Seminar Paper No. 564

FISCAL POLICY WHEN MONETARY POLICY IS TIED TO THE MAST

by

Jonas Agell, Lars Calmfors and Gunnar Jonsson

INSTITUTE FOR INTERNATIONAL ECONOMIC STUDIES

University of Stockholm

ISSN 0347-8769

Seminar Paper No. 564

FISCAL POLICY WHEN MONETARY POLICY IS TIED TO THE MAST

by

Jonas Agell, Lars Calmfors and Gunnar Jonsson

February 1994

Institute for International Economic Studies
S-106 91 Stockholm
Sweden

February 1, 1994

FISCAL POLICY WHEN MONETARY POLICY IS TIED TO THE MAST

by

Jonas Agell, Department of Economics, Uppsala University
Lars Calmfors, Institute for International Economic Studies, Stockholm University
Gunnar Jonsson, Institute for International Economic Studies, Stockholm University*

JEL Classification: E63.Key Words: time inconsistency, discretion versus commitment, exchange rate policy, fiscal deficits, monetary union.

Abstract

This paper analyses the time inconsistency problem of both exchange rate and fiscal policy in a small open economy. The equilibrium under discretion is characterised by inflation and a deficit. Commitment of the exchange-rate instrument only, e.g., through membership in a European monetary union with low inflation, contributes to price stability but increases the deficit. Whether the government will prefer this outcome to the discretionary one depends on the structure of the economy: commitment appears more favourable, the more open is the economy. The time-inconsistency arguments strengthen the case for simultaneous commitment of monetary and fiscal policy for inflation-prone countries joining a monetary union.

*We are grateful for secretarial help by Helena Matheou and for comments from Alberto Alesina, Nils Gottfries, Henrik Horn, Karl Jungenfelt, Paul Klein, Assar Lindbeck, Torsten Persson and Anders Vredin as well as from the participants in seminars at the Institute for International Economic Studies, the Department of Economics at Stockholm University, the Department of Economics at Uppsala University and the Stockholm School of Economics.

1. Introduction

It has become a standard conclusion in macroeconomics that discretionary monetary policy may produce an inflation equilibrium, and that binding commitments to fixed rules are likely to result in superior outcomes with more price stability. This reasoning goes back to the work on the time inconsistency problem of monetary policy by Kydland & Prescott (1977) and Barro & Gordon (1983a, 1983b).[1] However, a weakness in this literature is the implicit assumption that the policy maker has access to only one policy instrument. This makes it impossible to analyse the possible interrelationship between, for instance, monetary and fiscal policy. If both these instruments are used to influence employment in a discretionary regime, one might suspect that monetary-policy commitment might exacerbate the inconsistency problem associated with fiscal policy. This paper develops a formal analysis of this issue.

More specifically, we treat the interdependence between exchange rate and fiscal policies in a small open economy. In the discussion about the EMS and the proposed EMU, it has been a common argument that exchange-rate discipline may be an effective way of achieving credibility for disinflationary policies in inflation-prone countries (see, e.g., Giavazzi & Giovannini, 1987; Giavazzi & Pagano, 1988; or Weber, 1991). This issue has also been studied by, e.g., Horn & Persson (1988) and Gylfason & Lindbeck (1991), who have shown how a wage-devaluation cycle may arise in a small open economy under a discretionary exchange-rate regime. We extend this analysis by setting up a model in which the government can use both exchange rate and fiscal policy in order to affect output and employment. It is shown that the equilibrium under discretion will involve both inflation and a sustained fiscal deficit.

The discretionary regime described above is compared with a commitment regime in which the exchange rate is irrevocably fixed. A commitment technology giving this result is to delegate monetary policy to a foreign (supra-national) authority by substituting

---

1 See Persson & Tabellini (1990) or Cukierman (1992) for overviews of the literature.

a foreign (common) currency for the domestic one, as would be implied for an inflation-prone economy joining a prospective EMU with low inflation. Our conclusion is that such an institutional change will indeed reduce inflation, but in the absence of restrictions on fiscal policy, this will be achieved at the expense of increased government budget deficits.[2] In general, it will not be clear whether the government will prefer this outcome to the discretionary one or not.

Our analysis bears directly on the discussion about the need for fiscal rules and fiscal co-ordination within a European monetary union. This issue was first raised in the Delors Report (1989), which argued strongly in favour of such rules, which were eventually also included in the Maastricht Treaty. One argument is based on the traditional Mundell-Fleming analysis of an open economy: with a fixed exchange rate, the potency of fiscal policy increases for the individual country when no offsetting exchange-rate movements can occur. This creates incentives for more fiscal-policy activism, at the same time as the effects on the common exchange rate may create negative externalities on the other participants in the currency bloc. Other arguments have instead stressed how individual government might run up their debts to unsustainable levels leading either to a systemic collapse of financial institutions with international repercussions or a bail-out by other governments (see, e.g. *One market, one money,* 1990). On the other hand, fiscal rules have been criticised both because of the arbitrariness of the criteria suggested and because of a perceived need of fiscal flexibility in the case of shocks hitting the member countries of a monetary union asymmetrically (see, e.g., Buiter et al. 1993; or *The making of monetary union*, 1991)

Our analysis extends the earlier discussion on fiscal flexibility in the EMU by specifying an additional mechanism through which fiscal discipline may be weakened: in

---

[2] Our conclusion receives some empirical support from a comparison of the fiscal deficits in the countries choosing monetary co-operation with Germany within the ERM in 1979 and non-ERM OECD countries. In 1972-79, the average deficit in the former group (excluding Luxembourg) was 4.6 percent of GDP versus 2.9 in the latter (excluding Iceland, Portugal and Turkey). In 1980-87 the corresponding figures were 7.7 and 3.9 percent respectively, i.e., the average fiscal deficit rose by 2 percentage points more in the countries that opted for exchange-rate co-operation with Germany.

our model, monetary-policy commitment aggravates the time-inconsistency problem of fiscal policy in inflation-prone countries. It is, however, an open question whether this represents an argument for binding fiscal rules in the EMU or an argument against monetary union as such.

Turning to the vast theoretical literature on credibility issues in monetary policy, there has been surprisingly little work on the interaction between different policy instruments. A couple of studies have recognised that the time inconsistency problem of monetary policy may affect fiscal policy through seignorage revenue and a balanced-budget constraint. If the government uses an inflation tax to finance some of its expenditures, different monetary commitment regimes will have repercussions for fiscal policy because they affect seignorage revenue. As a consequence, credible commitment to a low inflation target may then be undesirable, as it may lead to increased distortionary taxes and/or to cuts of government expenditures (Alesina & Tabellini, 1987). The inflation tax argument has been extended to an open economy by de Kock & Grilli (1993). They conclude that it is not possible to Pareto-rank different exchange rate regimes, since a government that cares about its tax revenue must account for the fact that different exchange rate systems have implications for the flexibility of future seignorage revenue.

While theoretically appealing, the seignorage argument may have less practical relevance. In most OECD countries, the inflation tax makes up only a small fraction of total government revenue. It seems more natural to assume that governments consider the intertemporal (intergenerational) redistributions associated with fiscal deficits. While our set-up may appear more Keynesian than that of Alesina & Tabellini and Kock & Grilli, it still has distinctly classical equilibrium properties. *Ex ante,* our policy maker is exposed to a trade-off between deficit financing and economic activity. *Ex post,* in a rational-expectations equilibrium, the trade-off vanishes. The non-cooperative equilibrium of the repeated game between the government and domestic wage setters is characterised by a suboptimal deficit with no lasting output and employment effects.

Finally, our paper can be seen as a contribution to the positive theory of government budget deficits. There is now a substantial literature on how various political factors affect the government's incentives to run deficits. The general argument is that democratic decision making can generate a bias towards budget deficits.[3] Our focus is instead how different restrictions on monetary policy affect the incentives for fiscal policy, even though the political situation is unchanged.

The paper is organised as follows. Section 2 presents our model of a small open economy. Section 3 characterises the equilibrium under discretion, and Section 4 models the outcome under commitment to a fixed exchange rate to a currency bloc with zero inflation. Section 5 compares the implication of the two exchange-rate regimes for the fulfilment of government policy objectives. We draw conclusions in Section 6.

2. The Model

Our model is highly stylised with simple functional forms, permitting closed-form solutions. The basic set-up is an aggregate supply and demand model of a small open economy consisting of a number of identical consumers and identical firms. The home country produces and exports one good, while importing another. To highlight the consequences of adjusting to low foreign inflation in the commitment regime, the rate of price increase for the imported good is set to zero. To this basic framework, we add a wage equation reflecting union behaviour, and a government that determines the nominal exchange rate and the fiscal stance so as to maximise its welfare function.

