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STABILIZATION WITH EXCHANGE RATE MANAGEMENT

by

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Abstract

Stabilization programs in open economies typically consist of two stages. In the first stage the rate of currency devaluation is reduced without a sufficient fiscal adjustment to eliminate the deficit that causes continued growth of debt and loss of reserves. Only later, at a second stage, is this followed by either an abandonment of exchange rate management or by a sufficiently large cut in the fiscal deficit. We study how different second-stage policy changes affect economic dynamics during the first stage, both when the timing of a change is known, and when it is uncertain. These changes include tax increases, budget cuts on traded and nontraded goods, and increases in the growth rate of money.

Stabilization with Exchange Rate Management

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1. Introduction

Numerous countries have attempted to enact stabilization programs by fixing the exchange rate (or a table of future devaluations) without immediately eliminating the large fiscal deficits which necessitated eventual policy changes. The varying experience that countries have had suggests a need to analyze carefully the effect of expectations of future fiscal and monetary policy on the success of such programs. Israel, for example, saw several attempts to manage the exchange rate in order to reduce inflation, the last one being the current stabilization program that was enacted in July 1985. The latest program consisted of a cut in the budget deficit and a freeze of the exchange rate following a maxi devaluation (other measures, like price and wage controls, were also undertaken). It was clear in July 1985 (and it is even clearer at the time of our writing) that the remaining budget deficit is inconsistent with a fixed exchange rate in the longer run. For this reason a policy change is expected.

To take another example, the experiences of Chile and Argentina beginning in the late 1970's with stabilization programs, including a table of fixed devaluations and a period of a fixed exchange rate, were not identical. The very different fiscal programs which went along with these stabilizations played a large part in explaining the different measures of success the two countries experienced (see Baxter (1985). For a comparison of Argentina, Chile and Israel see Helpman and Leiderman (1986)).

It is therefore reasonable to think about actual stabilization programs in open economies as typically consisting of two stages. In the first stage the rate of currency devaluation is reduced, sometimes to zero, without a sufficient cut in spending or tax increase to eliminate the deficit which made previous policy infeasible or undesirable. However, the remaining budget deficit is typically not consistent with the maintained exchange rate policy and inflation target forever, because it implies an ever-growing level of public debt and\or a continual loss of foreign currency reserves. Therefore, this first stage will induce expectations of a further change in policy. Either the exchange rate policy will have to be abandoned, or the budget deficit will have to be cut to make it consistent with the exchange rate policy. The dynamic behavior of the economy before the further policy change will depend on expectations the public holds about it. Expectations about the timing of the policy change will be especially important. In what follows we concentrate on an exchange rate policy that consists of fixing the exchange rate, as in the Israeli program of July 1985.

Historically, the literature on the effects of fixing the exchange rate in a way that is infeasible in the long run has concentrated on the implications of its eventual abandonment, and the pre-abandonment dynamics induced by the expectation of this unavoidable policy change. This approach was pioneered by Krugman (1979), and was studied later by Flood and Garber (1984), Obstfeld (1984) and Calvo (1985) amongst others. Our stress in this paper is complementary to that which has been presented in the literature so far. We consider a policy change in the second stage consisting of a fiscal change, a tax increase or a cut on spending of traded or nontraded goods, which eliminates the budget deficit and the loss of reserves, without abandoning the fixed exchange rate. The abandoming of the exchange rate policy is also considered in conjunction with money financing. The effects of a tax increase were studied in Helpman and Razin (1985), but there the emphasis was on the effects on the time profile of consumption via a Ricardian non-neutrality channel, for a known policy switch date. In this paper we disregard Ricardian non-neutralities, and concentrate instead on the importance of both the timing of the policy change and the choice of which instrument is used to stabilize. We will derive the time paths of key variables before the stabilization actually takes place, both when the date of the stabilization is known and when it is uncertain, basing our analysis on expected utility maximization by the individual agents and combining this with market clearing. The methodology is analogous to that we used in Drazen and Helpman (1986) to analyze stabilization policies in a closed economy.

A summary of the results we obtain may be found in the concluding section of the paper (section 4). We emphasize the dynamic behavior of money balances and the current account. The behavior of these variables will turn out to provide information on the type of second-stage stabilization that individuals expect.

The plan of this paper is as follows. In the next section, we present the case where the date of a stabilization is known with certainty. In section 3 we analyze the effects of uncertainty about the timing of a stabilization. The final section contains a summary of our results.

2. The Case of Certainty

A. The model

We consider an open economy extension of the model from Drazen and Helpman (1986). Rather than assuming that there is a single type of output, we now assume that there are two consumption goods, traded and nontraded. This allows us to consider real exchange rate movements, as well as introducing a distinction between stabilization via budget cuts on traded and nontraded goods.

We consider an economy where current macroeconomic policy -- which consists of a fixed level of public spending on traded and on nontraded goods, fixed taxes in terms of traded goods, and a fixed exchange rate --implies that the policy is infeasible in the long run. The precise meaning of this infeasibility will be spelled out later. Output does not change over time and there are no restrictions on international capital movements. The assumed exchange rate and capital mobility policies imply that the government has no direct control over the money supply. Stabilization is effected by a change in at least one policy variable that is under direct control of the government.

A representative individual is assumed to derive utility from consumption of the two goods and from real money balances, where his instantaneous utility function is assumed separable across consumption, and real balances, and across time. We represent it by

$$u(c(t), c_N(t)) + v\left(\frac{M(t)}{Q(t)}\right)$$

where t is a time index, c, c_N, M, and Q are real consumption of traded goods, nontraded goods, nominal domestic currency balances, and the domestic currency price index of the two goods; that is, $Q(t)=Q(\epsilon(t), P_N(t))$, where ϵ is the exchange rate (the domestic currency price of foreign exchange), the foreign currency price of traded goods is constant and equal to one, and where P_N is the domestic currency price of nontraded goods. The functions $u(\cdot)$ and $v(\cdot)$ are increasing and concave, and the function $Q(\cdot)$ is increasing and positively linear homogeneous.

The individual can hold domestic currency or bonds denominated in foreign currency, where the latter asset pays the exogenously fixed world interest rate r. We denote individual holdings of interest bearing assets by b. Given that the price of traded goods in terms of foreign currency is equal to one, b also represents the real value of these bonds in terms of traded goods and r also represents the real interest rate in terms of traded goods. The individual's subjective discount rate is assumed equal to r and he receives fixed income of y in terms of traded goods plus y_N in terms of nontraded goods. The assumption that the subjective discount rate equals the real interest rate in terms of traded goods eliminates secular trends in the trade account and helps thereby to focus attention on the speculative aspects of the problem at hand, which is the main aim of this study. In addition, it considerably simplifies the arguments.

The individual's objective is to maximize discounted utility over an infinite horizon, subject to his budget constraints. His objective function is:

$$(1) \quad \int_0^{\infty} e^{-rt}\left[u(c(t),c_N(t)) + v\left(\frac{M(t)}{Q(t)}\right)\right]dt$$

He can switch between money and bonds at any instant of time. We may then write his budget constraint, using traded goods as the numeraire, as:

$$(2a) \quad b(t) = \int_0^{t} e^{r(t-x)}\left[- c(x) - \frac{P_N(x)}{\epsilon(x)} c_N(x) - \frac{z(x)}{\epsilon(x)} - \tau(x) + y + \frac{P_N(x)}{\epsilon(x)} y_N\right]dx - \Sigma_{t_i \leq t}\, e^{r(t-t_i)} \frac{\Delta M(t_i)}{\epsilon(t_i)} + e^{rt}b_0 \quad \text{for all } t$$

$$(2b) \quad \lim_{t\to\infty} e^{-rt}b(t) \geq 0$$

where $b(t)$ is the stock of private bond holdings, $z(t)$ is the flow addition to nominal balances, $\tau(t)$ is the level of non-distortionary taxes in terms of traded goods, $\Delta M(t_i)$ is the stock increase in domestic currency holdings that results from sale of foreign currency to the monetary authority, and b_0 is the initial stock of bonds. Asset swaps take place at discrete points in time t_i. Equation (2b) ensures intertemporal balancing of the private sector. Differentiation of (2a) yields the standard accumulation equation:

$$\dot{b} = rb - c - \frac{P_N}{\epsilon} c_N - \tau + y + \frac{P_N}{\epsilon} y_N - \frac{z}{\epsilon} \quad \text{for } t \neq t_i \tag{2'}$$

Nominal domestic balances at t are related to z and ΔM via

$$M(t) = M_0 + \int_0^t z(x)dx + \Sigma_{t_i \leq t} \Delta M(t_i) \quad \text{for all } t \tag{3}$$

where M_0 is the initial stock of money holdings.

The individual choses the functions $c(t)$, $c_N(t)$, $M(t)$, $z(t)$, the timing of stock adjustments t_i and their size $\Delta M(t_i)$, so as to maximize the objective function given in (1) under constraints (2) and (3). Using the clearing condition in the market for nontraded goods

$$c_N(t) + g_N(t) = y_N \tag{4}$$

the first-order conditions for this problem imply (see Appendix 1):

$$u_1'[c(t), y_N - g_N(t)] = \theta \quad \text{for all } t \tag{5}$$

$$p[c(t), y_N - g_N(t)] \equiv \frac{u_2'[c(t), y_N - g_N(t)]}{u_1'[c(t), y_N - g_N(t)]} = \frac{P_N(t)}{\epsilon(t)} \quad \text{for all } t \tag{6}$$

$$(7) \qquad \frac{1}{\epsilon(t)} = \frac{1}{\theta}\int_t^{\infty} e^{-r(x-t)} v'\left(\frac{M(x)}{Q(x)}\right)\frac{1}{Q(x)}\,dx \qquad \text{for all } t$$

where θ is the multiplier of constraint (2). Equation (5) states that the marginal utility of consumption of traded goods is constant over time. This implies a constant level of consumption of traded goods in time periods in which the government does not change its purchases of nontradeables. Equation (6) represents the standard equality of the marginal rate of substitution to relative prices. The marginal rate of substitution $p(\cdot)$ is equal to the inverse of the real exchange rate, where the real exchange rate is defined as the price of nontradeables in terms of tradeables. Finally, equation (7) may be seen as an asset pricing equation for domestic balances, relating the value of a unit of balances today to the future discounted marginal utility flow. Differentiating the asset pricing eqation (7) one obtains a variant of the standard implicit demand function for real balances:

$$(8) \qquad \frac{v'(m/q)}{\theta q} = r + \frac{\dot{\epsilon}}{\epsilon} \qquad \text{for all } t$$

where $q = Q/\epsilon$ and real balances m are defined as M/ϵ. The variable q is just another version of the inverse of a real exchange rate, where the real exchange rate is here defined as the price of traded goods in terms of a domestic basket of goods, the basket which serves to define the price index Q serving for this definition. In what follows we reserve the definition of the real exchange rate for the price of traded goods in terms of nontraded, which due to (6) is represented by the inverse of $p(\cdot)$. However, since the price index function $Q(\epsilon, P_N)$ is positively linear homogeneous, we have

$$q \equiv q[p(\cdot)] = Q(1, P_N/\epsilon) = Q[1, p(\cdot)]$$

implying that q is an increasing function of p or a declining fuction of the real exchange rate.

The government may be thought of as consisting of two branches. A fiscal authority is responsible for financing government expenditures, with sources of finance including real revenues from printing money. A monetary authority is responsible for printing money and for foreign exchange transactions to stabilize the exchange rate in a fixed rate system. Government debt exclusive of reserve holdings evolves over time according to:

$$(9) \quad B^G(t) = e^{rt}B_0^G + \int_0^t e^{r(t-x)}\left[g(x) + \frac{P_N(x)}{\epsilon(x)} g_N(x) - \tau(x) - \frac{\dot{M}^F(x)}{\epsilon(x)} \right]dx + \Sigma_{t_i' \leq t}\, e^{r(t-t_i')}\Delta R(t_i') \qquad \text{for all } t$$

where $B^G(t)$ is government debt exclusive of reserve holdings, B_0^G is the initial level of this debt, $\dot{M}^F(t)$ is the fiscal authority's monetary injection via the budget deficit, and $\Delta R(t_i')$ is the discrete increase in reserve holdings that results from a discrete increase in debt. The government can choose both the timing t_i' and the size of the stock adjustments in reserve holdings. Stock adjustments in reserve holdings by means of foreign borrowing is common practice by many countries, including overnight borrowing in periods in which the figures on the stock of reserves are being published. Differentiation of (9) yields:

$$(9') \qquad \dot{B}^G = rB^G + g + g_N P_N/\epsilon - \tau - \dot{M}^F/\epsilon \quad \text{for } t \neq t_i'$$

The monetary authority is holding foreign exchange reserves. It is assumed that these reserves bear interest at the rate r, like all other foreign currency denominated assets. Hence, reserve movements are governed by:

$$(10) \qquad R(t) = e^{rt}R_0 + \int_0^t e^{r(t-x)} \left[\frac{z(x) - \dot{M}^F(x)}{\epsilon(x)} \right] dx + \Sigma_{t_i' \leq t}\, e^{r(t-t_i')} \Delta R(t_i') + \Sigma_{t_i \leq t}\, e^{r(t-t_i)} \Delta M(t_i)/\epsilon \quad \text{for all } t$$

where R(t) is the stock of foreign exchange reserves at time t and R_0 is the initial stock of reserves. The monetary authority gains reserves from interest income on reserve holdings, from the flow purchase of foreign currency from the private sector, and from discrete increases that result from government borrowing or private sector swaps. Differentiation of (10) yields:

$$(10') \qquad \dot{R} = rR + (z - \dot{M}^F)/\epsilon \quad \text{for } t \neq t_i, t_i'$$

The government's net debt is:

$$b^G = B^G - R$$

Therefore, (9) and (10) imply:

$$(11) \quad b^G(t) = e^{rt}b_0^G + \int_0^t e^{r(t-x)}\Big[\, g(x) + \frac{P_N(x)}{\epsilon(x)}\, g_N(x) - \tau(x) - z(x)/\epsilon(x) \,\Big]dx$$
$$- \Sigma_{t_i \leq t}\; e^{r(t-t_i)}\Delta M(t_i)/\epsilon \quad \text{for all } t$$

where $b_0^G = B_0^G - R_0$. The evolution of the government's net debt, inclusive of reserve holdings, implies:

$$(11') \quad \dot{b}^G = rb^G + g + pg_N - \tau - \dot{M}/\epsilon \quad \text{for} \quad t \neq t_i$$

where use has been made of (3) to derive $\dot{M}$=z for $t \neq t_i$. The time derivative of the stock of money is not under the government's direct control when it controls the exchange rate. Intertemporal balancing of the consolidated budget constraint of the fiscal and monetary authorities requires:

$$(12) \quad \lim_{t \to \infty} e^{-rt}b^G(t) \leq 0$$

The difference between government net debt b^G and private holding of interest-bearing assets b is net foreign indebtedness, which we denote by $\overline{b}$ = b^G - b. Using (2), (11) and the clearing condition in the market for nontraded goods (4), we obtain:

$$(13) \quad \overline{b}(t) = e^{rt}\overline{b}_0 + \int_0^t e^{r(t-x)}[g(x) + c(x) - y]dx \quad \text{for all } t$$

Hence,

$$(14) \qquad \dot{\bar{b}} = r\bar{b} + g + c - y \qquad \text{for all } t$$

where the right hand side represents the deficit on current account.

It is clear that if (2b) and (12) hold; that is, the private sector and the government are intertemporally balanced, then the present value of net external debt is nonpositive (i.e., $\lim_{t\to\infty} e^{-rt}\bar{b}(t) \leq 0$), and the economy is also intertemporally balanced. However, apart from these constraints the government may be facing other constraints as well. It is often argued that the monetary authority faces an upper bound on reserve depletion, beyond which the government cannot use external borrowing in order to replenish them. Under these circumstances one has to add an additional constraint on government behavior (see, for example, van Wijnbergen (1985)). However, in the context of this study, in which there are no problems of debt repudiation and the only possible uncertainty is about the timing of stabilization, it seems to us most approapriate to assume that (12) is the only constrait on the government's intertemporal behavior.

