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ABSTRACT

In recent years the conventional wisdom has held that fixed rates provide more fiscal discipline than do flexible rates. In this paper we show that this wisdom need not hold in a standard model in which fiscal policy is endogenously determined by a maximizing fiscal authority. The claim that fixed rates induce more discipline stresses that sustained adoption of lax fiscal policies must eventually lead to an exhaustion of reserves and thus to a politically costly collapse of the peg. Hence, under fixed rates bad behavior today leads to punishment tomorrow. Under flexible rates bad behavior has costs as well. The difference is in the intertemporal distribution of these costs: flexible rates allow the effects of unsound fiscal policies to manifest themselves immediately through movements in the exchange rate. Hence, bad behavior today leads to punishment today. If fiscal authorities are impatient, flexible rates - by forcing the costs to be paid up-front - provide more fiscal discipline and higher welfare for the representative private agent. The recent experience of Sub-Saharan countries supplies some preliminary evidence that matches the predictions of the model.

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1. Introduction

Should countries adopt fixed or flexible exchange rates? One way to tackle this age-old question is to consider which exchange rate regime provides more discipline –be it discipline against loose monetary policies, high fiscal spending, or excessive wage demands. The recent conventional wisdom within the economics profession holds that fixed rates provide more discipline.[1] In this paper we concentrate on the issue of fiscal discipline, and show that the conventional wisdom need not hold in a standard intertemporal optimizing model in which fiscal policy is endogenously determined by a maximizing fiscal authority. On the contrary, we show that under flexible rates there are mechanisms which can provide more fiscal discipline and higher welfare for the representative agent.

There has been little work comparing the properties of exchange rate regimes since the classic paper by Helpman (1981). Moreover, while there is a great deal of informal discussion on the connection between exchange rate regimes and fiscal discipline, we are aware of no formal analysis of this link. In this paper we attempt to fill this gap by studying a simple dynamic general equilibrium model within which the disciplinary properties of exchange rate regimes can be systematically compared. We are able to obtain closed form solutions for the equilibrium of this model under both fixed and flexible exchange rates. As a result, we are also able to carry out unambiguous positive and welfare comparisons of the two exchange rate regimes.

According to the conventional wisdom, fixed rates induce more fiscal discipline because adopting lax fiscal policies must eventually lead to an exhaustion of reserves and an end to the peg. Presumably, the eventual collapse of the fixed exchange rate would imply a big political cost for the policymaker –that is to say, bad behavior today would lead to a punishment tomorrow. Fear of suffering this punishment leads the policymaker to be disciplined. If the deterrent is strong enough, then unsustainable fiscal policies do not occur in equilibrium.

There are empirical and theoretical problems with this kind of argument. Empirically, it is far from clear the evidence supports it. The mixed European experience of fiscal convergence under the EMS is one possible source of skepticism.[2] Even more striking is the experience of Sub-Saharan Africa in the early eighties, where countries with flexible rates implemented fiscal adjustment, while the French Franc zone countries –operating under fixed exchange rates– failed to do so.

Theoretically, it is unclear why it is politically costly to devalue under fixed rates, and it is presumably less so to have a depreciation under a floating rates regime. In any well specified model the costs to authorities of following given unsound policies should be stable functions of observable variables such as the rate of inflation, devaluation or unemployment, independently of the exchange rate regime. Moreover, the political costs of abandoning a peg are seldom identified and are notoriously difficult

[1] See Frenkel, Goldstein and Masson (1991) and Aghevli, Khan and Montiel (1991) for statements of this view. See also Giavazzi and Pagano (1988) for an analytical treatment.

[2] See, for instance, Buiter, Corsetti and Roubini (1993) and Svensson (1993) .

to quantify. After witnessing the recent collapse of the EMS and the popularity of reflationary measures adopted by devaluing countries, it is reasonable to be skeptical about the magnitude of the alleged political costs of abandoning a peg over and above the costs of inflation or unemployment.

Our argument is based on the observation that under flexible rates imprudent fiscal behavior has costs as well. The difference with fixed rates is in the intertemporal distribution of these costs. Under fixed rates unsound policies manifest themselves in falling reserves or exploding debts. Only when the situation becomes unsustainable do the costs begin to bite. Flexible rates, by contrast, allow the effects of unsound fiscal policies to manifest themselves immediately through movements in the exchange rate and the price level. The basic point of the paper is that if inflation is costly for the fiscal authorities, then flexible rates –by forcing the costs to be paid up-front– can provide more fiscal discipline.[3]

We formalize this idea in a standard dynamic general equilibrium model with optimizing agents, perfect foresight, price flexibility and perfect capital mobility. It is well known that in this benchmark setup, and for a given path of government spending and taxes, the choice between fixed and flexible exchange rates is immaterial. We depart from the benchmark case by endogenizing government spending in an environment in which there exist three distortions. First, the Fiscal Authority (FA) has the proclivity to spend more than is socially desirable because net transfers to individuals generate utility (political power, prestige, etc.) for those who control fiscal policy. Second, the FA discounts events after a certain point in time at a higher rate, as a result (for instance) of fixed terms of office and uncertainty about reappointment. Third, the Central Bank (CB) can precommit not to accommodate the wishes of the FA (by providing money financing for deficits) only for a finite period of time, not forever.

We introduce this last assumption for two reasons, one empirical and one theoretical. The empirical reason is that most monetary policy regimes –and especially fixed exchange rate experiments– are of limited duration.[4] As Calvo (1986, 1991) stresses, most attempted pegs face credibility problems, and are commonly regarded as temporary by investors and the public. The theoretical reason is that in a deterministic model such as the one we consider below, if the CB can precommit to a particular monetary policy rule for the entire future, the present value of monetary revenues is given, regardless of the exchange rate regime. This in turn fixes the present value

[3]There is also a related argument made by Johnson (1969). Under flexible rates adjustment takes place through exchange rate movements, which are widely observable; under fixed rates, it takes place through reserves losses, which are difficult to monitor because of central bank secrecy, forward operations and borrowing. Therefore, a system of fixed rates sends a weaker signal to the public on the need to avoid bad policies than does a system of flexible rates. Dornbusch and Giovannini (1990) and Hausmann (1990) also present related arguments. Earlier and classic works comparing fixed and flexible exchange rates are Nurkse (1944) and Friedman (1953). Views prevalent in the late sixties are compiled in the Burgenstock Papers edited by Halm (1970).

[4]Klein and Marion (1994) study a sample of 61 pegged exchange rate episodes in Latin America since the 1950s, and find that they have a mean duration of 32 months, a median of 10 and a standard deviation of 49.

of fiscal deficits, and leaves no room for the FA to make any interesting decision. In other words, if we just introduced the first two distortions –proclivity to spend and impatience of fiscal authorities, the equivalence of fixed and flexible exchange rates, found by Helpman (1981), would persist.

We analyze two alternative exchange rate arrangements. In one the CB fixes the rate of change of the nominal exchange rate for a finite period of time, and nominal money becomes endogenous. We label this the case of Predetermined Exchange Rates (PERS).[5] In the other, the CB fixes the growth rate of nominal money and the exchange rate is endogenous. This is the case of Flexible Exchange Rates (FERS). Confronted with each monetary regime, the FA chooses its preferred level of the primary fiscal deficit subject to the standard solvency constraints. In the model we study government spending in excess of revenue must be covered through seignorage, the inflation tax or borrowing.[6] The fiscal authority dislikes inflation, and therefore trades off the utility from higher spending against the associated inflation costs.[7] We address three issues. Under which regime will the FA set the level of spending (and the deficit) at a lower level? Under which regime will fiscal policy be more responsive to exogenous shocks? Under which regime will private agents attain higher welfare?

With fully flexible prices and purchasing power parity, the rates of inflation and devaluation are the same regardless of the exchange rate regime.[8] Under predetermined rates, therefore, the rate of inflation is exogenously determined as long as the peg is in place regardless of what the FA does with the level of spending. If there is a deficit (after including the revenue from money creation), the shortfall is made up by borrowing. This in turn means that inflation will have to rise (relative to what it was to start with) in the future in order to service the additional debt. Thus, by not reducing spending today the FA pays no cost in the short run, while inflation is low, but simply incurs the cost of high inflation in the future.

Consider now the case where the CB fixes the rate of nominal money growth. If the FA does not eliminate the fiscal deficit, private agents will anticipate higher money growth in the future, for the same monetarist arithmetic reasons stressed by Sargent and Wallace (1981) and developed further by Drazen (1985). As a result, in the short-run inflation will be higher than it would have been under predetermined rates. Hence, under FERS the cost of high spending is spread over time: high inflation tomorrow (though lower than under predetermined rates), but also inflation today.

Focus next on the option faced by a FA that understands the trade-offs just out-

[5]We use the formal label "predetermined" rather than "fixed" to allow for the possibility that the rate of nominal devaluation established by the Central Bank may not be zero. More informally, however, the terms "fixed", "pegged" and "predetermined", when applied to exchange rates, are used interchangeably throughout the paper.

[6]Or drawing down international reserves, which is the same as borrowing.

[7]The costs of higher spending derive from the fact that private agents' utility is a function of consumption and real money balances, and individual welfare is assumed to have some weight in the FA's objective function. Since higher anticipated inflation reduces the demand for real balances, it reduces private agents' welfare, and is therefore costly to the government.

[8]If non-traded goods are present, so that CPI inflation and devaluation are no longer the same, all theoretical arguments in the paper still go through, but quantitative effects may be altered.

lined. Will it have more incentives to set a lower level of spending under predetermined exchange rates or under flexible rates? Our first result is that if the FA is impatient in the sense described above, then spending and the deficit are lower under flexible rates.

The intuition is as follows. An exchange rate regime can be thought of as a mechanism to allocate intertemporally the burden of the inflation tax. Under fixed rates the bulk of the tax burden is pushed into to the future, when the peg is abandoned. In contrast, with flexible rates the inflation tax burden is spread across time. A FA that dislikes inflation and knows it might not be in office in the future would prefer to shift as much as possible of the inflation tax burden until after its term of office is over. Fixed rates come closer to implementing this intertemporal allocation than do flexible rates. This implies that the marginal cost of spending is higher under flexible rates, and therefore equilibrium spending is lower.

A similar intuition underlies our second result: fiscal policy is more responsive to shocks to exogenous government income (think of changes in the terms of trade for government-owned natural resources) under flexible exchange rates. When confronted with an adverse shock, a FA operating under PERS can postpone the necessary adjustment and still enjoy low inflation in the short run. By contrast, under FERS part of the costs of non-adjustment are inevitably paid immediately. As result, in equilibrium there is more adjustment under FERS.

Clearly, such results depend on the existence of an intertemporal choice for the policymaker. In situations in which a government has no access to capital markets and/or has insufficient reserves, money-financed deficits will inevitably cause an immediate depreciation, regardless of the exchange rate regime in force (under fixing, the depreciation will occur because of a balance of payments crisis). In those cases, the channels for inducing discipline stressed by the model operate in the same way under both regimes, and differences in their disciplinary properties vanish.

What are the implications for the welfare of the representative private agent? Our third result is that the regime that provides more fiscal discipline also provides higher individual welfare. In the model we consider government spending does not enter the individual's utility function. But since such spending must be financed (at the margin) with distortionary inflation taxes, individual welfare is indirectly a decreasing function of the level of government spending. Thus, any statement about spending can be readily translated into statements about welfare. In particular, if spending is lower under flexing than under fixing, individual welfare is higher under flexing.

