periodically elected government.

The third objection regards a matter of internal consistency of the theory of central bank independence and is rather more substantial. McCallum (1995) claims that the literature "features inappropriate interpretative mappings between analytical constructs and real world institutions". Two are the fallacies that he identifies. The first regards the assumption that if the central bank is not externally constrained to do otherwise, it will generate the discretionary rate of inflation. He argues that, although no technology exists for inescapably committing future actions, this does not imply that such behaviour is actually unfeasible. In this regard he argues:

"What is needed for avoidance of the inflationary bias is for the central bank to recognise the futility - on average, over extended time spans - of continually exploiting expectations that are given 'this period' but reflect responses to actions of the central bank taken in the past, and to recognise that its objectives

would be more fully achieved on average if it were to abstain from attempts to exploit these temporarily-given expectations".[McCallum 1995, AER]

Therefore, the actual issue remains whether the commitment equilibrium without incentive constraints is implementable. The second fallacy pertains the inappropriate interpretation of the Walsh contracts. In McCallum's own view, the unsatisfactory feature of this result is that such a contracting device does not actually eliminate the motivation for dynamic inconsistency. It merely relocates it to a different place[3]. Specifically, under the proposed arrangement, the government would have to enforce the contract by reducing the central bank's budget when inflation is high. However, the government has exactly the same incentive of the central bank not to do so. What this means is that, if the absence of a precommitment technology is a severe problem, then it must apply to a consolidated entity consisting of the central bank and the government together, just as it would to a very conservative central bank. Therefore, his conclusion is that the problem cannot be overcome analytically by a suggestion that the central bank's objective function should be specified at the constitutional stage of the political process. In fact, the constitution still needs to be enforced, and the enforcing party may be subject to the same temptations of an independent central bank. Hence, the main effect of central bank contracts

"... is not principally to constrain the central bank to act in accordance with the government objectives, but rather to constrain the government by increasing the difficulty of its bringing pressure to inflate upon the central bank". [McCallum 1995, AER]

The problem remains, however, that contracts may raise credibility relative to simple arrangements only to the extent that renegotiation costs are sufficiently high (Waller, 1995). The practical calibration of the Walsh tax, particularly when this is imposed as a non-pecuniary penalty, is of course another crucial issue.

A final objection, largely emphasised by Alesina (1988), Alesina and Summers (1993), Bade and Parkin (1984), Eijffinger and Shaling (1993), Grilli *et al.* (1991) and Cuckierman *et al.* (1992) among the many others, is grounded on the consistent empirical result of the free lunch provided by central bank independence in industrialised countries. In fact, central bank independence appears to be empirically associated with smaller rates of inflation, while carrying no costs in terms of growth[4]. Furthermore, both the variance of inflation and output growth are on average lower for countries that have more independent central banks. These results do not seem at first glance consistent with the predictions of Rogoff's model, which implies that central banks trade off between output and inflation variability. Fisher

[3] The same point has been made by al-Nowaihi and Levine (1996).
[4] These results only hold for developed economies.

(1995) suggests three explanations of this. First, more independent central banks are able to stabilise more effectively than less efficient banks, and therefore come closer to the stabilisation-efficiency frontier. Secondly, fiscal policy is more disciplined in countries whose central banks are relatively more independent. Finally, both inflation and output performance are primarily affected by shocks that differ from country to country. Alesina and Summers (1993) and Alesina and Gatti (1995) argue that this empirical result may also be explained by the fact that independence eliminates the uncertainty created by a polarised political system. In their own view, because the political conflict produces inefficiency in the determination of output and prices, delegation of monetary policy solves the problem by eliminating the political source of macroeconomic instability.