Our formulation implies also that the monetary authority faces no liquidity constraints, because the government can borrow instantaneously in order to replenish foreign exchange reserves. It seems to us that in order to deal intelligently with liquidity constraints it is necessary to use a more elaborate model, which may include explicit modelling of foreign lenders and the introduction of intrinsic uncertainty. Given our simplified modelling strategy, it is natural to concentrate on the government's consolidated budget constraint, although it is necessary to look at its composition in order to separate reserve movements from gross debt changes.

We consider a situation where the government fixes the exchange rate ϵ before a stabilization (more elaborate exchange rate policies can also be considered, although we do not deal with them in this study). In addition, the spending levels g and g_N and the tax level τ are maintained constant before stabilization. Stabilization takes place at a point in time T at which the government changes its policy so as to freeze its net debt at its then current level $b^G(T)$.

The constancy of g_N together with (4) and (5) imply that private consumption of tradeables and nontradeables is also constant before T, and constant after T, although not necessarily at the same level. Then (6) implies constancy of the real exchange rate at the level $1/p(c,y_N-g_N)$, where c is the constant level of consumption of tradeables, and constancy of q. Morover, given the fixed exchange rate before T, (6) implies a constant price of nontraded goods P_N and a constant price level Q before T. In the steady state that is reached after stabilization the triple (ϵ,P_N,Q) is rising at the rate of money growth. Under these circumstances condition (8) yields:

(15a) $$\frac{v'(m/q)}{\theta q} = r \qquad \text{for} \quad t < T$$

$$\text{(15b)} \qquad \frac{v'(m/q)}{\theta q} = r + \mu \qquad \text{for} \quad t \geq T$$

Equation (15a) implies constant nominal money balances before T (because the exchange rate is fixed). Hence,

$$\text{(16)} \qquad z = \dot{M} = 0 \quad \text{and} \quad \Delta M = 0 \quad \text{for} \quad t, t_i < T$$

and from (11)

$$\text{(17a)} \qquad \dot{b}^G = rb^G + g + pg_N - \tau \qquad \text{for} \quad t < T$$

$$\text{(17b)} \qquad \dot{b}^G = rb^G + g + pg_N - \tau - \mu m \qquad \text{for} \quad t \geq T$$

The motion of the system prior to stabilization is fully described by (15a) and (17a) which may be represented in a phase diagram in m–b^G space, as in Figure 1. For every value of b^G larger than

$$\underline{b}^G = -(g + pg_N - \tau)/r$$

government debt will grow without bound for unchanged policy parameters. Therefore, assuming $b^G(0) > \underline{b}^G$, a policy switch is inevitable if the government does not repudiate its debt (we use $b^G(0)$ rather than b_0^G because an asset swap may take place at $t=0$).

In the above described equilibrium some qualitative characteristics of the dynamic path before a stabilization takes place do not depend on the instruments that are used to stabilize. At all $t < T$ government net debt is increasing, money balances are constant, and so is private consumption of traded and nontraded goods. Apart from interest earnings on reserve holdings, the monetary authority gains or loses reserves at a rate equal to the money financed part of the fiscal deficit (see (10') and (16)). This means that every Shekel printed in order to finance the fiscal deficit induces an equivalent value reserve loss. More generally, the fiscal deficit increases government debt or brings about a reserve loss, with the split between the two determined by the money financed part of the fiscal deficit. Hence, monetary policy affects only the composition of the government's asset holdings. We may now consider the effects of known changes in policy parameters at T on the behavior of major economic variables before and at the time a stabilization takes place.

B. Tax increases and cuts in g

The simplest case to analyze is a stabilization effected by an increase in taxes, τ, or a cut in government consumption of traded goods, g. First, consider a tax increase that prevents further growth of net government debt with no reliance on monetary injections; that is, $\mu = 0$. We will discuss the effects of post-stabilization use of money financing at a later stage. In this case the locus of m-b^G combinations described by (15a) is the same as the locus of combinations described by (15b), while the locus of points such that $\dot{b}^G = 0$ shifts to the right as a result of a tax increase, as in Figure 2 (see (17)). The locus of m-b^G pairs consistent with steady state, denoted $m_s^{\tau}(b^G)$, is therefore identical to the $\overline{m}$ line defined by (15a). The motion of the system is on the horizontal line, as in Figure 2, and it remains on this line following the tax increase. Along this path the stock of money and consumption of both traded and nontraded goods are constant, while net government debt is rising over time.

A distinguishing feature of a tax-based stabilization is that its anticipation brings about a balanced current account. This is seen as follows. The dynamics of net foreign debt, given by (14), are depicted in Figure 3. The location of the line $\dot{\bar{b}}$ depends on $g + c$; the larger is $g + c$ the higher is this line. Since the location of this line does not change as a result of a tax-based stabilization (because c remains constant due to (5)), then if $\bar{b}^*$ is smaller than initial net foreign debt net foreign debt will grow without bound, and if it is larger than initial net foreign debt net foreign debt will decline without bound. Both cases are inconsistant with equilibrium, because the government freezes its net debt. The private sector, on the other hand, has to satisfy (2a), which excludes an unbounded net foreign debt, and it will not maximize welfare if it allows (2a) to be satisfied with a strict inequality. Hence, an equilibrium requires $\bar{b}^* = \bar{b}_0$, implying a balanced current account in all time periods. Moreover, there is a unique value of c that will bring about this outcome; that is,

$$c = y - g - r\bar{b}_0$$

and this is the level of private consumption of tradeables under a tax-based stabilization. Since net government debt is rising prior to stabilization and the current account is balanced, private asset holdings are also rising prior to stabilization, as depicted in Figure 4. This means that the increase in government net debt is held entirely by domestic residents. Budget deficits are financed by internal debt.

A stabilization via a cut in government consumption of traded goods with no relience on monetary injections can also be described by means of Figure 2, with $m_s^g(b^G)$ replacing $m_s^\tau(b^G)$. Obviously, the level of $\bar{m}$ and the location of $\dot{b}^G = 0$ are not the same for tax-based and g-based stabilizations, but both imply growth in the government's net debt and constant money balances. However, unlike the case of a tax-based stabilization, a g-based stabilization brings about an increase in net external debt for $t < T$. This is shown by means of Figure 5. The line that goes through $\vec{b}^*$ describes the current account prior to the expenditure cut while the line that goes through $\vec{b}^{**}$ describes the current account after the expenditure cut (again, due to (5) private consumption of tradeables does not change as a result of a cut in g). In order to reach a steady state when the expenditure cut takes place, net foreign debt at T has to be equal to $\vec{b}^{**}$. This means that just prior to stabilization the system has to be at point A, which is possible only if the initial level of net foreign debt is between $\vec{b}^*$ and $\vec{b}^{**}$. The latter implies a rising foreign net debt and a deficit on current account prior to T. The existence of a deficit on current account prior to stabilization implies that private consumption of tradeables is larger in this case than in the case of a stabilization effected by a tax increase (g is the same in both cases for $t < T$). The major reason for this difference in consumption levels is that changes in taxes do not affect real resources, while a cut in government spending increases real resources. This observation is particularly clear if one realizes that net foreign debt fulfills in an open economy a role similar to a capital stock; it produces an income stream whose magnitude can be changed by saving and dissaving.

Now, (2'), (6) and (16) imply

$$(18) \quad \dot{b} = rb - c - pc_N - \tau + y + py_N \qquad \text{for} \quad t < T$$

Therefore, by applying to (18) the reasoning that was applied to (14) in order to establish a balanced current account in the case of a tax-based stabilization, one establishes a zero level of private savings (the right-hand side of (18)) in the case of a g-based stabilization. This implies a constant level of private bond holdings and a consumption level

$$c = y + py_N + rb(0) - pc_N - \tau$$

for a g-based stabilization.

An important feature of this consumption level, as well as the consumption level that was derived for a stabilization effected by a tax increase, is that it does not depend on the timing of stabilization. This observation will prove useful at a later stage. Now, constant private bond holdings and rising net government debt imply that all increases in net government debt result from foreign borrowing. Therefore net foreign debt is rising over time, as described in Figure 6. Budget deficits are financed by external debt.

It is clear from this discussion that under a tax-based stabilization private asset holdings are rising over time and net external debt is constant prior to T, while under a g-based stabilization private assts are constant and net foreign debt is rising prior to T. Thus, the time trend in private asset holdings and in net foreign debt prior to stabilization enables us to identify the public's expectations about the instrument that will be used at T to stabilize the economy, provided the choice is between taxes and expenditure cuts on tradeables. These features are described in Figures 4 and 6. However, in both cases consumption, money holdings, and nominal prices--including the exchange rate--are constant over time. This means in particular that the fixed exchange rate can be retained forever, and it will remain at the predetermined level even if a floating exchange rate regime is announced following the stabilization. Hence, when budgetary measures are used to balance the consolidated budget in a way that does not require money financing, the fixed exchange rate becomes consistent with a floating exchange rate regime. (We will show in the next subsection that this result applies also when budget cuts on nontradeables are used to effect the stabilization.)

C. Cuts in g_N

The third case we analyze is a stabilization via a reduction in government spending on nontradeables with no reliance on money financing. It is straightforward to show from (5) and (6) that a reduction in g_N reduces the relative price of nontraded goods p, and that it increases private consumption of tradeables if and only if $u_{12}(\cdot) > 0$ (remember that $u(\cdot)$ is a concave function). This means that at the moment of stabilization there is a maxi real exchange rate devaluation resulting from a downward jump in the price of nontradeables P_N; the exchange rate remains constant (due to (7)). Since the budget cut reduces government spending in terms of tradeables (which is helped by the real devaluation), the $\dot{b}^G = 0$ line in Figure 2 moves to the right. On the other hand, the horizontal line $\bar{m}$ that satisfies (15b) shifts up or down relative to the line that satisfies (15a). This is seen as follows. A real devaluation reduces q, which is a declining function of p. With a lower value of q money balances m have to adjust. If the elasticity of $v'(\cdot)$ is equal to one in absolute value, then no adjustment in m is required. If it is larger than one m declines, and if it is smaller than one m increases. Since the elasticity of the demand for money with respect to the interest rate is equal to the inverse of $v'(\cdot)$, this implies that m declines as a result of a cut in g_N if and only if the elasticity of money demand is smaller than one. Hence, for an interest inelastic demand fuction for money budget cuts on nontradeables shift the steady state point to the southeast.

The curve $m^N(b^G)$ in Figure 7 describes all steady state points that can by attained by means of a cut in g_N with an interest inelastic demand function for money. Prior to the budget cut the system moves on the horizontal line $\bar{m}$. If a budget cut takes place when the system reaches point A, the jump to the steady state curve can take place only by means of a swap of assets, because no anticipated jump of the exchange rate is possible. A swap of assets implies a movement along a downward-sloping 45 degree line, like the broken line drawn through point A. Hence, the budget cut induces a jump from point A to point B. This means that at time T^- the private sector chooses a discrete downward adjustment of its money holdings by purchasing foreign currency denominated assets: there is a run on reserves. The budget cut shifts down the horizontal line $\overline{m}$ and the line $\dot{b}^G = 0$ to the right, so that they intersect at B.

Figure 8 describes the adjustment for an interest elastic demand function for money. In this case the public makes a discrete upward adjustment in money holdings, and the monetary authority gains reserves. However, in the more plausible case of an interest inelastic demand function for money, there is a run on reserves in anticipation of a g_N-based stabilization.

Now consider the balance of payments implications of a stabilization effected by a budget cut on nontraded goods. We assume $u_{12}(\cdot) \geq 0$, which is the more plausible case. If $u_{12}(\cdot) = 0$, then (5) implies that the budget cut does not affect private consumption of tradeables, so that c does not change as a result of stabilization. In this case (14) implies a balanced current account at all t and a consumption level c which is the same as in the case of a tax-effected stabilization (see the discussion of a tax increase). The consequence is that private bond holdings rise over time prior to T, as the private sector acquires all additional bonds issued by the government. In this case data collected at $t < T$ reveals no information about whether the public expects the stabilization to be effected by a tax increase or a budget cut on nontradeables, except for the last moment at which there is a run on reserves if a budget cut is expected, and no run if a tax increase is expected.

If, however, $u_{12}(\cdot) > 0$, then a cut in g_N implies an increase in c. The resulting shift in the current account equation is depicted in Figure 9, in which c stands for consumption of tradeables prior to stabilization and c_s stands for consumption of tradeables after stabilization. Clearly, in this case net foreign debt has to equal $\vec{b}^{**}$ at the moment of stabilization. Therefore the system has to be at point A at time T^-. This happens only if $\bar{b}_0$ is between $\vec{b}^{**}$ and $\vec{b}^{*}$. These inequalities imply that in this case private consumption of tradeables is smaller prior to stabilization and larger after stabilization than in a tax-based stabilization, and there is a surplus on current account with declining net foreign debt at all $t < T$. Since the government's net debt is rising over time, the last result implies that private bond holdings are increasing before T; all new government bonds are held by the private sector and the private sector also acquires additional foreign bonds. These features are described in Figure 10 (notice particularly the upward jump in private bond holdings at time T that results from the run on reserves).

By comparing Figures 4, 6, and 10 it is clear that available data for $t < T$ reveals information about the public's expectations concerning the policy tool that will be used to stabilize the economy, as long as it is known that it will consist of a fiscal adjustment and there will be no money financing. A balanced current account implies expectations of a tax increase, a deficit on current account implies expectations of a budget cut on tradeables, and a surplus on current account implies expectations of a budget cut on nontradeables. In all cases the quantity of money is constant prior to stabilization and reserve losses minus interest earnings on foreign reserve holdings are equal to the money-financed part of the fiscal deficit. The exchange rate remains constant for all t, and the price of nontradeables remains constant for all $t < T$. It changes as a result of stabilization only when a budget cut on nontradeables is used, in which case it jumps down bringing about a real devalutation. In the other cases it does not change.

C. <u>Money financing</u>

The last case we analyze is a stabilization via an increase in the rate of monetary growth μ. An increase in the rate of monetary growth does not change private consumption levels and the real exchange rate, but it nevertheless affects both of the steady state loci. After T the rate of depreciation $\dot{\epsilon}/\epsilon$ must equal μ, and (15b) implies that an increase in μ shifts down the steady state value of m. A positive value of μ means that the line $\dot{b}^G = 0$ will be upward sloping rather than vertical (see (17b)), increases in μ shifting the line down. Therefore the new steady state point will lie to the southeast of the original point, for example point B in Figure 11 (as long as increases in μ increase seignorage. See Drazen and Helpman (1986).) The locus of steady state combinations can be represented by the curve $m_s^{\mu}(b^G)$. We assume that the government chooses the lowest possible rate of money growth whenever there is more than one value that can finance the given budget deficit.

To derive the path of motion until T, we further note that at any point the individual can swap domestic for foreign currency, which would imply movement in $m-b^G$ space along a 45-degree line. With this in mind, the dynamic path until T may be easily described. Beginning at some $b^G(0)$ to the right of the intersection point E, the system moves horizontally along the $\overline{m}$ line until point A. There is then a discrete switch of domestic currency for bonds mediated by foreign exchange reserves, bringing about a jump from A to B. The lower level of domestic real balances is achieved by a run on foreign exchange reserves and there is no jump in the exchange rate at T (see (7)), nor in any other nominal price, as in Krugman (1979). From T onward, the nominal exchange rate depreciates at rate μ and all nominal prices rise at the rate μ. Clearly, in this case the fixed exchange rate policy is abandoned at time T.

Now consider consumption and the current account. Private consumption of nontradeables is the same for all t, and, from (4), so is private consumption of tradeables. The current account equation (14) implies in this case that c is the same as under a tax-based stabilization and the current account is balanced in all time periods. Consequently, private bond holdings are rising over time for $t < T$. Figure 4 describes the evolution of net foreign debt and private bond holdings for both a τ-based and a μ-based stabilization. These variables are identical prior to T. A difference emerges at T because in anticipation of an inflation tax there is a run on reserves and a drop in money holdings while no run takes place in anticipation of a lump-sum tax (there would be a discrete adjustment if the tax was distortionary, like a tax on wages with elastic labor supply). It is clear from this discussion that from observations prior to T one cannot distinguish whether the public expects a tax increase or inflationary finance, except for the last moment in which the presence or the absence of a run reveals this information.