We compare the predictions of the model to the recent fiscal performance of Sub-Saharan countries. French Franc (CFA) zone countries maintained a fixed exchange rate from 1948 until 1994, while the other countries did not. Because of the exogeneity of exchange rate arrangements (the CFA zone is a product of the colonial past), these countries provide an excellent case to study the fiscal performance of both exchange rate regimes.

In the late 1970s sub-Saharan Africa experienced a sharp decline in its terms of trade, and the response of government spending was starkly different across both sets of countries. Between 1980 and 1984, countries with variable exchange rates on average reduced government spending by 2.3 percentage points of GDP, while French Franc zone countries increased it by 2.5 percentage points! Similarly disparate behavior is also present in other relevant fiscal indicators.[9] Using cross-country data we regress measures of fiscal adjustment on changes in the terms of trade, initial debt, GDP per capita and on a dummy for the exchange rate regime. The coefficients on the dummy always have the right sign and are significant for three different specifications of fiscal adjustment. Hence, the data seem broadly compatible with the predictions of our model.

Some caveats are in order. We do not deal with other aspects of the trade-off between predetermined and flexible rates, such as the need to prevent futile attempts to engineer surprise inflation, or the need to impose discipline on wage-setting. With respect to monetary policy, it has been argued that fixing the exchange rate enhances the credibility of non-inflationary monetary policy, helping overcome the time inconsistency problem stressed by Barro-Gordon (1983). For similar reasons, fixed rates can allegedly introduce more discipline in the wage-setting behavior. These issues, which have been emphasized in the European context, are neglected here. Since we focus on the issue of fiscal discipline and the role of monetary policy as a source of fiscal revenue, our arguments are most relevant for countries –in Latin America, Africa, or Eastern Europe– where seigniorage and inflation tax revenues play an important role in government finances. Nor have we dealt with the many difficulties that flexible rates have demonstrated in practice, as catalogued by Obstfeld (1985). Two that have received recent attention are excess volatility and the possibility that under floating exchange rates may be guided by factors other than fundamentals.

The plan of the paper is as follows. In Section 2 we present the underlying economy and endogenize fiscal policy under alternative exchange rate regimes. Section 3 contains the main positive and normative results that arise from the comparison of fiscal performance under predetermined and flexible exchange rates. Section 4 studies the evidence from sub-Saharan Africa, and section 5 concludes.

2. The Model

We start out by setting up a standard optimizing model of a small open economy with price flexibility and perfect capital mobility, and solving the problem of the representative individual for a given set of fiscal and monetary policies. What follows should persuade readers that none of our later results depend on a non-standard specification of the underlying economy. Any reader familiar with this type of model can skip this subsection and the next.

The economy we consider is populated by a private sector and a government. We begin with a description of the private sector. There is a single good, which is the numeraire. Assuming purchasing power parity and letting the foreign price

[9] See Devarajan and de Melo (1990), Nashashibi and Bazzoni (1993) and World Bank (1994).

level be constant and equal to one implies that the nominal exchange rate is equal to the domestic price level: $E_t = P_t$. The private agent can store her wealth in two assets: domestic money, whose real value can be written as $m_t \equiv \frac{M_t}{E_t}$, and an internationally-traded bond, whose real value is denoted by f_t and which yields the constant world real interest rate r. The private agent receives each instant a constant flow of labor income y and interest income rf_t, consumes an amount c_t, and gets from the government a net transfer g_t (which equals gross transfers minus taxes, so that it can be positive or negative). It follows that the representative agent's flow budget constraint is $\frac{\dot{M}_t}{E_t} + \dot{f}_t = rf_t + y + g_t - c_t$. Letting $\pi_t = \dot{P}_t/P_t = \dot{E}_t/E_t$, we have that $\frac{\dot{M}_t}{E_t} = \dot{m}_t + \pi_t m_t$, which shows that the real value of monetary balances purchased by the agent is the sum of two components: the desired change in real balances outstanding $\dot{m}_t$ and an additional purchase $\pi_t m_t$ necessary to offset the effects of inflation. With this the private agent's flow budget constraint becomes

$$\dot{m}_t + \dot{f}_t = rf_t + y + g_t - c_t - \pi_t m_t \tag{2.1}$$

The agent is also bound by the standard solvency condition

$$\lim_{t\to\infty} (m_t + f_t)\, e^{-rt} \geq 0 \tag{2.2}$$

We now describe the accounts of the government sector, which is composed of a Fiscal Authority (FA) and a Central Bank (CB). Let b_t be the net stock of bonds owned by the consolidated government. Each period the government receives an exogenous income flow z and interest income rb_t, and makes a transfer (net of taxes) g_t to the private sector. It also receives monetary revenue $\frac{\dot{M}_t}{E_t} = \dot{m}_t + \pi_t m_t$, which is nothing but the counterpart of the real value of money purchased by the agent. Any resulting deficit is covered by running down assets. It follows that the government's flow budget constraint is

$$\dot{b}_t - \dot{m}_t = rb_t + z - g_t + \pi_t m_t \tag{2.3}$$

The relevant solvency condition for the government is

$$\lim_{t\to\infty} (b_t - m_t)\, e^{-rt} \geq 0 \tag{2.4}$$

Consolidating (2.1) and (2.3) we obtain

$$\dot{b}_t + \dot{f}_t = r\,(b_t + f_t) + y + z - c_t \tag{2.5}$$

which represents the current account balance.

2.1. The Private Agent's Problem

The objective function of the representative private agent is

$$\int_s^{\infty}\left[v(c_t)+\left(\frac{\epsilon}{\epsilon-1}\right)m_t^{\frac{\epsilon-1}{\epsilon}}\right]e^{-r(t-s)}dt,\quad \epsilon\in(0,1) \tag{2.6}$$

where $v(.)$ has the standard properties, and the discount rate is assumed equal to the world interest rate. In (2.6) we have imposed a specific functional form for the instantaneous utility from holding money balances in order to obtain closed-form solutions. We also assume $\epsilon \in (0,1)$ to ensure that inflation tax revenue is increasing in the inflation rate, so that the economy is always on the sensible side of the relevant Laffer curve.

The private agent solves the following problem:

- **Problem I** *During each instant t choose sequences for consumption and real money balances $\{c_s\}_t^{\infty}$ and $\{m_s\}_t^{\infty}$ to maximize (2.6), subject to budget constraint (2.1), to solvency condition (2.2), and to the sequences $\{g_s\}_t^{\infty}$ and $\{\pi_s\}_t^{\infty}$,*

The private agent behaves competitively, in that she takes the sequences $\{g_t\}$ and $\{\pi_t\}$ as given. Therefore, her problem can be solved for any such sequences, without specifying the exchange rate regime. We show in Appendix A that, if the government solvency constraint (2.4) holds with equality, so that the government transfers all of its resources to the private sector over the infinite horizon[10], the solution to Problem I can be written as:

$$c_t = \overline{c} = r(f_0 + b_0) + y + z \tag{2.7}$$

$$m_t = i_t^{-\epsilon}, \qquad i_t \equiv r + \pi_t \tag{2.8}$$

Consumption is constant in (2.7) because the subjective discount rare is equal to the fixed world interest rate. The only consumption level consistent with both optimality and solvency is one in which the private agent simply consumes her initial permanent income net of government taxes and transfers. Since the government consumes nothing, initial permanent income equals interest income on initial net national wealth $r(f_0 + b_0)$ plus labor income y plus government income z.

Finally, (2.8) indicates that demand for real balances is a decreasing function of the nominal interest rate, with the demand function displaying a constant elasticity ϵ. The functional form in (2.8) will be useful in the algebraic derivations that follow, because it implies that inflation tax revenue $\pi_t m_t$ can be expressed as $\pi_t[r+\pi_t]^{-\epsilon} = m_t^{\frac{\epsilon-1}{\epsilon}} - rm_t$. Note that since $\epsilon \in (0,1)$, such revenue is always increasing in the rate of inflation.

[10]Such behavior by the government will always obtain in equilibrium, as we shall see below.

2.2. Monetary and Fiscal Arrangements

Up to now the specification of the model is standard. Indeed, it is very close to that considered by Helpman (1981), who showed that, for a given fiscal policy and in the absence of distortions, the choice of exchange rate regime is essentially immaterial. We now depart from the standard treatment by endogenizing fiscal policy. In order to carry out an interesting comparison of the effect of fixed and flexible exchange rates on fiscal policies, we introduce three political and institutional distortions. First, the FA has preferences biased toward high fiscal spending. Second, the FA is impatient in a particular sense : it is not sure it will remain in office after its current term of length T is over. Thus, it discounts events after T at a higher rate than it does events that will occur within $[0, T)$. Third, the CB cannot precommit to an independent monetary policy forever. We will show below that if any one of these three distortions is eliminated, fixed and flexible exchange rates induce the same fiscal outcomes.

We postulate an objective function for the FA that incorporates the first two distortions:

$$\begin{aligned} U^{FA} &= \int_0^T U(g_t, m_t, c_t)e^{-rt}dt + e^{-\delta T}\int_T^{\infty} U(g_t, m_t, c_t)e^{-rt}dt \\ U(g_t, m_t, c_t) &\equiv \alpha u(g_t) + (1-\alpha)\left[v(c_t) + \left(\tfrac{\epsilon}{\epsilon-1}\right) m_t^{\frac{\epsilon-1}{\epsilon}}\right] \end{aligned} \tag{2.9}$$

where $u(g)$ has the usual properties, $\delta \geq 0$, and $\alpha \in (0,1)$.

Notice first that the instantaneous utility function is such that the FA internalizes the objective of the private agent (see (2.6)), and gives weight $(1-\alpha)$ to this objective; but it also derives utility –political power, prestige, etc.– from making gross transfers or setting low taxes[11], and it gives weight α to this objective. Notice that since money holdings by the individual were shown in (2.8) to be a decreasing function of the anticipated rate of inflation, according to (2.9) the FA likes fiscal transfers and dislikes anticipated inflation.

Second, the factor $e^{-\delta T}$ in (2.9) is meant to capture the fact that governments typically discount events in the distant future differently than does the public. In particular, $e^{-\delta T} \in (0,1]$ can be interpreted as the probability that the FA is in office after time T, in which case it gets utility $\int_T^{\infty} U(g_t, m_t, c_t)e^{-r(t-T)}dt$ starting at that point; if it is out of office, its utility is simply normalized to zero. The result is that, viewed from time $t = 0$ the FA gives less weight to what will happen after time T because the current authorities may not be around after T to enjoy the benefits of spending or pay the costs of higher inflation. Notice also that if $\delta = 0$ we are back in the standard infinite horizon model.

We now turn to the third distortion. We assume that the CB can precommit to an independent monetary policy that disregards the actions of the FA only for a finite period of time. After this period, monetary policy has to be adjusted to insure

[11] Recall that g stands for net transfers: gross transfers minus taxes.

that the inflation tax is sufficient to satisfy government's solvency. This imperfect CB ability to precommit captures the fact that central banks seldom have unlimited and everlasting independence. It is analogous to Calvo's (1986, 1991) and Drazen and Helpman's (1987) concept of "temporary" or "imperfectly credible" policies.

There is another important reason for making this assumption. Through simple manipulation of the government budget constraint it is straightforward to show that if the CB were able to commit its monetary policy forever, the present value of monetary revenues would be given regardless of the exchange rate regime. Hence, the FA would be limited to choosing only the time path for fiscal transfers, and not the present value of such transfers over the entire horizon. Hence the assumption that the CB cannot commit to an independent monetary policy forever is necessary for an interesting comparison of the fiscal discipline provided by fixed and flexible exchange rates.