VIII MODELS WITH ENDOGENOUS FISCAL POLICY

The main limitation of the most conventional macroeconomic models on time inconsistency is that they examine the issue most intensively within the context of monetary policy exclusively. They in fact specify carefully the connection of monetary policy to the evolution of the price level, while ordinarily leaving both the government budget constraint and fiscal policy entirely hidden. Despite the attempt made by Sargent and Wallace (1981) to demonstrate that sufficiently irresponsible fiscal policy will cause problem to monetary policy, the issue has often been treated as no more than an important footnote to the central role of monetary policy. It is only in the late 1980s – presumably as a response to the magnitude and duration of fiscal deficits experienced in many developed countries – that economists begin taking the view that fiscal policy plays a role at least as important as monetary policy in determining the price level. Development of this view requires new models and new forms of analysis. Yet, the main weaknesses of these later models remain essentially two: they either adopt a too simple *ad-hoc* IS-LM framework (Alesina and Tabellini (1987)), or they are based upon rather complicated structures (see for example Kritchel *et al.* (1996)). These mainly rely on microeconomic foundations, which are often unable to provide analytical results. Simulation techniques are therefore required. An additional limit of this literature, and in particular of the one dealing more specifically with strategic issues in a monetary union (Cuckierman (1992), De Grauwe (1994), Eijffinger and de Haan (1996), Giavazzi (1998) and Persson and Tabellini (1994)) is that it contributes only marginally to the understanding of the relationship of countries after monetary union has taken place.

The workhorse paper in the monetary-fiscal interaction literature is certainly the above-mentioned seminal work by Alesina and Tabellini (1987). They develop the Barro-Gordon model by assuming that real government purchases are controlled by a fiscal authority that may have different objectives – concerning the level of these purchases as well as inflation and output – than those of the central bank. The fiscal authority's revenues come from non-lump-sum taxes and money growth, government debt being excluded from the model. Using this setting, Alesina and Tabellini derive outcomes pertaining to

both discretionary and rule-like behaviour by the central bank. Their most striking result is that, when preferences of the central bank and the fiscal authority are sufficiently different, equilibrium outcomes with monetary policy commitment can be inferior to those obtained under discretion. This result, which is viewed as a message in favour of monetary and fiscal policy co-operation, is subsequently confirmed by the two-country extension of Bryson *et al.* (1993).

There have been several attempts to improve upon the framework devised by Alesina and Tabellini. Beetsma and Bovenberg (1995), for instance, extend their framework using a more sophisticated budget constraint allowing for public debt. Within this modified setting they analyse the implications of alternative institutional arrangements - centralisation versus decentralisation, Nash versus Stackelberg - for society's welfare. Unfortunately, their results are somewhat ambiguous. In fact, different arrangements are desirable depending on society's preferences over inflation, output and public spending, as well as the structural parameters of the economy. By contract, Agell *et al.* (1996) derive less ambiguous results. Developing an analytical structure very similar to the one devised by Beetsma and Bovenberg, they show how discretionary fiscal and monetary policies are bound to result in excessive inflation and deficits. With particular reference to public debt dynamics, they stress how, in a finite game where there is no binding borrowing constraint for the government during its term of office, the equilibrium will be characterised by sustained deficits. Conversely, with binding borrowing constraints there is a bias in running debts initially.

Beetsma and Bovenberg (1998, B&B henceforth) reconsider the original structure of Alesina and Tabellini in a multi-country model of monetary union, modelling the fiscal authorities as Stackelberg leaders *vis-à-vis* the central bank. Within this framework each fiscal authority acts strategically, perceiving that the output distortions caused by a tax increase is partly offset by an inflation surprise. Because rational wage setters are able to anticipate this, the advantage of the policymaker once again results into an inflation bias. The conclusion is that fiscal co-ordination in a monetary union is not desirable because it strengthens the bargaining position of the leader.

Yet, the work by B&B neglects the existence of open economy-effects from fiscal policy and the possibility that fiscal authorities might be tempted to use so called 'demand-side (i.e. public expenditures) policies' to increase output. This matter is discussed in great length by Levine and Pearlman (1998, L&P henceforth). They analyse a hypothetical closed trading bloc of ins and outs to a monetary union where both fiscal and monetary authorities are subject to time-inconsistencies. If on the monetary side the source of inconsistency is represented by the temptation to deliver a rate of inflation well above the one expected by the private sector, on the fiscal side a stabilising role for the fiscal authorities is given by the pressure these can exert on the real exchange rate. The argument goes as follows. When a government fiscal stance is looser relative to that of the others, its real exchange rate appreciates. This reduces the real