This completes our discussion of the certainty case. To summarize, no matter what policy instrument is used to stabilize our economy with a fixed exchange rate, there is no jump in the nominal exchange rate at the time of a stabilization. This includes the case of a move from a fixed to a floating rate system necessitated by a move to a positive steady state rate of monetary growth. The absence of a jump results from the possibility of discrete adjustments of desired real balances via a swap of domestic currency for foreign exchange with the monetary authority (a "run on reserves"). In the case of a cut in government consumption of non-traded goods there will be a jump in the real exchange rate, while in the other cases no adjustment in the real exchange rate takes place. The current account provides important information about the public's expectations concerning the policy which will be used to effect the stabilization.

We have seen that an attack on foreign exchange reserves takes place just prior to stabilization if the public expects the government to use money financing or a budget cut on nontraded goods (when the elasticity of money demand with respect to the interest rate is smaller than one, which is the empirically plausible case). No attack on reserves takes place if lump-sum taxes or a budget cut on tradeables is expected to effect the stabilization. It is however clear from our analysis that if a policy package is expected to be used, then whenever the package includes some money financing or some reduction of public spending on nontraded goods there will be a run on reserves just prior to stabilization.

The final point to be discussed in this section concerns the initial conditions. The value of net foreign debt is predetermined, so that if $\bar{b}(0^-)=\bar{b}_0$ then $\bar{b}(0)$ is also equal to $\bar{b}_0$. However, the same rule does not apply to government net debt and private asset holdings (including money), because once exchange rate management is announced the public can reshuffle its portfolio. The total value of its portfolio is, however, predetermined. Therefore, the initial conditions are:

$$m(0) + b(0) = m_0 + b_0$$
$$b^G(0) - b(0) = b_0^G - b_0$$

and the public chooses it desired portfolio composition. This choice depends on its expectations concerning the policy that will be used to effect a stabilization, because we have shown above that consumption of tradeables may depend on these expectations, which implies that q and θ, and therefore also $m(0)$, depend on them (via (15a)).

Suppose, for example, that prior to $t=0$ the economy is in a steady state with a floating exchange rate and a rate of money growth μ_0. In this steady state the price of nontradeables and the exchange rate are rising at the rate of money growth. This steady state is described by point S in Figure 11.

Now suppose that the government finds this inflation rate unacceptable, and it decides to stop it at time t=0 by an unexpected freeze of the exchange rate. Suppose also for concreteness that once the new policy is announced the public expects all future policy corrections to rely on money financing. Then our analysis implies that there will be no change in consumption, but there is an immediate increase in the demand for money that results from the decline of the inflation rate to zero. In terms of Figure 11 the system jumps from S to I. There is therefore an initial discrete reserve gain and a decline in net government debt. Following this initial adjustment the system moves gradually from I to A and jumps from A to B just prior to the policy switch. The run on reserves at T^- is larger than the reserve gain at 0. Moreover, net government debt and the inflation rate are larger in the new steady state. Hence, the temporary decline in inflation has been achieved at the cost of higher inflation in the future.

It is also clear from our analysis that if lump-sum taxes are used for stabilization purposes then the reduction in the rate of inflation will be permanent. Morover, if T is close enough to zero net government debt will be smaller in the new steady state. In order to save space, we do not expand this discussion to the other policy instruments.

3. Uncertainty About the Timing of a Stabilization

We now consider the case where the timing of a stabilization is not known ex-ante. We assume that the switch may occur at any time between 0 and some T_{max}, where the cumulative distribution of a switch occuring until T is F(T). Clearly $F(0) = 0$ and $F(T_{max}) = 1$. We consider the case where only one switch takes place.

The individual maximizes expected discounted utility over his horizon subject to the same budget constraints as above, the expectation taken over $dF(T)$. It will be useful to write the individual's present discounted utility if a switch occurs with certainty at T as follows. Let $V^s(\cdot)$ be the present discounted value of maximized utility from T onwards. It will be a function of the real value of an individual's assets at T, and perhaps of T as well. The present discounted utility from 0 to infinity if a switch occurs at T is then (using the instantaneous utility function from above):

$$(19) \qquad \int_0^T e^{-rt}[u(c(t), c_N(t)) + v(m(t)/q(t))]dt + e^{-rT}V^s[b(T) + m(T); T]$$

This is precisely the welfare function used in the above section written in a different form. Expected welfare is then the expected value of (19) taken over all possible realizations of T. The individual's problem may be written as maximizing expected welfare subject to equations (2) and (3), where this time all variables in equations (2) and (3) represent values conditional on no policy switch taking place before t. (The reader may refer to Appendix 2 for the exact mathematical formulation.)

The first-order conditions of this problem imply (see Appendix 2):

$$(20) \qquad \theta(t) = \int_t^{T_{max}} \theta^s(T) \frac{dF(T)}{1 - F(T)} \qquad \text{for} \quad t < T_{max}$$

$$(21) \quad \frac{1}{\epsilon(t)} = \frac{1}{\theta(t)} \int_t^{T_{max}} \left[e^{-r(T - t)} \frac{\theta^s(T)}{\epsilon^s(T)} + \int_t^T e^{-r(x - t)} \frac{v'(x)}{Q(x)} dx \right] \frac{dF(T)}{1 - F(T)}$$

for $t < T_{max}$

where a superscript s indicates the value of a variable after stabilization. Thus, $\theta^s(T)$ is the marginal utility of consumption of traded goods at time T provided stabilization takes place at time T and $\epsilon^s(T)$ is the exchange rate at time T provided stabilization takes place at time T. The value of T_{max} is smaller than or equal to the point in time at which the government reaches the limit of its ability to finance the budget without further growth of net debt. We will say more about this point in due course.

Condition (20) says that traded goods consumption is chosen at each point before a stabilization to equalize current marginal utility of consumption to expected future post-stabilization marginal utility. This condition allows for the fact that the marginal utility of consumption after a stabilization may depend on the timing of the stabilization. Condition (21) is an asset pricing equation with the return on the asset being uncertain. The value of the asset is determined by the expected flow of dividends plus resale value.

Equations (20) and (21) have a number of implications. First, as t approaches T_{max} they imply;

$$(22) \quad \theta^s(T_{max}) = \theta(T_{max})$$

and

$$(23) \quad \epsilon^s(T_{max}) = \epsilon(T_{max})$$

Namely, at the moment in which stabilization is sure to take place if it did not take place before, there can be no jump in the marginal utility of consumption of tradeables or in the exchange rate. This stems from the fact that at T_{max}^{-} there is no residual uncertainty, so that we obtain the same results as in the case of certainty.

Differentiation of (20) and (21), taking into account the fact that the exchange rate is fixed prior to stabilization (so that ϵ is the same for all $t < T_{max}$) yields:

$$(24') \quad \frac{d\theta}{\theta} = \frac{dF}{1 - F}\left(1 - \frac{\theta^{s}}{\theta}\right) \qquad \text{for} \quad t < T_{max}$$

$$(25') \quad \frac{v'}{\theta q}\, dt = r\, dt + \frac{dF}{1 - F}\,\frac{\theta^{s}}{\theta}\left[1 - \frac{\epsilon}{\epsilon^{s}}\right] \qquad \text{for} \quad t < T_{max}$$

Hence, the existence of a mass point in the distribution function F(•) prior to T_{max} implies a jump in private consumption of tradeables at this point in time if stabilization does not take place, unless a stabilization would not affect the marginal utility of consumption at this point in time (because the consumption of nontradeables is constant prior to stabilization), and it implies a jump in real money holdings unless no exchange rate jump is expected in the event of stabilization at this point in time.

For what follows, we assume differentiability of F(•) for all $t < T_{max}$. In this case (24') and (25') imply:

$$(24)\quad \frac{\dot{\theta}}{\theta} = \frac{f}{1 - F}\left(1 - \frac{\theta^s}{\theta}\right) \qquad \text{for} \quad t < T_{max}$$

$$(25)\quad \frac{v'}{\theta q} = r + \frac{f}{1 - F}\frac{\theta^s}{\theta}\left[1 - \frac{\epsilon}{\epsilon^s}\right] \qquad \text{for} \quad t < T_{max}$$

where f is the density function of F. The right hand side of (25) represents the nominal interest rate, which equals the interest on foreign currency denominated assets plus a term reflecting the expected capital gain or loss on nominal balance holdings as a rsult of a possible exchange rate jump. This last term is the product of the density of a stabilization at t conditional on no stabilization having ocurred until t, the change in the marginal utility value of real balances, and the percentage change in the foreign currency value of nominal balances due to an exchange rate jump.

Given the available financing instruments of the government's consolidated budget, there is a maximum level of debt consistent with a stabilization. Therefore, one expects that if no stabilization has occurred before debt hits some b^G_{max}, then a regime switch must occur at that point in time. More generally, one may argue that the probability of a stabilization grows as $b^G(t)$ approaches b^G_{max}, with a stabilization occurring with certainty sometime between time 0 and the time that $b^G(t)$ hits b^G_{max}. We therefore assume that the conditional density of a stabilization can be expressed as a non-decreasing function of the level of net government debt, namely:

$$(26) \qquad \frac{f(t)}{1 - F(t)} \equiv \phi(b^G(t)) \qquad \text{for} \quad t < T_{max}$$

The restriction that $F(T_{max}) = 1$ will imply that $\phi(\cdot)$ becomes infinite as debt approaches b^G_{max}, unless the distribution has a mass point at T_{max}. We may now discuss the effects of the policy changes considered in the previous section for the case of uncertainty about the timing of a policy switch. We begin with the case of a stabilization effected by an increase in taxes τ or a decrease in government spending on traded goods g.

A. Tax-based and g-base stabilizations

First, consider a tax-based stabilization. In this case private consumption is the same as in the case of complete certainty. This is seen as follows. Under certainty private consumption of tradeables ensures a balanced current account. If under uncertainty private consumption of tradeables is lower than this level at $t = 0$, then from (14) stabilization at $t = dt > 0$ will require a post stabilization consumption level that is larger than under certainty. In this case (24) implies that in the absence of stabilization consumption of tradeables at $t = dt$ is smaller than at 0. Repeating this argument sequentially we arrive at the conclusion that if there is no stabilization until T_{max} then at the last moment consumption of tradeables prior to stabilization is strictly smaller than after stabilization, contradicting (22) (remember that private consumption of nontradeables is constant in this case). The same reasoning implies that at $t=0$ private consumption of tradeables cannot exeed the level that balances the current account. Now, moving the initial point by $dt > 0$ and repeating the argument one establishes that at dt, at $2dt$, and so on, consumption has to balance tha current accout. Hence, the consumption level is constant and the same as under certainty.

The same reasoning establishes that private consumption of tradeables is the same under certainty and uncertainty for a money financed stabilizaton, and similar reasoning can be used to establish that the consumption level is the same under certainty and uncertainty for a g-based stabilization. Formal proofs of these arguments are given in Appendix 3. An alternative way to proceed is to assume that uncertainty does not affect consumption levels in these cases, and to construct equilibria under this supposition. The following analysis can be interpreted either way.

For a tax-based stabilization the system ends up on the line $m^{\tau}(b^G)$ in Figure 2 when stabilization takes place. Therefore in this case, taking into account the constancy of c which implies $\theta = \theta^s$ and (26), equation (25) can be written as:

$$\text{(25a)} \quad \frac{v'(m/q)}{\theta q} = r + \phi(b^G)\left[1 - \frac{M}{M^s}\frac{\bar{m}^{\tau}}{m}\right] \qquad \text{for} \quad t < T_{max}$$

where $m^{\tau}(b^G) \equiv \bar{m}^{\tau} = M^s/\epsilon^s$, and $\bar{m}^{\tau}$ is the steady state foreign currency value of money balances for a tax-based stabilization. It is now straightforward to verify that the following is an equilibrium:

a) the quantity of money is the same for all t,

b) the exchange rate is the same for all t.

These two conditions ensure that equation (25a) is satisfied with $m = \bar{m}^{\tau}$. Hence, prior to stabilization the dynamics are the same as under certainty and are described by Figures 2 and 4. The quantity of money is constant, government net debt grows over time, the current accout is balanced, and private bond holdings are rising over time. Whenever the government changes taxes so as to stabilize the economy, government net debt and private bond holdings stop increasing.

The independence of the economy's trajectory on timing uncertainty for a tax-based stabilization is the direct consequence of the fact that in the certainty case private consumption and money holdings are independent of the stabilization date. Under these circumstances uncertainty about the timing of stabilization can make no difference.

We show in Appendix 3 that for a g-based stabilization the supposition of constant money balances implies constant consumption of tradeables at the level that prevails when there is no uncertainty about the timing of stabilization. We need to show now that constant money balances do indeed constitute an equilibrium in this case. Since $m^g(b^G) \equiv \bar{m}^g$ for all b^G, and c is the same for all t under the supposition of constant m, equation (25a) applies also to a g-based stabilization with $\bar{m}^g$ replaceing $\bar{m}^{\tau}$. Hence, in this case too the presence of timing uncertainty does not affect the economy's trajectory prior to stabilization. The reason is again the fact that in the certainty case consumption and money holdings do not depend on the timing of stabilization.

B. Money financing

The next policy change we consider is a stabilization effected by an increase in the rate of monetary growth. We assume that stabilization at T is performed by choosing a positive rate of monetary growth to satisfy (17b) with $\dot{b}^G = 0$ at the level of government debt attained at T. To analyze this path recall first that consumption of traded goods is the same for all t (see Appendix 3). The locus of steady state points (the terminal surface) is $m_s^{\mu}(b^G)$, as in the certainty case, and it is described in Figure 12. With constant consumption of traded goods the marginal utility of consumption of traded goods is constant before and after a switch, so that (25), taking account of (26), becomes:

$$\frac{v'(m/q)}{\theta q} = r + \phi(b^G)\left[1 - \frac{M}{M^S} \frac{m_s^{\mu}(b^G)}{m} \right] \qquad \text{for} \quad t < T_{max}$$

Since in this case stabilization also implies the abandoning of the fixed exchange rate, there can be no jump in the quantity of money after stabilization, and there is no jump in the quantity of money prior to stabilization exept for times at which $F(\cdot)$ has mass points (see (25')). Our assumptions allow for only one mass point at T_{max}. Therefore $M^S = M$ for $t < T_{max}$ and our equation becomes:

$$\text{(25b)} \quad \frac{v'(m/q)}{\theta q} = r + \phi(b^G)\left[1 - \frac{m_s^{\mu}(b^G)}{m}\right] \qquad \text{for} \quad t < T_{max}$$

The right-hand side of (25b) gives the nominal interest rate as the sum of the real interest rate and the forward premium. The forward premium results from the possibility of an unexpected exchange rate jump following stabilization. Condition (25b) describes a curve in (b^G,m) space on which the system has to be prior to stabiliaztion. The direction of its movement is determined by (11'), which is reproduced here for convenience:

$$\text{(11')} \quad \dot{b}^G + \dot{m} = rb^G + g + pg_N - \tau \qquad \text{for} \quad t < T_{max}$$

Our assumption is that at time zero the right hand side of (11') is positive. Therefore, it remains positive if net government debt is rising over time.

Now, (25b) implies that $m_s^{\mu}(b^G) < m < \bar{m}$, where $\bar{m}$ satisfies $v'(\bar{m}/q)/\theta q=r$ (it is clear from Figure 5 that $m_s^{\mu}(b^G) < \bar{m}$). This is seen as follows. If $m > \bar{m}$, then the left hand side of (25a) is smaller than r, so that the right hand side implies $m < m_s^{\mu}(b^G) < \bar{m}$, a contradiction. If, on the other hand, $m < \bar{m}$, the left hand side is larger than r, so that the right hand side implies that m is above $m_s^{\mu}(b^G)$. This relationship is described in Figure 12 by the downward-sloping arrow curve. The curve is drawn on the assumption that $F(\cdot)$ has no mass point at T_{max} and $F'(\cdot)$ is positive close to T_{max}. In this case $\phi(\cdot)$ goes to infinity as b^G approaches b^G_{max}, so that (25a) implies that m converges to the terminal surface.

The arrows on the curve describe the direction of the system's movement. This direction is consistent with (11') if and only if the slope of the arrow curve is smaller than one. It has to be smaller than one for net government debt levels close to $\underline{b}^G$, and if it becomes larger than one close to b^G_{max} then the distribution function is not consistent with an equilibrium, because in this case net debt levels close to b^G_{max} bring about a movement away from point Q (see (11')). Hence, if there is no mass point at T_{max} the slope of the path is smaller than one and the equilibrium trajectory is as described in Figure 12.