In this spirit, we define predetermined and flexible exchange rates as follows:

Definition 2.1. *A Predetermined Exchange Rate Regime (PER) is one where the CB determines the rate of devaluation $\pi_t \equiv \frac{\dot{E}_t}{E_t}$ and the quantity of money is endogenous. A Flexible Exchange Rate Regime (FER) is one where the CB determines the growth rate of nominal money $\mu_t \equiv \frac{\dot{M}}{M}$ and the nominal exchange rate is endogenous.*

Using this definition we have that under PERS the CB fixes the rate of devaluation exogenously during the time interval $[0,T)$, and after time T it adjusts the rate of devaluation to insure government solvency. That is, under PERS the CB uses the following rule

$$\pi_t = 0, \; t \in [0,T); \qquad \pi_s = \pi(b_t, \{g_k\}_{k=t}^{\infty}), \;\; s \geq t \geq T \tag{2.10}$$

Since under FERS the CB sets the rate of nominal money growth, its rule is

$$\mu_t = 0, \; t \in [0,T); \qquad \mu_s = \mu(b_t, \{g_k\}_{k=t}^{\infty}), \;\; s \geq t \geq T \tag{2.11}$$

where, under PERS, $\pi(b_t, \{g_s\}_t^{\infty})$ is the constant inflation level that satisfies with equality solvency condition (2.4) for an initial level of net government assets b_t and an announced sequence of government net transfers $\{g_s\}_t^{\infty}$. An analogous interpretation applies to $\mu(b_t, \{g_s\}_t^{\infty})$ under FERS. Equations (2.10) and (2.11) state that after T the CB, based on FA announcements about the future course of fiscal policy, announces and implements a sequence of constant π (or μ) that will raise enough revenue to balance the government's books over the remaining infinite horizon.[12] Notice that for simplicity we have let the period of CB precommitment coincide with the period the

[12]The assumption that after T the CB announces a constant π (or μ) is in no way restrictive. After T the CB simply accomodates the behavior of the FA. Thus, while the CB is bound to announce a constant sequence going forward from each instant $t \geq T$, the announced sequence can change if the FA deviates from its previous announcements. In equilibrium this will not happen, and the CB will both announce and implement a constant rate of devaluation (or nominal money growth) over the infinite horizon.

FA is in office, so that one can think of T as the duration of the fiscal and monetary regime.

The temporary CB autonomy can be though of in the following way. Imagine that unusual political circumstances (or the presence of an outside enforcer such as the IMF) enables the CB exogenously to determine a path for money or the exchange rate. But these special circumstances do not last forever. Eventually, the monetary program will have to be "flexibilized" in response to the course of fiscal policy, as it often happens with real-life experiences.

2.3. Timing and Solution Concept

Next we describe the timing of events. At time 0 the monetary experiment defined in (2.10) or (2.11) is announced. Thereafter, the timing of moves within each instant of time is as follows. The FA moves first, setting g_t and announcing the sequence $\{g_s\}_t^\infty$. Then moves the CB, announcing the sequence $\{\pi_s\}_t^\infty$ under PERS or $\{\mu_s\}_t^\infty$ under FERS, contingent on the announcement made by the FA. Finally, the private agent chooses $\{c_s, m_s\}_t^\infty$. She sets m_t on the basis of the realized g_t and π_t under PERS (or μ_t under FERS) and the announced sequences for future monetary and fiscal policy. We impose this timing in order to abstract from issues related to the time consistency of monetary policies, which have received a great deal of attention since the work by Calvo (1978).[13]

When computing the equilibrium we assume that the CB takes as given the evolution of future fiscal transfers, and private agents take as given the evolution of future government policies. In contrast, the FA recognizes the effects of its policies on the decisions of private agents and the CB. For all $t > 0$ the equilibrium sequences $\{c_s, m_s, g_s, \pi_s\ \mu_s\}_t^\infty$ satisfy the following conditions: (i) at each $t, \{g_s\}_t^\infty$ maximizes the FA's payoff subject to its budget and solvency constraints, and to the responses of the CB and private agents $\{c_s, m_s, \pi_s \text{ (or } \mu_s)\}_t^\infty$; (ii) at each t, $\{\pi_s, \text{ (or } \mu_s)\}_t^\infty$ satisfy monetary policy rule (2.10) followed by the CB under PERS (or rule (2.11) under FERS), taking $\{g_s\}_t^\infty$ as given; (iii) at each t, $\{c_s, m_s\}_t^\infty$ maximize the private agent's utility subject to her budget constraint and solvency condition, taking as given the announced sequences $\{g_s, \pi_s \text{ (or } \mu_s)\}_t^\infty$. It follows that the equilibrium is sustainable in the sense of Chari and Kehoe (1990). Notice also that, given the assumed timing of moves, this equilibrium is time consistent: plans are self-enforcing and announced polices are implemented when the time comes to do so.[14]

[13] It follows from Calvo's (1978) analysis that a government with preferences such as those contained in (2.9) (in which only unanticipated inflation is costly) would set the rate of inflation equal to infinity whenever it controls monetary policy (as our FA effectively does after time T). The simplest way to avoid this very unrealistic result is to let the FA move before the individual at each instant of time. This arrangement endows the FA with the sort of "instantaneous" precomittment ability proposed by Cohen and Michel (1988): the government can make announcements and precommit to them for an instant of time.

[14] Given the timing of moves and the behavior of the government, this equilibrium corresponds to the Stackelberg closed-loop equilibrium concept in Basar and Olsder (1982).

2.4. A Digression on Initial Conditions

In this subsection we ensure the FA faces the same budget constraint under both exchange rate regimes. Flow constraints (2.1) for the individual and (2.3) for the government do not incorporate possible "jumps" in m_t, which can occur either because of discrete changes in M_t or because of jumps in the exchange rate E_t. There is one type of jump in m_t that could possibly introduce an asymmetry between the two regimes: changes in m_0 caused by unanticipated jumps in E_0 under FERS.

The private agent enters time 0 with a stock of international bond f_0 and of real balances m_0, and the government with a stock of net assets b_0. Then the FA and the CB announce their policy sequences as discussed above. Given these announcements the private agent rearranges her portfolio from (m_0, f_0) to (m_{0+}, f_{0+}).

Consider first the case of PERS. The private agent rearranges her portfolio by buying or selling domestic money from the CB. Since the nominal exchange rate E_0 is given by history and cannot jump under PERS, $E_0 = E_{0+}$. It follows that portfolio rebalancing is accomplished through the following asset swap:

$$\frac{M_{0+} - M_0}{E_0} = m_{0+} - m_0 = b_{0+} - b_0 \tag{2.12}$$

Thus, we have that $b_0 - m_0 = b_{0+} - m_{0+}$. Therefore, at $t = 0$ there is no transfer of wealth between the private agent and the government as a result of the surprise announcement.

That is not the case under FERS, for the CB does not intervene in the foreign exchange market. Thus, the market can only clear as a result of an exchange rate movement at time zero. Therefore, it must be the case that

$$m_{0+} = m_0(1 - \Delta E_0) \tag{2.13}$$

where $\Delta E_0 \equiv \frac{E_{0+} - E_0}{E_0}$ measures the jump taken by the exchange rate at $t = 0$. Hence, in this case private agents experience a capital gain (loss) of magnitude $\Delta E_0 m_0$ that has a counterpart in an equal loss (gain) for the government. Such an effect on the government budget constraint was absent under PERS. This gives the FA operating under FERS extra degrees of freedom in setting $\{g_s\}$, for it can rely on a capital levy to erode the real value of outstanding money balances. In order to carry out a consistent comparison of exchange rate regimes, it is necessary to offset this additional revenue-raising capacity of the government under FERS. Thus, we assume that, under FERS, at $t = 0$ the government gives a rebate to private agents equal to $\Delta E_0 m_0$ in the form of bonds. Private agents, acting atomistically, do not internalize the effect their demand for real balances has on the size of the rebate. Since m_{0+} is the equilibrium level of real domestic balances, agents do not attempt to exchange the bonds they receive for money.

Hence, the stock of bonds remaining in the hands of the government is $b_{0+} = b_0 - \Delta E_0 m_0$. After all transactions have taken place at time $t = 0$ government net assets are $b_{0+} - m_{0+} = b_0 - \Delta E_0 m_0 - (m_0(1 - \Delta E_0)) = b_0 - m_0$. Therefore, with the assumed rebate at $t = 0$, government net assets at time 0 (after announcements are made) are the same under FERS and PERS. In both cases, $b_{0+} - m_{0+} = b_0 - m_0$. This equality will play an important role in the derivation of (2.22), which determines the optimal level of fiscal transfers under FERS.

2.5. Equilibrium Under Predetermined Exchange Rates

Under PERS the private agent solves Problem I, the CB follows rule (2.10), and the FA solves the following problem:

- **Problem II.** *During each instant t choose a sequence of net transfers $\{g_s\}_t^\infty$ in order to maximize (2.9), subject to accumulation equation (2.3), solvency condition (2.4), the private agent's consumption function (2.7) and money demand function (2.8), and the monetary rule followed by the CB (2.10).*

An equilibrium under PERS is a sequence $\{g_s, m_s, \pi_s, c_s\}_t^\infty$ that solves Problem I and Problem II and satisfies monetary rule (2.10). In section 2.1 we obtained optimal sequences $\{m_s, c_s\}_t^\infty$ for exogenously given $\{g_s, \pi_s\}_t^\infty$. Here we will derive the optimal $\{g_s, \pi_s\}_t^\infty$.

Note that under PERS the FA, in addition to controlling g_t on $[0, \infty)$, also indirectly controls π_t on $[T, \infty)$, because the CB behaves in an accommodative manner after time T. Furthermore, given the private agent's demand for real balances (2.8), the FA also indirectly controls m_t on $[T, \infty)$. We show in Appendix B that the solution to the FA's problem involves the following path for transfers:

$$u'(g_t^P) = \begin{cases} \left(\frac{1-\alpha}{\alpha}\right)\left(\frac{\epsilon}{1-\epsilon}\right)e^{-\delta T} & t \in [0, T) \\ \left(\frac{1-\alpha}{\alpha}\right)\left(\frac{\epsilon}{1-\epsilon}\right) & t \in [T, \infty) \end{cases} \tag{2.14}$$

Since the FA's discount rate is equal to the world interest rate, government transfers are constant on $[0, T)$ and on $[T, \infty)$. We label these two levels g_0^P and g_T^P respectively. Transfers experience a discontinuity at T because of the "change" in the discount rate at that point. If $\delta > 0$, so that $e^{-\delta T} < 1$, it follows that g_0^P must be greater than g_T^P to ensure that the marginal utility of the "last dollar transferred" is the same regardless of when the transfer is made.

Note also that g_t^P is not a function of inflation nor of real money balances. This is because the marginal utility cost of lower money balances at any time t is equal to $(1-\alpha)\, m_t^{-1/\epsilon} e^{-rt}$, while the marginal benefit in terms of higher π and therefore higher monetary revenue is equal to (*constant*) $\times\, m_t^{-1/\epsilon} e^{-rt}$. Hence, the ratio of the two is independent of the actual level of real balances. This fact considerably simplifies the necessary computations.

