NBER WORKING PAPER SERIES

FISCAL PREREQUISITES FOR A VIABLE MANAGED EXCHANGE RATE REGIME: A NON-TECHNICAL ECLECTIC INTRODUCTION

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Working Paper No. 2041

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
October 1986

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ABSTRACT

The paper first reviews the budget identities of the fiscal and monetary authorities and the solvency constraint or present value budget-constraint of the consolidated public sector, for closed and open economies. It then discusses the new conventional wisdom concerning the fiscal roots of inflation and the budgetary prerequisites for generating and stopping hyperinflation. The popular rational expectations "Unpleasant Monetarist Arithmetic" model of Sargent and Wallace has ambiguous inflation implications from an increase in the fundamental deficit and is incapable of generating hyperinflation. The only runaway, explosive or unstable behavior it can exhibit is "hyperdeflation"! In the open economy, the need to maintain a managed exchange rate regime does not impose any constraint on the growth rate of domestic credit, arising through the government's need to remain solvent. Obstfeld's proposition to the contrary is due to the omission of government bonds and borrowing.

There is not yet any "deep structural" theory justifying the (exogenous) lower bounds on the stock of foreign exchange reserves characteristic of the collapsing exchange rate literature. Absent such a theory of "international liquidity," one cannot model satisfactorily a foreign exchange crisis that is not at the same time a government solvency crisis. Given such a lower bound, the existence or absence of a pecuniary opportunity cost to holding reserves is shown to condition the fiscal and financial actions consistent with prolonged survival of the managed exchange rate regime.

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1. Introduction

It has long been recognized that monetary, fiscal and financial policy cannot be determined independently. Like most insights in economics, this one is rediscovered, repackaged and re-emphasized periodically. Unfortunately, our subject is not one in which progress in monotonic. Rather, half-truths gain acceptance and popularity, wax, peak and wane in cyclical fashion, in order to be forgotten and displaced by new half-truths until the next turn of the wheel. While these cycles take place against a steadily rising trend as regards technical and mathematical sophistication and achievement, there appears to be, at any rate in the fields of macroeconomics and international finance, no such positive trend at the conceptual level, or as regards new ideas and insights about the way the economy works.

As a graduate student and beginning assistant professor, I witnessed, and in a minor way contributed to, one of these periodic revivals of the notion that there is one less degree of freedom in monetary, fiscal and financial policy than an innocent bystander might assume. Ott and Ott (1965), Oates (1966), Christ (1967, 1968), Silber (1970), Blinder and Solow (1973), Tobin and Buiter (1976), Branson (1976) and many others all added what was rather misleadingly called the government budget constraint (or worse: the government budget restraint) to the familiar static closed or open IS-LM models. In what follows I shall refer to this "government uses and sources of funds statement" by the descriptively more accurate name of government or public sector budget identity. The constraint on public sector fiscal and financial choices will be reviewed below.

The plan of the paper is as follows. The remainder of this Section reviews the open economy public sector budget identity and characterizes the public sector's intertemporal budget constraint or solvency constraint. Section 2 reviews the fiscal determinants of long-run inflation in the closed economy and points out some problems associated with the casual application of a popular model of Sargent and Wallace to the analysis of hyperinflations. Section 3 returns to the open economy and establishes, contrary to what has been asserted by Obstfeld, that the need to maintain a managed exchange rate regime does not impose an upper limit on the growth rate of domestic credit, if there is no exogenously given lower bound on the stock of foreign reserves. If the regime is viable (i.e. if the government is solvent) for any rate of domestic credit expansion (however low), then it is viable for all rates of domestic credit expansion (however high). Section 4 reviews the collapsing exchange rate literature for the case where there is an exogenously given lower bound on the level of reserves.

Consider the following set of accounts for the monetary authority (or Central Bank) and fiscal authority (or Treasury) of an open economy. The nation's foreign exchange reserves are assumed to be held by the Central Bank. Equation (1) is the monetary authority's budget identity; equation (2) the fiscal authority's budget identity:

$$(1) \quad S - ei_R^* R^* - iD \equiv -e\dot{R}^* - \dot{D} + \dot{M}$$

$$(2) \quad p(G + \dot{K}) + i(B + D) - T - S - p\xi K \equiv \dot{B} + \dot{D}$$

M is the nominal stock of base money (or high-powered money) which is non-interest-bearing. B is the stock of government interest-bearing debt held outside the Central Bank. For simplicity only one kind of debt with a fixed nominal market value in domestic currency and a variable nominal interest rate i is considered. D is the stock of government debt held by the monetary authority, i.e. the stock of domestic credit. The change in D, $\dot{D}$ is domestic credit expansion (dce), the monetary target so dear to the IMF. R^* is the stock of foreign exchange reserves (denominated in foreign currency), i_R^* the interest rate on reserves and e the spot foreign exchange rate. S is the payments made by the Central Bank to the fiscal authority. G is the volume of government consumption spending, K the public capital stock, T taxes net of transfers (excluding payments by the Central Bank to the fiscal authority) and ξ the real cash rate of return on the public sector capital stock. (This need bear no relation whatsoever to the social rate return on the public sector capital stock). To keep life simple, p is the general price level, the price of government consumption and the cost of a unit of public sector capital.

The (often implicit) assumption that the Central Bank pays to the Treasury the entire amount it earns on its portfolio of domestic and foreign assets (net of the costs of running the show, ignored here), yields the familiar identity that

$$(3) \quad \dot{M} \equiv \dot{D} + e\dot{R}^*$$

Contrary to what is generally asserted, (3) cannot be derived by differentiating both sides of the standard Central Bank balance sheet reproduced below.

