ELSEVIER

Journal of Economic Dynamics and Control
22 (1998) 219–245

JOURNAL OF Economic Dynamics & Control

Capital controls policy
An intertemporal perspective

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Received 28 November 1995; accepted 17 January 1997

Abstract

This paper studies capital controls policy from an intertemporal perspective. Using a small, open economy model with optimizing agents, it derives a policy rule which conforms real-world stylized facts and is sustainable in the long run. In particular, it explicitly models the constraints on the policy rule implied by the dynamics of the economy.

Studying several prevalent policy experiments, it is demonstrated that significant real effects are generated by the interaction between controls policy and traditional policy tools. This happens as controls affect agents' intratemporal asset allocation and intertemporal consumption patterns. The use of controls enlarges the set of possible outcomes, generating some 'non-traditional' results. The analysis points to new tradeoffs and hence new dilemmas faced by a government that uses controls.

Keywords: Capital controls; Fiscal policy; Monetary policy; Intertemporal optimization
JEL classification: E61; E63; F32; F41

1. Introduction

The issue of capital controls policy has reemerged as a key issue in open economy analysis. Recent events – such as the 1992 and 1993 crises in the EMS and the global crisis following the Mexican Peso devaluation in December

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I am indebted to Elhanan Helpman and to an anonymous referee for very valuable comments. I am also grateful to Guillermo Calvo and seminar participants at Tel Aviv University, the Hebrew University of Jerusalem, New York University, DELTA (Paris), HEC, and INSEAD for helpful comments on previous versions of the paper. Any remaining errors are all mine.

PII S0165-1889(97)00056-0

1994 – have attracted considerable attention and have placed the topic high on policymakers' agenda.[1] These episodes were marked by huge capital flows which led to the collapse of the prevailing exchange rate regime and consequently to far reaching macroeconomic consequences. A recurrent idea that followed these and similar episodes is that capital controls should be augmented to prevent such occurrences.

Two questions naturally arise in this context: how should the government formulate capital controls policy and how would such policy interact with traditional policy tools – monetary and fiscal? The goal of this paper is to explore these normative questions from an intertemporal perspective. In particular we seek to discuss the following issues:

(i) What policy rule should be adopted by governments given the real-world characteristics of relevant economies? It should be noted that currently there is no single, widely accepted model of capital controls that answers this question.[2] However, there is a widespread notion that capital-controls are related to the foreign debt position of the economy. We make this notion more precise by deriving a feedback rule from the stock of debt to the tightness of controls.

(ii) How does capital controls policy interact with monetary and fiscal policy? We investigate this question showing that some significant real effects are generated by this interaction. These occur as controls affect agents' intratemporal asset allocation and intertemporal consumption patterns. Studying several prevalent policy experiments, we demonstrate that the use of controls enlarges the set of possible outcomes, generating some 'non-traditional' results.

(iii) What tradeoffs does the government face when carrying out capital controls policy? We show that the use of controls creates new tradeoffs and thus new dilemmas for policy. For example, there sometimes exists, but not always, a tradeoff between the rate of inflation and the severity of capital controls.

A key obstacle to the formulation of a useful model of capital controls is that governments may be implementing controls policy in an arbitrary way, at least in the short run. The question, then, is why should one policy rule be modelled rather than another. In this paper we formalize a policy rule that satisfies two criteria: it conforms real-world stylized facts and it is sustainable in the long run. Thus, the modelling route we take is the following: we examine the stylized facts of capital controls in the real world. We find that there are two prevalent

[1] See, for example, the discussion in Eichengreen et al. (1995) and Garber and Taylor (1995).