To determine the equilibrium level of real balances on $[T, \infty)$ note that they must be constant since inflation is constant. Furthermore, the level they take must insure that the government is solvent. That is, the present value of the inflation tax must equal the difference between the government's net assets at T and the present value of expenditures minus exogenous revenues:

$$\frac{m_T^P \pi_T}{r} = \frac{g_T^P - z}{r} - b_T \tag{2.15}$$

From the government budget constraint (2.3) we have that the stock of government's net assets at time T is

$$b_T = b_0 e^{rT} - [g_0^P - z][e^{rT} - 1]r^{-1} \tag{2.16}$$

Using (2.16) and $m_t \pi_t = (m_t)^{\frac{\epsilon-1}{\epsilon}} - r m_t$ to eliminate b_T from (2.15) we get:[15]

$$(m_T^P)^{\frac{\epsilon-1}{\epsilon}} - r m_T^P = g_0^P (e^{rT} - 1) + g_T^P - z e^{rT} - r b_0 e^{rT} \tag{2.17}$$

Since $0 < \epsilon < 1$, the left hand side is strictly increasing in m_T^P, taking values on $(-\infty, \infty)$. Thus, (2.17) uniquely determines m_T^P. Summing up, under PERS the equilibrium sequence $\{g_s, \pi_s, m_s, c_s\}_0^\infty$ is uniquely determined by (2.7), (2.8), (2.14), and by $\pi_t = 0$ on $[0, T)$ and $\pi_t = \pi_T^P = (m_T^P)^{-\frac{1}{\epsilon}} - r$ on $[T, \infty)$, where m_T^P is given by (2.17).

2.6. Equilibrium Under Flexible Exchange Rates

Under FERS, at every instant the FA solves Problem II replacing monetary rule (2.10) by (2.11). An equilibrium under FERS is a sequence $\{g_s, m_s, \pi_s, \mu_s, c_s\}_t^\infty$ that solves Problem I and Problem II, and satisfies monetary rule (2.11).

Under FERS the CB controls the growth rate of nominal money. Thus, unlike the case of PERS, inflation is endogenously determined on $[0, T)$ and responds to events anticipated to take place after T. This makes the FA's problem more complicated because now, when computing the optimal sequence $\{g_s\}_0^\infty$, the FA has to calculate the effect that alternative paths for fiscal transfers will have on money demand and inflation during the time interval $[0, T)$. This channel is absent under PERS because inflation is exogenously fixed on $[0, T)$. It is through it that FERS provide more fiscal discipline than PERS.

As in the case of PERS, since the rates of interest and time discounting are the same g_t is constant on $[0, T)$ and $[T, \infty)$. We show in Appendix C that on $[T, \infty)$ the constant level of fiscal transfers g_T^F is determined by

$$u'(g_t^F) = \left(\frac{1-\alpha}{\alpha}\right)\left(\frac{\epsilon}{1-\epsilon}\right), \quad t \in [T, \infty) \tag{2.18}$$

Notice that just as in the case of PERS the level of transfers that solves (2.18) is independent of the inflation path, and the reason for this result is the same as under

[15] The alert reader will notice that the composition of government assets will shift at T as inflation changes and agents consequently reshuffle their portfolio, but the net position $[b_T - m_T]$ will not change.

PERS. Note also that comparing (2.14) and (2.18) it follows that for t in $[T,\infty)$ the level of fiscal transfers under FERS is the same as that under PERS. Since at any $t \geq T$ the FA's discount rate remains unchanged thereafter and is equal to the world interest rate, this result shows that the second distortion (i.e., that FA discounts events after T particularly heavily) is a necessary condition for fiscal transfers to be different across exchange rate regimes.

Next we turn to the determination of g_t on $[0,T)$. On this interval transfers are also constant and denoted by g_0^F. To determine the level of g_0^F the FA equalizes marginal benefits and marginal costs. The former are simply $\alpha u'(g_0)[1-e^{-rT}]r^{-1}$. The latter derive from lower real balances (and higher inflation) on $[0,\infty)$. To determine the marginal costs the FA calculates the impact of changes in g_0 on the entire path of real balances, and not only on $[T,\infty)$ as was the case under PERS.

For the interval $[T,\infty)$ this calculation is the same as the one we carried out for PERS. As shown in Appendix C, starting at T the economy is in a steady state, real balances are constant and $\mu_t = \pi_t$ for all t on $[T,\infty)$. Solvency dictates that the equilibrium level of real balances m_T^F is simply the one that solves $(m_T^F)^{\frac{\epsilon-1}{\epsilon}} - rm_T^F = g_T^F - z - rb_T$. To determine b_T note that since $\mu_t = 0$ on $[0,T)$, $\dot{b}_t = rb_t + z - g_0^F$. Thus, $b_T = rb_0e^{rT} + [z-g_0^F][e^{rT}-1]$. Therefore, we have that

$$(m_T^F)^{\frac{\epsilon-1}{\epsilon}} - rm_T^F = g_0^F[e^{rT}-1] + g_T^F - ze^{rT} - rb_0e^{rT} \tag{2.19}$$

Since $\epsilon < 1$,the left hand side of (2.19) is decreasing in m_T^F. Therefore, real balances on $[T,\infty)$ are uniquely determined by (2.19). Hence, we can substitute $\int_T^\infty [m_t^{\frac{\epsilon-1}{\epsilon}}]e^{-rt}dt = [m_T^{\frac{\epsilon-1}{\epsilon}}]/r$ in the objective function of the FA. As equation (2.19) shows, m_T^F is a function of g_0^F and some constants.

Next, note that real balances and inflation are not constant in the interval $[0,T)$ because the economy is not in a steady state. To calculate the response of $\int_0^T [m_t^{\frac{\epsilon-1}{\epsilon}}]e^{-rt}dt$ to changes in g_0^F we integrate (2.3) over $[0,T)$, and use the solvency condition derived in the preceding paragraph. For any $t < T$ we have that

$$\int_t^T [m_s^{\frac{\epsilon-1}{\epsilon}}]e^{-r(s-t)}ds = \frac{g_T^F - z - (m_T^F)^{\frac{\epsilon-1}{\epsilon}}}{re^{r(T-t)}} + \frac{[g_0^F - z][1-e^{-r(T-t)}]}{r} - [b_t - m_t] \tag{2.20}$$

Using (2.19) and (2.20) evaluated at $t=0$ to substitute out $\int_0^\infty [m_t^{\frac{\epsilon-1}{\epsilon}}]e^{-rt}dt$ from the FA's objective function (2.9), the latter can be written as

$$\begin{aligned} rU^{FA} = {} & [1-\alpha]\left(\tfrac{\epsilon}{\epsilon-1}\right)\left\{\frac{g_T^F - z - (m_T^F)^{\frac{\epsilon-1}{\epsilon}}}{e^{rT}} - \left[z - g_0^F\right]\left[1-e^{-rT}\right] - r[b_0 - m_0]\right\} + \\ & \alpha u(g_0^F)[1-e^{-rT}] + e^{-(r+\delta)T}\left[\alpha u\left(g_T^F\right) + (1-\alpha)\left(\tfrac{\epsilon}{\epsilon-1}\right)\left(m_T^F\right)^{\frac{\epsilon-1}{\epsilon}}\right] \end{aligned} \tag{2.21}$$

Note that the FA's objective function is expressed just in terms of g_0^F and m_T^F and some constants. The marginal benefits of increasing g_0^F are $\alpha u'(g_0)[1-e^{-rT}]r^{-1}$, and the marginal costs are:

$$\frac{1-\alpha}{r}\left\{-\frac{\epsilon}{\epsilon-1}[1-e^{-rT}]+\left[e^{-rT}\ \left(m_T^F\right)^{-1/\epsilon}-e^{-(r+\delta)T}\ \left(m_T^F\right)^{-1/\epsilon}\right]\ \frac{dm_T^F}{dg_0^F}\right\} \tag{2.22}$$

The first two terms reflect the decrease in the FA's payoff from changing holdings of money balances on the interval $[0,T)$. The third term reflects the effect of changing money balances after T. The effects on b_0 and m_0 do not appear in (2.22) because the rebate from the CB to private agents at $t=0$, discussed in section 2.4, insures that initial conditions (b_0-m_0) are simply given by history.

Computing $\frac{dm_T^F}{dg_0}$ from (2.19), substituting it in (2.22) and equalizing marginal costs to marginal revenues we obtain:

$$u'(g_t^F)=\left(\frac{\epsilon}{1-\epsilon}\right)\left(\frac{1-\alpha}{\alpha}\right)e^{-\delta T}\left[\frac{re^{\delta T}+\left(\frac{1-\epsilon}{\epsilon}\right)\ \left(m_T^F\right)^{-1/\epsilon}}{r+\left(\frac{1-\epsilon}{\epsilon}\right)\left(m_T^F\right)^{-1/\epsilon}}\right],\quad t\in[0,T) \tag{2.23}$$

Now we find the equilibrium level of m_t on $[0,T)$. Since $\mu_t=0$ on $[0,T)$, $\dot{m}_t=-\pi_t m_t=rm_t-m_t^{\frac{\epsilon-1}{\epsilon}}$. The solution of this differential equation, using m_T^F in (2.19) as the terminal condition, is:

$$m_t^F=\left[\left(m_T^F\right)^{1/\epsilon}\ e^{(t-T)r/\epsilon}+\frac{1-e^{(t-T)r/\epsilon}}{r}\right]^{\epsilon},\quad t\in[0,T) \tag{2.24}$$

Finally, we determine the equilibrium levels of μ_t and π_t. Given m_T^F, the constant level that π_t and μ_t take on $[T,\infty)$ follows directly from the money demand equation (2.8): $\pi_T^F=\mu_T=[m_T^F]^{-\frac{1}{\epsilon}}-r$. The path for the inflation rate on $[0,T)$ is given by $\pi_t^F=[m_t^F]^{-\frac{1}{\epsilon}}-r$.

Summing up, under FERS the equilibrium sequence $\{g_s,\mu_s,m_s,c_s,\pi_s\}_0^\infty$ is uniquely determined by (2.7), (2.8), (2.18), (2.23), (2.19), (2.24), $\mu_t=0$ on $[0,T)$ and $\mu_t=\mu_T=[m_T^F]^{-\frac{1}{\epsilon}}-r$ on $[T,\infty)$.

3. Comparison of Exchange Rate Regimes

In this section we compare PERS and FERS from three perspectives: degree of fiscal discipline, short-run responsiveness of fiscal policy to exogenous shocks, and individual welfare.

3.1. Comparing Fiscal Discipline

We define fiscal discipline as follows:

Definition 3.1. *An exchange rate regime A induces more fiscal discipline than an exchange rate regime B if the present value of net transfers made by the FA to the private sector is lower under regime A. That is, if* $\int_0^\infty [g_t^A - g_t^B]e^{-rt}dt < 0$.

We begin by comparing fiscal performance after T –that is to say, after the end of the current fiscal and monetary administration. Equations (2.14) and (2.18) reveal that, for $t \in [T, \infty)$, we have $g_t^P = g_t^F$.

Next we compare net transfer levels before T. Recall that such levels are constant within the interval $[0, T)$ and denoted by g_0^P and g_0^F. Comparing (2.23) and (2.14) we see that in equilibrium $u'(g_0^F)$ is equal to $u'(g_0^P)$ multiplied by a term that is greater than one if $\delta > 0$. Since $u''(.) < 0$, it follows that $g_0^F < g_0^P$.