Standard (incomplete) Central Bank Balance Sheet

Liabilities	Assets
M	D eR^*

Clearly, differentiating both assets and liabilities yields

$$\dot{M} = \dot{D} + e\dot{R}^* + R^*\dot{e}$$

The last term, capital gains (when positive) or losses (when negative) on the stock of foreign exchange reserves due to changes in the exchange rate, has to be got rid of. This is accomplished by adding the missing entry, Central Bank net worth, W, to the liability side of the balance sheet. With the further assumption that capital gains and losses (here only due to exchange rate changes, but in more realistic models also associated with changes in the market value of long-dated domestic government debt) are absorbed into net worth ($\dot{W} \equiv R^*\dot{e}$), i.e. are not "monetized", equation (3) emerges triumphant.

Adding (1) and (2) together yields the consolidated public sector budget identity (4)

$$(4)\quad p(G + \dot{K}) + iB - i_R^* eR^* - p\xi K - T \equiv \dot{M} - e\dot{R}^* + \dot{B}$$

With a bit of rearranging, the public sector budget identity (4) can be written as the differential equation in $B - pK - eR^*$ given in equation (5). $\pi \equiv \frac{\dot{p}}{p}$ denotes the rate of inflation and $\epsilon \equiv \frac{\dot{e}}{e}$ the rate of exchange rate depreciation.

$$(5) \quad \frac{d}{dt}(B-pK-eR^*) \equiv i(B-pK-eR^*) - \left[T+\dot{M}-pG-(i-(\xi+\pi))pK-(i-(i_R^*+\epsilon))eR^*\right]$$

Solving (5) forward in time and imposing the terminal condition given in (6), finally gives us a government budget constraint. Equation (7) represents the government's intertemporal or present value budget constraint or its solvency constraint. (See Buiter (1983a, b) and Buiter (1985a)).

$$(6) \quad \lim_{v\to\infty} \left[B(v) - p(v)K(v) - e(v)R^*(v)\right] \exp\left[-\int_t^v i(u)du\right] \leq 0$$

$$(7) \quad \int_t^\infty T(s)\exp\left[-\int_t^s i(u)du\right]ds + \int_t^\infty \dot{M}(s)\exp\left[-\int_t^s i(u)du\right]ds$$

$$\geq B(t) - p(t)K(t) - e(t)R^*(t)$$

$$+ \int_t^\infty p(s)\,G(s)\exp\left[-\int_t^s i(u)du\right]ds$$

$$+ \int_t^\infty \left[i(s) - (\xi(s) + \pi(s))\right] p(s)K(s)\exp\left[-\int_t^s i(u)du\right]ds$$

$$+ \int_t^\infty \left[i(s) - (i_R^*(s) + \epsilon(s))\right] e(s)R^*(s)\exp\left[-\int_t^s i(u)du\right]ds.$$

For simplicity I'll assume in most of what follows, that (6) and (7) hold as strict equalities.

Equation (6) states that the present value of the government's net non-monetary tangible liabilities should ultimately be non-negative.[1] If (6) is violated, the public sector never repays its debts; instead it plays a Ponzi game by borrowing more in order to service its already outstanding debt. If (6) is satisfied, the growth rate of the nominal value of the government's debt ultimately is less than the nominal interest rate. Equivalent statements are that the growth rate of the real value of the public debt ultimately is less than the real interest rate $r \equiv i-\pi$, or that the growth rate of the public debt-domestic product ratio ultimately is less than $r-n$, where n is the trend growth rate of real domestic output. If (6) holds, then ultimately the comprehensive primary (non-interest) government deficit (the second term on the right-hand-side of (5)), must become a surplus. While the validity of (6) is not uncontroversial (why should it be required to hold e.g. if the growth rate of real output systematically exceeds the real interest rate?), I'll assume it to be satisfied in what follows. Note that even if (6) holds, net public debt and interest on the public

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[1] It can easily be shown using integration by parts that (6) could be replaced by (6') $\lim_{v\to\infty} \left[M(v)+B(v)-p(v)K(v)-e(v)R^{*}(v)\right] \exp(-\int_t^v i(u)du) \leq 0$

provided the term $\int_t^{\infty} \dot{M}(s) \exp\left[-\int_t^s i(u)du\right]ds$ in (7) is replaced by

$\int_t^{\infty} i(s)M(s) \exp\left[-\int_t^s i(u)du\right]ds-M(t)$. (See Buiter (1983 a, b)).

debt can grow without bound, even relative to domestic output (if the growth rate of net nominal debt, while ultimately less than i (to satisfy (6)) exceeds $n + \pi$). This can occur because the growing government interest bill represents growing interest income to the private sector and therefore a growing tax base for the government. If lump sum (non-distortionary) taxes can be raised one-for-one with the increase in debt service, we could, as pointed out by McCallum (1984) and Obstfeld (1986) have an exploding, but sustainable public debt-GDP ratio. Both the distortionary nature of real world taxes and the existence of political and administrative constraints on the ability indefinitely to raise taxes one-for-one with pre-tax income, suggest that the case of the sustainable explosive net public debt-GDP ratio is an example of economics strictly for economists only. In what follows it will often be safe to restrict the analysis to the case of a net public debt-GDP ratio that is bounded from above.