product wage therefore raising the domestic level of output. Hence, uncoordinated fiscal authorities are induced to loosen their fiscal stances. It follows that, in contrast to B&B, an argument is established in favour of fiscal policy co-ordination. The weaknesses of this line of analysis, however, are essentially two. First, it fails to account for the effects on output of both distortionary taxation and an endogenously determined balanced budget constraint. Catenaro(1999) shows that important spillover effects of the fiscal bias on the more traditional inflationary bias can be accounted for when extending the analysis in this direction. Second, L&P's contribution is grounded on the assumption of simultaneity in the policy decision process. Such an assumption is not very realistic because fiscal authorities are relatively slow in delivering their policies, whereas monetary authorities adjust more easily to the cyclical disturbances. A model like the one of B&B, where the choice of the tax instrument provides governments with a first-mover advantage *vis-à-vis* the central bank, therefore appears to be more adequate to describe the real nature of the fiscal and monetary policy interactions.

It is important to observe that, as far as the sign of the fiscal transmission is concerned, within the framework devised by L&P, a relatively looser domestic fiscal stance negatively affects output abroad *via* a depreciation of the foreign real exchange rate. Hence, fiscal policy has acquires a *beggar-thy-neighbour* nature since it increases domestic output at the expenses of foreign countries' welfare. A negative externality connected to the use of fiscal policy in a monetary union, however, is also derived in Sibert (1992). Here the negativity of the sign relates to the fact that an increase in one country's tax lowers disposable income in the same country, therefore decreasing seignorage in the area as a whole. Thus, the lack of fiscal policy co-ordination causes income taxes to be too high. As a consequence, the provision of the public good is too high and the central bank sets inflation below the optimal level. Yet, the result that lack of international co-ordination results in too little inflation is unusual and contradicted by Miller and Salmon (1985), Cohen and Wyplosz (1989) and Levine and Brociner (1994) among the many others[5].

IX AN ENCOMPASSING MODEL OF STACKELBERG LEADERSHIP

We conclude by sketching an encompassing open-economy model accounting for both the B&B and the open-economy effects. Our aim is to show that Beetsma and Bovenberg's argument for applying the subsidiarity principle to fiscal policymaking in a monetary union may not necessarily be in contrast with L&P's (1998). Our treatment draws on Catenaro and Tirelli (1999).

Let us consider a *n*-symmetric countries monetary union characterised by a single monetary authority (ECB), which sets monetary policy for all countries, and by *n* decentralised fiscal authorities (FAs)

[5] It is not the aim of this survey to enter into the debate of the sign of the international transmission of fiscal policy. However, from a number of more empirical researches conducted during the past decade (an excellent survey is

conducting policies at their national level. Governments run balanced budgets, therefore they can finance public expenditures only by levying distortionary taxes. The results concerning the desirability of fiscal policy co-ordination crucially depend on the introduction of a demand factor – public expenditure – as in L&P. Standard models (Alesina and Tabellini, 1987) neglect such an effect assuming that the central bank perfectly stabilises demand without consequences for the price level. This result still holds within our framework at the union level, where a generalised increase in expenditures aiming to stimulate demand will be entirely offset by a monetary contraction. However, the ECB will be unconcerned with purely asymmetric effects originating from the domestic fiscal stances.

Introduction of open-economy (i.e. relative price) effects from fiscal policy yields the following reduced form for output[6]:

$$x = p - p^{e} - t_i + \bar{c}\left[g_i - \sum_{h=1}^{n}\left(\frac{g_h}{n} \right)\right] - e_i \qquad (16)$$

where $p - p^{e}$ is the traditional inflation surprise of the union wide consumer price index, *t* stands for the distortionary output effects of a tax imposed on firms' revenues, and $g_i - \sum_{h=1}^{n}\left(\frac{g_h}{n} \right)$ is the domestic fiscal stance relative to the union average. The output impact of the latter is described by the coefficient $\bar{c}$ <1. Equation (16) shows that if the ECB controls the inflation rate, each FA can boost domestic output in two ways, either through a reduction in the tax rate or by means of policies that appreciate the real exchange rate. Such an appreciation occurs when domestic expenditures increase *vis-a-vis* the rest of the union[7].