For future reference we summarize these results in the following proposition

Proposition 3.2. *(i) Flexible exchange rates provide more fiscal discipline than predetermined exchange rates if* $\delta > 0$, *so that the FA discounts events after* T *more heavily than it does events before* T*; (ii) both regimes exert the same fiscal discipline if* $\delta = 0$, *so that the FA's intertemporal preferences are not distorted.*

To get some intuition for this result it is helpful to analyze how the FA would allocate the inflation tax across time if it could control monetary policy on $[0, \infty)$, and not only on $[T, \infty)$ as we have assumed so far. Consider any fixed amount of net transfers that must be financed; because of its ability to borrow and lend, the FA could choose to endure as much as possible of the necessary inflation tax burden before T or to defer as much as possible of it until after T. It is straightforward to show that if $\delta > 0$, the FA would prefer to delay the inflationary burden until after time T.

Return now to our monetary exercise, and ask what happens if the FA increases the level of transfers during the period $[0, T)$. Under PERS the entire necessary increase in the inflation tax is shifted to period $[T, \infty)$ because the nominal exchange rate (and hence inflation) are predetermined on $[0, T)$. In contrast, under FERS, this necessary increase is spread between the present and the future; this is because, under rational expectations, higher money creation means higher inflation today, and not just tomorrow.

It follows that if the FA discounts events after time T at a higher rate than events before T, then PERS implement an intertemporal distribution of the inflation tax burden which is closer to the FA's preferred allocation. This also implies that for the FA the marginal utility cost of financing an increase in fiscal transfers is lower under PERS than under FERS. As a result, in the period before T transfers are lower under FERS than under PERS.

In short, we can think of exchange rate regimes (under temporary CB autonomy) as specific rules to distribute intertemporally the burden of the inflation tax. The ability of an exchange rate regime to induce fiscal discipline depends on the extent to which it allows the FA to achieve its desired allocation of the inflation tax burden across time.

This analysis also suggests that the only way to insure that fixed rates provide more fiscal discipline is to introduce costs that are unrelated to economic fundamentals. For instance, assuming that there are large fixed costs of abandoning a peg which do not presumable extend to devaluation under flexible rates will deliver that result.

3.2. Adjustment to shocks

Here we ask whether the choice of exchange rate regime makes any difference for the short-run response of fiscal policy to exogenous shocks to government income. This question will be particularly relevant below when we examine the evidence for sub-Saharan Africa.

We study the following kind of shock to the government budget constraint. Think of z as the income that accrues to the government from exporting a state-owned natural resource, and consider the effect of an unanticipated and permanent decrease in z (i.e., a negative terms-of trade shock) that takes place at time $t = 0$. We investigate under which regime there is more short-term fiscal adjustment : does g_0 fall more under PERS or under FERS?[16]

Under PERS, it is clear from (2.14) that g_0^P does not depend on z, so that $\frac{dg_0^P}{dz} = 0$. Under FERS the situation is different. We show in Appendix D that $\frac{dg_0^F}{dz} < 0$ if $\delta > 0$ and $\frac{dg_0^F}{dz} = 0$ if $\delta = 0$ This partial derivative can be calculated in the following way. Take (2.19) and recall from (2.18) that g_T^F is simply a function of parameters. We then have an equation in g_0^F, m_T^F and z. Now take (2.23), which is also an equation in $g_0^F$and m_T^F. Total differentiation of these two equations yields the desired result. We therefore have:

Proposition 3.3. *(i) Adverse permanent shocks to government revenue lead to more short-run fiscal adjustment under flexible exchange rates than under predetermined exchange rates if $\delta > 0$, so that the FA discounts events after T more heavily than it does events before T; (ii) adverse permanent shocks to government revenue lead to the same short-run adjustment under both regimes if $\delta = 0$, so that the FA's intermporal preferences are not distorted.*

The result provided here is somewhat extreme, for transfers do not adjust at all under PERS. The general principle, however, would still hold in other formulations: because a FA that discounts events after T more heavily would prefer to defer the inflationary costs of adjustment to shocks until after T, and it can do this more readily under PERS than under FERS, not adjusting is more costly under FERS. Therefore, FERS prompt the FA to carry out greater adjustment.

[16] We know from the previous section that transfers after T are independent from z in both regimes, so there can be no question of which regime induces more fiscal adjustment in that period.

3.3. Comparing Private Agent's Welfare

Next we address the issue of which regime generates higher welfare for private agents. Integrating (2.3) subject to (2.4) (written with equality) yields

$$\int_0^\infty (m_t)^{\frac{\epsilon-1}{\epsilon}} e^{-rt}dt = \int_0^\infty g_t e^{-rt}dt - \frac{z}{r} - (b_0 - m_0) \tag{3.1}$$

Using (3.1) the private agent's utility function (2.6) can be written as

$$\left(\frac{\epsilon}{\epsilon - 1}\right)\left[\int_0^\infty g_t e^{-rt}dt - \frac{z}{r} - (b_0 - m_0)\right] + \text{constant} \tag{3.2}$$

Since z and $(b_0 - m_0)$ are exogenous and $\epsilon < 1$, individual welfare is simply a decreasing function of the degree of fiscal discipline. This leads to

Proposition 3.4. *The exchange rate regime that provides more fiscal discipline also provides higher welfare for the representative private agent.*

The intuition for this result is very simple. In our model fiscal transfers do not enter the utility function of the private agent (i.e., they are not public goods). Thus, changes in transfers only affect the private agent's welfare indirectly through changes in the inflation tax needed to finance them. Given that the individual's discount rate is always the same as the world rate of interest, and given that total revenue from money creation in each period, $m_t^{\frac{\epsilon-1}{\epsilon}}$, is of the same form as the instantaneous utility function, the agent is indifferent about the intertemporal allocation of the inflation tax. She only cares about its present value -and this present value, of course, is an increasing function of the level of transfers. Hence, the higher the level of transfers in any given exchange rate regime, the lower the welfare of the individual agent. Since the level of fiscal transfers is lower under FERS than under PERS, it follows that welfare is higher under FERS.

Of course, the extreme simplicity of this result is due to the specification of preferences, but the general thrust of the result would still hold more generally. Under other types of preferences, the agent would care about the intertemporal allocation of the inflation tax and not just about its present value. As long as the instantaneous utility function is concave, the regime that provides more fiscal discipline would also yield higher private welfare if the time path of real money balances that it induced were "smoother". But if we think that FERS is likely to provide more fiscal discipline, this qualification should not create much of a problem. This is because -since under FERS the exchange rate can move in anticipation of future events- for any degree of fiscal discipline the time path of real balances will be smoother under FERS than under PERS. Hence, if individual preferences are for smoothing the path of money holdings, this fact provides an additional channel through which FERS can provide higher welfare than PERS.[17]

[17] Calvo (1991) makes the same point in a slightly different context (one in which fiscal policy is exogenous), arguing that the welfare losses from "temporary stabilization" are likely to belower

4. Fiscal Adjustment in sub-Saharan Africa

The experience of the sub-Saharan African countries during the 1980s is a good case to illustrate the theoretical points made in this paper. These countries can be classified in two groups: those in the *Communauté Financière d'Afrique* (CFA) franc zone, which maintained a fixed exchange rate with the French franc from 1948 until 1994 (we will refer to them as PERS countries); and those with variable exchange rates (we will refer to them as FERS countries). Notice that participation in one group or another is determined exclusively by colonial history, and not by recent economic or political events. Hence, we have something close to a "natural experiment" for analyzing the impact of alternative exchange rate regimes. Notice, moreover, that with the exception of their different exchange rate regimes, the two groups are reasonably similar. Both are exporters of primary commodities and have a similar average GNP per capita.[18, 19]

The CFA Franc zone consists of 12 countries which are grouped in two currency unions: the *Union Monetaire Ouest Africaine* and the *Banque des Etats de l'Afrique Centrale*. These monetary unions have the following rules: changes in the exchange rate require the unanimous consent of all members (including France); each government's borrowing from the Central Bank cannot exceed 20% of the previous year's tax revenue; and the French government guarantees the convertibility of the CFA franc.

In the early 1980s some FERS countries had fully flexible rates, while others had multiple exchange rates. A World Bank study (La Ferrara et al. (1994)) describes the exchange rate arrangements of a "stylized" non-CFA sub-Saharan country in the following way: "The official exchange rate was pegged...and applied to debt service payments, official current account transactions and essential imports; all other transaction (private capital and **most commercial transactions**) had to be financed on the parallel market, where the exchange rate was floating." Note that because the floating rate applied to a significant share of commercial transactions, movements in this rate were transmitted to domestic inflation. Therefore, the channels identified in the model were operative. Moreover, in the mid-1980s several non-CFA countries which previously had dual rates (The Gambia, Ghana, Nigeria, Uganda, Zaire and Zambia) moved toward unification and full floating (see Quirk et. al (1987)).

As shown in Figure 4.1, during the 1970s the prices of major Sub-Saharan exports (oil, coffee and cocoa) experienced a positive shock. This led to significant increases in government spending. These price hikes were reversed by the late 1970s, and the enlarged levels of spending became unsustainable. Although during the first half of the 1980s the behavior of the terms of trade of both groups of countries did not differ significantly, the adjustment responses of both groups were markedly different:

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under FERS than under PERS.

[18]The average GNP per capita of FERS countries for the period 1980-1984 is \$513.29, while for PERS countries is \$519.4 (excluding Gabon, which had an average GNP per capita of \$3,978).

[19]For an comparison of the economic performance of both groups of sub-Saharan countries see Devarajan and de Melo (1990), Devarajan and Rodrik (1991), and World Bank (1994).

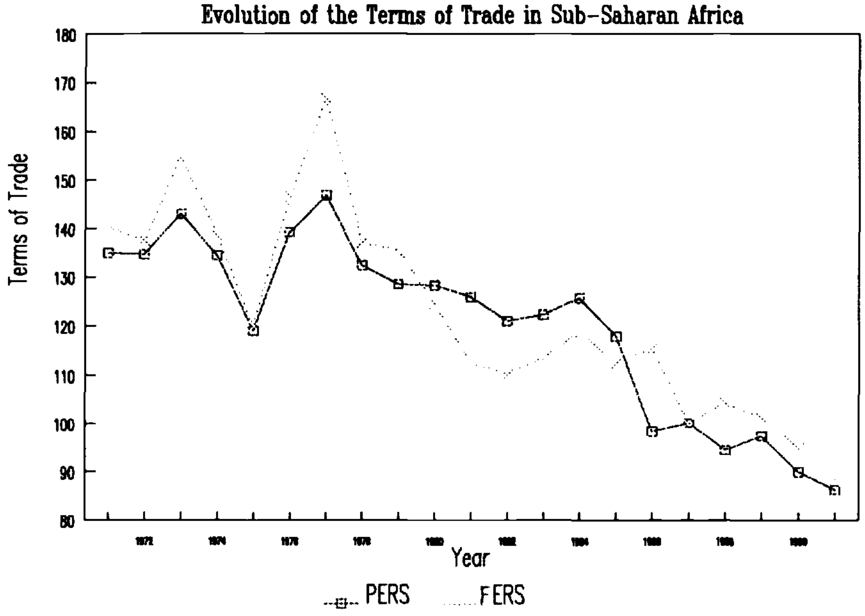

Figure 4.1:

i) Between 1980 and 1984, the primary fiscal deficit as a proportion of GDP declined by 5 percentage points in FERS countries, while it remained constant in PERS countries. The same tendency can be observed in central government expenditure, which declined by 2.3 percentage points of GDP in FERS countries, while it increased by 2.5 percentage points in PERS countries.

ii) During 1980-1984 inflation was lower in PERS countries than in FERS ones, as the fixed exchange rate held prices down in the former group. Inflation averaged 9% in the PERS countries and 23% in the FERS countries.