Let us review briefly the items in the government's solvency constraint (7). It states that the present discounted value of future explicit taxes net of transfers T plus the present discounted value of future money issues or seigniorage $\dot{M}$ should be sufficient to cover the outstanding net tangible non-monetary liabilities of the government ($B-pK-eR^*$) plus the present discounted value of future government consumption spending pG. In addition, current and future tax and seigniorage should cover any future drain (gain) on (to) the Exchequer due to the opportunity cost of government borrowing i exceeding (falling short of) the cash flow rate of return generated by public sector capital, $\zeta+\pi$, and / or due to the opportunity cost of government borrowing exceeding (falling short of) the pecuniary rate of return on international reserves, $i_R^*+\epsilon$. Note e.g. that if $i = \zeta+\pi$, the existing stock of public sector capital is entered "at cost" in the public sector balance sheet as an asset, and future public sector capital formation is not a charge on the government's solvency: unlike public consumption, it finances itself in the long run. Also note that in the case of an ideal gold standard, $i_R^* = 0$ and $\epsilon = 0$. By holding a "barren" asset with a zero nominal rate of return the government, presumably in order to maintain its international liquidity, weakens its solvency if the nominal interest rate on its debt i is positive, as I shall assume henceforth. Borrowing to defend the exchange rate (increasing B and eR^* by equal amounts) will then require either a reduction in the present discounted value of the government's consumption program, an increase in the present value of future taxes net of transfers or an increase in the present value of future seigniorage in order to maintain solvency (see Buiter (1986a)).

2. The Fiscal Roots of Inflation in A Closed Economy

Somewhere in the early 1980's the "New Classical" macroeconomics, led by Thomas Sargent and Neil Wallace, rediscovered the importance of the government solvency constraint for monetary theory. It is possible to date this quite precisely, because Sargent's well-known textbook, Macroeconomic Theory (Sargent (1979)) still contains a section titled "In Defense of Keynesian Analyses That "Ignore" the Government's Budget Constraint" (Sargent (1979, pp 107-111)), while the first of the papers analysing the fiscal origins of inflation (both hyper- and moderate) appeared in 1981 and 1982 (see Sargent and Wallace (1981,1984), Sargent (1982), and Sargent (1983)). Ironically, the New Classical rediscovery of the government budget identity virtually coincided with the New Cambridge rediscovery of the same identity by Godley and Cripps (1983).

The essence of Sargent and Wallace's argument (Sargent and Wallace (1984)), is very simple. Throwing out foreign exchange reserves for the moment, the public debt-GDP ratio, b, and the public sector capital stock - GDP ratio, k, are kept constant. In the case of public debt, this may reflect the fact that the debt burden has reached its upper limit, because of economic or political limits on the government's ability to tax or for other reasons. Nominal debt issues, $\dot{B}$, are therefore just sufficient to offset the decline in the debt-GDP ratio that would otherwise occur because of inflation or GDP growth ($\dot{B} = (n+\pi)B$). Similarly, $\dot{K} = nK$. For simplicity we consider only the case where the share of exhaustive public spending in GDP, g, and the share of taxes net of transfers in GDP, τ, are constant. This permits us to obtain the following expression for the proportional rate of growth of the nominal money stock, $\mu \equiv \frac{\dot{M}}{M}$

$$(8) \quad \mu \equiv v\left[g-\tau + (r-\xi)k + (r-n)(b-k)\right]$$

v denotes the income velocity of circulation of money, $v \equiv \frac{pY}{M}$ where Y is real output.

The expression in square brackets on the right hand side of (8) is a public sector deficit measure, but not the standard public sector financial deficit (as a proportion of GDP) that is collected by the national income and flow of funds statisticians. First the conventional deficit is "corrected" for the effects of inflation on the debt-GDP ratio and for the effects of real growth on the debt-GDP and public sector capital-GDP ratio. The interest component is therefore not $i(b-k)$, as it would be in the conventional accounts, but $(r-n)(b-k)$. Second, the primary (or non-interest) deficit in (8) only includes part of public sector exhaustive spending. Public sector capital formation is excluded and only consumption spending is included. (Transfers, subsidies, etc. are of course negative entries in τ). Finally, allowance is made for any difference between the government's opportunity cost of borrowing and the cash rate of return it obtains from the public sector capital stock (this cash return could of course be negative). Thus the deficit that, given velocity, governs the long-run or eventual rate of growth of the high-powered money stock is the inflation-and-real-growth-corrected, return-on-public sector capital-adjusted-government current account (or consumption account) deficit. (See Buiter (1984)).

Given velocity, an increase in this "underlying" deficit will raise monetary growth and thus, sooner or later, inflation, since π is given by

$$(9) \quad \pi \equiv \mu - n + \frac{\dot{v}}{v}$$

In the long run, velocity settles down. Assuming that real growth in the long run is independent of the rate of inflation, the long-run rate of inflation varies one-for-one with the rate of growth of money. Specifically, Sargent and Wallace (1984) focus on policies that raise the debt burden b. Provided the interest rate exceeds the growth rate of output and barring a reduction in the primary consumption deficit $\delta \equiv g-\tau+(r-\xi)k$ an increase in the debt burden b will raise inflation. Reductions in monetary growth without changes in the primary deficit will force the authorities to borrow more to satisfy the budget identity. The need to service the debt will eventually, after the debt burden settles down at a higher level than it would have reached without the earlier reduction in money growth, compel an eventual rate of monetary growth rate which is higher than it would otherwise have been. Thus, with constant velocity, lower money growth (and thus lower inflation) <u>now</u> without a reduction in the primary consumption deficit, means higher money growth and higher inflation <u>in the future</u>.

If velocity is endogenous, an even less friendly outcome may occur. A standard assumption is that velocity is an increasing function of the nominal interest rate, e.g.

$$(10) \quad v^{-1} = \gamma_1 - \gamma_2(r+\dot{\pi}) \qquad \gamma_1 > 0; \ \gamma_2 \geq 0$$

Sargent and Wallace (1984) show that in a very simple, very classical model with an exogenous real interest rate and exogenous output the following may happen: The response to an early reduction in money growth followed by a later increase in money growth (due to the higher debt service incurred through the increased borrowing during the period of lower money growth) may be higher inflation both earlier and later. The reason is that with endogenous velocity, a freely flexible price level and rational, forward-looking expectations, the rate of inflation today is a forward-looking exponentially weighted moving average of all future rates of money growth, i.e. current inflation is like a "present discounted value" of future money growth. It is possible that, in this present value calculation, the early lower rates of money growth are dominated by the later higher rates of money growth, leading to higher inflation throughout as a result of a decision to lower money growth in the near term without implementing a "fundamental" fiscal correction, i.e. a reduction in the primary consumption deficit.