There is a potential role for stabilisation policy because unions, unlike the government, trade lower employment against higher real consumption wages. The game between unions and the government is repeated a *finite* number of times. A plausible

---

3 A government that faces some probability of losing a coming election to a party with different preferences may not internalise the full cost of borrowing, as discussed by, e.g., Persson & Svensson (1989) and Alesina & Tabellini (1990). An alternative approach focuses on generational issues. Depending on the age of the median voter, debt policy may be used as means for redistributing revenue across generations (e.g., Cukierman & Meltzer, 1989; and Tabellini, 1991). Finally, the work of Roubini & Sachs (1989) and Alesina & Drazen (1991) suggests that the reaction to an adverse budget shock might be slower in the case of multi-party governments encompassing different preferences.

interpretation of this is that government and union policies are formulated by officials with a limited period of office. As the players make their moves simultaneously in each period, we focus on the Cournot-Nash equilibrium of the game.

To keep our game theoretical analysis simple, the behaviour of consumers, firms and unions is modelled in the simplest way possible without dynamic links, so that one-period utility maximisation also implies intertemporal utility maximisation. It is only the government, the decisions of which we are primarily concerned with, that has to consider the future implications of its present actions.

A. The demand side

The representative domestic consumer is characterised by a Cobb-Douglas utility function defined over the domestically produced good and the imported good. In each period the following optimisation problem is solved:

$$\max_{D,M} U_i = D_i^{\alpha} M_i^{1-\alpha}$$

(1)

$$s.t.\ PY_i(1+B) = PD_i + EM_i,$$

where D is the demand for the domestic good, P the price of the domestic good, M the demand for the imported good, Y gross income before taxes and transfers (measured in terms of the domestic good), B the government budget deficit measured as a proportion of gross income (the rate of net transfers to households), and E the nominal exchange rate defined as domestic currency units per unit of the foreign currency. The foreign-currency price of the imported good has been normalised to unity. The i subscript denotes the representative consumer.

The LHS of the budget constraint is current nominal disposable income of a domestic consumer. $B = 0$ means that the government budget is balanced, so that taxes paid equal received transfers. $B > 0$ means that the government runs a deficit to finance positive net transfers, which increases disposable income. Consumers are assumed to be constrained in the credit market, with the consequence that they spend all their income. This simplification allows variations in the fiscal deficit to affect aggregate demand in a straightforward way. The crucial assumption is, however, only that strict Ricardian equivalence does not hold, i.e., that changes in the government budget deficit are not *fully* offset by changes in private savings. It is, however, analytically convenient to disregard private savings altogether, at the same time as the qualitative results are not affected.

Aggregating over all individuals, the first order conditions that follow from (1) yield the aggregate domestic demand functions for the two goods as

$$D = \alpha Y(1+B) \tag{2}$$

$$M = (1-\alpha)\frac{P}{E}Y(1+B), \tag{3}$$

where Y is aggregate gross income (before taxes and transfers, and measured in domestic goods), which equals aggregate output of the domestic good. The parameter α is the expenditure share of domestic goods and it can thus be interpreted as a measure of the country's degree of openness (the economy being more open, the lower is α). Export demand is given analogously by

$$X = \alpha^f \frac{E}{P} Y^f, \tag{4}$$

where Y^f and α^f denote income and share of imports for the rest of the world. Equilibrium in the market for the domestically produced good implies that $Y = D + X = Y^d$, where Y^d is demand for the domestically produced good. Equations (2) and (4) then give us

$$Y^d = \left[1-\alpha(1+B)\right]^{-1}\frac{E}{P}\alpha^f Y^f. \tag{5}$$

If we take logarithms of (5), and invoke a first-order Taylor approximation for $\ln[1-\alpha(1+B)]$, evaluated at $B=0$, we get

$$y^d = \phi + e - p + \frac{\alpha}{1-\alpha}B, \tag{6}$$

where $\phi = \ln(\alpha^f Y^f) - \ln(1-\alpha)$, and where small letters denote logarithms. Total demand for the domestic good is a function of the real exchange rate (with a unitary elasticity) and of the fiscal-policy parameter, where the elasticity depends negatively on the economy's degree of openness (the higher is α, the less open is the economy).

B. The supply side

We assume perfect competition in the market for the domestically produced good. The production technology for a representative firm is given by a Cobb-Douglas production function

$$Y_j = AL_j^{\gamma}, \tag{7}$$

where A is a constant and L_j is labour input. Subscript j denotes the firm. The capital stock is assumed to be fixed and is normalised to unity. Profit maximisation in each period then gives us log of employment, l_j, and log of output, y_j, in the representative firms as

$$l_j = \bar{l} - \beta(w_j - p) \tag{8}$$

$$y_j = \bar{y} - (\beta - 1)(w_j - p), \tag{9}$$

where w_j is log of the nominal wage in the firm, $\beta = 1/(1-\gamma) > 1$ the elasticity of labour demand, $\bar{l} = \beta\ln(A\gamma)$, and $\bar{y} = \ln A + \gamma\bar{l}$. Assuming a symmetric equilibrium, aggregation gives the corresponding equations for total employment and total output of the domestic good:

(8a) $$l = \tilde{l} - \beta(w - p)$$

(9a) $$y = \tilde{y} - (\beta - 1)(w - p),$$

where $w = w_j$ for all j is the log of the aggregate wage, l the log of aggregate employment, $\tilde{l} = \bar{l} + m$, $\tilde{y} = \bar{y} + m$, and m the log of the number of firms. From (6), (9a) and the goods market equilibrium condition $Y = Y^d$, we can derive the price of domestic output as a function of the policy parameters, B and e, and of the nominal wage w:

(10) $$p = \bar{\phi} + \frac{1}{\beta}e + \frac{\alpha}{(1-\alpha)\beta}B + \frac{(\beta - 1)}{\beta}w,$$

where $\bar{\phi} = (\phi - \tilde{y})/\beta$.

C. Wage-setting behaviour

Wages are assumed to be set by unions that have monopoly power. For each firm there is a separate union. It organises a fixed pool of workers, since we assume that there is no labour mobility. In conformity with the literature on trade union wage setting, the representative union is assumed to care about the real consumption wage and unemployment among its members (see, e.g., Oswald, 1986). The simultaneous-move assumption implies that unions set nominal wages given their expectations of the government's policy parameters, B and e. Each union is assumed to be so small that it can ignore the effects of its own wage decision on the aggregate price level.

We normalise so that full employment exists when $w = p$, i.e., when $l = \tilde{l}$ and $l_j = \bar{l}$. The levels of aggregate and firm-specific unemployment -- measured in logs -- are then $\tilde{l} - l$ and $\bar{l} - l_j$, respectively. The real consumption wage, adjusted for net transfers, is $W(1+B)/P_c$, where $P_c = P^{\alpha}E^{1-\alpha}$ is the consumer price index. The instantaneous utility in each period of a representative union is defined as

$$(11) \qquad V_{jt} = \left(w_{jt} - p^e_{ct} + B^e_t\right) - \frac{\lambda}{2}\left(\bar{l} - l^e_{jt}\right)^2,$$

where we have used the approximation $\ln(1+B_t) \approx B_t$. Superscript e denotes expectations, subscript t the time period (which is now convenient to write out) and λ the weight the union puts on employment relative to the real consumption wage. We assume union utility to be linear in the log of the real consumption wage but quadratic in unemployment. This formulation is chosen because it will, as we shall see, define a given natural rate of unemployment, which is independent of the fiscal-policy stance.[4]

A representative union is assumed to maximise the intertemporal utility function

$$(12) \qquad Z_j = \sum_{t=1}^{J} \delta^{t-1} V_{jt},$$

where $0 \leq \delta \leq 1$ is the discount factor and J the (finite) number of periods that the union cares about. Since there are no intertemporal links on the union side, maximisation of (12) simply implies maximisation of (11) in each period. This is done subject to the expectation of the employment equation (8) and the assumptions that $dp^e/dw^i = dp^e_c/dw^i = 0$. From the first-order condition we can derive that

$$(13) \qquad w_j = w = p^e + \frac{1}{\lambda\beta^2}$$

---

[4] All qualitative results are unchanged if we instead assume that instantaneous utility is quadratic in both arguments. This specification, however, adds a supply-side effect of expected deficits on the natural rate: it will be affected to the extent that a change in the net transfer rate changes the equilibrium real product wage.

in a symmetric equilibrium. In every period, the nominal wage is set in a one-to-one relation with the expected producer price. If (13) is inserted in (8a), we obtain

$$l = \tilde{l} - \frac{1}{\lambda\beta} + \beta(p - p^e). \tag{14}$$

The natural rate of employment, i.e., the employment that occurs in a fulfilled-expectations equilibrium when $p = p^e$, is given by $n = \tilde{l} - 1/\lambda\beta$. As can be seen, the natural rate is determined only by the structural parameters of the model and it is thus independent of the size of the government budget deficit. The natural employment level will be closer to full employment, the higher is the weight put on employment relative to real wages by the representative union λ, and the higher is the labour-demand elasticity β.