The loss function of the FAs is a traditional quadratic in output, inflation and expenditure deviations from the target:

$$V^{FA} = \frac{1}{2}\left\{ a_{pf}(p - \tilde{p})^2 + x_i^2 + a_{gs}(g_i - \tilde{g})^2 \right\} \qquad (17)$$

where $\tilde{p}, \tilde{g}$ define the bliss points for inflation and public expenditure (Svensson 1997). Conversely, the loss function of the ECB depends on a weighted average of output in each country and on inflation:

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provided in Douven and Peeters 1997), we observe that in Europe this has often deviated from the positive effect that often assumed by the traditional Mundell-Flemming literature.

[6] (16) is obtained by combining linearised demand and supply functions derived from standard microfoundations as in Levine and Pearlman (1998). The algebra is tedious but relatively straightforward. For a complete derivation see Appendix I of Catenaro and Tirelli (1999).

[7] Equation (16) is a reduced form of an underlying structural model that does not necessarily imply a negative transmission of domestic fiscal policy on foreign demand as in Levine and Pearlman (1998) (see Catenaro and Tirelli (1999)).

$$V^{CB} = \frac{1}{2}\left\{ a_{pm}(p - \tilde{p})^2 + \frac{1}{n}\sum_{i=1}^{n}(x_i)^2 \right\} \tag{18}$$

The sequence of events follows B&B:

1. nominal wage contracts are signed;
2. shocks are observed;
3. the FAs set taxes and public expenditure conditional to the expected inflation rate;
4. the ECB sets inflation taking taxes and expenditures as given.

As far as our simple model is concerned we concentrate only on systematic policies (see Catenaro and Tirelli (1999) for a treatment on fiscal policy responses to shocks). Our aim is to compute the equilibrium solutions for distortionary taxes under the monetary delegation scheme of weight-conservatism ($a_{pm} > a_{pf}$) and the two fiscal policy scenarios of non-coordination (FPNC) and co-ordination (FPC) respectively. Recalling the definition of x_i given in (16), the central bank's reaction function is:

$$p = \frac{1}{1 + a_{pm}}\left\{ a_{pm}\tilde{p} + p^{e} + \frac{1}{n}\sum_{i=1}^{n}(t_i) \right\} \tag{19}$$

On the fiscal side, each FA sets the tax rate so as to balance the marginal benefits of a tax-financed increase in expenditure with the costs of higher taxes. It is important to observe that the FAs, acting as Stackelberg leaders *vis-a-vis* the central bank, anticipate the monetary responses to their own decisions. To begin with, let us assume that the tax rate in each country in set non co-operatively, so that the FA fails to internalise the responses of the other FAs. Combining equations (16) and the balanced condition $t_i = g_i$ we get:

$$\frac{\partial x_i}{\partial t_i} = -\left[1 - \bar{c}\left(\frac{n-1}{n}\right)\right] + \frac{\partial p}{\partial t_i} = -\left[1 - \bar{c}\left(\frac{n-1}{n}\right)\right] + \frac{1}{(1 + a_{pm})}\frac{1}{n} \tag{20}$$

Each FA, by taking as given public expenditures in the rest of the union, realises that an increase in domestic expenditures will boost output. Such an effect will partly compensate for the distortionary impact of the higher taxes required to finance the rise in expenditures. Furthermore, the FAs correctly anticipate that asymmetries in public spending policies have no effect on inflation. On the other hand, they foresee that the ECB will increase inflation following a rise in the average EU tax rate. Therefore the FAs take into account the inflationary consequences of raising the domestic tax rate. As in Beetsma and Bovemberg, we assume that the FAs do not internalise the adverse effect of taxation on expectations. Hence, they perceive that the inflation response to t_i partly offsets output distortions. Yet, without co-ordination each FA neglects the symmetric tax policies pursued in rest of the union. As a result, the

impact of higher domestic taxes on inflation is underestimated. This, in turn, mitigates the consequences of time inconsistency.