With endogenous velocity, will a permanent increase in the underlying deficit necessarily be associated with a higher rate of inflation? Here the model begins to creak a bit. It is easily checked that the non-linear model of equations (8), (9) and (10), with r, n, ξ, k, b, g and τ exogenous can have zero, one or two stationary solutions for π. When there are two solutions, the low inflation equilibrium is locally unstable while the high inflation equilibrium is locally stable. Following the precedent of linear rational expectations models with a single non-predetermined state variable (velocity or the price level), Sargent and Wallace (1984) focussed on the locally unstable, low inflation equilibrium. For this equilibrium, a permanent increase in the underlying deficit does indeed raise inflation. If the locally stable high inflation equilibrium had been chosen instead, a permanently higher fundamental deficit would, in the long run, have been associated with a lower rate of inflation. The analysis of the transitional dynamics in this case would have suffered from the non-uniqueness problem that is always present when a non-predetermined variable is required to converge to a (locally) stable equilibrium: there is a continuum of initial values of $\bar{v}$ or p that are consistent with convergence to the steady state.

The model begins to creak even more loudly when it is used to analyse hyperinflations. The spirit of this model did indeed motivate Sargent's well-known study on this subject (Sargent (1982) and (1986)). There is unfortunately no way in this model to generate the kind of explosive, unstable behavior characteristic of hyperinflations. When there are two stationary solutions, the only explosive behavior is with reference to (and away from) the locally unstable low inflation equilibrium. However, this unstable behavior represents an implosion rather than an explosion. The model generates a steadily growing rate of deflation.

Successively larger values of the underlying deficit will move the economy from the range characterized by two stationary equilibria, through the range with one stationary equilibrium into the range with no stationary equilibrium. Here there is again plenty of unstable behavior but it too takes the form of "hyperdeflations" rather than of hyperinflations. One attempt to save the model for the analysis of hyperinflations is to restrict the analysis to the range of underlying deficits for which there are two stationary equilibria and to call a hyperinflation the transition from the low inflation stationary equilibrium to the high inflation stationary equilibrium. This, however, is silly. Both stationary equilibria are just that: well-behaved long-run equilibria with constant, finite rates of inflation. There is nothing "runaway" or explosive about the transition from the low to the high inflation steady state. In fact the move from the low inflation equilibrium to the high inflation equilibrium involves initially an accelerating rate of inflation ($\dot{\pi}$ rises) but ultimately a decelerating rate of inflation ($\dot{\pi}$ falls) with $\dot{\pi}$ smoothly approaching zero as the economy eases into the high inflation steady state. (See the transition from π_L to π_H in Figure 1).

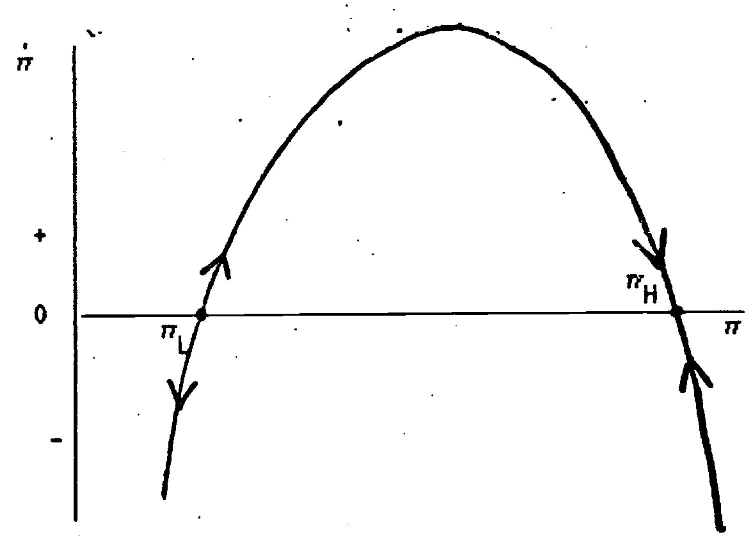

Figure 1

To describe the traverse from π_L to π_H as a hyperinflation is akin to describing a mild summer breeze as a hurricane. (See also Buiter (1985b).

Where does this leave us? An equation like (8) provides a useful benchmark for evaluating the long-term money growth consequences of a given fiscal-financial package. Apart from specifying the fiscal-financial benchmarks (g, τ, k and b), we must be able to determine velocity, v, the real interest rate r and the cash rate of return on public sector capital $\bar{\xi}$, in order to calculate μ. The obvious conclusion in a constant-velocity framework, that a higher underlying deficit implies a higher eventual rate of growth of money, becomes ambiguous even in the simple rational-expectations, flexible price level, exogenous output version of the endogenous velocity model. Unlike the adaptive expectations (Cagan (1956)) version of this model, the Sargent and Wallace (1984) rational expectations version cannot generate hyperinflations. Next we extend these insights to the case of an open economy with a managed exchange rate.