These differences in fiscal adjustment are those predicted by our model: in the short run PERS deliver lower inflation than FERS, but also induce less fiscal discipline. Eventually, however, PERS countries could not avoid adjustment as conditions deteriorated in the second half of the 1980s. Between 1985 and 1990, the terms of trade of PERS countries declined further by 22 percent, while those of FERS countries declined by 7 percent. This finally forced adjustment on PERS countries: between 1985-86 and 1990-91 government expenditure fell by 2.6 percentage points of GDP. Government expenditure in FERS countries, which had adjusted earlier, increased by

Table 4.1: SUB-SAHARAN FISCAL PERFORMANCE

		1980	1984
Primary Deficit	PERS	4.7	4.6
	FERS	7.9	3.0
Total Deficit	PERS	6.52	7.74
	FERS	9.6	6.3
Total Revenue	PERS	20.1	21.4
	FERS	18.1	19.0
Current Expenditure	PERS	26.7	29.2
	FERS	27.7	25.4
Interest Payments	PERS	1.8	3.1
	FERS	1.6	2.3

Source: Sub-Saharan Fiscal Data Base from the IMF. All figures are average percentages of GDP.

1.57 percentage points of GDP. Ultimately the fixed exchange rate proved unsustainable for the CFA zone: the peg to the French Franc established in 1948 fell prey to a 100 percent devaluation in January 1994.

Next we deal with three conceivable objections to this line of argument. First, the 20 percent cap on government borrowing from the Central Bank in the CFA franc zone might suggest that there should be more fiscal discipline in PERS countries because the monetary union imposes limits on the capacity of governments to obtain resources from the monetary authority. However, in practice PERS countries could circumvent this rule by having domestic banks rediscount domestic debt with the union's Central Bank. The French government had a line of credit known as the *compte d'operations* that covered Central Banks' losses. Therefore, the mechanism of our model is applicable in this case.

Second, it might be thought that the "special relation" with France implied that PERS countries had more recourse to debt financing than FERS countries, and that as a consequence FERS countries were forced to reduce the deficit, while PERS countries were not. Table 4.1 shows that this is simply not true. Between 1980 and 1984 the average debt-to-GDP ratio of FERS countries increased proportionately more than that of PERS countries. Moreover, debt service-to-exports ratios during the same period was higher for FERS countries than for PERS countries.

Table 4.2: SUB-SAHARAN DEBT AND DEBT SERVICE PERCENTAGE RATIOS

		1980	1984
Debt/GNP	PERS	51	70
	FERS	43	61
Debt service/ exports	PERS	3.7	10
	FERS	1.8	6.8

Source: World Tables of the World Bank.

Third, it could be conjectured that non-CFA countries were subject to IMF discipline, while CFA countries were shielded by a protective France. But this is not supported by the fact that the share of countries with an IMF program was the same across both sets of countries. Between 1980 and 1984, 13 out of 17 non-CFA countries in our sample had IMF programs; for CFA countries the figure is 8 out of 11 (see Khan (1990)).

In order to test the hypothesis that during the early 1980s in sub-Saharan Africa fiscal discipline was greater in FERS countries than in PERS countries, we regressed measures of fiscal adjustment during 1980-84 on an exchange rate regime dummy, controlling for differences in terms of trade, ability to borrow, and level of development. We ran cross-country regressions of the following form

$$\Delta F_i = \gamma_0 + \gamma_1 D_i + \gamma_2 R_i + \gamma_3 G_i + \gamma_4 \Delta T_i + u_i \tag{4.1}$$

where ΔF is a measure of fiscal adjustment. We consider three such measures: the increase, between 1980 and 1984, in the primary fiscal deficit, in central government expenditures net of interest payments, and in central government expenditures. All are measured as a percentage of GDP. R is the debt-to-GDP ratio in 1980, G is income per-capita in 1980, and ΔT is the rate of change in the terms of trade between 1980 and 1984. D is a dummy variable that equals one for a PERS country and zero for a FERS country.

The PERS countries considered are Benin, Burkina Faso, Cameroon, Central African Republic, Congo, Cote d'Ivoire, Gabon, Mali, Niger, Senegal, and Togo. The FERS countries included in the study are Botswana, Burundi, Gambia, Ghana, Kenya, Madagascar, Malawi, Mauritania, Mauritius, Nigeria, Rwanda, Sierra Leone, Tanzania, Uganda, Zaire, Zambia, and Zimbabwe. The sample consists of the all the countries for which the IMF sub-Saharan fiscal data base has the relevant data.

It is important to note that the dummy variable is genuinely exogenous because only countries that are former French colonies belong to the fixed-exchange rate area. Therefore, the exchange rate regime in our sample does not reflect underlying fiscal imbalances or other factors that could create simultaneity problems.

We considered the period 1980-84 for the following reason. As can be seen in Figure 1, the terms of trade of sub-Saharan Africa experienced a first deterioration in 1978-79 and a second, more pronounced, deterioration starting in 1985. Thus, one might argue that during the period 1979-1984, although the terms of trade had deteriorated, sub-Saharan countries still had latitude to borrow. Therefore, the observed behavior of fiscal aggregates can be presumed to reflect the choice of authorities, and not borrowing constraints. In contrast, the further deterioration in the terms of trade that started in 1985 eliminated this latitude, forcing PERS countries to adjust.[20]

Table 4.3 shows the regression results for the case in which the dependent variable is the increase in the primary fiscal deficit. The coefficient on the dummy is positive and statistically significant at the 5% level in all cases, implying that we cannot reject the hypothesis that FERS provide more fiscal discipline than PERS. According to the first equation, all else equal, between 1980 and 1984 a PERS country increased on average its primary fiscal deficit 1.33 percentage points of GDP more than a FERS country. It is also interesting to note that the point estimate of the dummy's coefficient is robust to the set of controls we consider in equations (2) through (8). It takes values in the interval [1.16, 1.38].

The estimated coefficient of the initial debt-to-GDP ratio is negative in all cases, although it is significant at the 10% level in only two cases. The intuition for the negative sign is as follows. This ratio controls for the debt burden and the ability to borrow. Thus, all else equal, countries with higher initial debt find it more difficult to finance a fiscal deficit in the face of a negative shock.

The estimated coefficient of the change in terms of trade is positive and significant at the 5% level. This might seem surprising, for the standard neoclassical approach to fiscal policy would seem to suggest that an increase in the terms of trade should cause a decrease and not an increase in the deficit. Yet the model in Tornell and Lane (1994) implies that the coefficient on ΔT should be positive. The argument is as follows. Since sub-Saharan countries are heavily dependent on exports of primary commodities, changes in the terms of trade have strong effect on income and fiscal revenue. Since several groups in these countries have the power to extract government transfers, a tragedy of commons exists with respect to the accumulation of public assets. Thus, any windfall (caused, for instance, by a temporary improvement in the terms of trade) is not saved, but spent. If a group allowed public assets to accumulate, other groups would take advantage of this and increase their fiscal appropriations.

Lastly, the estimated coefficient on initial per-capita income is positive in all cases, but significant in only two cases. This reflects the fact that richer countries may find it easier to finance a given deficit.

Tables 4.4 and 4.5 present regression results for the cases in which the dependent

[20]Since the IMF fiscal data base starts in 1980 we did not consider 1979 as the base year.

variables are government expenditure net of interest payments and government expenditure, respectively. In both tables the estimated coefficients on the dummy are positive in all cases. In twelve cases they are significant at the 5% level, and in four at the 10% level. Hence, we cannot reject the null hypothesis that during the early 1980s in sub-Saharan Africa FERS provided more fiscal discipline than PERS, even when controlling for initial indebtedness, initial level of income per-capita, and variations in the terms of trade.

5. Summary and Conclusions

This paper offers both theoretical reasons and some empirical evidence suggesting that the conventional wisdom that fixed exchange rates provide more fiscal discipline is in need of revision.

On theoretical grounds, we argue that under imperfect credibility or limited central bank autonomy the choice of exchange rate regime is essentially a choice of when to collect inflation tax revenues. In turn, this choice determines the costs the fiscal authorities must pay if they want to increase spending and the deficit. If the fiscal authorities are impatient, flexible rates –by forcing the costs to be paid up-front– provide more fiscal discipline.

Some preliminary evidence suggests that the conventional wisdom is also at variance with the facts –at least in some regions of the world. In Africa in the 1980s, countries in the CFA zone were notoriously slow in undertaking fiscal adjustment compared with countries elsewhere in sub-Saharan Africa operating under a variety of flexible exchange rate regimes: our regression results suggest the choice of exchange rate regime affects the degree of fiscal adjustment even after controlling for other factors such as terms of trade, initial GDP, and initial level of debt.

We do not claim that all countries with flexible exchange rates will have more fiscal discipline than all countries with fixed exchange rates. Such discipline depends on both economic fundamentals –preferences, government access to capital markets– and on political fundamentals –institutions, budget-making rules, degree of distributive tensions. Our claim is just that in situations where there is no fiscal discipline to begin with and authorities have recourse to debt financing, fixed rates per se do not generate discipline; conversely, flexible rates may tilt the balance in favor of greater discipline because of the immediacy of the punishment associated with imprudent fiscal policies. We should also note that if a country has sufficiently low reserves and no recourse to debt finance, then any increase in the deficit will immediately be reflected in a collapse of the peg. In that case, fixed exchange rates exert the same type of fiscal discipline than flexible rates do.

Appendix A: The Private Agent's Problem

In order to solve Problem I we will denote the real assets held by the individual as $k_t \equiv m_t + f_t$ and rewrite (2.1) as

$$\dot{k_t} = rk_t + y - c_t - i_t m_t + g_t \tag{.1}$$

It follows that the present value Hamiltonian associated with Problem I is $H = v(c) + \frac{\epsilon}{\epsilon-1} m^{\frac{\epsilon-1}{\epsilon}} + \lambda[rk + y - c - im + g]$. The necessary conditions for a maximum are

$$v'(c_t) = \lambda_t, \qquad m_t^{-1/\epsilon} = i_t \lambda_t, \qquad \dot{\lambda}_t = 0 \tag{.2}$$

$$\lim_{t \to \infty} \lambda_t k_t e^{-rt} = 0 \tag{.3}$$

It follows from (.2) that c_t is constant on $[0, \infty)$. To determine its level we integrate (.1) forward and get

$$\frac{\bar{c}}{r} = k_0 + \frac{y}{r} - \int_0^\infty \left[(m_t)^{\frac{\epsilon-1}{\epsilon}} + g_t \right] e^{-rt} dt - \lim_{t \to \infty} k_t e^{-rt} \tag{.4}$$

Since λ_t is constant, (.3) implies that the last term on the right hand side of (.4) is zero. Taking the government flow budget constraint (2.3) and integrating, we have

$$\int_0^\infty \left[(m_t)^{\frac{\epsilon-1}{\epsilon}} + g_t \right] e^{-rt} dt = (b_0 - m_0) + \frac{z}{r} - \lim_{t \to \infty} (b_t - m_t) e^{-rt} \tag{.5}$$

Government solvency condition (2.4) will always hold with equality if the transversality conditions of the government's problem are satisfied. Using this fact the last term on the R.H.S. of (.5) is zero. Combining the resulting equation with (.4) we get

$$\bar{c} = r(f_0 + b_0) + y + z \tag{.6}$$

Equation (2.8) is obtained by performing the following normalization:
$v' [r(f_0 + b_0) + y + z] = 1$.