The equilibrium level of distortionary taxes when the FAs act non co-operatively is obtained differentiating (17) with respect to g_i, subject to (16), (19), (20), the balanced-budget condition $g_i = t_i$, and noting that in equilibrium $p = p^e; g_i^s = 0;\ t_i = t;\ p = t/a_{pm} + \tilde{p}$, $\forall j$. This gives:

$$t_i^{FPNC} = \frac{a_{gs}\tilde{g}}{\left[\frac{1}{(1+a_{pm})n}\left(\frac{a_{pf}}{a_{pm}} - 1\right)\right] + \left[1 + a_{gs} - \bar{c}\left(\frac{n-1}{n}\right)\right]} \tag{21}$$

Let us now move on to the second scenario of co-operative fiscal policies. In this case each FA realises that, since governments are subject to identical incentives, any attempt to stimulate output *via* an increase in domestic expenditures is bound to fail. Yet, co-ordination exacerbates the time inconsistency problem, because each FA correctly anticipates the global effect of symmetric tax policies on inflation, but still neglects its adverse impact on expectations. Hence in this case we shall have that:

$$\frac{\partial x_i}{\partial t_i} = -1 + \frac{\partial p}{\partial t_i} = -1 + \frac{1}{(1+a_{pm})} \tag{22}$$

Therefore, straightforward calculations yield:

$$t_i^{FPC} = \frac{a_{gs}\tilde{g}}{\left[\frac{1}{(1+a_{pm})}\left(\frac{a_{pf}}{a_{pm}} - 1\right)\right] + (1+a_{gs})} \tag{23}$$

Subtracting (23) from (21) we can finally determine the sign of the tax difference under the two scenarios. This is given by

$$t_i^{FPNC} - t_i^{FPC} = \left[\frac{1}{(1+a_{pm})}\left(\frac{a_{pf}}{a_{pm}} - 1\right)\right] + \bar{c} \tag{24}$$

Some comments are in order. When the central bank is not independent and shares the same preferences about inflation of the national fiscal authorities $(a_{pm} = a_{pf})$, $t_i^{FPNC} - t_i^{FPC} = 0$ so that incentives for a strategic use of the tax instrument are invariant to the fiscal policy scenario. In this case absence of conflict between fiscal authorities and the central bank about the inflation objectives means that fiscal authorities will not need to exert extra pressure on the ECB to loosen its monetary stance. This in a way removes governments' commitment problem. However, our maintained assumption that the central bank assigns a larger weight on inflation stabilisation than the government does implies that fiscal authorities raise taxes in order to encourage the ECB to deliver a higher rate of inflation, thereby bringing the equilibrium outcome more in line with governments' preferences. It follows that the sign of (24)

depends on the relative strength of two factors. On the one hand, the factor $\left[\left(a_{pf}/a_{pm}-1\right)/\left(1+a_{pm}\right)\right]<0$, which affects the economy in case of fiscal co-operation, describes the perceived impact that the central bank response to a co-ordinated tax increase bears on the inflation and output components of the governments' loss function. On the other hand, the factor ($\bar{c}$) captures the strength of the open-economy effect, which obtains when fiscal policies are uncoordinated. Hence, a trade-off between co-ordination and non co-ordination is established. This is due to the fact that the choice to co-ordinate fiscal policies produces two effects. On one hand it enhances the bargaining power of the fiscal authorities creating the premises for a more aggressive use of the tax instrument. This in turn raises inflation. On the other hand, co-ordination implies that fiscal authorities internalise the effects of open-economy policies on output as well as the externalities originating from their excessively loose fiscal stances. We can therefore conclude that when the perceived output effects of an expenditure surprise are sufficiently strong, the results obtained by B&B are in fact reversed and fiscal policy co-ordination remains desirable as in the case of simultaneous policy decisions described by L&P. In this particular case, using a model with open-economy effects, Catenaro (1999) shows that fiscal discretion requires an extremely inflation-adverse central banker to mitigate the negative spillover effects on inflation arising from excessively loose fiscal stances. This result is in fact confirmed in a Stackelberg framework as well, without open-economy effects being required.