On this trajectory net government debt is rising and money holdings are declining. The decline in money holdings results in reserve losses. If a policy switch takes place before point Q is reached, the system jumps downwards to the terminal surface, like from point A to point B. This jump cannont involve a discrete change in money holdings, because the policy switch brings to an end exchange rate stabilization. Hence, the jump results from an unexpected discrete exchange rate devaluation. There is no discontinuous exchange rate change at T_{max}, so that (23) is satisfied. However, unlike the certainty case, even at T^-_{max} there is no reserve run. This stems from the fact that the distribution function F(•) has no mass point even at T_{max}.

It remains to consider the case in which the distribution function has a mass point at T_{max}. In this case we obtain a combination of the trajectories described in Figures 5 and 12. This is depicted in Figure 13. If no policy switch takes place before the system reaches point Z at $t = T^-_{max}$, then when it reaches point Z there is a run on reserves that brings it to Q. The exchange rate does not jump at this last moment, so that (23) is also satisfied. Point Z is defined by the intersection of the curve that satisfies (25a) and a 45-degree line that passes through Q (Q is the point on the terminal surface that corresponds to b^G_{max}).

Our analysis implies that expectations of a money-financed stabilization lead to the same consumption levels and the same evolution of debt as expectations of a tax-based stabilization, but that in the presence of uncertainty they generate different expectations of exchange rate movements and therefore also different trajectories of money holdings. In the latter case no exchange rate jump is expected while in the former case a devaluation is expected to follow a policy switch. Consequently, in the former case there are no changes in money holdings while in the latter money holdings decline over time. Hence, in the presence of uncertainty the economy's trajectory prior to stabilization enables one to distinguigh between expectations of a tax-based and a money-based stabilization, contrary to the certainty case.

C. g_N-based stabilization

We now consider a stabilization via a cut in expenditures on nontraded goods. For the discussion that follows it is assumed that $u(c,c_N)$ is additively separable. In this case c is constant over time and the same as the consumption level for a tax-based and a money-based stabilization (see Appendix 3). This stems from the fact that in the certainty case this property of the utility function implies a consumption level which is independent of the timing of stabilization. In this case the current account is balanced.

Now, assuming for the moment that stabilization includes the abandoning of exchange rate management, the dynamic path is once again described by (25b) with the terminal surface for changes in g_N, namely $m_s^N(b^G)$, replacing $m_s^\mu(b^G)$ on the right-hand side. (We will point out at a later stage what happens if exchange rate management is maintained after stabilization.) For convenience we reproduce this here as

$$(25c) \qquad \frac{v'(m/q)}{\theta q} = r + \phi(b^G)[1 - \frac{m_s^N(b^G)}{m}] \qquad \text{for} \quad t < T_{max}$$

The system has to be on the curve described by (25c) and its direction of movement is given by (11'). The path therefore depends on the characteristics of the terminal surface $m_s^N(b^G)$, which is of course the same terminal surface as in the certainty case. In our discussion of the terminal surface above, we noted it may either fall, rise, or change sign. We consider these cases in turn.

In the case where the terminal surface $m_s^N(b^G)$ is falling (i.e., the interest elasticity of demand for money is smaller than one), the curve described by (25c) must be below the horizontal line $\bar{m}$ in Figure 14 but above the terminal surface. If initial net government debt is large enough so that the right hand side of (11') is positive for $t = 0$, the dynamic path must be monotonically falling until the policy switch takes place, as shown in Figure 14. The reasoning is identical to that used for the money-financed case above. At T_{max} the dynamic path intersects the terminal surface at b^G_{max}

(point Q) if the distribution function has no mass point at T_{max}, as shown in Figure 14. If a policy switch takes place before point Q is reached, the system jumps down to the terminal surface, like from point A to point B. This jump results from an unexpected devaluation.

If the government was to maintain the fixed exchange rate also after stabilization, then an unexpected policy switch whould not result an exchange rate jump, but rather a run on reserves that would bring the system instantaneously to the terminal surface. In this case (25) implies that prior to stabilization the system moves on the horizontal line in Figure 14, like in the certainty case, and if an unexpected policy switch takes place when it reaches point C it jumps instantaneously to point D. Point D is the intersection point between the terminal surface and a 45-degree line that passes through C.

Hence, if the fixed exchange rate is not maintained after stabilizatrion, the dynamic trajectory prior to stabilization is characterized by a continuous reserve loss as a result of the decline in money holdings, followed by a surprise devaluation if the policy switch occurs before T_{max}. If, on the other hand, the fixed exchange rate is maintained after the policy switch, there is no reserve loss on account of changes in the demand for money, but there is a run on reserves immediately following the policy switch. Finally, if there is a mass point at T_{max}, then there is a run on reserves at T_{max}^{-} if a policy switch does not take place before that time. We do not provide a graphic description of this case.

In the case where $m_s^N(b^G)$ is upward sloping (i.e., the interest elasticity of demand for money is larger than one), the dynamic path described by (25c) lies above $\bar{m}$ but below $m_s^N(b^G)$ when stabilization involves the abandoning of the fixed exchange rate. In this case the path need not be monotonic. Inspection of (25c) indicates that in this region, starting from a point where the equation is satisfied, both increases or decrease in m are consistent with (25c). The non-monotonicity of the path until b^G_{max} means that we may have alternating periods of reserve gains and losses even if there is no money financing of the budget (i.e., $\dot{M}^F = 0$ for $t < T_{max}$). Figure 15 describes a possible path for the case in which there is no mass at T_{max}. If a policy switch takes place before T_{max}, then there is an unexpected appreciation of the currency. If stabilization does not involve the abandoning of the fixed exchange rate, the dynamic path is again as in the certainty case.

Finally, if the terminal surface is not monotonic, we will get even more complicated paths, with the dynamic path always between $\bar{m}$ and the terminal surface, as in Figure 16.

So far our discussion relied on the assumption that $u(\cdot)$ is additively separable; that is, $u_{12} = 0$. By continuity, one may argue that if u_{12} is positive but small enough, then the qualitative features of the macrodynamics that were described above will not change, except that the current account will not be balanced. We show in Appendix 3 that for u_{12} positive but small enough the current account will be initially in surplus. Intuitively, this stems from the fact that in the certainty case there is a surplus on current account for every known policy switch date T. Hence, in the presence of uncertainty, expectations of an expenditure cut on nontradeables are clearly identifiable from the resulting macrodynamics.

4. Summary

We have studied the consequences of two-stage stabilization programs for open economies, with the first stage consisting of fixing the exchange rate in order to achieve an immediate reduction in the rate of inflation. These types of programs have been used in practice, Israel being a case in point. We have shown that a zero rate of inflation can indeed be achieved by this policy, but that long-term inflation depends on the nature of the second stage policy. When the timing of the second stage is known with certainty, the inflation gain becomes permanent if the second stage consists of a budget cut on traded goods or a tax increase which ensures budget balance. If the second stage consists of a budget cut on nontraded goods, then the sustainable rate of inflation is also zero, except that at the time of the expenditure cut there is a drop in the price level as a result of a decline in the price of nontraded goods. In all these cases the exchange rate remains constant forever. If, however, the second stage policy switch does not ensure budget balancing, then it is necessary to rely on money financing and the fixed exchange rate has to be abandoned, implying inflation whose magnitude depends on the size of the public debt and the extent of the budgetary adjustment.

An important result that emerges in the certainty case is that current account developments associated with expectations of a second stage tax increase, spending cut on traded goods, and spending cut on nontraded goods are different. Expectations of a tax increase lead to a balanced current account, of a budget cut on traded goods to a deficit on current account, and of a budget cut on nontraded goods to a surplus on current account. In the first case all additions to public debt are additions to internal debt, in the second case to external debt, and in the last internal debt is rising while external debt is declining.

When the second stage is expected to consist of money financing, the balance of payments developments are the same as in the case of an expected tax increase. Certainty about timing of the second stage policy switch makes these two cases indistinguishable, except for the last moment in which there is a run on reserves if money financing is expected and no run if tax financing is expected. A run on reserves also takes place when a budget cut on nontraded goods is expected, but not when a budget cut on traded goods is expected. In all of these cases the quantity of money is constant before the second stage policy switch (except at the last moment in the cases in which there is a run on reserves).

Uncertainty about the timing of stabilization does not change balance of payments developments in any significant way (qualitativly speaking). It does affect, however, the path of money holdings and the exchange rate when the second stage is expected to consist of a budget cut on nontraded goods or increased money financing. In the other two cases uncertainty about timing of a policy switch does not effect macrodynamics.

When money financing is expected, the quantity of money is declining as long as the policy switch does not take place. Therefore, the behavior of the stock of money in this case enables us to make a distinction between expectations of a tax increase or money financing. When money financing is enacted before the last possible moment, a maxi devaluation acompanies the stabilization effort.

In the case of a budget cut on nontraded goods there are two possibilities: the fixed exchange rate policy can be maintained when the budget cut takes place or it can be abandoned. In the former case the quantity of money is constant prior to the policy switch and a run on reserves takes place the moment it is enacted. In the latter case the quantity of money declines over time and a maxi devaluation accompanies the policy switch, provided the demand for money is inelastic with respect to the interest rate and preferences are additively separable in the consumption of traded and nontraded goods. Under the same conditions the current account is balanced. If preferences are not additively separable, then there is a presumption that the current account will be in surplus at least immediately after the fixing of the exchange rate. Hence, the nature of the policy to be enacted in the second stage plays a major role in the determination of macroeconomic developments prior to its implementation.

APPENDIX 1 - KNOWN SWITCH DATES

In this appendix we derive the first-order conditions when the switch date is known. These are necessary and sufficient conditions. The problem of maximizing present discounted utility (1) subject to budget constraints (2) and (3) may be written

$$\text{(A1.1)} \qquad \underset{\{c(t), c_N(t), M(t), z(t), \Delta M(t_i)\}}{\text{Max}} \int_0^\infty e^{-rt}[u(c(t), c_N(t)) + v(\frac{M(t)}{Q(t)})]dt$$

$$+ \theta\Big[\int_0^\infty e^{-rt}[-c(t) - \frac{p_N(t)}{\epsilon(t)}c_N(t) - \frac{z(t)}{\epsilon(t)} - \tau(t) + y + \frac{p_N(t)}{\epsilon(t)}y_N]dt$$

$$- \Sigma_{t_i<t}\, e^{-rt_i} \frac{\Delta M(t_i)}{\epsilon(t_i)} + b_0\Big]$$

$$+ \int_0^\infty \gamma(t)[M_0 + \int_0^t z(x)dx + \Sigma_{t_i \leq t}\, \Delta M(t_i) - M(t)]dt$$

where θ is the multiplier on the budget constraint (2a) in the text and $\gamma(t)$ is the multiplier on equation (3) in the text. Maximization of (A1.1) with respect to each of the $c(t)$, $c_N(t)$, $M(t)$, and $z(t)$ yields (where u_1 and u_2 refer to the marginal utility of consumption of traded and nontraded goods respectively),

$$\text{(A1.2)} \qquad e^{-rt}u_1(c(t), c_N(t)) = \theta e^{-rt}$$

(A1.3) $$e^{-rt}u_2(c(t),\ c_N(t)) = \theta e^{-rt}\,\frac{p_N(t)}{\epsilon(t)}$$

(A1.4) $$e^{-rt}v'\left(\frac{M(t)}{Q(t)}\right)\frac{1}{Q(t)} = \gamma(t)$$

(A1.5) $$\theta e^{-rt}\,\frac{1}{\epsilon(t)} = \int_t^{\infty}\gamma(x)dx$$

Maximization with respect to $\Delta M(t_i)$ yields a condition identical to (A1.5) for $t = t_i$. Using the market clearing condition $c_N(t) = y_N - g_N(t)$, (A1.2) yields equation (5) in the text, while (A1.2) and (A1.3) yield equation (6). Conditions (A1.4) and (A1.5) can be combined to yield

(A1.7) $$\frac{1}{\epsilon(t)} = \frac{1}{\theta}\int_t^{\infty}e^{-r(x-t)}v'\left(\frac{M(x)}{Q(x)}\right)\frac{1}{Q(x)}dx$$

which is equation (7) in the text.

Differentiating (A1.7) with respect to t, one obtains

(A1.8) $$-\frac{\dot{\epsilon}}{\epsilon^2} = -\frac{1}{\theta}v'\left(\frac{M}{Q}\right)\frac{1}{Q} + r\,\frac{1}{\theta}\int_t^{\infty}e^{-r(x-t)}v'\left(\frac{M}{Q}\right)\frac{1}{Q}dx$$

which, on rearrangement, using (A.7) yields equation (8) in the text, where $q = \frac{Q}{\epsilon}$ and $m = \frac{M}{\epsilon}$.

APPENDIX 2 - UNCERTAIN DATE OF A REGIME SWITCH

In this appendix, we derive the first-order conditions when the date T of a switch is unknown. When the cumulative distribution of a switch occurring until T is $F(T)$, maximization of (19) in the text subject to constraints (2) and (3) may be written

$$\text{(A2.1)} \quad \underset{\{c(t), c_N(t), M(t), z(t), \Delta M(t_i)\}}{\text{Max}} \int_0^{T_{max}} \Bigg[\int_0^T e^{-rt} [u(c(t), c_N(t)) + v(\frac{M(t)}{Q(t)})]dt$$

$$+ e^{-rT} V^S (e^{rT} b_0 - \int_0^T e^{r(T-t)} [c(t) + \frac{P_N(t)}{\epsilon(t)} c_N(t) + \frac{z(t)}{\epsilon(t)} + \tau(t) - y$$

$$- \frac{P_N(t)}{\epsilon(t)} y_N]dt - \Sigma_{t_i \le T} e^{r(T-t_i)} \frac{\Delta M(t_i)}{\epsilon(t_i)} + \frac{M_0 + \int_0^T z(x)dx + \sum_{t_i \le T} \Delta M(t_i)}{\epsilon(t)}; T)$$

$$+ \int_0^T \gamma(t)[M_0 + \int_0^t z(x)dx + \sum_{t_i \le t} \Delta M(t_i) - M(t)] \Bigg] dF(T)$$

where $\gamma(t)$ is the multiplier on constraints (3) in the text. Maximization of (A2.1) with respect to each of the $c(t)$, $c_N(t)$, $M(t)$, and $z(t)$ yields (where $\theta(t)$ is the marginal utility of traded goods at time t, $u_2(t)$ is the marginal utility of consumption of nontraded goods, and where a superscript s indicates the variable after stabilization):

$$\text{(A2.2)} \qquad \int_t^{T_{max}} e^{-rt}\theta(t)dF(T) = \int_t^{T_{max}} e^{-rt}\theta^s(T)dF(T)$$

$$\text{(A2.3)} \qquad \int_t^{T_{max}} e^{-rt}u_2(t)dF(T) = \int_t^{T_{max}} e^{-rt}\theta^s(T)\,\frac{P_N(T)}{\epsilon(T)}dF(T)$$

$$\text{(A2.4)} \qquad \int_t^{T_{max}} e^{-rt}v'(t)\frac{1}{Q(t)}dF(T) = \int_t^{T_{max}} \gamma(t)dF(T)$$

$$\text{(A2.5)} \qquad \int_t^{T_{max}} \left[e^{-rT}\theta^s(T)\ \left(-\ \frac{e^{r(T-t)}}{\epsilon(t)} + \frac{1}{\epsilon^s(T)}\right) + \int_t^T \gamma(x)dx\right]dF(T) = 0$$

Maximization with respect to $\Delta M(t_i)$ yields a condition identical to (A2.5) for $t = t_i$. (A2.2) clearly simplifies to

$$\text{(A2.6)} \qquad \theta(t) = \int_t^{T_{max}} \theta^s(T)\,\frac{dF(T)}{1-F(t)}$$

which is equation (20) in the text. (A2.3) then yields equation (6) in the text. Since (A2.4) implies

$$\gamma(t) = e^{-rt}v'(t)\,\frac{1}{Q(t)}$$

(A2.5) becomes

$$\text{(A2.7)} \qquad \frac{1}{\epsilon(t)} = \frac{1}{\theta(t)} \int_0^{T_{max}} \left[e^{-r(T-t)} \frac{\theta^s(T)}{\epsilon^s(T)} + \int_t^T e^{-r(x-t)} \frac{v'(x)}{Q(x)} dx \right] \frac{dF(T)}{1-F(t)}$$

which is equation (21) in the text.