From (10), (13) and (14), we can derive the following reduced-form expressions:

$$p - p^e = \frac{1}{\beta}(e - e^e) + \frac{\alpha}{(1-\alpha)\beta}(B - B^e) \tag{15}$$

$$l = n + (e - e^e) + \frac{\alpha}{(1-\alpha)}(B - B^e). \tag{16}$$

The government can reduce the real product wage, and thus stimulate output and employment, by creating a price surprise in two different ways. It can resort either to an unexpected depreciation or to an unexpected fiscal stimulus. In the first case, both domestic and foreign expenditures switch to domestic output through a real-exchange-rate depreciation. In the second case, there is a domestic aggregate-demand increase at the same time as the real exchange rate appreciates.

D. The government's strategy

The utility experienced by the government in each period is assumed to depend on unemployment, inflation and the size of the budget deficit. We define an instantaneous loss function, R_t, which is quadratic in its terms, so that

$$R_t = (\tilde{l} - l_t)^2 + \mu_B B_t^2 + \mu_\pi \pi_t^2, \tag{17}$$

where

$$\pi_t = \alpha(p_t - p_{t-1}) + (1-\alpha)(e_t - e_{t-1}) \tag{18}$$

is the rate of inflation (the change of the consumer price index), and μ_B and μ_π the relative weights on the deficit and inflation, respectively. Unemployment and inflation are standard arguments in the government's objective function in the literature on rules versus discretion in monetary policy. An interpretation of the deficit argument is that the government experiences disutility from a budget deficit, either because it entails a political cost, or because the government is concerned with the redistribution of consumption possibilities over time (across generations) that are associated with an unbalanced budget.

The government is assumed to minimise the intertemporal disutility function

$$S = \sum_{t=1}^{K} \theta^{t-1} R_t, \tag{19}$$

where $0 \le \theta \le 1$ is the discount factor and K the (finite) number of periods that the government cares about.[5]

As domestic consumers do not save, a fiscal deficit is equivalent to a trade deficit and increased foreign indebtedness of the government. Our maintained hypothesis is that foreign lenders willingly supply all the funds required by the government, i.e., the supply curve for external funds is horizontal throughout the game. Ultimately, beyond our K-period horizon, the government must, of course, satisfy an explicit intertemporal budget restriction. It is because such a constraint exists that it makes sense to assume that the government is concerned with current fiscal deficits on behalf of future generations. At

[5] As the model has been set up, it may very well be that $K \neq J$, i.e., the government and the unions may have different time horizons.

the same time, the experience of many heavily indebted countries during the 1970s and 1980s seems to suggest that governments have large freedom to choose seemingly unsustainable deficit levels before their borrowing capacity is exhausted (e.g., Masson & Taylor, 1993).

Since we have provided no microeconomic underpinnings for the union and government utility functions, it may be pertinent to point out the implications of our assumptions. We want to capture the standard notion that the natural rate of employment is lower than the rate of employment that the government strives for, so that there is an incentive to inflate. Our specific formulations is one way of doing this. The assumption that unions do not care about government budget deficits and inflation is not, however, important. Adding a government-deficit and an inflation term in the union utility function (11) would not change the first-order condition for utility maximisation, as long as we assume a Cournot-Nash equilibrium (in which the values of the government policy parameters are taken as exogenous) and that each individual union is too small to affect the aggregate price level.

3. Discretionary exchange rate policy

In a discretionary exchange rate regime, the government chooses the exchange rate, e, and the fiscal parameter, B, so as to minimise (19) subject to (17), (8a), (18), and (10) given the nominal wage level. To unravel the solution, we start by looking at the last period K, for which the first-order conditions become

(20) B: $$\frac{\alpha}{(1-\alpha)}\left(\tilde{l}-l_K\right)=\mu_B B_K+\mu_\pi \pi_K \frac{\alpha^2}{\beta(1-\alpha)}$$

(21) e: $$\tilde{l}-l_K=\mu_\pi \pi_K \frac{1}{\beta}(\alpha+(1-\alpha)\beta).$$

The LHS of either equation represents the government's marginal incentive to reduce unemployment. The RHS of (20) is the marginal cost of a larger deficit, represented by a direct effect via μ_B and an indirect effect via higher inflation (B_K affects p_K, and hence π_K). The marginal cost of an exchange rate adjustment in (21) is solely due to inflation - a depreciation increases the price of both imported and domestically produced goods.

In a fulfilled-expectations equilibrium, $e = e^e$ and $B = B^e$, which according to (16) implies that unemployment must be at its natural level. After some rearrangement of the first-order conditions, we obtain inflation and the fiscal deficit in the last period as

$$\pi_K^d = \frac{1}{\lambda\mu_\pi(\alpha + (1-\alpha)\beta)} \tag{22}$$

$$B_K^d = \frac{\alpha}{\lambda\mu_B(\alpha + (1-\alpha)\beta)}, \tag{23}$$

where superscript d denotes the discretionary exchange rate regime. It is straightforward to see that π_K^d and B_K^d will also be the inflation rate and deficit in all earlier periods. Since the values of these variables in the last period K depend only on the structural parameters of the model, but not on the values of e and B in period K-1, earlier policy decisions do not influence the instantaneous utility in that period. Hence intertemporal optimisation in period K-1 involves only minimisation of the instantaneous loss function R_{K-1} etc.

Equations (22) and (23) reveal a time inconsistency problem for both instruments. In a non-cooperative equilibrium both inflation and the fiscal deficit are positive, but unemployment remains at its natural level. Combining (10), (13) and (18), it is easy to show that, given rational expectations, we can decompose equilibrium inflation in any given period t as

$$\pi_t = \alpha(p_t - p_{t-1}) + (1-\alpha)(e_t - e_{t-1}) = \alpha\left(e_t - e_{t-1} + \frac{\alpha}{1-\alpha}(B_t - B_{t-1})\right) + (1-\alpha)(e_t - e_{t-1}). \tag{24}$$

In the discretionary case when the deficit remains unchanged from period to period, i.e., when $B_t^d = B_{t-1}^d$, it follows from (24) that $\pi_t^d = e_t^d - e_{t-1}^d$. The rate of inflation equals the rate of exchange rate depreciation (from which follows that the real exchange rate will be constant). Equations (22) and (24) thus capture the standard notion of an inflation-depreciation cycle. The depreciation bias depends on the size of μ_π in an intuitive manner -- a government that is more inflation-averse creates less inflation -- but not on the aversion against budget deficits, i.e., on μ_B. More interestingly, (23) captures the idea of a sustained deficit bias. The optimal deficit *ex ante* balances marginal employment gains against marginal costs in terms of both perceived disutility directly associated with the deficit and indirect inflationary effects. As should be expected, the more averse the government is against deficits, i.e., the larger is μ_B, the smaller is the deficit. In contrast, the deficit is not affected by the size of μ_π.

For both instruments, the severity of the time inconsistency problem depends on the natural rate of employment. If unions put a relatively high value on employment (i.e., when λ is large), the natural rate of employment goes towards full employment, and there will be weaker incentives to create inflation or run a deficit. A similar argument holds for a large value of β, i.e., the elasticity of labour demand. Both the equilibrium deficit and inflation depend on the openness of the economy. In economies where a large share of private consumption consists of imported goods (i.e. when α is small), the time inconsistency problem for deficit policy is mitigated for standard leakage reasons. Similarly, the larger the share of imported goods, the larger the increase of the consumer price index that follows from an exchange rate depreciation. Hence there will be a weaker incentive to inflate, the more open is the economy.

The government would benefit from stable exchange rates and a balanced budget. But with a finite horizon there are no reputation mechanisms to support first-best policy. If private-sector agents were to set wages on the basis of an announced policy of low inflation and small deficits, the government could always make itself better off by inflating the economy through some combination of deficits and currency depreciations. The private sector takes this into account, and we end up with the equilibrium characterised by

(22) and (23). If one could devise credible commitment technologies that simultaneously constrained the use of *both* monetary and fiscal policy, the situation would clearly improve. However, much of the recent discussion has stressed *only* the desirability of committing monetary policy, for instance through participation in international exchange rate arrangements or monetary unions (such as the EMS and the EMU). We shall demonstrate that such a commitment of only monetary policy may not necessarily be desirable, because it may aggravate the time-inconsistency problem for fiscal policy.

4. An irrevocably fixed exchange rate

Consider a regime of irrevocably fixed exchange rates, where the nominal exchange rate E is normalised to unity. How does such a commitment regime affect the incentive to run a budget deficit?