Appendix B: FA's Problem Under Predetermined Exchange Rates

First we obtain the solution for $[T, \infty)$. Noting that private consumption is independent of $\{g_s\}_t^\infty$, internalizing the CB's rule (2.10) and the money demand function (2.8), Problem II reduces to the following problem. During each instant choose $\{g_s, m_s\}_t^\infty$ to maximize (2.9) subject to (2.4) and to

$$\dot{a}_t = ra_t + z - g_t + m_t^{\frac{\epsilon-1}{\epsilon}} \tag{.7}$$

where $a_t \equiv b_t - m_t$. The necessary conditions for an optimum are

$$\alpha u'(g_t) = \psi_t, \qquad (1-\alpha)m_t^{-1/\epsilon} = -\psi_t\left(\frac{\epsilon-1}{\epsilon}\right)m_t^{-1/\epsilon}, \qquad \dot{\psi}_t = 0 \qquad (.8)$$

$$\lim_{t\to\infty} \psi_t a_t e^{-r(t-T)} = 0 \qquad (.9)$$

ψ_t is the costate variable associated with (.7). Since ψ_t is constant, g_t is also constant. We will denote this constant level by g_T^P. Using (.8) we obtain $u'(g_T^P) = \left(\frac{1-\alpha}{\alpha}\right)\left(\frac{\epsilon}{1-\epsilon}\right)$.

Next, we determine the path of real balances on $[T,\infty)$. Notice that (.8) and (.9) are not sufficient to fully characterize the path of m_t and π_t. In what follows we show that there exists an equilibrium where m_t and π_t are constant. Suppose that the inflation rate is constant on $[t,\infty)$. Equation (2.8) implies that real balances are also constant on $[t,\infty)$. Thus, integrating (.7) forward we get

$$a_s = a_t\, e^{r(s-t)} - \frac{[g_T^P - z - m_t^{\frac{\epsilon-1}{\epsilon}}][e^{r(s-t)}-1]}{r}, \quad s \geq t \geq T \qquad (.10)$$

Since by (.8) ψ_t is constant and different from zero, transversality condition (.9) and (.10) imply

$$r\, m_t^P - \left(m_t^P\right)^{\frac{\epsilon-1}{\epsilon}} = rb_t + z - g_T^P, \qquad \forall t \geq T \qquad (.11)$$

Since $0 < \epsilon < 1$, the left hand side is strictly increasing in m_t^P (taking values on $(-\infty,\infty)$). It follows that (.11) uniquely determines m_t^P for each pair (b_t, g_T^P).

Since g_t is constant on $[T,\infty)$, equation (.11) implies that the conjecture of constant inflation is correct if and only if, government net assets b_t are constant on $[T,\infty)$. To show that b_t is constant substitute (.11) in (.7) to get $\dot{b}_t = r[b_t - m_t^P] + z - g_T^P + [m_t^P]^{\frac{\epsilon-1}{\epsilon}} = 0$. Since first order conditions (.8) and (.9), and the CB's rule are satisfied, it follows that there exists an equilibrium with constant inflation on $[T,\infty)$. The equilibrium inflation rate $\pi(b_t, g_T^P)$ is uniquely determined by the money demand equation $m_T^P = (r+\pi)^{-\epsilon}$.

Next, we consider the interval $[0,T)$. Using (2.8), the lower portion of (2.14), and taking into account that during this interval inflation is exogenously set by the CB at $\pi_0 = 0$, and that $m_t = m_T^P$ for $t \geq T$, Problem II becomes: choose $\{g_s\}_t^T$ and m_T^P in order to maximize (2.9), subject to (.7), and to the scrap value function given by the value of the continuation game at time T

$$J(a_T) = \left[\alpha u(g_T^P) + (1-\alpha)\left(\frac{\epsilon}{\epsilon-1}\right)(m_T^P)^{\frac{\epsilon-1}{\epsilon}}\right] r^{-1} e^{-(r+\delta)T} \qquad (.12)$$

The necessary conditions for an optimum are:

$$\alpha u'(g_t) = \psi_t, \qquad \dot{\psi}_t = 0 \qquad (.13)$$

$$\psi_T = \frac{dJ(a_T)}{da_T} = \frac{e^{-(r+\delta)T}}{r}[\alpha u'(g_T)\frac{dg_T}{da_T} + (1-\alpha)m_T^{-\frac{1}{\epsilon}}\frac{dm_T}{da_T}] \\ = (1-\alpha)\left(\frac{\epsilon}{1-\epsilon}\right)e^{-(r+\delta)T} \tag{.14}$$

The second equality follows from $dg_T/da_T = 0$ (recall $u'(g_T^P) = \left(\frac{1-\alpha}{\alpha}\right)\left(\frac{\epsilon}{1-\epsilon}\right)$) and from $dm_T/da_T = \left(\frac{\epsilon}{1-\epsilon}\right)rm^{\frac{1}{\epsilon}}$ (this follows from (.11) by setting $a = b - m$). Since $\psi_t = \psi_T$ for all t in $[0, T)$, substituting (.14) in (.13) we get the top portion of (2.14).

Appendix C: FA's Problem Under Flexible Exchange Rates

First we consider the time interval $[T, \infty)$. Internalizing the CB's rule (2.11) and the money demand function (2.8), Problem II reduces to the following: during each instant t in $[T, \infty)$ choose $\{\mu_s, g_s\}_t^\infty$ in order to maximize (2.9) subject to (2.4), and

$$\dot{b}_t = rb_t - g_t + \mu_t m_t \quad \text{and} \quad \dot{m}_t = [\mu_t - \pi_t]m_t = [\mu_t + r]m_t - m_t^{\frac{\epsilon-1}{\epsilon}} \tag{.15}$$

By substituting the two equations in (.15) for (2.3), and considering a control problem with b and m as state variables we simplify the problem because we avoid representing real balances in (2.9) in terms of $\{\mu_s\}_t^\infty$. It follows that the present value Hamiltonian is

$$H = U(g, m, c) + \psi[rb - g + \mu m] + \varphi[(\mu_t + r)m_t - m_t^{\frac{\epsilon-1}{\epsilon}}] \tag{.16}$$

Necessary conditions for an optimum are

$$\alpha u'(g_t) = \psi_t, \qquad -\varphi_t = \psi_t, \qquad \dot{\psi}_t = 0 \tag{.17}$$

$$\dot{\varphi}_t = \varphi_t r - \psi_t\mu_t - \varphi_t(\mu_t + r) + \frac{\epsilon-1}{\epsilon}\varphi_t m_t^{-1/\epsilon} - (1-\alpha)m_t^{-1/\epsilon} \tag{.18}$$

$$\lim_{t\to\infty} \varphi_t m_t e^{-rt} = 0 \qquad \lim_{t\to\infty} \psi_t b_t e^{-rt} = 0 \tag{.19}$$

Setting $\dot{\varphi}_t = 0$ and $-\varphi_t = \psi_t$ in (.18) we get $\varphi_t = (1-\alpha)\left(\frac{\epsilon}{\epsilon-1}\right)$. By substituting this in (.17) it follows that $u'(g_t) = \left(\frac{1-\alpha}{\alpha}\right)\left(\frac{\epsilon}{\epsilon-1}\right)$ for t on $[T, \infty)$. We label the constant level of g that solves this equation g_T^F.

Next, we determine the equilibrium levels of μ_t and π_t on $[T, \infty)$. Notice that (.17), (.18) and (.19) are not sufficient to characterize the path of μ_t. In what follows we show that there exists an equilibrium where μ_t is constant. Thus, suppose that μ_t is constant on $[T, \infty)$, at a level $\mu_T = \mu(b_T, g_T^P)$. To determine this constant level note first that a constant μ_s on $[t, \infty)$ implies that $\pi_s = \mu(b_t, g_T^F)$ on $[T, \infty)$. To see this differentiate the second equation in (.15) and evaluate it at the steady state (i.e., at $\pi_s = \mu(b_t, g_T^F)$)

$$\left.\frac{\partial \dot{m}}{\partial m}\right|_{SS} = \frac{r + \mu(b_t, g_T^F)}{\epsilon} > 0$$

The positive sign implies that the second equation in (.15) is unstable. It then follows from the arguments in Sargent and Wallace (1973) that, for any $t \geq T$, m_t must equal its steady state level. Thus, (.15) in turn implies that $\pi_s = \mu(b_t, g_T^F)$ for all $s \geq t \geq T$ if $\mu_s = \mu(b_t, g_T^F)$ for all $s \geq t \geq T$.

Second, note that monetary rule (2.11) and the transversality conditions in (.19) imply that $\mu(b_t, g_T^P)$ must satisfy solvency condition (2.4) with equality. Thus, integrating (.7) forward and using the fact that m_s and g_s are constant on $[t, \infty)$, it follows that $\mu(b_t, g_T^P)$ must satisfy

$$r\, m_t^F - \left(m_t^F\right)^{\frac{\epsilon-1}{\epsilon}} = rb_t + z - g_T^F, \quad \forall t \geq T \tag{.20}$$

Since $0 < \epsilon < 1$, the left hand side is strictly increasing in m_t^F (taking values on $(-\infty, \infty)$). It follows that (.20) uniquely determines m_t^F for each pair (b_t, g_T^F). The equilibrium levels of π_t and $\mu(b_t, g_T^P)$ are in turn uniquely determined by the money demand equation $m_t^F = (r + \pi_t)^{-\epsilon}$ and $\pi_t = \mu(b_t, g_T^P)$.

Third, note that in equilibrium the CB will set $\mu_t = \mu(b_T, g_T^P)$ for every t in $[T, \infty)$ (as conjectured above) because b_t is constant along the equilibrium path. The argument is the same as the one made for the case of PERS.

We now turn to the determination of transfers before T. As in the previous cases, since the interest rate on government debt is equal to the FA's discount factor on $[0, T)$, g_t is constant on this interval. We will refer to the corresponding level as g_0^F. To determine its level we will rewrite objective function (2.9) in the text in terms of g_0^F, m_T^F and some constants. Integrating (.7) we get

$$\int_0^T m_s^{\frac{\epsilon-1}{\epsilon}} e^{-rs} ds = a_T e^{-rT} - a_0 - \frac{(g_0 - z)[e^{-rT} - 1]}{r} \tag{.21}$$

Substituting (.21) in (2.9), and using solvency condition (.20) to replace ra_T by $g_T^F - z - \left(m_T^F\right)^{\frac{\epsilon-1}{\epsilon}}$, it follows that the payoff function of the FA is given by (2.21). The necessary condition for g_0^F to maximize (2.21) is

$$\left[\alpha u'(g_0^F) + (1-\alpha)\left(\frac{\epsilon}{\epsilon - 1}\right)\right]\left(e^{-rT} - 1\right) = (1-\alpha)\left(m_T^F\right)^{-1/\epsilon}\left[\frac{e^{-\delta T} - 1}{e^{rT}}\right]\left(\frac{dm_T^F}{dg_0^F}\right) \tag{.22}$$

In (.22) we made use of the fact that the rebate from the CB to private agents at $t = 0$ discussed in subsection 2.3 implies that initial condition $b_0 - m_0$ is given by history. The rest of the argument is in the text.