As t approaches T_{max}, (A2.2) implies that $\theta(T_{max}) = \theta^s(T_{max})$, which is equation (22), while (A2.6) implies that $\epsilon(T_{max}) = \epsilon^s(T_{max})$, which is equation (23).

Differentation of (A2.6) when $F(T)$ is differentiable yields

$$\text{(A2.8)} \qquad \frac{\dot{\theta}}{\theta} = \frac{f}{1-F}\left(1 - \frac{\theta^s}{\theta}\right)$$

where f is the density function associated with F. Differentiation of (A2.7) (actually starting with (A2.5)) together with (A2.8) yields

$$\text{(A2.9)} \qquad e^{-rt}\left[-r \frac{1}{\epsilon}\int_t^{T_{max}} \theta^s(T)dF(t) - \frac{\dot{\epsilon}}{\epsilon^2} \int_t^{T_{max}} \theta^s(T)dF(T) - \frac{1}{\epsilon}\, \theta^s(T)f(T)\right]$$

$$= - \theta^s(T)e^{-rt} \frac{f(T)}{\epsilon^s(T)} - \int_t^{T_{max}} e^{-rt} v'(t) \frac{1}{Q(t)} dF(T)$$

which, for the case where $\epsilon(t)$ is constant before T_{max}, becomes

$$\text{(A2.10)} \qquad \frac{v'(m/q)}{\theta q} = r + \frac{f}{1-F} \frac{\theta^s}{\theta}\left[1 - \frac{\epsilon}{\epsilon^s}\right]$$

which is equation (25).

APPENDIX 3

We discuss in this appendix the evolution of consumption and debt prior to stabilization in the presence of uncertainty about the timing of a stabilization. The relevant dynamic equations are (2'), (11'), (14) and (24), with the side conditions (4), (6), (26) and

$$\dot{M} = z$$

Using these side conditions the dynamic equations become:

$$\text{(A3.1)} \qquad \dot{b} = rb + y + pg_N - c - \tau - \dot{M}/\varepsilon$$

$$\text{(A3.2)} \qquad \dot{b}^G = rb^G + g + pg_N - \tau - \dot{M}/\varepsilon$$

$$\text{(A3.3)} \qquad \dot{\bar{b}} = r\bar{b} + g + c - y$$

$$\text{(A3.4)} \qquad \frac{\dot{\theta}}{\theta} = \phi(b^G)(1 - \frac{\theta^s}{\theta}) \qquad \text{for} \quad t < T_{max}$$

These equations describe values of variables at $t < T_{max}$ conditional on no regime switch taking place prior to or at t. The initial value of $\bar{b}$ is given, the terminal condition on θ is (22), and the initial value of b and

b^G are chosen by the public under the constraints:

$$b(0) + m(0) = b_0 + m_0$$

$$b^G(0) - b(0) = \bar{b}_0$$

The choice may depend on the expected instrument of stabilization and the hazard rate function $\phi(\cdot)$. Our analysis applies to all initial values. Clearly, only two equations out of (A3.1)-(A3.3) are independent, and we may choose any two.

Since g_N is constant prior to stabilization, so is $c_N = y_N - g_N$ (and so are g and τ). Therefore θ is a declining function of c, or c is a declining function of θ.

$$\text{(A3.5)} \qquad c = c(\theta) \quad , \quad c'(\theta) < 0$$

By the same token, assuming that c_N is normal in consumption, p is an increasing function of c or a declining function of θ; i.e.,

$$\text{(A3.6)} \qquad p = p(\theta) \quad , \quad p'(\theta) < 0$$

τ-based and μ-based stabilizations

In these cases g_N is the same for all t so that (A3.5) and (A3.6) apply for all t. Since after stabilization all three debt variables remain constant, (A3.3) implies:

$$(A3.7) \qquad r\bar{b} + c(\theta^{s}) + g - y = 0$$

This implies that θ^{s} depends on time only through the dependence on time of net foreign debt. Hence, using (A3.5):

$$(A3.8) \qquad \theta^{s} = \theta^{s}(\bar{b}) \qquad , \qquad \theta^{s\prime}(\bar{b}) > 0$$

In this case (A3.3) and (A3.4) imply:

$$(A3.9) \qquad \dot{\bar{b}} = r\bar{b} + g + c(\theta) - y$$

$$(A3.10) \qquad \frac{\dot{\theta}}{\theta} = \phi(b^{G})[1 - \frac{\theta^{s}(\bar{b})}{\theta}]$$

In this system the curves $\dot{\bar{b}} = 0$ and $\dot{\theta} = 0$ coincide (see (A3.7)) and they are independent of b^{G}. The resulting phase diagram is described in Figure A3.1.

The upward sloping curve describes $\theta^{s}(b)$, $\dot{\bar{b}} = 0$ and $\dot{\theta} = 0$. The arrows describe the direction of the system's movement when it is off this curve. The speed of the upward or downward movement depends on b^{G}, despite the fact that the location of the steady state point does not.

It is clear from this diagram that (22) (i.e., $\theta(T_{max}) = \theta^{S}(T_{max})$) is satisfied if and only if, given $\bar{b}_0$, θ at time zero is such that $(\bar{b}_0, \theta)$ is a steady state point. Therefore:

$$c = y - g - r\bar{b}_0 \qquad \text{for all} \quad t$$

for a τ- and a μ-based stabilization, exactly as in the certainty case. In this case:

$$\dot{\bar{b}} = 0 \qquad \text{for all} \quad t$$

$$\dot{b}^G = \dot{b} \qquad \text{for all} \quad t$$

with $\dot{b} > 0$ for $t < T_{max}$ as long as there is no stabilization.

g-based stabilization

In this case too g_N is the same for all t. Therefore (A3.1), together with (A3.5) and (A3.6), imply:

(A3.11) $$rb + y + p(\theta^S)g_N - c(\theta^S) - \tau = 0$$

Assuming that an increase in c does not increase private savings in terms of tradeables as a consequence of the increase in the relative price of nontradeables (i.e., $c + pc_N - y - py_N$ increases), (A3.11) implies that θ^s is a declining function of b. In this case (A3.1) and (A3.4) yield (remember that $\dot{M} = 0$):

$$\text{(A3.12)} \qquad \dot{b} = rb + y + p(\theta)g_N - c(\theta) - \tau$$

$$\text{(A3.13)} \qquad \frac{\dot{\theta}}{\theta} = \phi(b^G)[1 - \frac{\theta^s(b)}{\theta}]$$

with $\theta^s(b)$ being a declining function. The phase diagram of this system is described in Figure A3.2.

The curves $\theta^s(b)$, $\dot{b} = 0$, and $\dot{\theta} = 0$ coincide and they do not depend on b^G. Condition (22) is satisfied if and only if (b,θ) is a steady state at $t = 0$. Therefore c is constant for all t and satisfies:

$$rb(0) + y + p(c,y_N-g_N)g_N - c - \tau = 0$$

as in the certainty case.

g_N-based stabilization

When $u(c,c_N)$ is additively separable θ depends only on c. Therefore in this case:

$$r\bar{b} + c(\theta^s) + g - y = 0$$

implies that θ^s is a declining function of $\bar{b}$ and it does not depend on the size of the cut in g_N (and increase in c_N). Therefore (A3.3) and (A3.4) imply (A3.9) and (A3.10). Consequently, in this case too c is constant at the level that balances the current account and it does not change after a g_N-based stabilization.

In the case in which $u(\cdot)$ is not additively separable θ^s depends on both $\bar{b}$ and b^G. Using (A3.2), (A3.3) and (6), we have:

$$\text{(A3.14)} \qquad rb^G + g + g_N^s\, u_2(c^s, y_N - g_N^s)/\theta^s - \tau = 0$$

$$\text{(A3.15)} \qquad r\bar{b} + g + c^s - y = 0$$

where the superscript s indicates values that obtain as a result of an expenditure cut on nontradeables. By definition:

$$\text{(A3.16)} \qquad \theta^s = u_1(c^s, y_N - g_N^s)$$

Equations (A3.14)-(A3.16) provide implicit values of (g_N^s, c^s, θ^s) as functions of $(\bar{b}, b^G)$. In particular, $\theta^s = \theta^s(\bar{b}, b^G)$. Differentiation of the system yields:

$$\text{(A3.17)} \qquad \frac{\partial\theta^s}{\partial b^G} = \frac{r\theta u_{12}}{u_2(1 + g_N^s u_{12}/\theta^s) - u_{22} g_N^s}$$

$$\text{(A3.18)} \qquad \frac{\partial\theta^s}{\partial\bar{b}} = \frac{r[u_{11}u_{22}g_N^s - u_{11}u_2 - u_{12}^2]}{u_2(1+g_N^s u_{12}/\theta^s) - u_{22}g_N^s}$$

Assuming $u_{12} > 0$, it is clear from (A3.17) that $\theta^s(\cdot)$ is increasing in b^G, while (A3.18) implies that it is also increasing in $\bar{b}$ if u_{12} is sufficiently small or g_N is sufficiently large.

Now, from the dynamic equations (A3.2)-(A3.4) we obtain as before:

$$\text{(A3.19)} \qquad \dot{b}^G = rb^G + g + p(\theta)g_N - \tau$$

$$\text{(A3.20)} \qquad \dot{\bar{b}} = r\bar{b} + g + c(\theta) - y$$

$$\text{(A3.21)} \qquad \frac{\dot{\theta}}{\theta} = \phi(b^G)\left[1 - \frac{\theta^s(\bar{b},b^G)}{\theta}\right]$$

for $t < T_{max}$. Let $\theta*$ satisfy:

$$r\bar{b}_0 + g + c(\theta*) - y = 0$$

i.e., $\theta*$ is the marginal utility of consumption of tradeables when the c brings about a balanced current account at time $t = 0$. Then we claim:

If $\theta^s(\bar{b},b^G)$ is increasing in both arguments then $\theta(0) > \theta*$.

Proof: Since $rb^G(0) + g + p(\theta*)g_N - \tau > 0$ by assumption, then $\theta^s(\bar{b}_0, b^G(0)) > \theta*$, because $\theta^s[\bar{b}_0, (g + p(\theta*)g_N - \tau)/r] = \theta*$, and $\theta^s(\cdot)$ is increasing in b^G. Therefore, if $\theta(0) \leq \theta*$ (A3.21) implies $\dot{\theta}(0) < 0$. Moreover, in this case (A3.19)-(A3.20) imply $\dot{b}^G(0) > 0$ and $\dot{\bar{b}}(0) > 0$. It is now clear that for all $t < T_{max}$ $\bar{b}$, b^G and c will be increasing while θ will be declining, implying: $\theta^s(T_{max}) > \theta(T_{max})$, which contradicts (22). Therefore if $\theta^s(\bar{b}, b^G)$ is an increasing function of both arguments then $\theta(0) > \theta*$, which implies that $\dot{\bar{b}}(0) < 0$; i.e., there is initially a surplus on current account. On the other hand, the function $\theta^s(\bar{b}, b^G)$ is increasing in both arguments if u_{12} is positive and sufficiently small, or if it is positive and g_N is sufficiently large ($g_N > 1$ is sufficient).

The inequality $\theta(0) > \theta^*$ implies that consumption of tradeables at time t=0 is lower than the consumption level that balances the current account. Consequently, there is initially a surplus on current account.

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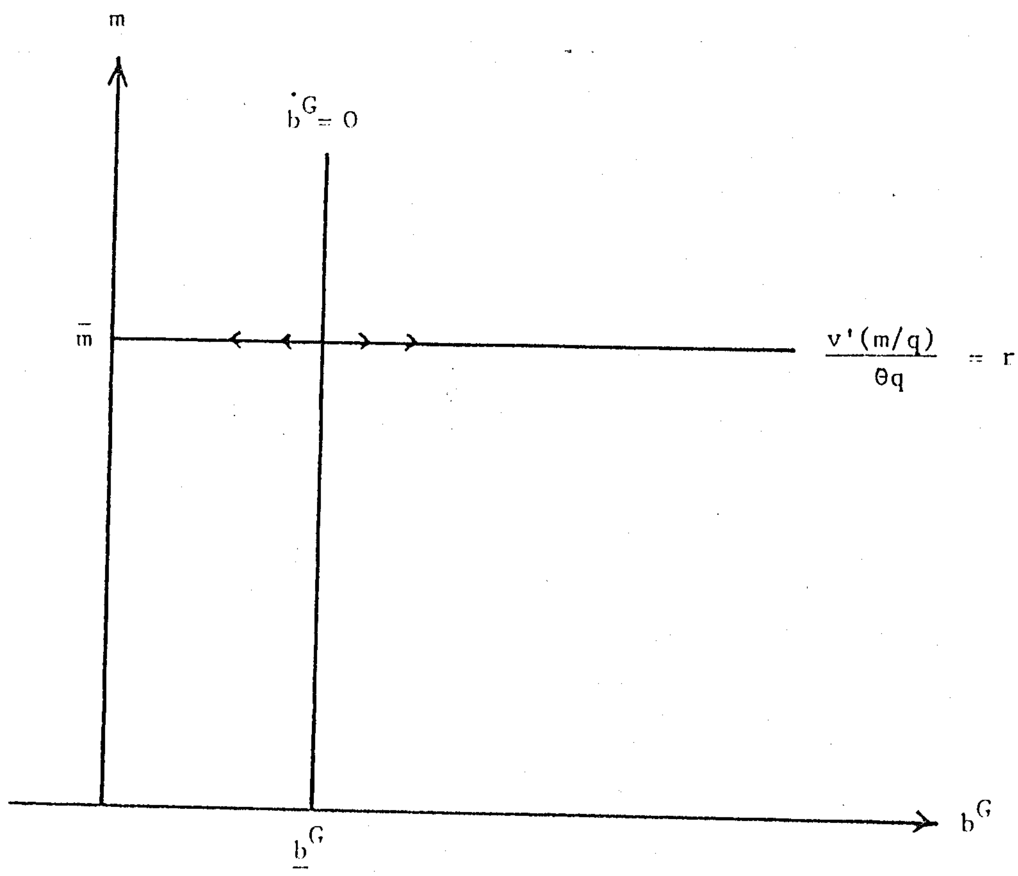