A. The general solution

If we set $e_t = e_t^e = 0$ for all t, all key structural equations remain valid. In particular, we may write the inflation rate as

$$\pi_t = \alpha(p_t - p_{t-1}), \tag{25}$$

where manipulations of (10) give

$$p_t - p_{t-1} = \frac{\alpha}{(1-\alpha)\beta}(B_t - B_{t-1}) + \frac{(\beta - 1)}{\beta}(w_t - w_{t-1}). \tag{26}$$

To solve for the optimal value of B, we again start with the last period. If (19) is minimised with respect to B_K subject to (17), (8a), (25), and (10), treating lagged or expectational variables as constants, we obtain a first order condition that in a fulfilled-expectations equilibrium reduces to

$$B_K^c = c_1 B_{K-1}^c + c_2, \tag{27}$$

where $c_1 = \alpha^4\mu_\pi / \{(1-\alpha)^2\beta\mu_B + \alpha^4\mu_\pi\}$, $c_2 = \alpha(1-\alpha)/\lambda\{(1-\alpha)^2\beta\mu_B + \alpha^4\mu_\pi\}$, superscript c stands for commitment, and $0 < c_1 < 1$. Unlike the case of a discretionary exchange rate regime, the deficit now changes over time. The deficit in period K-1 appears as a state variable in the optimal solution to the final period problem, which turns our repeated game into a dynamic one. Using backward induction and assuming that the government solves this optimisation problem in each period under the assumption that a Nash game is going to be played in the subsequent periods, it is straightforward to characterise the dynamic equilibrium. Let R_K^* denote the value of the government loss function in the Nash equilibrium represented by (27). In the penultimate period the government's minimisation problem then becomes

$$\min_{B_{K-1}} R_{K-1} + \theta R_K^*, \tag{28}$$

with the primitive first order condition

$$\frac{\alpha}{(1-\alpha)}\left(\tilde{l} - l_{K-1}\right) = \mu_B B_{K-1} + \mu_\pi \pi_{K-1} \frac{\alpha^2}{\beta(1-\alpha)} + \frac{1}{2}\theta \frac{dR_K^*}{dB_{K-1}}. \tag{29}$$

As before, the LHS represents the government's incentive to reduce unemployment, while the RHS gives the marginal cost of a deficit in period K-1. Unlike the case of a discretionary exchange rate regime, the marginal cost also depends on the effect on future welfare, evaluated in a Nash equilibrium. In a rational expectations equilibrium the LHS reduces to a constant, as shown by equation (14). From (24) equilibrium inflation in the commitment regime can be written as

$$\pi_t^c = \frac{\alpha^2}{(1-\alpha)}(B_t^c - B_{t-1}^c), \tag{30}$$

in any period t. As a consequence, we may rewrite (29) as

$$B^c_{K-1} = c_1 B^c_{K-2} + c_2 - \theta \frac{(1-c_1)}{2\mu_B} \frac{dR^*_K}{dB^c_{K-1}}. \tag{31}$$

The pattern for the backward recursion is now set. In the K-t round of the game the equivalent of (31) is

$$B^c_{K-t} = c_1 B_{K-t-1} + c_2 - \frac{(1-c_1)}{2\mu_B}\left[\theta \frac{dR^*_{K-t+1}}{dB^c_{K-t}} + \theta^2 \frac{dR^*_{K-t+2}}{dB^c_{K-t}} + \ldots + \theta^t \frac{dR^*_K}{dB^c_{K-t}}\right], \tag{32}$$

where the terms in square brackets represent the effect of a deficit in period K-t on future government utility, evaluated in a Nash equilibrium.

B. The myopic case

It follows from (24) and (27) that with a fixed exchange rate, neither deficit nor inflation will stay constant over time. To understand the intuition, it is instructive to start with the case of a myopic government in the sense that $\theta = 0$. From (27), (31) and (32) it is easy to see that the deficit in this case evolves according to the first-order difference equation $B^c_t = c_1 B^c_{t-1} + c_2$ in any period t. Assume next that the initially inherited deficit is zero, i.e., that $B_0 = 0$. It then follows that the deficit will grow monotonically, but at a decreasing rate. In the first period the deficit is c_2, in the second $c_2(1+c_1)$, in the third $c_2(1+c_1+c_1^2)$, etc. In the last period K the deficit will take on the value

$$B^c_K = c_2 \sum_{t=0}^{K-1} c_1^t. \tag{33}$$

Inflation, on the other hand, will decrease monotonically: from (30) we see that equilibrium inflation falls as the deficit grows more slowly. The intuition is simple. In any given period, the deficit of the previous period creates a ratchet effect. Holding private sector agents' expectations constant, the only way the government can inflate the economy is by injecting a deficit that is higher than in the previous period. This incentive means that the deficit grows over time, and that inflation must be positive in a rational-expectations equilibrium. However, as the government cares about the size of the deficit, the marginal cost of increases in the deficit also increases over time. As a consequence, the rate of growth of the deficit decreases gradually and inflation falls.

Will commitment produce a larger deficit than discretion? For a sufficiently large K, the answer is unambiguously yes in the myopic case. Taking the limit of (33), we obtain

$$(34) \qquad B_\infty^c = \lim_{K\to\infty} B_K^c = c_2/(1-c_1) = \frac{\alpha}{\lambda\mu_B(1-\alpha)\beta}.$$

It is straightforward to show that this deficit towards which the economy tends to converge -- although it is never reached, since we assume a finite K -- is larger than the discretionary deficit given by (23). More precisely, we have

$$(35) \qquad B_\infty^c - B^d = \frac{\alpha^2}{\lambda\beta\mu_B(1-\alpha)[\alpha+\beta(1-\alpha)]}.$$

It follows that there will always exist a K such that $B_K^c > B^d$. The intuition is that the disciplining effect of high inflation on the policy maker's incentive to run a deficit gradually disappears over time: a given deficit appears less inflationary near the end of the game, and the more so the larger is K. Further, from (35) we see that the difference between the deficit that the economy converges to in the commitment regime and the deficit in the discretionary regime is increasing in α, i.e., the difference is larger the more closed is the economy. This can be given an intuitive interpretation. In a completely open economy $(\alpha = 0)$, fiscal policy will not be used in any of the regimes, since it has no output effect. In an economy with very little foreign trade $(\alpha \to 1)$ there are incentives to run deficits in both regimes but they are stronger in the commitment case: the reason is that the (inflation) cost of marginally increasing the deficit is lower if exchange rate depreciations do not contribute to price rises.

From (35) it also follows that the difference between the deficits in the two regimes is decreasing in λ (union aversion against unemployment), β (the labour-demand elasticity) and μ_B (government aversion against deficits). With low values of λ and β, we have according to (14) a low natural rate of employment. Hence there is a strong incentive for the government to inflate, and this can only be done by creating deficits in the commitment regime, which explains why this policy measure is then used more than in the discretionary case when both instruments are available. Finally, a rise of μ_B makes deficit policy less attractive in both regimes, but the change will be the largest in the commitment case where the fiscal instrument is used the most.[6]

C. The two-period case

When $\theta > 0$ the analysis becomes more complex. Consider first a two-period version of our repeated game with an inherited zero deficit. After appropriately redefining the time indices, the resulting equilibrium is characterised by (27') and (31'):

(27') $$B_2^c = c_1 B_1^c + c_2$$

(31') $$B_1^c = c_2 - \theta \frac{(1-c_1)}{2\mu_1} \frac{dR_2^*}{dB_1^c}.$$

When $\theta > 0$, the government also accounts for the effects of a period 1 deficit on period 2 welfare. It is easy to show that the deficit is larger in period 2 than in period 1. One can

[6] It can be seen directly from (34) and (23) that both $\lim B^d = 0$ and $\lim B_\infty^c = 0$ when $\lambda \to \infty$, $\beta \to \infty$ or $\mu^B \to \infty$. Hence it also holds that $\lim(B_\infty^c - B^d) = 0$.

also derive that the increase between period 1 and 2 is smaller than that between periods 0 and 1. The additional term in (31') will however create a potentially important level effect. Combining (17) and (30) we obtain

$$(36) \qquad \frac{dR_2^*}{dB_1^c} = 2\mu_B B_2^c \frac{dB_2^c}{dB_1^c} - 2\mu_2 \frac{\alpha^2}{1-\alpha}\left(B_2^c - B_1^c\right)\left[1 - \frac{dB_2^c}{dB_1^c}\right].$$

From (27') it follows that $dB_2^c / dB_1 = c_1$, where $0 < c_1 < 1$. The important observation is that a marginal deficit increase in the first period has two counteracting effects on R_2^*. On the one hand, it leads to a larger deficit in the final period, which tends to increase R_2^* and reduce government welfare (the first term on the RHS). On the other hand, the induced increase in the period 2 deficit is always smaller than the original period 1 deficit increase. This implies less inflation in the final period, which tends to decrease R_2^*. While the first effect tends to discipline period 1 deficit policy, the second effect goes in the other direction: the government knows that a higher deficit today means less inflation tomorrow. Which effect will dominate? In general we can not tell. Depending on the parameters of the model, dR_2^* / dB_1^c can be either positive or negative. In the former case, a forward looking government ends up with a smaller deficit than a myopic one in both periods, in the latter case the opposite holds true.