3. What Constrains Domestic Credit Expansion Under a Managed Exchange Rate?

A managed exchange rate regime is any rule for setting the nominal spot exchange rate. In what follows I restrict the analysis to open-loop rules, and withing this class of rules to those involving a constant proportional rate of depreciation or appreciation of the nominal spot exchange rate. Most of the results will apply unchanged to more general closed-loop or feedback rules for determining the exchange rate. I assume there to be a unified spot exchange market and no capital controls or other foreign exchange restrictions. Unless otherwise indicated, there is perfect capital mobility and perfect substitutability between foreign bonds and domestic bonds. Uncovered interest parity (UIP) therefore holds. If i^* denotes the nominal interest rate on riskless foreign bonds, then

$$(11) \quad i = i^* + \epsilon \; [2]$$

I ignore direct currency substitution. The formal analysis goes through even with direct currency substitution, as long as it is less than perfect. With a managed exchange rate, the stock of foreign exchange reserves adjusts passively to reconcile the private sector's demand for money and the stock of domestic credit chosen by the monetary authorities. Money demand equals money supply at each instant. When the authorities decide no longer to supply the foreign exchange demanded at the prevailing exchange rate, the managed exchange rate regime collapses. Many variants exist on what takes its place.

I shall deal only with he simplest case of a free float of indefinite duration. A few of the possible alternatives are: a

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[2] Here, as elsewhere, rational expectations are assumed. In the not explicitly stochastic formal analysis summarized here, actual and expected depreciation therefore coincide. Uncertainty is considered explicitly in many of the papers on the subject, e.g. Flood and Garber (1984), Buiter (1986a, b), Grilli (1986) etc.

temporary float followed by a new managed exchange rate; a discrete devaluation (or "maxi-devaluation") followed by the adoption of another exchange rate management rule; the imposition of foreign exchange controls and/or a two-tier foreign exchange market etc.

What limitations does the need to maintain a managed exchange rate regime put on the domestic credit expansion (dce) policies that can be pursued by the authorities? First consider the case considered by Obstfeld (1986a) where $i_R^* = i^* = i-\epsilon$ and there is therefore no financial opportunity cost to the government of holding foreign exchange reserves. In this case, the only reason why the government could be prevented from running down one of its financial assets to an arbitrarily large negative value is that its overall financial position is insolvent. If that happens, the government runs out of credit everywhere, i.e. it encounters a limitation on its ability to borrow in any form. Barring insolvency, if reserves are required, the government can borrow them abroad. An infinite credit line is no problem in such a world. There is no reason, in orther words, why reserves cannot become an arbitrarily large negative number. Alternatively, one could visualize the authorities as acquiring an infinite stock of reserves at the inception of the managed exchange rate regime, financed by issuing an infinite amount of debt with no net effect on public sector net worth and solvency. To see this, consider equations (6) and (7). Assume given paths of taxes-net-of-transfers T(s), public consumption spending G(s) and public sector capital formation $\dot{K}(s)$ (and thus K(s). The interest rate i(s) is given by (11) and the exogenously given path of the nominal exchange rate. For simplicity, let ξ and real output Y be exogenous and let the domestic price level be given by the law of one price, i.e.

(12) $p = p^{*}e$

p^{*} is the exogenous world price level. The analysis can be extended to incorporate non-traded goods, endogenous terms of trade and sluggish price adjustment.

The answer to the question "what limit on dce policies are imposed by the need to maintain a managed exchange rate is: "none whatsoever." Of course the real value of seigniorage that can be extracted by the monetary authorities may be a function of the path of the nominal exchange rate (i.e. specifically of the (expected) proportional rate of depreciation of the exchange rate), but this has nothing to do with the choice of dce for a given path of the exchange rate. Consider the budget identity in equation (5) again. With the assumptions made so far, everything on the right-hand-side of that equation is determined. (Note from equation (10) that with r and ϵ constant and with foreign inflation denoted π^{*}, seigniorage is given by $\dot{M} = (n+\epsilon+\pi)M)$. With the path of K also given, the fiscal program, and the growth in the demand for money fully determine the behavior of the government's non-monetary financial liabilities, $B-eR^{*}$. Government solvency requires, from equation (6) (and ignoring public sector capital) that $B-eR^{*}$ grows ultimately at a proportional rate less than the nominal interest rate. The behavior of $B-eR^{*}$ is quite independent of the path of domestic credit expansion, which only determines the composition of the <u>given</u> change in $B-eR^{*}$ between changes in B and changes in $-eR^{*}$. Specifically, higher dce will, since $e\dot{R}^* \equiv \dot{M}-\dot{D}$, lead to lower $\dot{R}^*$ and lower $\dot{B}$, with $\dot{B}-e\dot{R}^*$ unchanged: the authorities run down foreign exchange reserves more rapidly but borrow less. Specifically, and in contradiction to the analysis of Obstfeld (1986a, pp. 9-12), domestic credit can grow at a proportional rate in excess of the nominal interest rate; this will of course lead to reserve losses, possibly at a proportional rate in excess of the nominal interest rate. What matters for solvency, however, is the ultimate proportional growth rate of $B-eR^*$. If this is less than the nominal interest rate for any rate of dce it will be less than the nominal interest rate for all rates of dce, however high, because solvency when $i_R^* = i^*$ is independent of the dce policy. By not considering government borrowing, (other than by running down foreign exchange reserves), the asymptotic constraint on the growth rate of $B-eR^*$ becomes a constraint on $-eR^*$ in Obstfeld's analysis. In other words, with $\dot{B} \equiv 0$, changes in dce are <u>ipso facto</u> changes in the public sector deficit. With seigniorage independent of dce under a managed exchangea rate regime, changes in dce are also <u>ipso facto</u> changes in the rate at which reserves are run down. With $\dot{B} \equiv 0$, the consequences for solvency of a change in the public sector deficit are erroneously attributed to the change in dce.

On the right hand side of equation (7), the last term (which involves R^*) will vanish when $i_R^* = i^* = i-\epsilon$. Apart from this last term, R^* enters only with B as $B-eR^*$. This indicates that any stock-shift open market sale or purchase of government debt will, since it leaves $B-eR^*$ unchanged, leave the solvency of the government's fiscal-financial program unaffected.