Figure 1

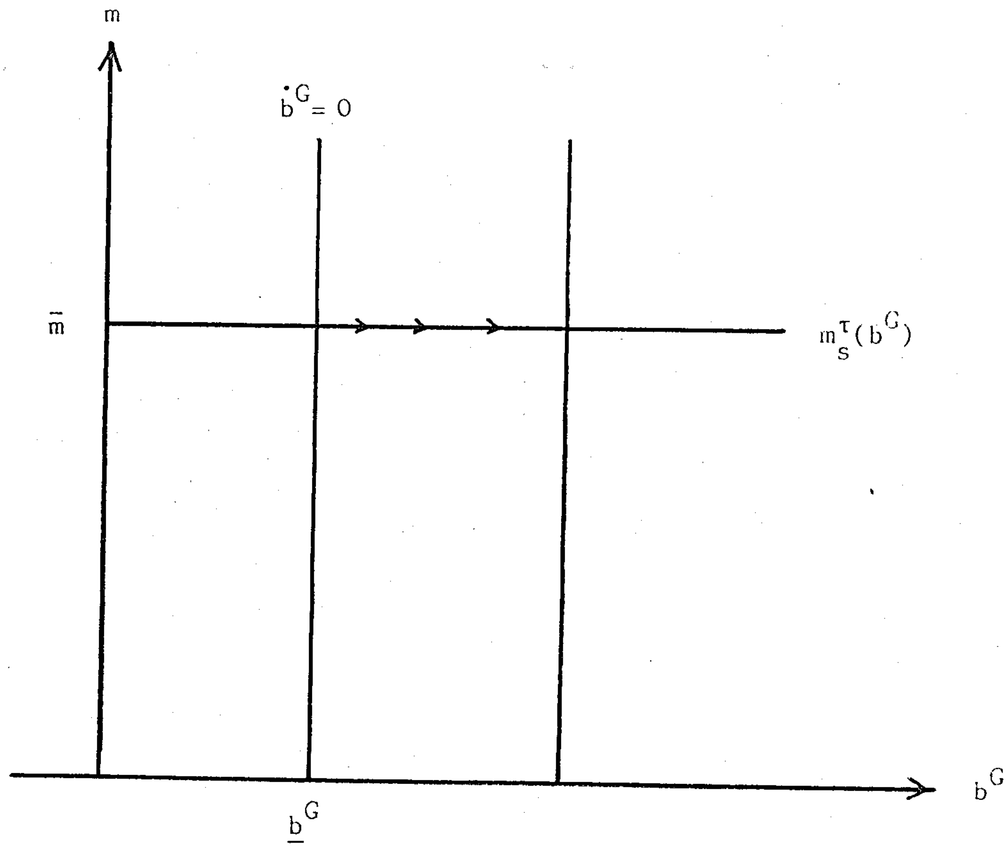


Figure 2

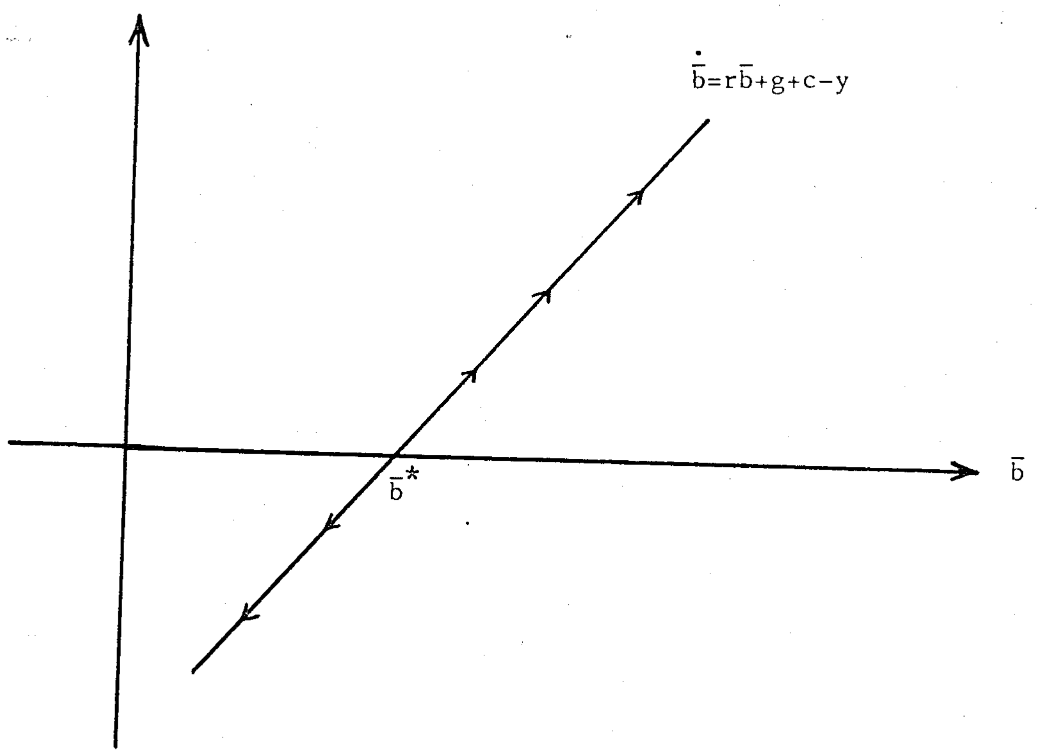
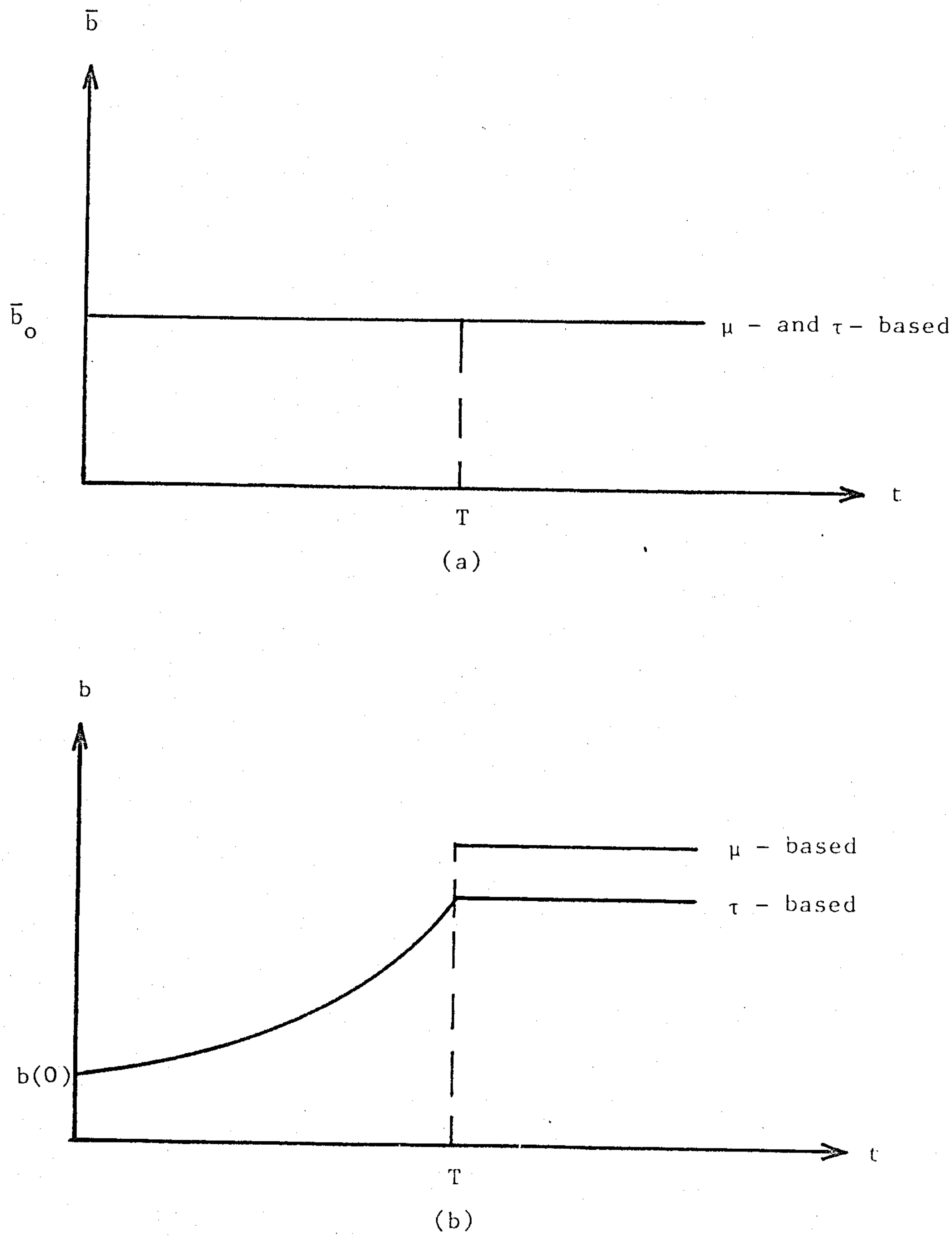


Figure 3



τ - and μ - based stabilizations

<u>Figure 4</u>

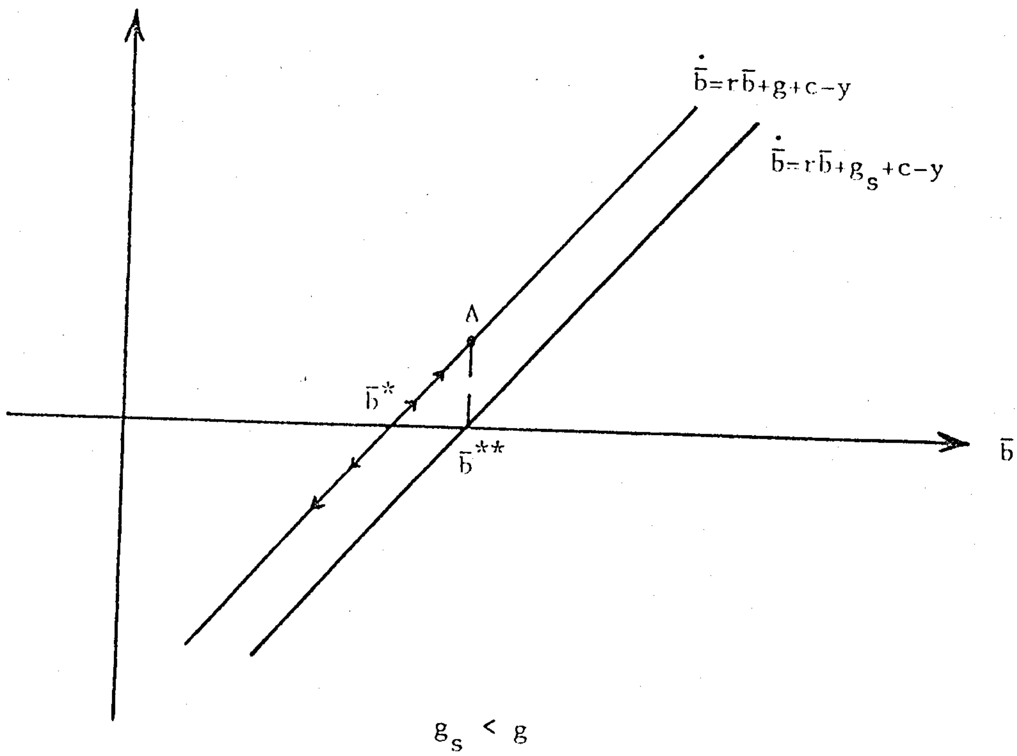
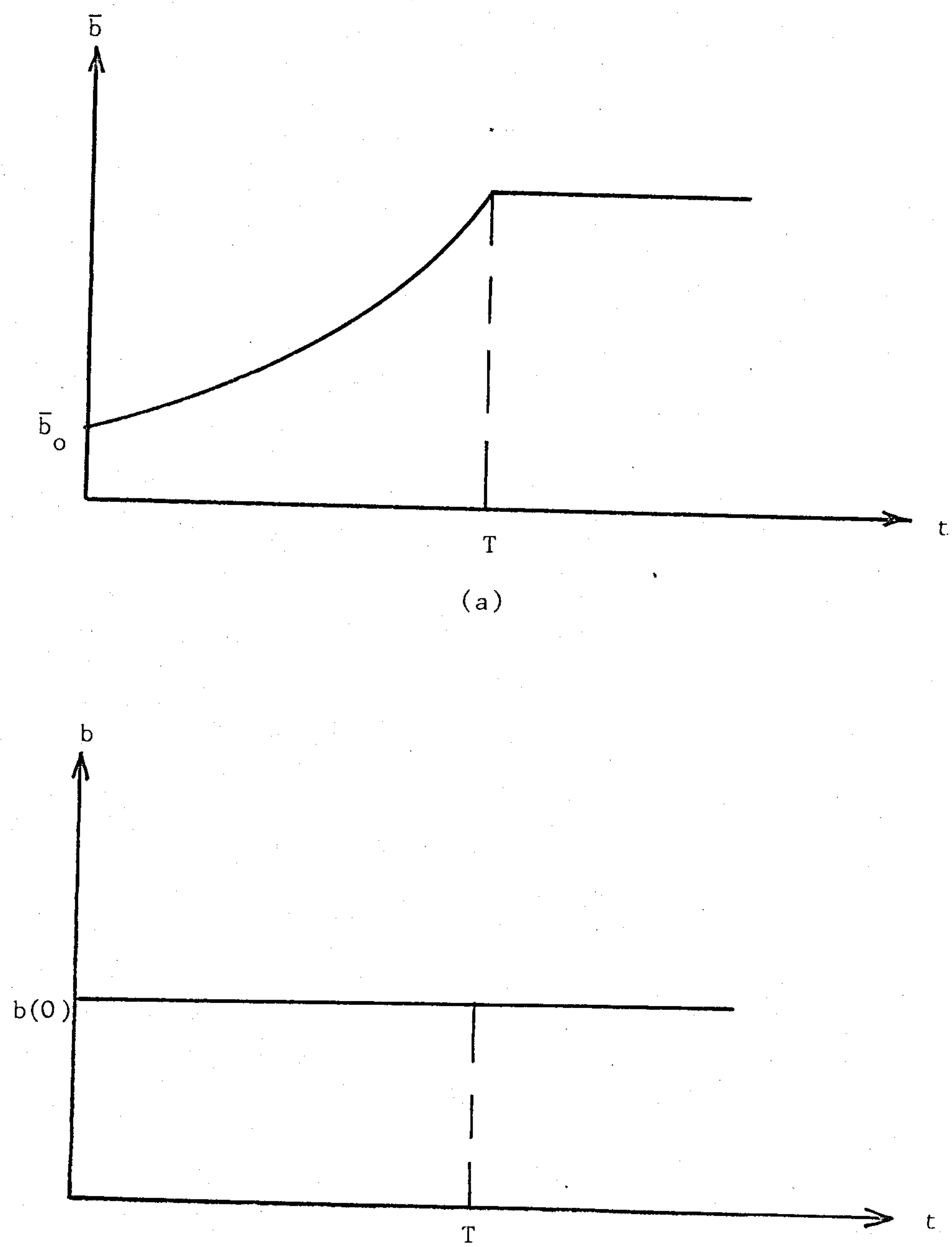


Figure 5

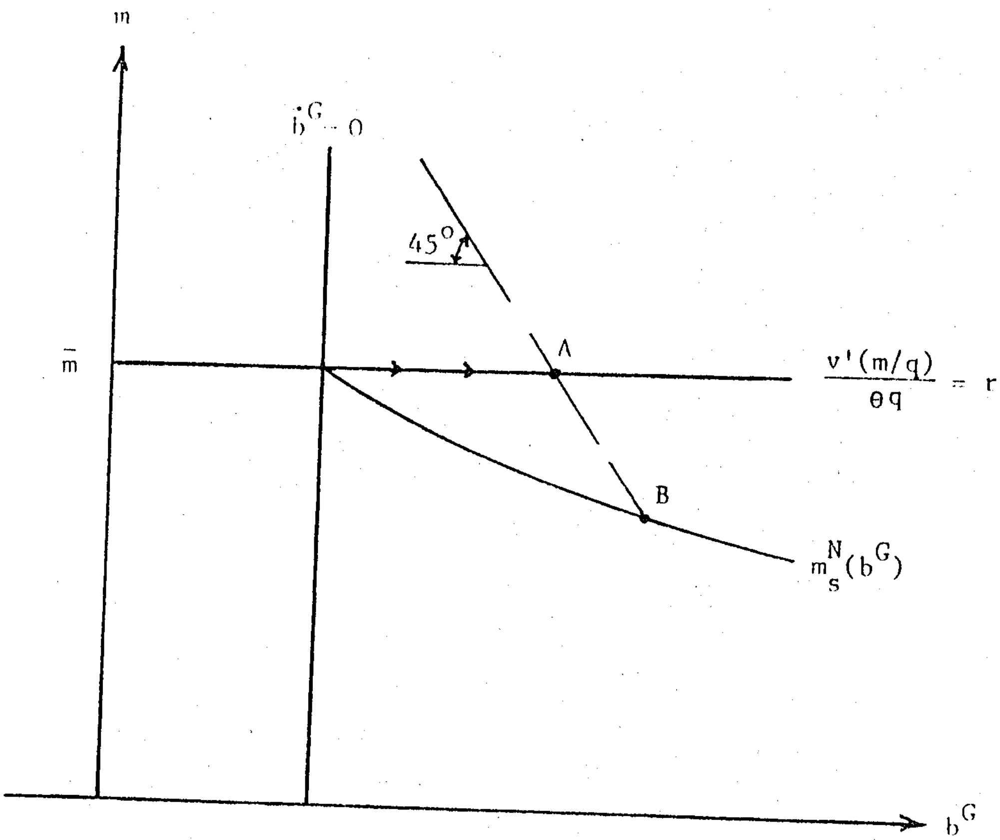


(a)

(b)