D. Simulations of the multi-period case

With $\theta > 0$ algebraic analysis of the multi-period case becomes very complex. We have therefore chosen to illustrate the results by a number of simulation exercises. In Figures 1-2 we let $K = 10$ and $\theta = 0.9$. A base case is shown in Figures 1a and 1b, where we have chosen parameter values so that under discretion inflation is 6.1 percent and the fiscal deficit 4.5 percent of GDP. This occurs with for instance $\alpha = 0.75$, $\beta = 1.4$, $\mu_\pi = \mu_B = 1$ and $\lambda = 15$. Figures 2a and 2b depict an alternative case with $\alpha = 0.65$, $\beta = 1.6$, $\mu_B = 1.25$, $\mu_\pi = 0.75$ and $\lambda = 15$, implying a discretionary deficit of 2.9 percent of GDP and an inflation rate of 7.3 percent. In both sets of diagrams we allow for three different initial fiscal situations in the period preceding the game, ranging from the deficit under discretion to a surplus of 5 percent of GDP.

All the cases shown confirm the picture from the myopic case. The fiscal deficit in the commitment regime will after a few periods be larger than under discretion. At the same time inflation converges to zero. Even when there is an original government budget surplus, the commitment case will show a larger deficit already after 3 periods. The rate of change of the deficit develops in a non-monotonic way. The deficit increases at a falling rate up to the last periods, with a continuously falling rate of inflation as a result. However, towards the end of the game, when there are fewer future periods to take into account, the deficit starts to increase more rapidly with the consequence that inflation rises again.

Figures 3a and 3b illustrate the importance of various discount factors under the assumption that the initial government budget deficit is zero. As can be seen, the deficits under commitment will, with the parameter configurations chosen, be smaller the higher the discount factor, i.e., the more the future periods are considered, and the rate of inflation will fall more quickly (but also rise more towards the end of the game). Finally, Figure 4 compares the paths of the deficits with varying lengths of the game. The more periods the game is played, i.e., the higher is K, the larger is the deficit in the final period in these examples.

5. Rules versus discretion: which regime is preferred by the government?

In the analysis of Alesina & Tabellini (1987) of rules versus discretion in a closed economy, only monetary policy is subject to a time inconsistency problem. Credible monetary commitment may therefore decrease the welfare perceived by the government only when monetary and fiscal policy makers have different objective functions. This is not an issue in our model -- we have only one policy maker and one objective function. Despite this, the credible commitment regime is not necessarily preferable to the discretionary one for the government. Employment is the same in both regimes. With discretionary exchange rate policy we obtain persistent inflation and a time-invariant deficit. With a credible fixed exchange rate, the economy settles on a transition path characterised by low inflation as well as increasing deficits, where the last-period values of these variables will depend upon structural parameters and the number of periods. As we show below, there is no simple way of ranking the equilibria: in general we cannot tell whether the lower inflation in the commitment regime makes up for the larger deficits or not.

Again it is instructive first to study the myopic case. If we evaluate the single period loss function at the values of inflation and deficits that are obtained under discretion and in the steady state towards which the economy tends to converge under commitment, we obtain that

$$R^d = \left\{\frac{1}{\lambda\beta}\right\}^2 + \mu_B\left\{\frac{\alpha}{\lambda\mu_B(\alpha+(1-\alpha)\beta)}\right\}^2 + \mu_\pi\left\{\frac{1}{\lambda\mu_\pi(\alpha+(1-\alpha)\beta)}\right\}^2 \tag{37}$$

$$R^c_\infty = \left\{\frac{1}{\lambda\beta}\right\}^2 + \mu_B\left\{\frac{\alpha}{\lambda\mu_B(1-\alpha)\beta}\right\}^2. \tag{38}$$

It turns out that $R^c_\infty > R^d$ if

$$\mu_\pi\alpha^2\left(\beta^{-1}\frac{\alpha}{1-\alpha}+2\right) > \mu_B\frac{1-\alpha}{\alpha}\beta. \tag{39}$$

The discretionary regime appears more favourable for the government, the larger is the relative weight assigned to inflation in the loss function μ_π. That is, the more averse the government is to inflation, the less likely is it that it will benefit from joining a monetary union. The simple reason is that the gains in terms of disinflation will be small, as inflation is low anyway (see equation (22)). At the same time, according to (35) the difference between the deficits in the two regimes is not affected by the size of μ_π. The argument also works the other way around. A government that tries primarily to keep the budget in balance is more likely to gain from tying up the monetary instrument. The explanation is that the larger is μ_B, the smaller is the deficit under commitment in relation to the deficit under discretion, whereas the inflation differential is not affected.

It is also clear from (39) that the commitment case will be more attractive to the government, the smaller is α, i.e., the more open is the economy, and the larger is the labour-demand elasticity β. Here the intuition is less clear cut. On the one hand, (22) shows that a small α and a large β give low inflation under discretion, so that there will be small disinflationary gains from tying the exchange-rate instrument to the mast. But on the other hand, there will according to (35) also be a small difference in budget deficits. It turns out that the disinflationary gains from commitment fall more slowly than the utility losses in terms of larger deficits when α falls or β increases.

Again, it turns out that the myopic case is a good guide to the more realistic cases when $\theta > 0$. This is illustrated in Table 1, which shows the difference between the discounted present values of government disutility in the commitment and discretionary regimes for $K = 5$ and $K = 10$, respectively, under the assumption that the initial deficit is equal to the one under discretion. The ranking of the two regimes in terms of the welfare experienced by the government is very sensitive to the parameter assumptions made. For instance, in the five-period case, with $\mu_B = \mu_\pi = 1$ and $\beta = 1.1$, it is enough to lower α from 0.85 to 0.55 in order to move from a result where discretion is preferred by the government for all θ to the opposite conclusion that commitment is always preferred.

The sensitivity of the results to the parameter values chosen is further illustrated by, e.g., a comparison of rows (6) and (8) in Table 1a. With $\alpha = 0.85$, $\beta = 1.1$, $\mu_B = 0.5$ and $\mu_\pi = 1.5$, the discretionary regime will always be preferred by the government. But with instead $\alpha = 0.75$, $\beta = 1.4$, $\mu_B = 1.5$ and $\mu_\pi = 0.5$, the government will experience a higher welfare in the commitment than in the discretionary case.

In our example, it also turns out in most cases that the higher the discount factor θ, the more favourable does commitment appear to the government. However, this result cannot be generalised. For instance, rows 1 and 6 in both Table 1a and 1b indicate exceptions.

6. Conclusions

The theory of second best suggests that policy makers may have a difficult time in economies with many distortions. A strategy of piecemeal policy reforms may not always be desirable. Remedying one distortion may aggravate others and produce a net welfare loss. The same logic applies to time inconsistency problems.

We have analysed how different exchange rate regimes affect the incentives for a government in a small open economy to run deficits. The main findings are as follows. In a discretionary policy regime, the government faces credibility problems both with respect to fiscal and exchange rate (monetary) policy. The outcome is an inflation-devaluation cycle accompanied by persistent deficits. A commitment to an irrevocably fixed exchange rate vis-à-vis a currency bloc with low inflation, such as may be implied by membership in a prospective European monetary union, will succeed in bringing inflation down. But the time-inconsistency problem for fiscal policy and hence the tendency towards deficits will be aggravated, because there are incentives to substitute discretionary fiscal policy for discretionary monetary policy in order to stimulate employment. The ranking of the two regimes in terms of the degree to which the government can achieve its policy aims will depend on the structural parameters of the economy, and on the weights assigned to inflation and deficits in the government's welfare function. In general the ranking is sensitive to small variations in parameter values, so no unambiguous conclusions can be drawn.

Our analysis can also be read as a positive theory of which countries are likely to opt for a common European currency in order to gain disinflationary credibility. One result is that inflation-prone governments are likely to see larger benefits, the more open is the economy. This is not because such economies are more vulnerable to exchange-rate volatility or experience larger transactions costs in connection with foreign trade, but because the perceived gains in terms of lower inflation are likely to outweigh the perceived losses from larger fiscal deficits.