It could of course happen that equation (6) is violated for the given fiscal program (T(s), G(s), $\dot{K}$(s)) and for the path of seigniorage ($\dot{M}$(s)) generated by the exchange rate management rule chosen by the authorities. Given the exchange rate rule, the government then is insolvent for any dce rate. Depending on the nature of the money demand function, i.e. on the way in which seigniorage varies with the chosen exchange rate path (or with the exchange rate path generated when the exchange rate is left to float freely) a different exchange rate rule (or a free or dirty float) may restore solvency to the government even without changes in the paths of current and future T, G or $\dot{K}$. The money demand function given in equation (10) e.g. has real seigniorage varying with the nominal interest rate. All this, however, doesn't change the proposition that if reserves carry the same interest rate as government debt, the solvency of a given managed exchange rate regime is not contingent on the growth rate of domestic credit.

Now consider the case where reserves earn less than government debt. For simplicity consider the case where $i_R^* = \epsilon = 0$, as would be the case with an ideal gold standard, and $i > 0$. From equation (7) it is clear that setting oneself up with a larger stock of reserves (let alone an infinitely large stock) now hurts solvency. A stock-shift open market sale of government debt (equal increases in B and eR^*) will now, for a given path of dce, raise the value of the last term on the right-hand-side of equation (7). Since a non-interest-bearing asset is acquired by issuing an interest-bearing liability, solvency is impaired.

On the other hand, given any initial stocks of debt, capital and reserves, and given future trajectories for T, G and $\dot{K}$, higher rates of domestic credit expansion will improve solvency, by permitting the government to run down non-interest-bearing foreign exchange reserves rather than issue interest-bearing debt. When $i_R^* = 0$, equations (6) and (7) can be replaced by:

$$(6') \quad \lim_{v \to \infty} \left[B(v) - p(v)K(v)\right] \cdot \exp\left[-\int_t^v i(u)du\right] \leq 0$$

and

$$(7') \quad \int_t^{\infty} T(s) \exp\left[-\int_t^s i(u)du\right]ds + \int_t^{\infty} \dot{D}(s) \exp\left[-\int_t^s i(u)du\right]ds$$

$$\geq B(t) - p(t)K(t)$$

$$+ \int_t^{\infty} p(s) G(s) \exp\left[-\int_t^s i(u)du\right]ds$$

$$+ \int_t^{\infty} \left[i(s) - (\xi(s) + \pi(s))\right] p(s)K(s) \exp\left[-\int_t^s i(u)du\right]ds$$

Equations (6') and (7') and the budget identity

$$\frac{d}{dt}(B-pK) \equiv i(B-pK) - [T-pG-(i-(\xi+\pi))pK] - \dot{D}$$

make it apparent that government solvency again doesn't put any upper limits on dce rates whatsoever. Quite the contrary, by choosing a sufficiently high rate of dce, otherwise insolvent fiscal-financial plans can be made solvent. Why should large negative reserve holdings matter, when the government's balance sheet is strengthened by substituting reserve financing for borrowing? Cet.par. higher dce makes it easier for debt (B) to grow (ultimately) at a rate less than i and thus to satisfy (6′).

The upshot is that the government budget identity and solvency constraint literature really hasn′t taught us anything about the need for international reserves, the reasons for foreign exchange rate crises and the fiscal and dce prerequisites for a viable managed exchange rate regime. When $i_R = i^* = i-\epsilon$, one would not expect to see an exchange rate crisis that isn′t also a debt crisis. A selling attack on the currency should be accompanied by the government′s interest-bearing debt (even when this is denominated in terms of foreign currency, index-linked or whatnot) selling at a discount relative to its nominal parity. Here an exchange rate crisis is a purely fiscal phenomenon. When $i_R^* = 0$, and more generally when $i_R^* < i^* = i-\epsilon$, borrowing worsens future deficits while running down reserves doesn′t, and the reasons for foreign exchange crises that aren′t also solvency crises are even less apparent.

A satisfactory theory of foreign exchange crises in spite of solvency requires two ingredients, both missing thus far. First, a reason for the existence of a specific class of financial or real claims required in international exchange and distinct from general credit. Second, a reason given why these ′required′ reserves cannot be borrowed instantaneously. Deeper theory is needed here than is offered by the ad-hoc and question-begging open economy cash-in-advance model, to provide acceptable microeconomic foundations of the alleged unique transactions role of certain reserve assets and of the alleged inferior liquidity characteristics of other financial or real claims, (some of which may be liabilities of the same agent that issue the reserves). Reserve assets with these two features will indeed provide a rationale for the existence of a lower bound on the stock of reserves at any instant. Limits on the government's ability to tax will set a finite upper bound on the government's net-interest-bearing debt-output ratio, but this involves an upper limit on $B-eR^*$ when $i_R^* = i^*$ and an upper limit on B when $i_R^* = 0$, and never a lower limit on R^*.

Given such a limit, it becomes possible to generate scenarios in which there could be a run on the currency without a default risk discount on the public debt.

Advanced industrial countries like the Netherlands, which are tightly integrated into a sophisticated system of international financial markets do, however, seem to be poorly characterized by a model in which significant penalties are attached to holding inadequate quantities of a limited class of international reserve assets or in which there are non-trivial delays in the process through which the Central Bank can raise readily spendable resources. Indeed the very meaning of "international reserves" becomes fuzzy for such countries, as the official balance sheet contains both highly liquid, market-rates-of-interest-bearing-assets and highly liquid, market-rates-of-interest-bearing-liabilities and as unused lines of credit, swap arrangements etc. are available to back the Bank's resolve to defend the parity. (See Dooley (1986) and Buiter (1986c)). For such a country a foreign exchange crisis is neither more nor less than a fiscal or solvency crisis, which doesn't, however, make it any easier to solve.