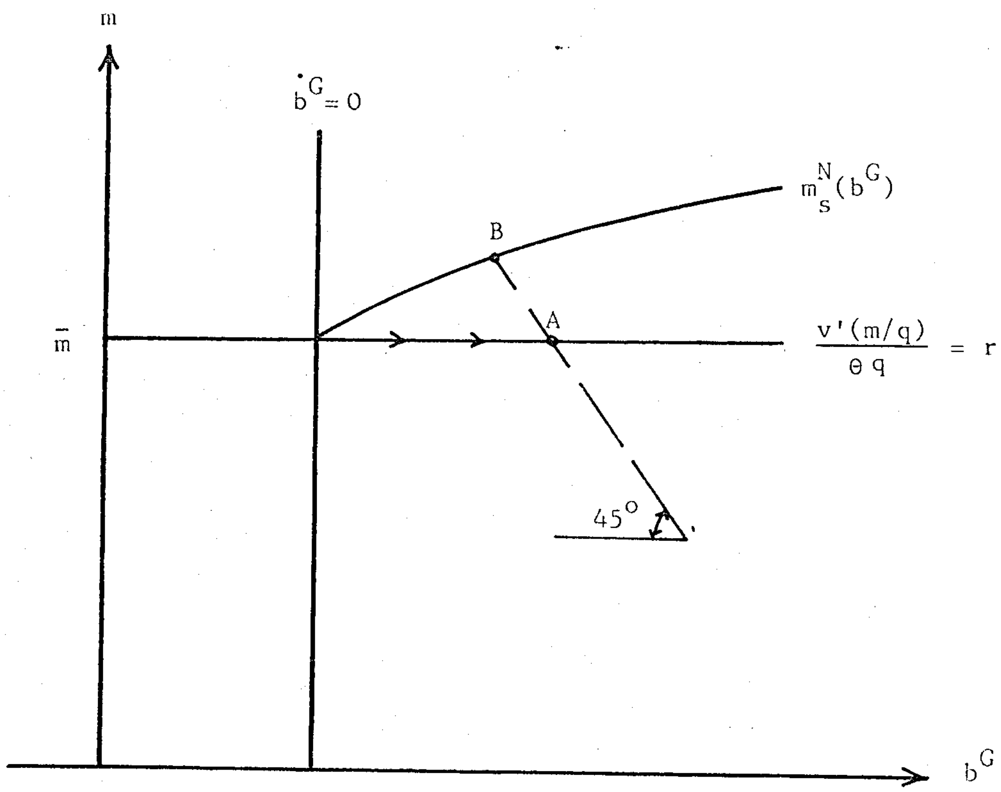
g - based stabilization

Figure 6



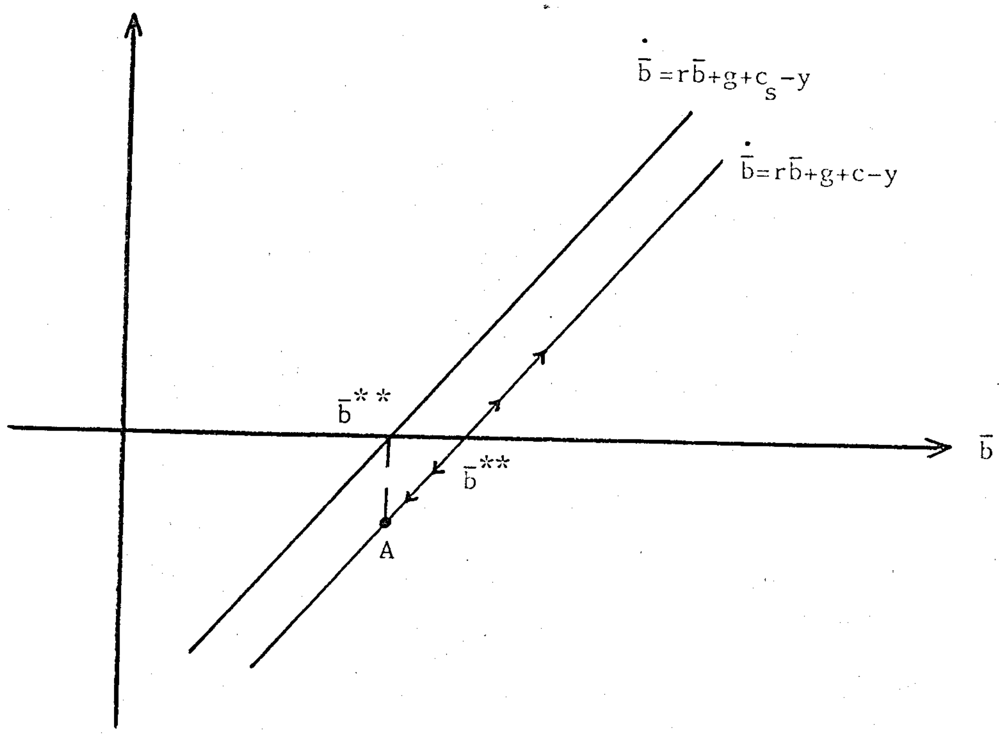
Interest inelastic demand for money

Figure 7



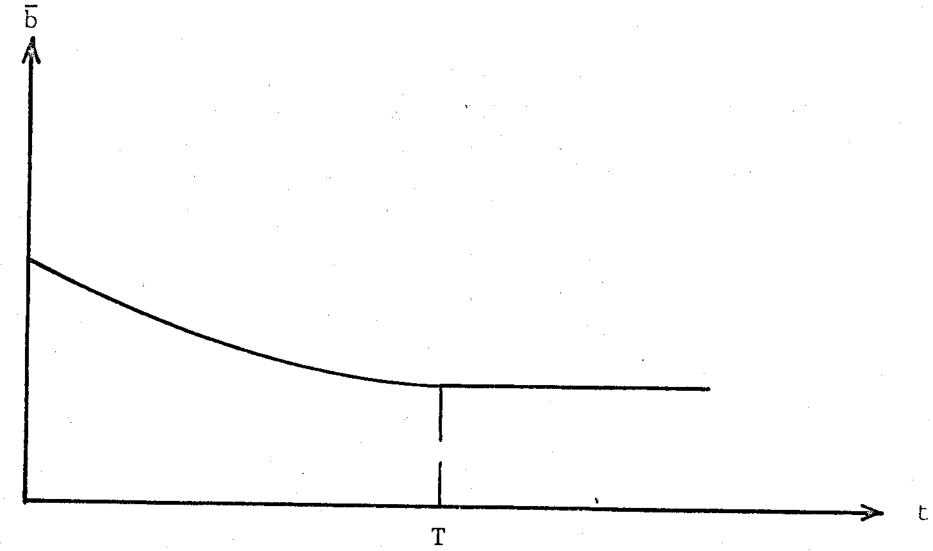
Interest elastic demand for money

Figure 8

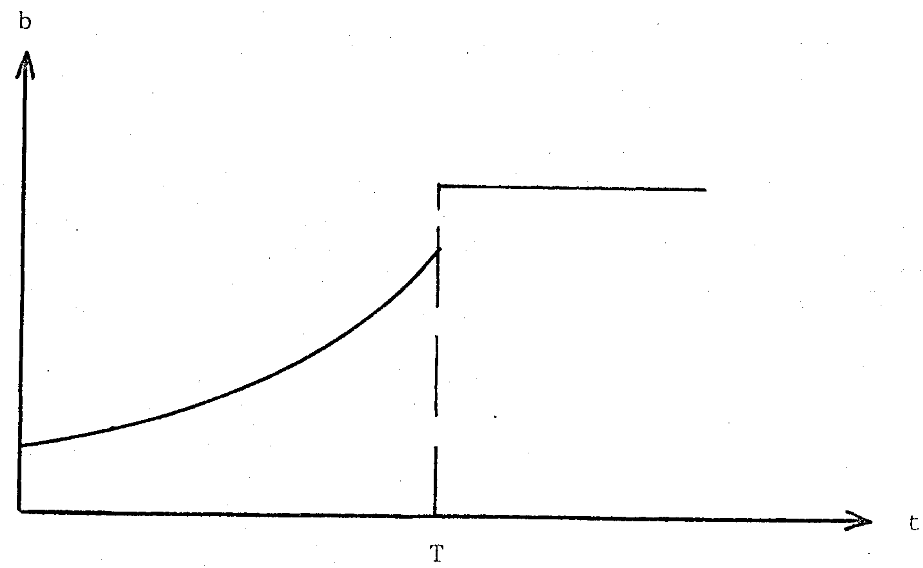


$c_s > c$

Figure 9



(a)



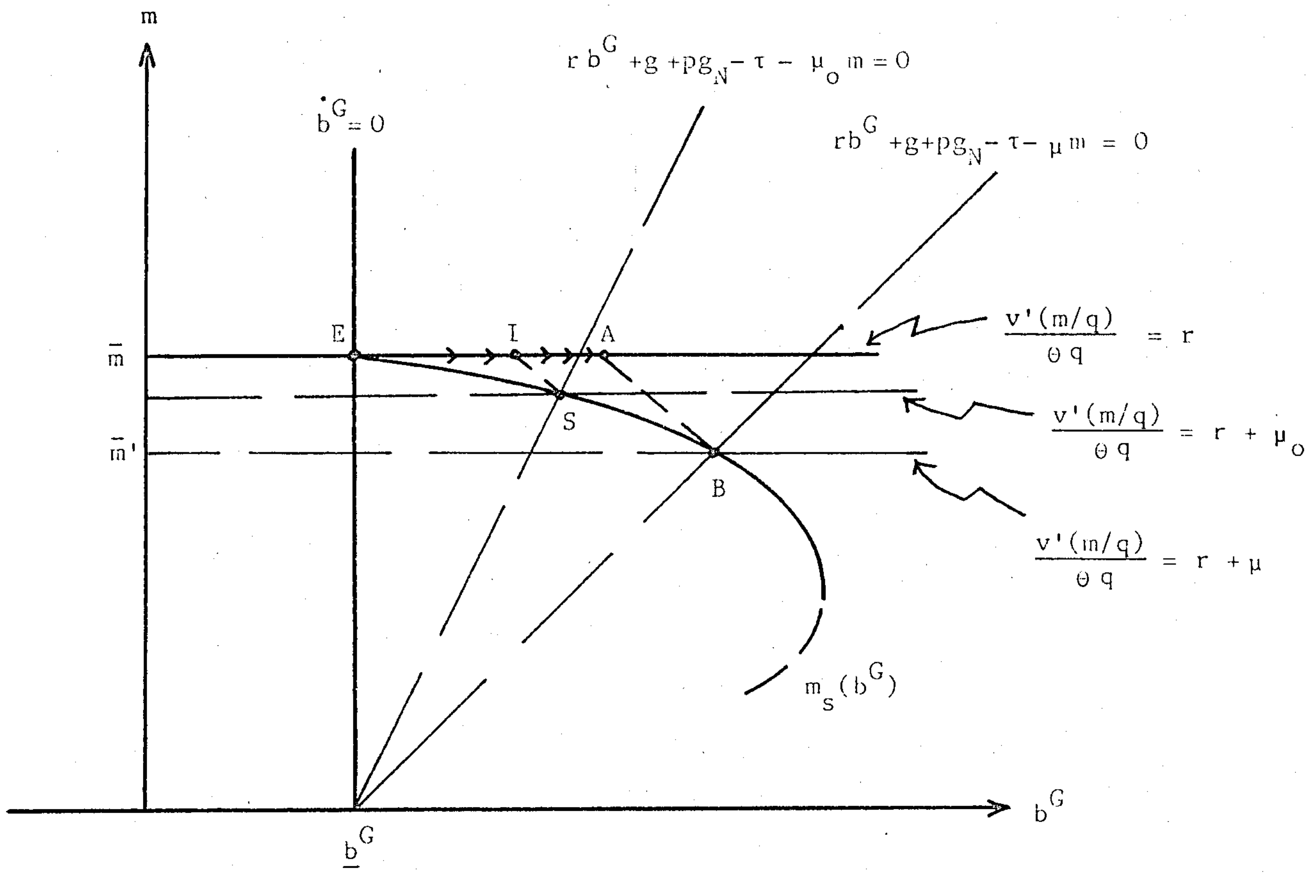
(b)

g_N - based stabilization

interest inelastic demand for money

$u_{12} > 0$

Figure 10



m
$r b^G + g + pg_N - \tau - \mu_o m = 0$
$\dot{b}^G = 0$
$rb^G + g + pg_N - \tau - \mu m = 0$
E
I
A
$\bar{m}$
$\frac{v'(m/q)}{\theta q} = r$
S
$\frac{v'(m/q)}{\theta q} = r + \mu_o$
$\bar{m}'$
B
$\frac{v'(m/q)}{\theta q} = r + \mu$
$m_s(b^G)$
b^G
$\underline{b}^G$

Figure 11

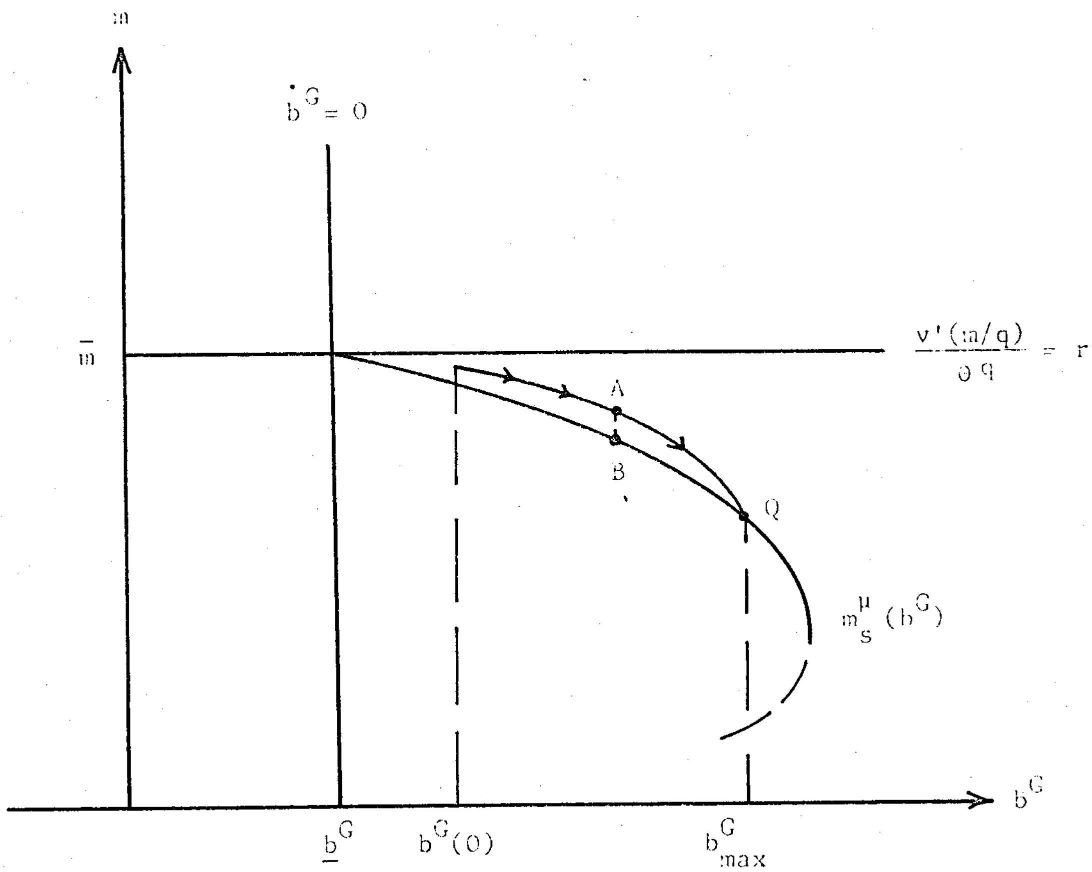
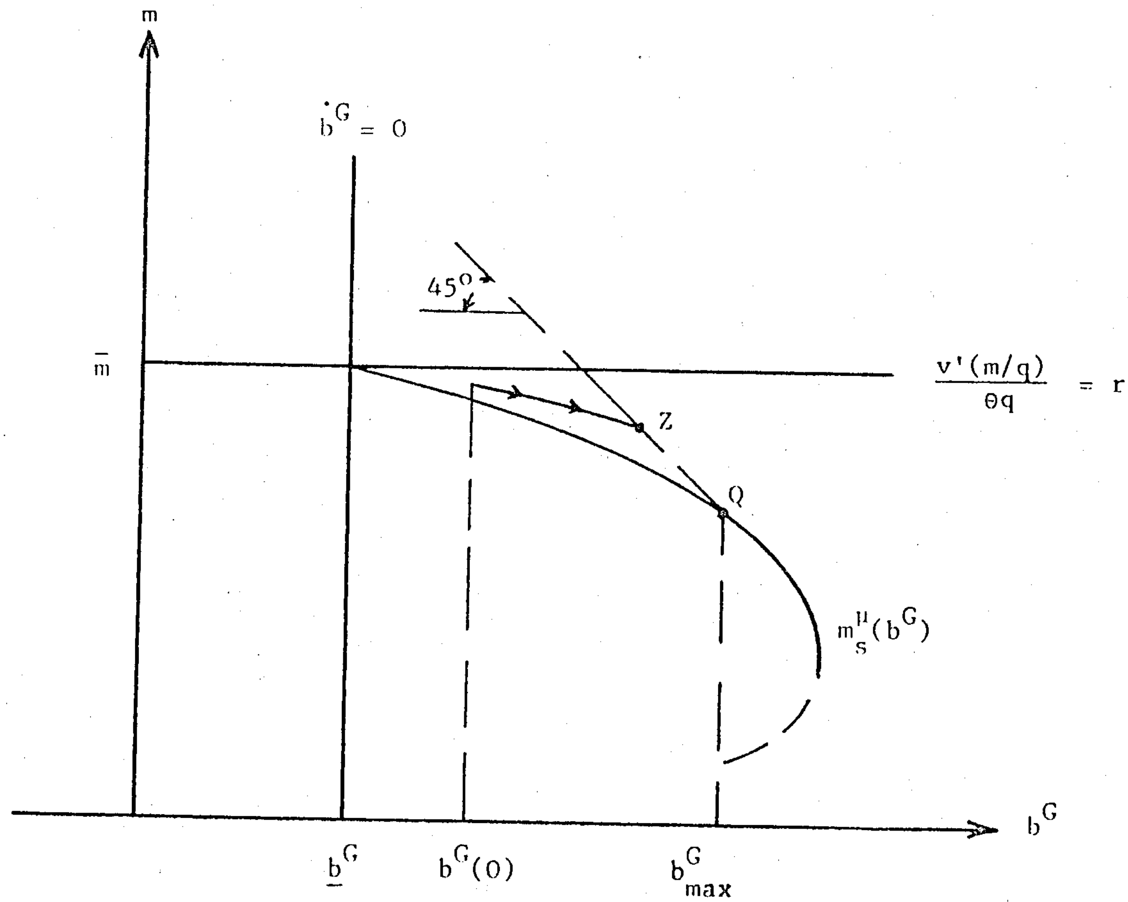