[2] Recent literature has examined issues such as the use of controls in connection with speculative attacks (see, for example, Agenor and Flood, 1994), the optimal sequence of liberalizing the capital account (see McKinnon, 1993), and the role of controls in exchange rate systems such as the EMS (see Giavazzi and Giovannini, 1989). For a survey see Dooley (1995).

forms of controls: (i) taxing capital flows or, equivalently, using dual exchange rates and (ii) imposing restrictions on flows while offering some 'compensation' to domestic investors in the form of indexed government bonds. We construct a model that encompasses both forms and allows us to examine capital controls policy within a unified framework. The model is set up so that it incorporates essential characteristics of economies that use controls in practice. We then ask what type of policy rule will be consistent with this framework. In particular, we delineate the constraints on the policy rule that are implied by the dynamics of the model. Doing so we derive a rule that is sustainable, i.e. is consistent with convergence to the (unique) steady state. Finally, we explore the interaction of capital controls policy under this rule with monetary and fiscal policies. The latter analysis essentially characterizes equilibrium behavior of a small open economy with two distortionary taxes: inflation and capital controls.

The paper proceeds as follows: Section 2 sets up the model along the lines described above. Section 3 derives the policy rule and discusses its characteristics. We then study the interaction of controls with monetary policy (Section 4) and fiscal policy (Section 5). Section 6 concludes. Technical issues are relegated to the appendix.

2. The model

Our modelling strategy has two underlying principles: (a) to endow the economy with real-world features including the forms of capital controls actually used; (b) to employ a fairly standard optimizing agent framework that is consistent with open-economy dynamics.

2.1. Basic set-up and notation

The essential ingredients of the model are the following:

(i) We first examine the real-world experience with capital controls policy schemes. Looking at data published by the IMF (see IMF, 1995) we find that there are two prevalent forms of controls: [3]

  (a) Private sector holdings of foreign assets or debt are prohibited. When this type of controls is imposed the government frequently resorts to the issuance of foreign-currency-linked (or otherwise indexed) domestic debt to prevent massive capital flight but typically pays less than the nominal foreign rate of interest. This may take the form of indexing the debt only partially to the foreign currency rate of depreciation.

  (b) The government does allow capital flows and domestic ownership of foreign assets (or holding of debt) but it taxes interest receipts or uses

[3] Or a hybrid of the two.

a dual exchange rate system. The latter employs different exchange rates for current account and capital account transactions. Adams and Greenwood (1985) have shown that these two alternatives – an interest tax on foreign bonds or a dual exchange rate system – are equivalent.

The model formalizes these two types of control within a unified framework.

(ii) The economy is a small open economy with two goods: traded (Y^{T}) and non-traded or home goods (Y^{H}). Assuming a small economy the foreign currency price of traded goods, $P^{\mathrm{T}*}$, is constant and set equal to one; foreign interest (i^*) is constant as well.

(iii) All nominal quantities are deflated by a price index $P = P^{\mathrm{H}^{\alpha}} E^{1-\alpha}$ where E is the nominal exchange rate. The rate of inflation in this price is denoted π. The relative price of the two goods ('the real exchange rate', $q = E/P^{\mathrm{H}}$) determines private production and consumption decisions and hence current account flows.

(iv) In the case of the first type of controls, there are two domestic financial assets issued by the government: money (M) and foreign-currency-linked bonds (F in foreign terms), both held by domestic citizens. Money balances and foreign-linked bonds in terms of the price index will be denoted $m = M/P$ and $f = FE/P$, respectively. Foreign assets and debt are held by the government; we shall use R to denote net foreign assets, i.e. reserves minus gross foreign debt. Thus, when R is negative the economy is a net debtor. In the case of the second type of controls , the two financial assets held by domestic residents are money and foreign bonds (R^{p}) while the government holds net foreign assets R^{g}.

(v) The government consumes both types of goods ($G^{\mathrm{T}}, G^{\mathrm{H}}$) financing this consumption with debt issuance and two distortionary taxes – the inflation tax and capital controls. The latter have been shown to yield substantial revenue for the government; Giovannini and de Melo (1993) present data according to which it reaches sizable proportions of total tax revenue or GDP. They report that controls yield an average of 9% of total government revenue for a sample of 24 countries in the period 1972–1987, with some countries having 20–40% of government revenues from this source. For example, in Mexico in the period 1984–1987 it constituted almost 40% of tax revenues and 6% of GDP.

(vi) The government manages the nominal exchange rate, i.e. it sets $\hat{E}$. This encompasses regimes such as a fixed peg or a crawling peg. Alesina et al. (1994) show that this is indeed the prevalent case for economies using capital controls.