The final section reviews some of the results derived in models where an ad-hoc exogenous lower bound on R^*, which without loss of generality I choose to be zero, is assumed to exist.

4. Running Out of Reserves

Consider the case of a small open economy which manages the exchange rate (i.e. fixes ϵ at some constant level) as long as the stock of international reserves is positive, but adopts a free float once reserves fall below zero.

A quick check on the viability of the managed exchange rate regime involves the comparison of the eventual rate of growth of the money stock from equation (8), μ^* say, and the rate of growth of money demand under the managed rate, $\hat{\mu} = \pi^* + \epsilon + n - \frac{\dot{v}}{v}$, where, from (10) $\dot{v} = 0$ if $r + \pi + \epsilon$ is constant. If μ^* exceeds $\hat{\mu}$ the reserve threshold will be crossed eventually, and the regime will collapse.

It is, however, possible to be more precise about the nature (including the magnitude) and the timing of a collapse. It is easiest to think of this in the context of a "structurally weak" currency i.e. one for which dce systematically exceeds money demand growth (though both may be stochastic). An eventual collapse is therefore certain.

In the case of structurally weak currency, the (endogenous) expected proportional rate of currency depreciation after the collapse will typically be higher than the exogenous proportional rate of depreciation of the managed exchange rate. With UIP this means that the nominal interest rate increases at the moment the managed exchange rate regime collapses. If the demand for money is a declining function of the nominal rate of interest, there will be a stock-shift reduction in the demand for money at the moment the managed exchange rate regime collapses. Given dce, this stock-shift reduction in money demand is reflected in a stock-shift reduction in the stock of reserves to the critical threshold level. This final stock-shift purchase by the private sector of the monetary authority's remaining foreign exchange reserves has been called a "speculative attack." Even though the exogenous shocks to money demand and dce may be small, the final depletion of the official reserves includes an endogenous component (reflecting the increase in the nominal interest rate and the interest sensitivity of money demand) which may be large relative to the final exogenous shocks that triggered the attack. The top panel of Figure 2 illustrates this for the case of a continuous time model where the instantaneous exogenous shocks are infintesimal relative to the outstanding stock of reserves. Except at the moment the attack occurs, at t_1, the stock of reserves declines in a continuous fashion. (See Krugman (1979), Flood and Garber (1984), Obstfeld (1984), Buiter (1986a), Grilli (1986), Garber and Grilli (1986), Connolly and Taylor (1984)).

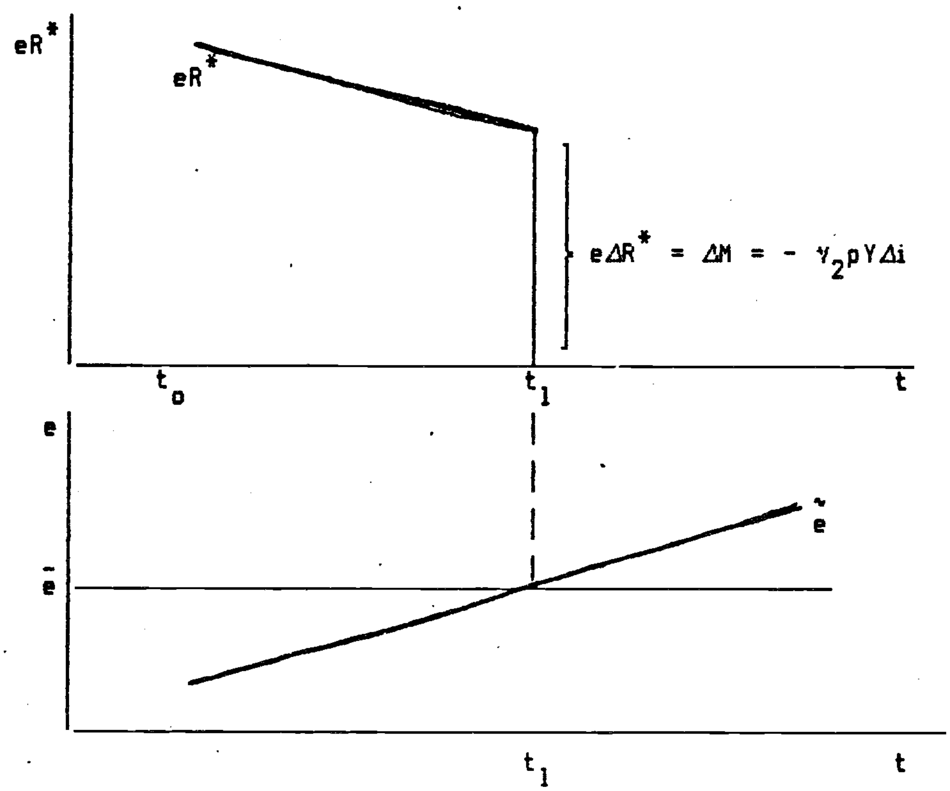

Figure 2

A convenient device for calculating the timing (or in stochastic models the probability density function of the timing) of a collapse is the "shadow floating exchange rate," $\tilde{e}$. The shadow floating exchange rate at time t is the floating exchange rate that would prevail at time t if the managed exchange rate regime were to collapse at that instant. If the dce process does not change if and when the managed exchange rate system collapses, the managed regime is viable as long as the shadow exchange rate is below the managed rate but collapses the first time the shadow floating rate exceeds the managed rate. The lower panel in Figure 2 illustrates this for the case of a fixed exchange rate, $\bar{e}$.