Appendix D: Adjustment to Shocks

To determine the effects of changes in z on g_0^F and m_T^F, we totally differentiate (2.23) and (2.19) to obtain

$$-u''\left(g_0^F\right)dg_0^F - \frac{\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{r}{\epsilon}\right)\left(m_T^F\right)^{-\left(\frac{1}{\epsilon}+1\right)}\left(1-e^{-\delta T}\right)}{\left[\left(\frac{1-\epsilon}{\epsilon}\right)+r\left(m_T^F\right)^{-1/\epsilon}\right]^2}dm_T^F = 0 \qquad (.23)$$

$$\left(e^{rT}-1\right)dg_0^F + \left(\frac{1-\epsilon}{\epsilon}\right)\left(m_T^F\right)^{-1/\epsilon}\ dm_T^F = e^{rT}dz \qquad (.24)$$

Using Cramer's rule we have that

$$\frac{dg_0}{dz} = -\frac{e^{rT}}{D}\ \frac{\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{r}{\epsilon}\right)\left(m_T^F\right)^{-\left(\frac{1}{\epsilon}+1\right)}\left(1-e^{-\delta T}\right)}{\left[\left(\frac{1-\epsilon}{\epsilon}\right)+r\left(m_T^F\right)^{-1/\epsilon}\right]^2} \geq 0 \text{ as } \delta \geq 0 \qquad (.25)$$

where $D < 0$ is the determinant of the system (.23) and (.24).

References

[1] Aghevli, B. M. Khan and P. Montiel "Exchange Rate Policies in Developing Countries: Some Analytical Issues" IMF Occasional Paper No. 78, March 1991.

[2] Barro, R. and D. Gordon "A Positive Theory of Monetary Policy in a Natural Rate Model" *Journal of Political Economy*, 1983.

[3] Basar, T and G. Olsder *Dynamic Noncooperative Game Theory* New York: Academic Press, 1982.

[4] Buiter, W., G. Corsetti and N. Roubini "Excessive Deficits: Sense and Non-Sense in the Treaty of Maastrich" *Economic Policy*, No. 16, April 1993.

[5] Calvo, G. "On the Time Consistency of Optimal Policy in a Monetary Economy" *Econometrica*, Vol. 46, 1978.

[6] ——— "Temporary Stabilization: The Case of Predetermined Exchange Rates" *Journal of Political Economy*, 1986.

[7] ——— "Temporary Stabilization Policy: The Case of Flexible Prices and Exchange Rates" *Journal of Economic Dynamics and Control*, 1991.

[8] Cohen, D. and P. Michel "How Should Control Theory Be Used to Calculate a Time-Consistent Government Policy?" *Review of Economic Studies*, Vol. LV, 1988.

[9] Devarajan, S. and D. Rodrik "Do the Benefits of Fixed Exchange Rates Outweigh their Costs? The Franc Zone In Africa" Working Paper, The World Bank, 1991.

[10] ——— and J. de Melo, "Membership in the CFA Zone: Odyssean Journey or Trojan Horse?" World Bank Policy Research and External Affairs WP Series No. 482, 190.

[11] Dornbusch, R. and A. Giovannini "Monetary Policy in the Open Economy" in *Handbook of Monetary Economics*, Vol. II, B. M. Friedman and F.H. Hahn (eds.) North-Holland Elsevier Science Publishers, 1990.

[12] Drazen, A. "Tight Money and Inflation: Further Results" *Journal of Monetary Economics*, Vol. 15, 1984.

[13] ——— and E. Helpman "Stabilization with Exchange Rate Management" *Quarterly Journal of Economics*, November 1987.

[14] Frenkel, J. M. Goldstein and P. Masson "Characteristics of a Successful Exchange Rate System" IMF Occasional Paper No. 82, July 1991.

[15] Friedman, M. "The Case for Flexible Exchange Rates," in *Essays in Positive Economics*, The University of Chicago Press, 1953.

[16] Giavazzi, F. and M. Pagano, "The Advantage of Tying One's Hands: EMS Discipline and Central Bank Credibility," *European Economic Review*, June 1988.

[17] Halm, G. *Approaches to Greater Flexibility of Exchange Rates, the Burgenstock Papers,* Princeton University Press, 1970.

[18] Hausmann, R. *Shocks Externos y Ajuste Macroeconómico* Caracas: Banco Central de Venezuela, 1990.

[19] Helpman, E. "An Exploration into the Theory of Exchange Rate Regimes" *Journal of Political Economy* Vol. 89, 1981.

[20] Johnson, H. "The Case for Flexible Exchange Rates, 1969" *Federal Reserve Bank of St. Louis Review,* Vol 51, June 1969.

[21] Chari, V. V., and P. J. Kehoe, "Sustainable Plans," *Journal of Political Ecoonmy*, Vol. 98, 1990.

[22] Khan, M. "The Macroeconomic Effects of Fund-Supported Adjustment Programs" *IMF Staff Papers* Vol. 37, June 1990.

[23] Klein, M. and N. Marion "Explaining the Duration of Exchange Rate Pegs" NBER Working Paper No.4651, February 1994.

[24] La Ferrara, E., G. Castillo and J. Nash "The Reform of Mechanisms for Foreign Allocation: Theory and Lessons from Sub-Saharan Africa" Policy Research Department, Trade Policy Division, The World Bank, March 1994.

[25] Nashabibi, K. and S. Bazzoni "Alternative Exchange Rate Strategies and Fiscal Performance in Sub-Saharan Africa" IMF Working Paper 93/68, August 1993.

[26] Nurkse, R. *International Currency Experience*, League of Nations, 1944.

[27] Obstfeld, M. "Floating Exchange Rates: Experience and Prospects" *Brookings Papers on Economic Activity*, 1985.

[28] Quirk, P., B.V. Christensen, K.M. Huh and T. Sasaki "Floating Exchange Rates in Developing Countries" *IMF Occasional Paper* No. 53, May 1987.

[29] Sargent, T. and N. Wallace "The Stability of Models of Money and Growth With Perfect Foresight" *Econometrica*, Vol. 41, 1973.

[30] ______________ "Some Unpleasant Monetarist Arithmetic" *Federal Reserve Bank of Minneapolis Quarterly Review*, 1981.

[31] Svensson, L. E. O. "Fixed Exchange Rates as a Means to Price Stability:What Have We Learned?" NBER Working Paper No. 4504, October 1993.

[32] Tornell, A. and P. Lane "Are Windfalls a Curse? A Non-Representative Agent Model of the Current Account and Fiscal Policy" NBER Working Paper 4839, 1994.

[33] World Bank *Adjustment in Africa* Washington: The World Bank, 1994.

Table 4.3: FISCAL ADJUSTMENT UNDER ALTERNATIVE EXCHANGE RATE REGIMES. DEPENDENT VARIABLE: INCREASE IN THE PRIMARY FISCAL DEFICIT OF THE CENTRAL GOVERNMENT

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	-0.80	-0.62	-0.75	-1.29	-0.59	-1.38	-1.14	-0.59
	(-1.68)	(-1.43)	(-1.32)	(-5.03)**	(-1.20)	(-4.12)**	(-4.43)**	(-1.29)
Dummy	1.33	1.27	1.38	1.26	1.33	1.29	1.16	1.22
	(2.40)**	(2.40)**	(2.38)**	(2.13)**	(2.40)**	(2.08)**	(2.03)**	(2.09)**
$Debt_0$	-1.06	-1.23	-1.34		-1.49			
	(-1.39)	(-1.71)*	(-1.67)		(-1.98)*			
Δ TOT	17.60	17.24		19.31			19.18	
	(2.68)**	(2.50)**		(3.51)**			(3.22)**	
GNP_0	.14		.12	.19		.19		
	(1.64)		(1.24)	(2.75)**		(2.35)**		
Adj. R^2	0.20	0.22	0.13	0.20	0.15	0.10	0.20	0.08
N. Obs.	28	28	28	28	28	28	28	28

Note: t-statistics are in parenthesis. (**) Denotes variables significant at the 5 percent level. (*) Denotes variables significant at the 10 percent level. The dummy variable takes the value of 1 for countries with predetermined exchange rates. The standard errors are heteroskedastic-consistent estimates. GNP_0 is equal to GNP in 1980 multiplied by E^{-10}. *Source:* The dependent variable is from the IMF sub-Saharan fiscal data base, and the independent variables from the World Tables of the World Bank.

Table 4.4: FISCAL ADJUSTMENT UNDER ALTERNATIVE EXCHANGE RATE REGIMES. DEPENDENT VARIABLE: INCREASE IN CENTRAL GOVERNMENT EXPENDITURE NET OF INTEREST PAYMENTS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.36	-0.03	0.37	-0.38	-0.03	-0.41	-0.56	-1.23
	(0.55)	(-0.05)	(0.57)	(-0.87)	(-0.04)	(-0.88)	(-1.28)	(-3.93)**
Dummy	1.20	1.32	1.21	1.09	1.33	1.10	1.20	1.20
	(2.15)**	(2.36)**	(2.13)**	(1.91)*	(2.33)**	(1.90)*	(2.09)**	(2.01)**
$Debt_0$	-1.60	-1.24	-1.66		-1.31			
	(-1.73)*	(-1.32)	(-1.69)		(-1.31)			
Δ TOT	3.92	4.70		6.50			6.65	
	(0.41)	(0.50)		(0.58)			(0.61)	
GNP_0	-0.30		-0.31	-0.22		-0.23		
	(-2.84)**		(-2.87)**	(-2.02)**		(-2.11)**		
Adj. R^2	0.09	0.06	0.12	0.05	0.09	0.08	0.06	0.11
N. Obs.	28	28	28	28	28	28	28	28

Note: t-statistics are in parenthesis. (**) Denotes variables significant at the 5 percent level. (*) Denotes variables significant at the 10 percent level. The dummy variable takes the value of 1 for countries with predetermined exchange rates. The standard errors are heteroskedastic-consistent estimates. GNP_0 is equal to GNP in 1980 multiplied by E^{-10}. *Source:* The dependent variable is from the IMF sub-Saharan data base, and the independent variables from the World Tables of the World Bank.

Table 4.5: FISCAL ADJUSTMENT UNDER ALTERNATIVE EXCHANGE RATE REGIMES. DEPENDENT VARIABLE: INCREASE IN CENTRAL GOVERNMENT EXPENDITURES

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.02	-0.47	0.34	-0.72	-0.46	-0.76	-0.96	-1.0
	(0.03)	(-0.76)	(0.06)	(-1.83)*	(-0.75)	(-1.81)*	(-2.45)**	(-2.45)**
Dummy	1.23	1.38	1.25	1.12	1.40	1.14	1.27	1.29
	(2.13)**	(2.38)**	(2.13)**	(1.88)*	(2.38)**	(1.89)*	(2.12)**	(2.14)**
$Debt_0$	-1.60	-1.15	-1.69		-1.25			
	(-1.84)*	(-1.29)	(-1.79)*		(-1.29)			
Δ TOT	5.62	6.59		8.20			8.40	
	(0.77)	(0.92)		(0.91)			(0.97)	
GNP_0	-0.38		-0.38	-0.30		-0.30		
	(-4.60)**		(-4.72)**	(-3.76)**		(-3.92)**		
Adj. R^2	0.15	0.09	0.18	0.11	0.11	0.13	0.08	0.10
N. Obs.	28	28	28	28	28	28	28	28

Note: t-statistics are in parenthesis. (**) Denotes variables significant at the 5 percent level. (*) Denotes variables significant at the 10 percent level. The dummy variable takes the value of 1 for countries with predetermined exchange rates. The standard errors are heteroskedastic-consistent estimates. GNP_0 is equal to GNP in 1980 multiplied by E^{-10}. *Source:*The dependent variable is from the IMF sub-Saharan data base, and the independent variables from the World Tables of the World Bank.