Our discussion underlines how little we know about the effects of monetary-policy commitments. It is not obvious how our results should be interpreted. They might be taken to strengthen the argument that measures imposing greater exchange-rate discipline should be accompanied by reforms increasing also fiscal discipline, as was indeed envisaged in the Maastricht Treaty. However, to the extent that this is regarded as infeasible, our analysis might instead be considered to weaken the case for monetary union. One should emphasise though that our results have been derived within a very simple framework. It is easy to suggest a number of directions in which the analysis might be extended.

(i) The behaviour of consumers and firms have been modelled in the simplest way possible. A more elaborate analysis could introduce intertemporal links for these agents as well.

(ii) We have chosen simple ad-hoc representations of government and union preferences, which capture the basic notion that the natural rate of employment is lower than the employment desired by the government. It would be more satisfactory to derive these utility representations from individual preferences. Also, it would be worthwhile to explore how an assumption of co-ordinated wage bargaining would change the character of the game between the government and the private sector.[7]

(iii) The intertemporal government budget constraint could be modelled explicitly, which might give a better basis for discussing the costs imposed by current deficits. Our government loss function may exaggerate the tendency towards deficits in both the discretionary and the commitment regime, because it implies in effect a constant marginal disutility of deficits independent of the debt that has been accumulated.[8] An assumption of a marginal disutility of deficits that rises with the stock of debt does not change the conclusion that there will be more fiscal expansion and debt accumulation under

---

[7] Co-ordinated wage bargaining would both have implications for the natural rate of employment (see, e.g., Calmfors & Driffill, 1988; Calmfors, 1993a,b; and Driffill & van der Ploeg, 1993) and allow strategic interaction between the government and the private sector (see, e.g., Cubbit, 1988; Yashiv, 1991; and Agell & Ysander, 1993, who analyse the possibility of the union side acting as a Stackelberg leader exploiting the government's monetary-policy reaction function).

[8] This follows from the additive-separability-assumptions in the government disutility functions (17) and (19).

commitment than under discretion, but the fiscal deficits will diminish over time in both regimes.

(iv) The introduction of country-specific shocks that may be counteracted through exchange rate changes would in general make the discretionary regime appear more favourable. To the extent that such shocks can be offset through fiscal policy, they also weaken the case for committing also the fiscal instrument.

(v) Finally, one should stress that our results follow from a specific class of models. It is conceivable that other mechanisms than those modelled here could work in other directions. When future inflation taxes are ruled out, governments may face stronger incentives to control current deficits. Or alternatively, a government concerned also with the composition of output, employment and consumption, may be less inclined to accept deficits and domestic demand expansion that crowd out the tradable sector, if its competitiveness cannot be quickly restored through exchange rate devaluations. Models exploring such alternative mechanisms need certainly to be developed as well.

References

Agell, J. and B.-C. Ysander (1993), "Should Governments Learn to Live with Inflation: Comment", *American Economic Review*, **83**, 305-311.

Alesina, A. and A. Drazen (1991), "Why are Stabilizations Delayed ?", *American Economic Review*, **81**, 1170-1188.

Alesina, A. and G. Tabellini (1987), "Rules and Discretion with Noncoordinated Monetary and Fiscal Policies", *Economic Inquiry*, **25**, 619-630.

Alesina, A. and G. Tabellini (1990), "A Positive Theory of Fiscal Deficits and Government Debt", *Review of Economic Studies*, **57**, 403-414.

Barro, R. and D. Gordon (1983a), "A Positive Theory of Monetary Policy in a Natural Rate Model", *Journal of Political Economy*, **91**, 589-610.

Barro, R. and D. Gordon (1983b), "Rules, Discretion and Reputation in a Model of Monetary Policy", *Journal of Monetary Economics*, **12**, 101-121.

Buiter, W., Corsetti, G. and N. Roubini (1993), "Excessive Deficits: Sense and Nonsense in the Treaty of Maastricht", *Economic Policy*, 16, 57-100.

Calmfors, L. (1993a), "Lessons from the Macroeconomic Experience of Sweden", *European Journal of Political Economy*, **9**, 25-72.

Calmfors, L. (1993b), "Centralization of Wage Bargaining and Macroeconomic Performance - A Survey", Seminar Paper No. 536, Institute for International Economic Studies, Stockholm University. Forthcoming in *OECD Economic Studies*.

Calmfors, L. and J. Driffill (1988), "Bargaining Structure, Corporatism, and Macroeconomic Performance", *Economic Policy*, no. 6.

Cubitt, R. (1990), "Monetary Policy Games and Private Sector Precommitment", Discussion paper No. 47, School of Economic and Social Studies, University of East Anglia.

Cukierman, A. (1992), *Central Bank Strategy, Credibility and Independence*, MIT Press, Cambridge, Massachusetts.

Cukierman, A. and A. Meltzer (1989), "A Political Theory of Government Debt and Deficits in a Neo-Ricardian Framework, *American Economic Review*, 79, 713-731.

De Kock, G. and V. Grilli (1993), "Fiscal Policies and The Choice of Exchange Rate Regime", *Economic Journal*, **103**, 347-358.

Delors Report (1989), "Report on Economic and Monetary Union in the European Community", Committee for the Study of Economic and Monetary Union, April.

Driffill, J. and F. van der Ploeg (1993), "Monopoly Unions and the Liberalisation of International Trade", *Economic Journal*, **103**, 379-385.

Giavazzi, F. and A. Giovannini (1987), "The EMS and the Dollar", *Economic Policy*.

Giavazzi, F. and M. Pagano (1988), "The Advantage of Tying one's Hands: EMS Discipline and Central Bank Credibility", *European Economic Review*, **32**, 1055-1082.

Gylfason, T. and A. Lindbeck (1991), "The Interaction of Monetary Policy and Wages", Working Paper No.551, Centre for Economic Policy Research.

Horn, H. and T. Persson (1988), "Exchange Rate Policy, Wage Formation and Credibility", *European Economic Review*, **32**, 1621-1623.

Kydland, F. and E. Prescott (1977), "Rules Rather than Discretion: The Inconsistency of Optimal Plans", *Journal of Political Economy*, **85**, 473-492.

Masson, P. and M. Taylor (1933), "Fiscal Policy within Common Currency Areas", *Journal of Common Market Studies*, **31**, 29-44.

"One market, one money", *European Economy*, No. 44, (1990).

Oswald, A. (1986), "The Economic Theory of Trade Unions: An Introductory Survey", in Calmfors, L. and H. Horn (eds.) *Trade Unions, Wage Formation and Macroeconomic Stability*, MacMillan.

Persson, T. and L. Svensson (1989), "Why a Stubborn Conservative would run a Deficit: Policy with Time-Inconsistent Preferences", *Quarterly Journal of Economics*, 104, 325-346.

Persson, T. and G. Tabellini (1990), *Macroeconomic Policy, Credibility and Politics*, Harwood Academic Publishers, Chur, Switzerland.

Roubini, N. and J. Sachs (1989), "Political and Economic Determinants of Budget Deficits in Industrial Democracies", *European Economic Review*, *33*, 903-933.

Tabellini, G. (1991), "The Politics of Intergenerational Redistributions", *Journal of Political Economy*, 99, 335-357.

The Making of Monetary Union. Monitoring European Integration. CEPR Annual Report 1991.

Weber, A. (1991), "Reputation and Credibility in the European Monetary System", *Economic Policy*, No. 12, 57-102.

Yashiv, E. (1991), "Inflation, Wages and the Role of Money under Discretion and Rules: A New Interpretation ", Mimeo, Department of Economics, MIT.

Table 1: The present discounted value difference between the loss under commitment and the loss under discretion.