The reason is that private speculators would, if $\tilde{e} > \bar{e}$, buy up the remaining foreign exchange reserves of the authorities and force an abandonment of the managed rate. The floating rate that would result would be $\tilde{e} > \bar{e}$, thus giving the speculators handsome excess returns on their purchase of the foreign exchange reserves. The "efficient markets" requirement that there can be no anticipated excess returns locates the date of the collapse at the first crossing of $\bar{e}$ by $\tilde{e}$ from below. Note the strong parallels with the literature on the collapse of price stabilization schemes for commodities, through buffer stocks etc. The collapsing exchange rate regime literature is indeed a (recognized) offspring of this older literature (see especially Salant and Henderson (1978) and Salant (1983)).

There is an important caveat here, as was pointed out by Obstfeld in an elegant paper (Obstfeld (1986b)), which applied a chain of reasoning similar to that used by Diamond and Dybvig (1983) in their analysis of "commercial bank runs." If the nature of the dce process varies according as to whether there is a managed exchange rate or a freely floating exchange rate in effect, there may be multiple equilibria and "bootstrap" or rational and self-fulfilling balance of payments crises. Consider the case where in the absence of an attack, the fixed exchange rate regime is indefinitely viable. In the absence of a speculative attack, e.g., the dce process and the growth of money demand are such that the stock of reserves follows a stationary (or stable) first-order autoregressive process with random shocks that have bounded support, i.e.

$$(13) \quad R_t^* = \alpha R_{t-1}^* + u_t, \quad |\alpha| < 1, \ \underline{u} < u_t < \bar{u}$$

Given this specification, R_t^* will always be above $\underline{u}(1-\alpha)^{-1}$ and below $\bar{u}(1-\alpha)^{-1}$ (assuming it started off between these two values). If the reserve threshold is below $\underline{u}(1-\alpha)^{-1}$, there can be no "natural collapse" of the fixed exchange rate, i.e. no collapse without a speculative attack. Could a speculative attack ever be rational under these circumstances? Consider the case where, if the fixed exchange rate regime were to collapse, the authorities would change their dce policy from the restrained one which generates (13) to a wildly expansionary one which would generate a very much higher expected rate of exchange depreciation and a very much higher nominal interest rate than under the fixed rate. It is now possible, as Obstfeld (1986b) shows, that if private agents expect a run to take place in a period, it will be profitable for them to participate in it, because the shadow exchange rate in that period exceeds the fixed exchange rate. If they don't expect a run, they will refrain from buying up the authorities' remaining reserves, and this decision too will be validated because without a run reserves stay above their minimum threshold level. The events that trigger the belief that a run will occur can be totally extraneous. Since what permits such self-rationalizing attacks is the expectations-validating dce behavior of the authorities in the event of an attack, policy makers can avoid them by abandoning their policy of responding to collapses in that manner.

In Buiter (1986a) dce is broken down into its components: the primary deficit, interest payments and government lending. Borrowing to defend the exchange rate, i.e. holding constant the primary deficit and engaging in a once-off stock-shift open market sale, will, if reserves earn an interest rate below the rate on government debt, lower the likelihood of an early collapse (by raising the level of the stock of reserves) but increase the likelihood of a collapse in the longer run (by raising the rate at which reserves are being run down). If there is no financial opportunity cost, as pointed out before, an open market sale will lower the likelihood of a collapse for all future periods.

Finally, in Buiter (1986b), which develops an approach initiated in Grilli (1986), the collapsing managed exchange rate regime literature is put in a (very simple) two-country setting, where speculative selling attacks against either currency can force the system off the managed standard. When holding reserves involves a pecuniary opportunity cost, dce management in both countries is required to avoid crossing reserve thresholds and management of the primary deficits is required to avoid the possibility of reserve stabilization leading to public debt destabilization. In a stochastic environment even the policy combination of 1) no sterilization of reserve gains or losses and 2) continuously balanced budgets, may not be capable of safeguarding both the managed exchange rate system and fiscal solvency.

It should not come as a surprise that there is nothing automatic about the viability of managed exchange rate systems, even one as rarified as an idealized gold standard. When survival of the exchange rate system is defined in terms of reserve thresholds and solvency in terms of a debt burden threshold, it is to be expected that dce and primary deficit policies that are consistent with survival should "feed back" from these stocks or stock-flow ratios. Open-loop dce and fiscal policies in a stochastic environment are bound to spell disaster.

5. Conclusion.

In a recent paper, Helpman and Razin (1986) make the following apt observation.

> "It is now understood that exchange rates cannot be managed without the pursuit of other policies which make the entire package internally consistent. ... Governments or central banks can only temporarily target exchange rates without giving due attention to other policies. However, eventually they have to choose or are forced to choose measures which validate ex-post the feasibility of

their exchange rate policy. These measures will typically be anticipated by economic agents during the initial periods of exchange rate management, thereby generating immediate pressure in various markets. Hence, the success of exchange rate management policy depends to a large extent on other policies, commitments to future policies, and their effects on expectations." (Helpman and Razin (1986), p. 1)

This paper has tried to make concrete the points made by Helpman and Razin in the above quote, and it underwrites completely their general argument. The specific propositions that emerge do, however, contradict or qualify a certain amount of recent conventional wisdom. One such qualification applies to the effect of larger public sector deficits on the rate of inflation when velocity is endogenous. A rather basic flaw in some popular models of hyperinflation also stands out. The meaning and relevance of reserve thresholds in a world with solvent governments than can borrow at home and abroad is still unclear. A recent proposition that the government solvency constraint implies a limit on dce growth if a managed exchange rate regime is to survive appears incorrect.

One encouraging (or surprising?) fact is that managed exchange rate regimes have been in existence for long periods of time, including the present, in spite of this absence of a satisfactory "deep theory." The analogy with driving a car comes to mind: I can get it to work although I haven't a clue why or how it works. The difference is that in the case of cars there are (I presume) those who truly do know and understand. As regards managed exchange rate regimes I'm not so sure.

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