m
$\dot{b}^G = 0$
$\bar{m}$
$\frac{v'(m/q)}{\theta q} = r$
A
B
Q
$m_s^\mu(b^G)$
b^G
$\underline{b}^G$
$b^G(0)$
b^G_{max}

Figure 12



m
$\dot{b}^G = 0$
45°
$\bar{m}$
$\frac{v'(m/q)}{\theta q} = r$
Z
Q
$m_s^\mu(b^G)$
b^G
$\underline{b}^G$
$b^G(0)$
b^G_{max}

Figure 13

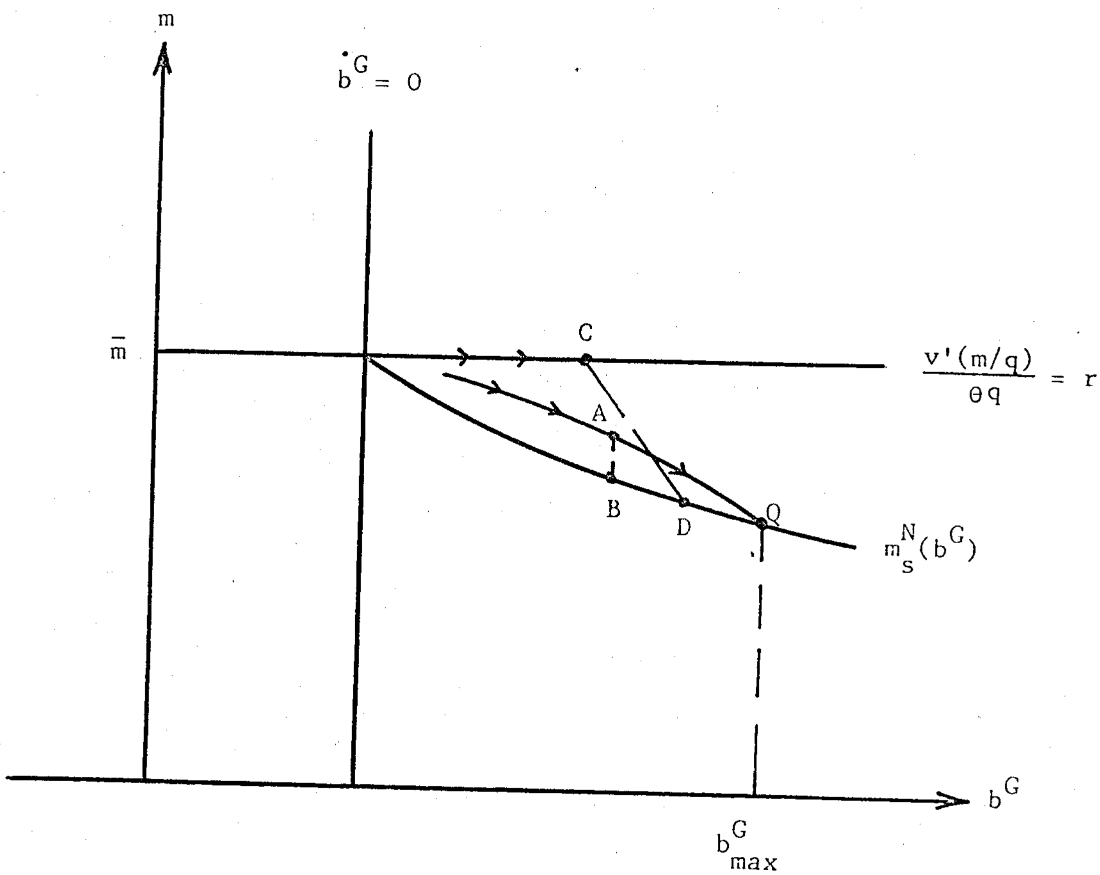


Figure 14

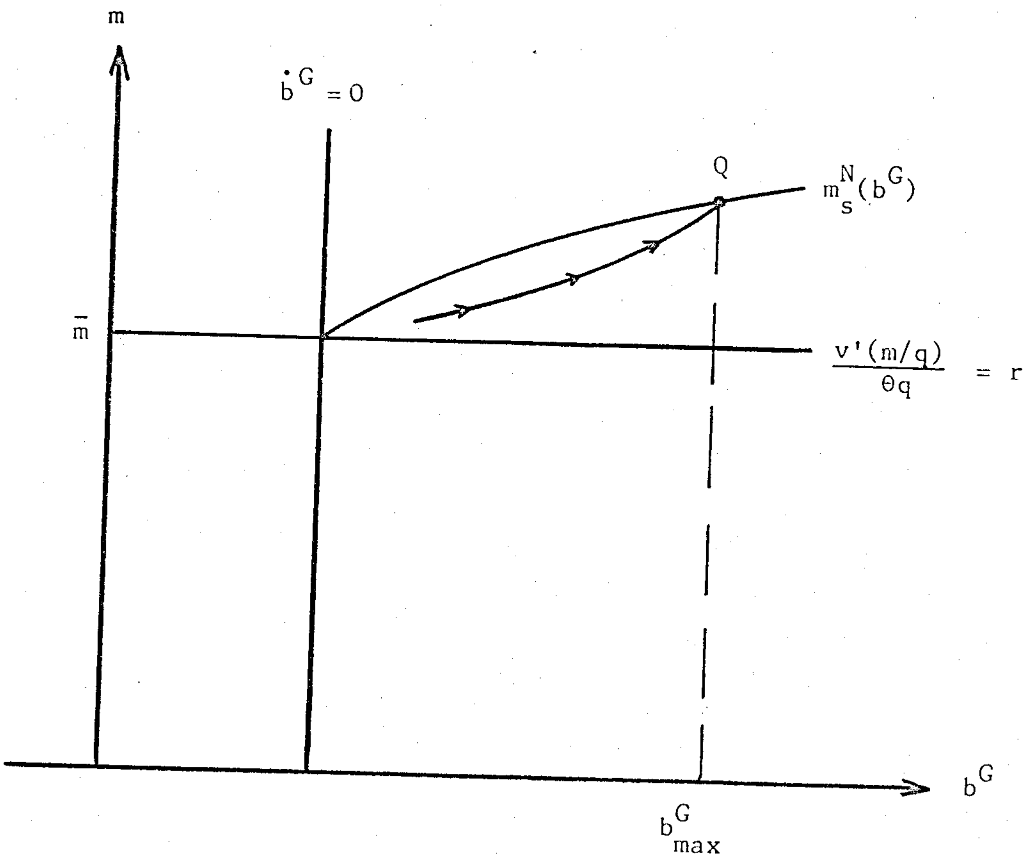


Figure 15

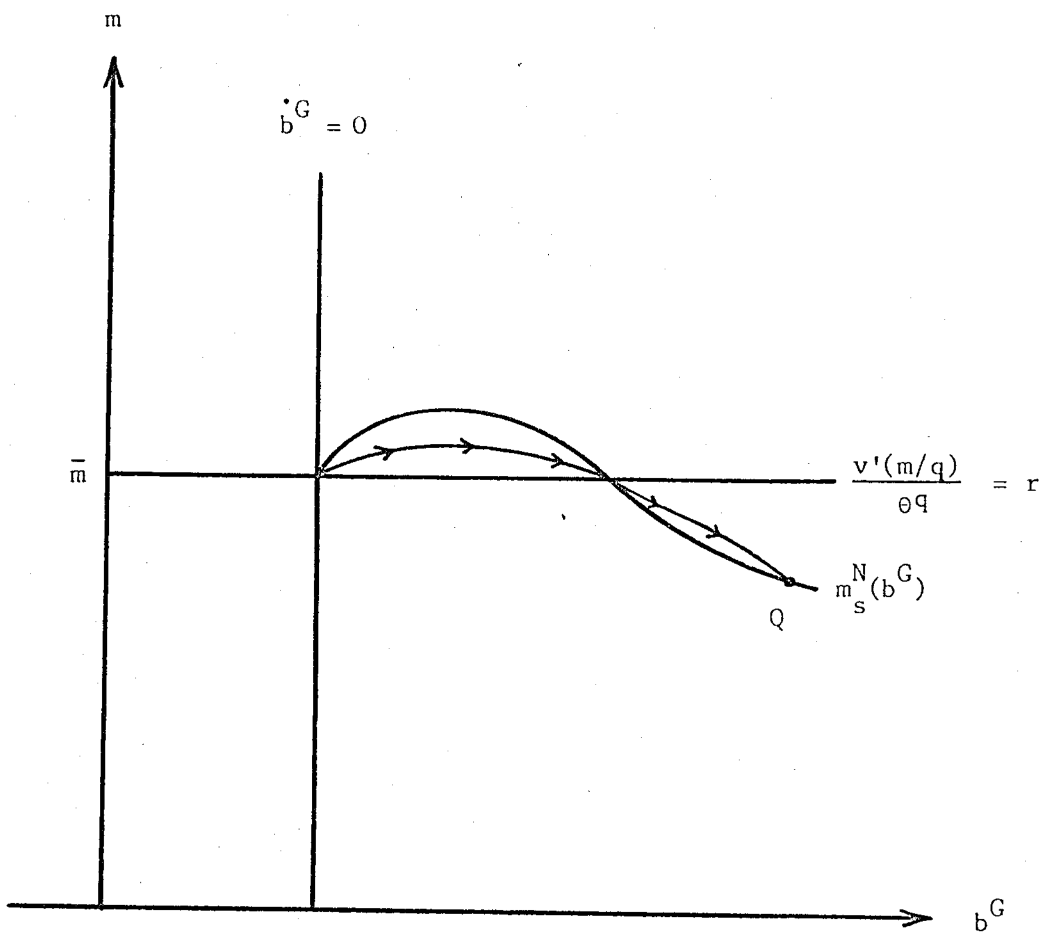


Figure 16

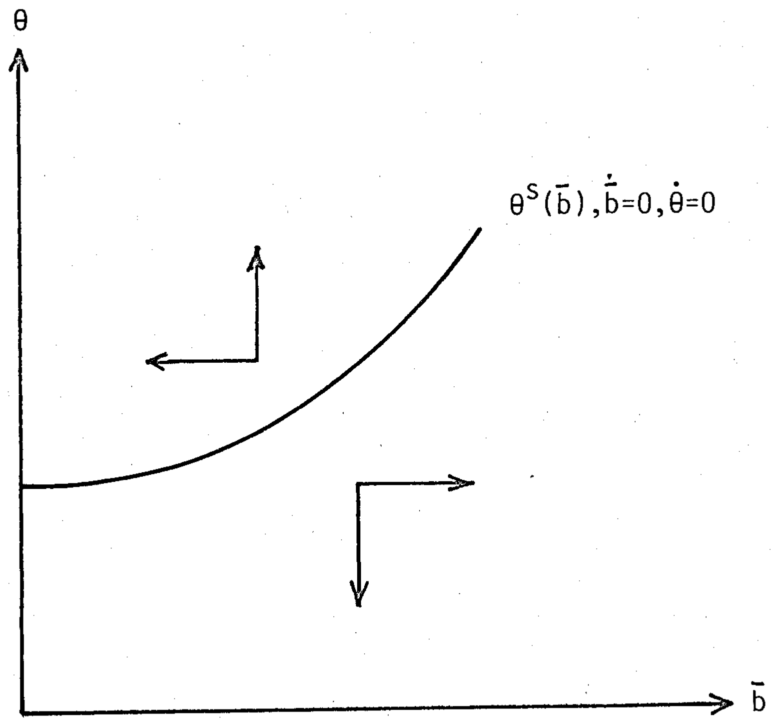


Figure A3.1

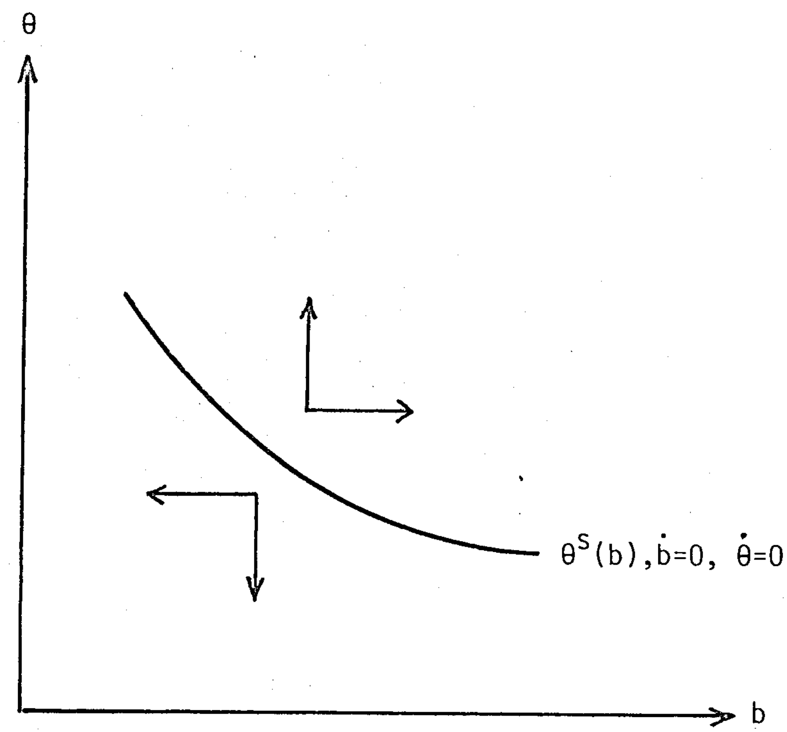


Figure A3.2