(vii) Agents are modelled in a Sidrauski-type model with endogenous time preference (the latter makes the model consistent with the small open economy setup). Their consumption of the two goods is denoted $C^{\mathrm{T}}, C^{\mathrm{H}}$.

Throughout the discussion we shall use the following notation for any variable s:

$$\dot{s} = \partial s/\partial t; \quad \hat{s} = \dot{s}/s; \quad s_x = \partial s/\partial x; \quad s_{xy} = \partial s_x/\partial y.$$

2.2. Goods markets

Price flexibility of the home good ensures continuous equilibrium in its market:

$$Y^{\mathrm{H}}(q) = C^{\mathrm{H}} + G^{\mathrm{H}}, \qquad \partial Y^{\mathrm{H}}/\partial q < 0. \tag{1}$$

We assume that given full wage flexibility, output depends only upon relative prices. G^{H} is a policy parameter, while C^{H} is determined by utility maximization, to be examined below. The supply and consumption of the traded good is determined likewise and thus the current account flow is

$$\dot{R} = Y^{\mathrm{T}}(q) - C^{\mathrm{T}} - G^{\mathrm{T}} + i^{*}R, \quad \partial Y^{\mathrm{T}}/\partial q > 0. \tag{2}$$

Note that net foreign assets earn the foreign interest i^*. Whenever the economy is a net debtor, as is typically the case in many of the relevant economies, R is negative and i^*R are foreign interest payments.

2.3. The government

The term 'government' is taken to mean both fiscal and monetary authorities. Under the first type of capital controls the following budget (flow) constraint, which is key to the analysis, obtains[4]

$$G^{\mathrm{H}}q^{\alpha-1} + G^{\mathrm{T}}q^{\alpha} + i^{*}f - i^{*}Rq^{\alpha} = \mu m + \tau f + \hat{F}f - \dot{R}q^{\alpha}, \tag{3}$$

where $\mu = \dot{M}/M$, $m = M/P$, $\hat{F} = \dot{F}/F$, $f = FE/P$, and τ is the financial tax (capital controls) to be explained below. The equation is set in real terms.

The LHS of the equation shows that government expenditures consist of expenditures on home goods ($G^{\mathrm{H}}q^{\alpha-1}$), traded goods ($G^{\mathrm{T}}q^{\alpha}$), interest payments on domestic debt (i^*f) and interest payments on net foreign debt ($-i^*Rq^{\alpha}$).[5] The RHS shows that these expenditures are financed by taxes and debt issuance. The taxes consist of two distortionary taxes:[6] the inflation tax (μm) and capital controls (τf). The financial tax (τ) is the policy parameter which formally expresses capital controls. It reflects the gap between foreign interest receipts in the absence of controls and the actual interest receipts on foreign linked bonds. We explore its

[4] We explore the second case below.

[5] Note that foreign reserves held by the central bank are a part of R which is defined as reserves minus gross debt. Thus, the interest earned on them is part of this last expression.

[6] Adding a lump-sum tax or an income tax would not change the analysis below.

determination in detail below.[7] Consumers' utility maximization explored below will demonstrate why these two taxes are distortionary. Debt issuance consists of domestic foreign-linked debt ($\hat{F}f$) and foreign-debt ($-\dot{R}q^{\alpha}$).

We consider $G^{\mathrm{H}}, G^{\mathrm{T}}$ and $\hat{E}$ exogenous policy variables. Given that m, f, q, and R are endogenously determined and i^* is given, μ and $\hat{F}$ are assumed to be adjusted so as to satisfy (3).[8] Essentially, this means that once the government 'targets' the nominal interest rate ($i^* + \hat{E} - \tau$) it has to adjust the quantities of financial assets in accordance with the target.