(a) 5 periods

α	β	μ_B	μ_π	θ 0.10	0.25	0.50	0.75	0.90
0.85	1.1	1	1	13.0	13.7	13.4	8.2	0.5
0.75	1.1	1	1	14.7	13.4	7.4	-6.2	-19.7
0.65	1.1	1	1	5.0	1.6	-8.2	-25.6	-41.3
0.55	1.1	1	1	-12.6	-17.4	-30.2	-53.4	-74.7
0.85	1.1	1.5	0.5	14.6	12.9	5.2	-12.3	-29.6
0.85	1.1	0.5	1.5	10.1	11.0	11.9	9.1	3.1
0.75	1.4	1	1	8.3	5.5	-3.4	-20.1	-35.2
0.75	1.4	1.5	0.5	-15.9	-24.3	-46.6	-85.8	-121.1

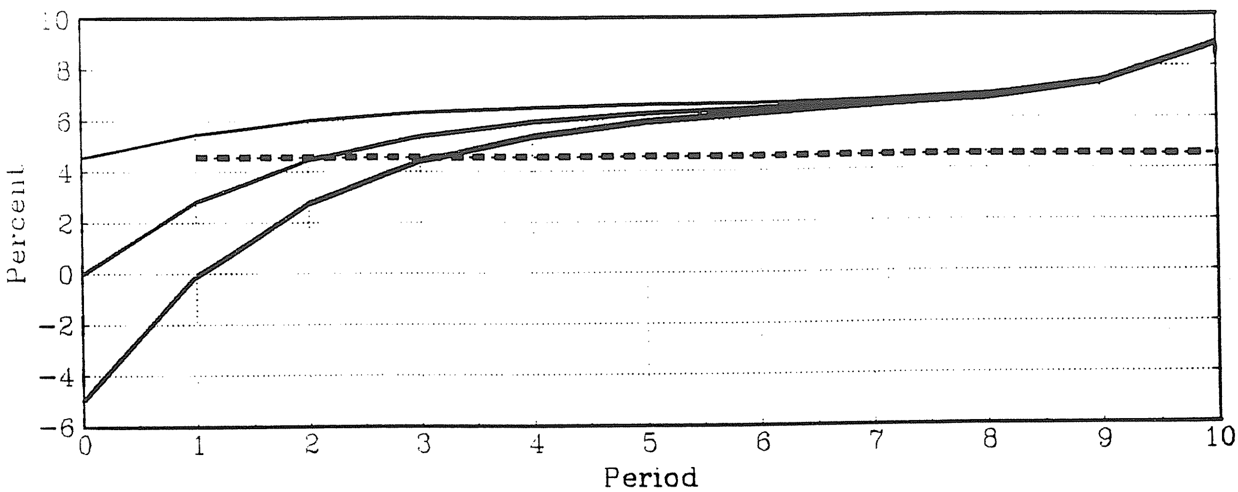
The present discounted value of the loss differential has been calculated as $\sum_{i=1}^{5}\theta^{i-1}(R_i^c - R_i^d)$. It is assumed that $\lambda = 15$, and that $B_0 = B^d$

(b) 10 periods

α	β	μ_B	μ_π	θ 0.10	0.25	0.50	0.75	0.90
0.85	1.1	1	1	13.0	13.7	12.2	-6.9	-52.4
0.75	1.1	1	1	14.7	13.3	6.0	-21.4	-66.8
0.65	1.1	1	1	5.0	1.5	-9.4	-38.8	-83.3
0.55	1.1	1	1	-12.6	-17.4	-31.6	-68.8	-125.7
0.85	1.1	1.5	0.5	14.6	12.8	3.2	-33.7	-95.1
0.85	1.1	0.5	1.5	10.1	11.0	11.1	-5.7	-59.3
0.75	1.4	1	1	8.3	5.4	-4.9	-34.8	-80.2
0.75	1.4	1.5	0.5	-15.9	-24.3	-49.1	-113.4	-209.9

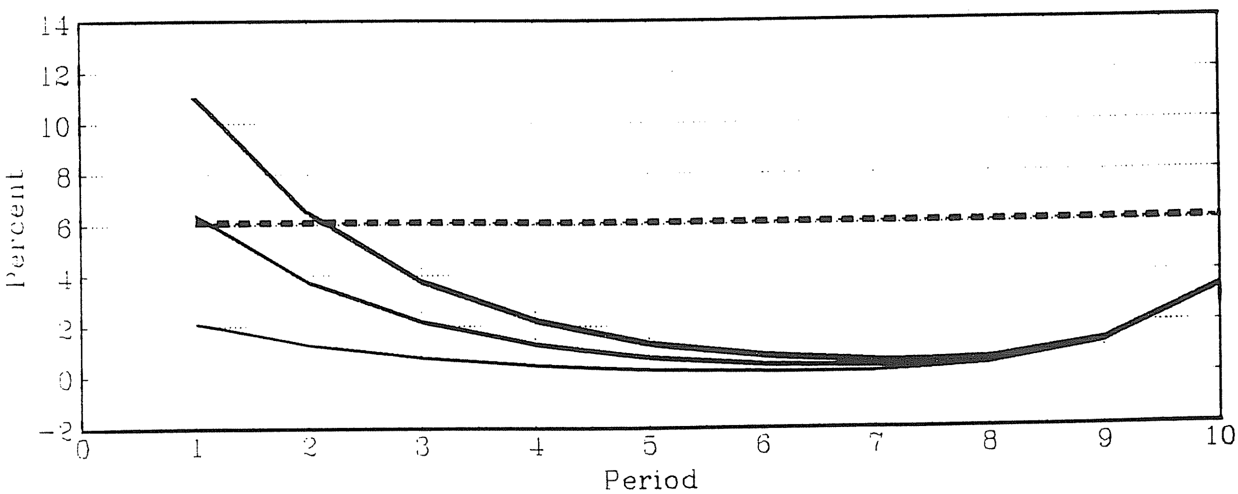
The present discount value of the loss differential has been calculated as $\sum_{i=1}^{10}\theta^{i-1}(R_i^c - R_i^d)$. It is assumed that $\lambda = 15$, and that $B_0 = B^d$.

Figure 1a: Government budget deficit (base case)



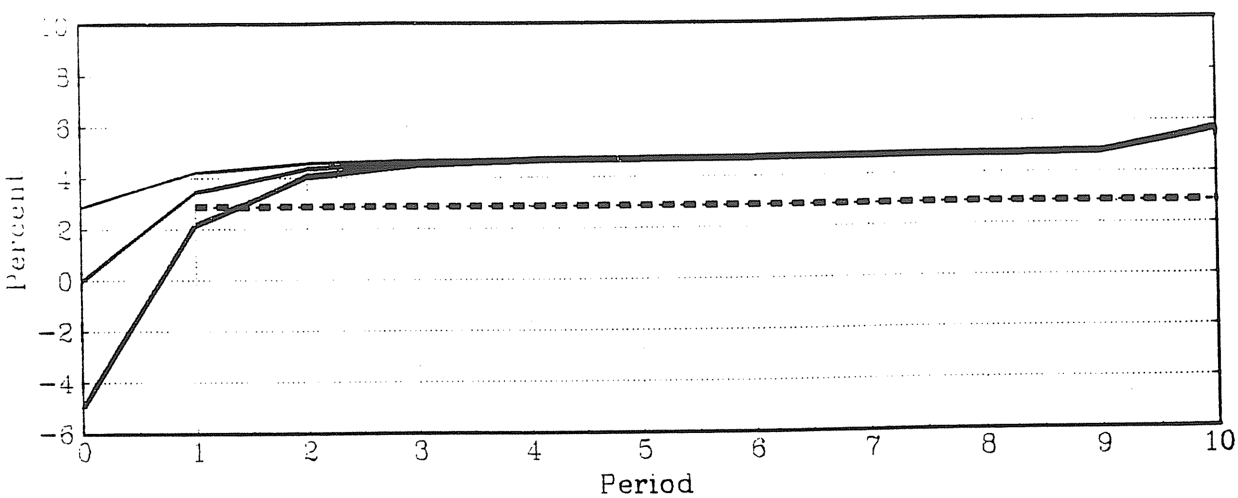
Parameter values: $K = 10$, $\theta = 0.9$, $\alpha = 0.75$, $\beta = 1.4$, $\mu_B = \mu_\pi = 1$ and $\lambda = 15$. The dashed line represents the discretionary case, the solid lines represent the outcomes under commitment with different initial deficits.

Figure 1b: Inflation (base case)



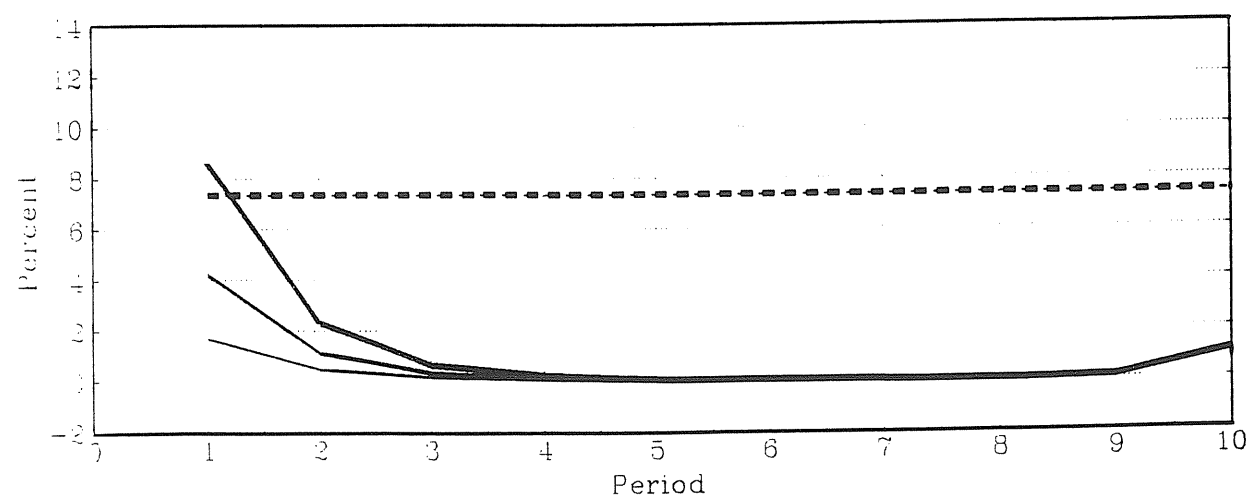
Parameter values are as in Figure 1a. The dashed line represents the discretionary case, the solid lines correspond to the various commitment cases depicted in Figure 1a.