Catenaro and Tirelli (1999) extend this line of analysis in two ways. They first consider a monetary regime where the central bank is assigned a contract endorsing an inflation target. Their result is that, paradoxically, the time inconsistency problem affecting the FAs worsens. Governments in fact anticipate that a target brings down inflation. However, by taking the target as given, they will still expect that systematic tax policies cause inflation surprises. Therefore, by reducing such a level, the target induces the FAs to use their tax instrument more heavily. Secondly, turning to countercyclical-policy analysis, they observe that – *per se* – co-ordinated responses to shocks may appear to be always optimal, since responses to shocks do not affect expectations. Therefore fiscal co-ordination, which allows to correctly anticipate the strength of the monetary policy responses to fiscal actions, is always preferable, unless the weight-conservative ECB implements too inefficient monetary responses to shocks. They derive welfare implications from their analysis, suggesting that novel institutional arrangements should be designed to achieve fiscal restraint. They in fact argue that adverse incentives in the use of systematic tax policies can be eliminated by assigning to each FA a properly designed public expenditure target, in analogy with the popular inflation-targeting proposal (Svensson 1997). Thus, their proposal gives specific content to the recent argument presented in Dixit and Lambertini (2000) who, using a different analytical framework, make a strong case for constitutional constraints on fiscal policy.

We conclude this final section with a note on co-ordination. The simple model presented in this section shows that, whenever open-economy effects from fiscal policy are sufficiently strong, the traditional Nash equilibrium result in favour of co-operative management of fiscal policies is reaffirmed. Yet, co-ordination is not an easy matter, and may prove sometimes difficult to implement in practice. In this case, it can easily be shown that the same positive result of co-ordination may be obtained through the indirect precommitment of fiscal policies, *via* a sort of stability pact (SGP) limiting the use of public expenditure as an instrument for stabilisation purposes. Such an *ad hoc* SGP can be thought as a linear penalty on public expenditure imposed upon each government, modifying the welfare function (17) as:

$$V_W^{FA} = \frac{1}{2}\left\{J\left[\alpha_{pf}(p-\tilde{p})^2 + x_i^2 + \alpha_{gs}(g_i-\tilde{g})^2\right] + p_i g_i\right\} \tag{25}$$

where the last term on the R.H.S. of (32) stands for a linear penalty in public expenditure[8]. The latter should be endogenously determined so as to eliminate the governments 'fiscal bias and maximise society's utility function. This is a straightforward fiscal application of the Walsh contracts 'theory (see al Nowaihi and Levine (1996) and Catenaro (1999)). Alternatively, the penalty could be directly inserted into the governments 'budget constraint. The results would be unaffected.

X CONCLUSION

Time-inconsistency within simple policy games arises because policymakers face the temptation of increasing the output level by delivering a rate of inflation that is above the one expected by the private sector. Although such policies may produce short-term real effects, in the long run expectations will be revised upwards so as to eliminate any surprises. Such revisions result in both an inflation and a fiscal bias. Despite the several attempts to solve the *inconsistency* problem of macroeconomic policies, we argued that the most successful recipe today remains the delegation of monetary policy to a central bank characterised by high aversion to inflation. Alternatively, a principal-agent approach à la Walsh may be devised to modify the loss function of the monetary authority so as to help it achieving its bliss point of inflation. We also focused on the several contributions to account for the important monetary and fiscal interactions, illustrating how a simple open-economy model is in fact capable of reconciling the two currently prevailing views concerning the optimality of fiscal policy co-ordination in the EMU. We showed that, whenever open-economy effects from fiscal policy are sufficiently strong, the traditional literature result that co-ordination is always beneficial is reaffirmed. In this regard, we argued that such a positive result can also be obtained by extending a contractualist approach similar to the one devised by Walsh to the conduct of fiscal policy, setting explicit public expenditure targets.

[8] Observe that the factor J is required to convert the social loss into monetary units so that it can be added to the monetary cost given by the public expenditure penalty term.

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