2.4. The private sector

Under the first type of capital controls, private agents' financial wealth consists entirely of government issued assets:

$$w = m + f. \tag{4}$$

To obtain the private sector's budget constraint, differentiate (4) with respect to time and use Eqs. (1)–(3) and the definition of q to obtain

$$\dot{w} = q^{\alpha-1}(Y^{\mathrm{H}} - C^{\mathrm{H}}) + q^{\alpha}(Y^{\mathrm{T}} - C^{\mathrm{T}}) + [i^* - \tau + \alpha\hat{q}]w - [i^* - \tau + \hat{E}]m. \tag{5}$$

Assets are accumulated (in real terms) by savings net of taxes and by interest receipts on foreign-linked bonds. The unlinked part (m) depreciates in real terms at the rate of nominal depreciation. If, however, there is real depreciation ($\hat{q} > 0$) then assets accumulate in real terms. The intertemporal constraint faced by private agents is given by

$$\int_0^{\infty} \mathrm{e}^{-(i^*-\tau)s}[Y^{\mathrm{T}}q^{\alpha} + Y^{\mathrm{H}}q^{\alpha-1}]\,\mathrm{d}s + w_0$$
$$\geq \int_0^{\infty} \mathrm{e}^{-(i^*-\tau)s}[C^{\mathrm{T}}q^{\alpha} + C^{\mathrm{H}}q^{\alpha-1} + \{(i^* - \tau) + (\hat{E} - \hat{P})\}f + \hat{P}M]\,\mathrm{d}s. \tag{6}$$

Private agents' utility is given by the following function allowing for endogenous time preference. It is based on Epstein and Hynes (1983) and its two-sector open economy application by Penati (1987):

$$U = -\int_0^{\infty} \exp\left\{-\int_0^{s} [u(C^{\mathrm{T}}, C^{\mathrm{H}}) + v(m)]\,\mathrm{d}\sigma\right\}\mathrm{d}s, \tag{7}$$

where

(i) $u, v > 0$,

[7] Capital controls in this case are made up of two main elements: (i) τ as expressed above; (iia) prohibition on private sector ownership of foreign assets or (iib) a 'surrender' requirement on foreign assets.

[8] In the steady state $\mu = \hat{E}$ and $\hat{F} = 0$.

(ii) $u', v' > 0$,
(iii) $u'', v'' < 0$,
(iv) $\lim_{c^{\mathrm{T}} \to 0} u'(c^{\mathrm{T}}) = \lim_{C^{\mathrm{H}} \to 0} u'(C^{\mathrm{H}}) = \lim_{m \to 0} v'(m) = \infty$,
with $u(C^{\mathrm{T}}, C^{\mathrm{H}})$ being some form of a Cobb–Douglas utility function. In what follows, we shall assume the loglinear version, i.e. $u = \alpha \ln C^{\mathrm{H}} + (1 - \alpha) \ln C^{\mathrm{T}}$, but this specific form is not essential for the analysis.

This form of modelling agents' time preference merits some explanation: the underlying intuition is that the rate of time preference is positively dependent upon the utility derived from future consumption and money balances. [9] Thus, the specification of utility in (7) establishes an intertemporal dependence in consumption decisions. This is a more plausible characterization of individual choice than intertemporal independence from both the empirical and theoretical points of view (Obstfeld, 1990, elaborates on these points). Were we to use a constant rate of time preference, then under the open-economy set-up, we would not obtain a determinate and reasonable steady state. In small open economies, each inhabited by an infinitely lived representative consumer, either the long run distribution of global wealth is indeterminate or the country with the lowest rate of time preference ends up having all the wealth. This is so because the rate of interest in the steady state equals the lowest rate of time preference; thus the consumption of all other economies is declining and eventually their share in consumption is zero (see Svensson and Razin, 1983). Note too that the use of this type of utility function in the current context provides a channel through which changes in financial wealth generate changes in consumption patterns by affecting the intertemporal marginal rate of substitution.

Private agents seek to maximize (7) with respect to C^{T}, C^{H} and m subject to the budget constraints (4)–(6). The first-order conditions for maximum are:

$$\begin{aligned}
&\text{(a) } U_{\mathrm{T}}/U_{\mathrm{H}} = q,\\
&\text{(b) } (v_m/U_{\mathrm{T}})q^{\alpha} = i^* - \tau + \hat{E},\\
&\text{(c) } \dot{U}_{\mathrm{T}}/U_{\mathrm{T}} = \rho[z(w)] - (i^* - \tau),\\
&\text{(d) the constraints (4)–(6)},\\
&\text{(e) } \lim_{s \to \infty} \lambda_s w_s = 0 \text{ (the transversality condition)},
\end{aligned} \tag{8}$$