Figure 2a: Government budget deficit (alternative case)



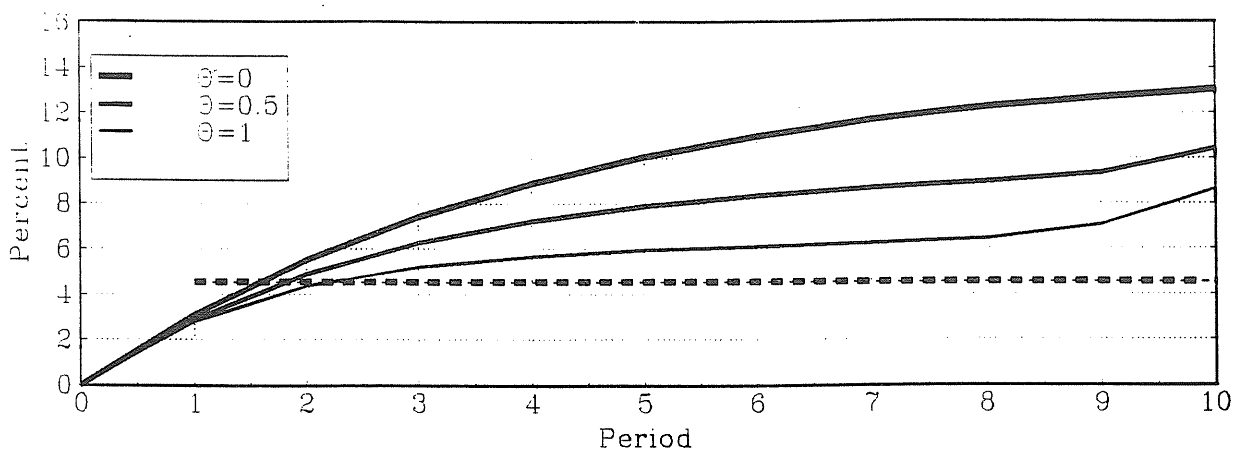
Parameter values: $K = 10$, $\theta = 0.9$, $\alpha = 0.65$, $\beta = 1.6$, $\mu_B = 1.25$, $\mu_\pi = 0.75$ and $\lambda = 15$. The dashed line represents the discretionary case, the solid lines represent the outcomes under commitment with different initial deficits.

Figure 2b: Inflation (alternative case)



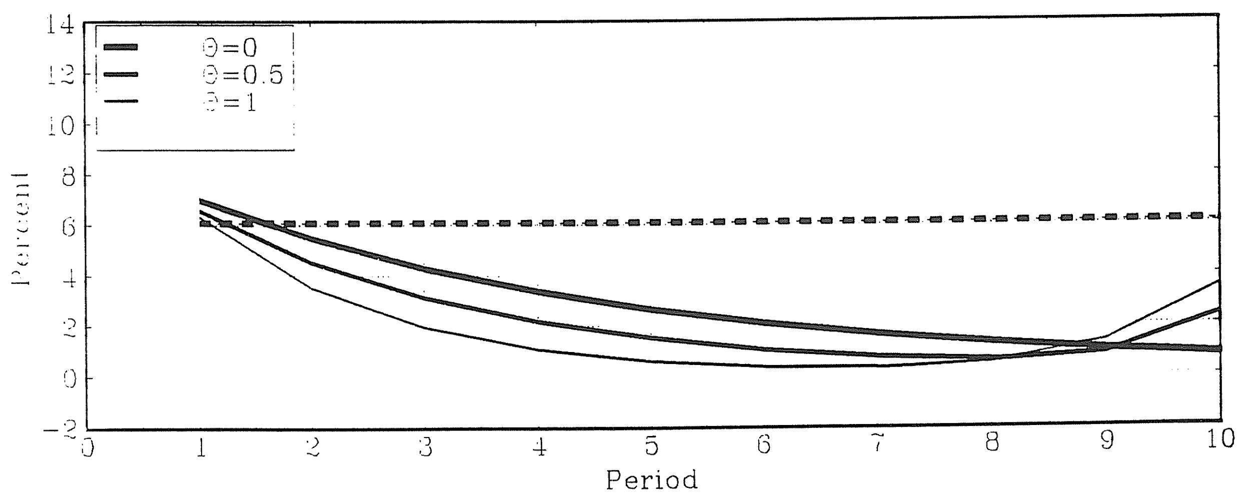
Parameter values are as in Figure 2a. The dashed line represents the discretionary case, the solid lines correspond to the various commitment cases depicted in Figure 2a.

Figure 3a: Government budget deficit with alternative discount factors



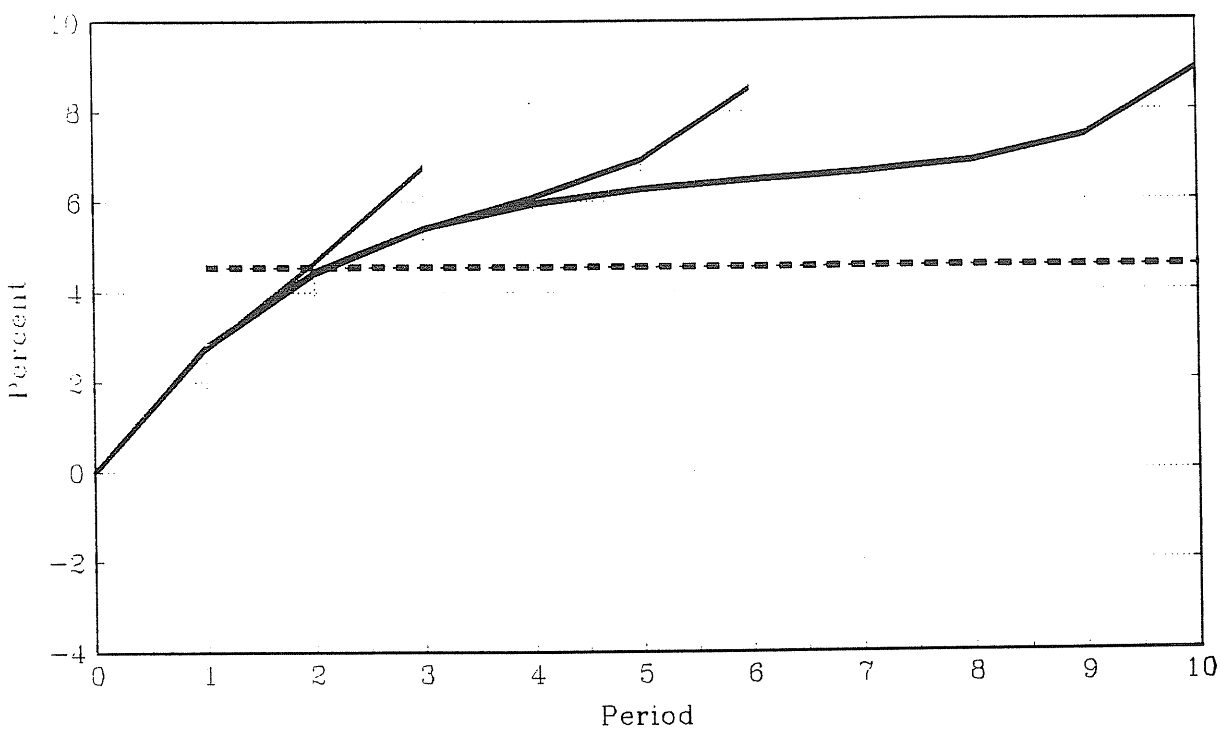
The dashed line represents the discretionary case, the solid lines represent the outcomes under commitment. Except for θ, the parameter values are as in Figure 1a.

Figure 3b: Inflation with alternative discount factors



The dashed line represents the discretionary case, the solid lines represent the outcomes under commitment. Except for θ, the parameter values are as in Figure 1a.

Figure 4: Government budget deficit with varying length of the game (base case)



The dashed line represents the discretionary case, the solid lines represent various commitment cases ($K = 3$, $K = 6$, $K = 10$). Otherwise the parameter values are as in Figure 1a.