[9] The formulation in (7) embodies the following endogenous rate of time preference:

$$\rho = \left[\int_{\mathrm{T}}^{\infty} \exp\left\{ - \int_{\mathrm{T}}^{s} \left[u(C^{\mathrm{T}}, C^{\mathrm{H}}) + v(m) \right] \mathrm{d}\sigma \right\} \mathrm{d}\sigma \right]^{-1}.$$

In the steady state where C^{T}, C^{H} and m are constant this becomes

$$\bar{\rho} = u(\bar{C}^{\mathrm{T}}, \bar{C}^{\mathrm{H}}) + v(\bar{m}).$$

For the derivation, see Epstein and Hynes (1983, pp. 615–618). Obstfeld (1990) provides a detailed survey and a clear exposition of intertemporal dependence and impatience, discussing among other things this particular formulation. The basic idea was introduced by Uzawa (1968).

where $U_T = \partial U/\partial C^T$, $U_H = \partial U/\partial C^H$, $v_m = \partial v/\partial m$, and z is a positive function of w [see Epstein and Hynes (1983) or Penati (1987) for the full derivation which relies on Proposition 9 in Arrow and Kurz (1970, p. 50)].

The economic interpretation of the optimal solution is as follows: (a) is the standard equality between the marginal rate of substitution and the relative price of the two goods. (b) determines money holdings as a function of nominal interest, of the real exchange rate, and of marginal utility from traded goods consumption. Basically, it equates the marginal utility received from real money balances with the marginal utility from consumption foregone when holding money balances. (c) is derived from two relations: the first is the equality between the marginal utility from traded goods consumption (U_T) and the marginal value of wealth (λ). The second relation implies that the marginal value of wealth increases (decreases) if the rate of time preference (ρ) is bigger (smaller) than the real rate of interest on financial wealth ($i^* - \tau$). This is the so-called Keynes–Ramsey rule which equates the intertemporal marginal rate of substitution with the marginal rate of transformation which is the real rate of interest. Whenever the rate of time preference is above (below) the real rate of interest, it pays to raise (lower) the current consumption level so as to enjoy consumption earlier (later). Thus, consumption will be decreasing (increasing) along the optimal path.

Note that the distortionary role of inflation may be seen in (b) and that of capital controls in (b) and (c). The inflation tax distorts agents' decisions with respect to their financial portfolio allocation and capital controls distorts the portfolio decision as well as optimal intertemporal consumption plans.

2.5. *An alternative form of capital controls*

We shall now consider the second form of capital controls discussed above, whereby the private sector is allowed to hold foreign assets. Denoting these assets by R^p, the private sector portfolio is now made up of real money balances and foreign bonds. Thus, Eq. (4) becomes

$$w = m + R^p q^\alpha \tag{9}$$

The government continues to hold net foreign assets (denoted R^g) so now

$$R = R^p + R^g. \tag{10}$$

The government taxes interest receipts ($i^* R^p$) on private sector foreign bonds or alternatively uses a dual exchange rate system.[10] Thus, the government budget constraint is

$$G^H q^{\alpha-1} + G^T q^\alpha - i^* R^g q^\alpha = \mu m + \tau i^* R^p q^\alpha - \dot{R}^g q^\alpha. \tag{11}$$

[10] The equivalence of these two formulations is demonstrated in Adams and Greenwood (1985).

Note that here again τ is the parameter expressing capital controls, standing for taxation of foreign interest receipts or for a dual-exchange rate system.

To see that the two forms of capital controls may be treated within the same framework, combine Eqs. (1), (2), (9), and (10). This generates once more Eq. (5) (the private sector budget constraint) with w being defined as in (9). We can therefore continue the analysis from that point onward, including private sector optimization and the dynamics analyzed in the next section, in identical form for the two types of capital controls, noting that w and R are defined differently in the two cases. We turn now to the formulation of capital controls policy.

3. The capital controls policy rule

A policy rule for capital controls may obviously be formulated in different ways. The path we have chosen to take here is the following: in the preceding section we have modelled the two prevalent forms of controls in real-world economies within a unified framework. Moreover, we have endowed this framework with the essential characteristics of small open economies that use such controls. We now ask what type of policy rule will be consistent with this framework. In particular, we seek to uncover the constraints on the policy rule that are implied by the dynamics of the model. The aim is to formulate a rule which is both realistic and sustainable, i.e. one which insures that the economy is placed on a convergent path to long run equilibrium, ruling out unsustainable policy. We derive the policy rule in Section 3.1, discuss the ensuing steady state and the unique convergent path in Section 3.2 and propose an example by parameterizing the rule in Section 3.3.

3.1. The dynamic system and the derivation of the policy rule

Using (1) and (8a) the following relations hold for optimal consumption:

$$\partial C^{\mathrm{H}}/\partial q < 0, \qquad \partial C^{\mathrm{H}}/\partial G^{\mathrm{H}} < 0, \tag{12}$$

$$\partial C^{\mathrm{T}}/\partial q < 0, \qquad \partial C^{\mathrm{T}}/\partial G^{\mathrm{H}} < 0. \tag{13}$$

The relations in (12) and (13) enable us to transform (8c), the intertemporal condition of consumer maximization into a differential equation for the real exchange rate:

$$\dot{q} = (U_{\mathrm{T}}/U_{\mathrm{T}q})\{\rho[z(w)] - i^{*} + \tau\}. \tag{14}$$

Inserting (12) and (13) and the consumer's FOC relating to money balances (8b) into the flow constraint for private sector assets (5) yields

$$\dot{w} = q^{\alpha-1}[Y^{\mathrm{H}}(q) - C^{\mathrm{H}}(q, G^{\mathrm{H}})] + q^{\alpha}[Y^{\mathrm{T}}(q) - C^{\mathrm{T}}(q, G^{\mathrm{H}})] + [i^* - \tau + \alpha\hat{q}]w - [i^* - \tau + \hat{E}]m\{q, \hat{E}, G^{\mathrm{H}}, \tau, i^*\}. \tag{15}$$

Reproducing (2) with the relations implied by (13) we get

$$\dot{R} = Y^{\mathrm{T}}(q) - C^{\mathrm{T}}(q, G^{\mathrm{H}}) - G^{\mathrm{T}} + i^*R. \tag{16}$$

Linearizing the system in the neighborhood of the steady state yields the following first-order linear differential equation system:

$$\begin{bmatrix} \dot{q} \\ \dot{w} \\ \dot{R} \end{bmatrix} = \begin{bmatrix} 0 & \dot{q}_w & \dot{q}_R \\ \dot{w}_q & \dot{w}_w & \dot{w}_R \\ \dot{R}_q & 0 & \dot{R}_R \end{bmatrix} \begin{bmatrix} q - \bar{q} \\ w - \bar{w} \\ R - \bar{R} \end{bmatrix}. \tag{17}$$

We derive the policy rule that will be consistent with the stability of this system (17), i.e. we focus on sustainable policy. By solving for the stability requirements of the system (see the appendix) we obtain the following characterization:

$$0 \le \tau \le i^*, \tag{18}$$

$$\tau = \tau(R), \quad \frac{\partial \tau}{\partial R} < 0, \tag{19}$$

$$|\tau_R| < \frac{i^* \dot{w}_q \rho_w}{(Y_q^{\mathrm{T}} - C_q^{\mathrm{T}})\{\rho_w(w - m) + \rho_w(i^* + \hat{E} - \tau)m_\tau + i^* - \tau\}}. \tag{20}$$

First, τ has to be smaller than (or equal to) the interest rate it taxes; second, it has to be a positive function of the stock of foreign debt (i.e. a negative function of net foreign assets R); third, the marginal change in τ whenever foreign debt changes is bounded from above. This bound means that the government should raise more revenue whenever foreign debt increases, but is constrained not to do so too drastically. Raising τ too much implies that more foreign debt might be accommodated, thus creating the possibility for divergence of the system. The reasoning here is as follows: suppose there is an increase in foreign debt and the government increases capital controls without abiding by the constraint. Consequently, there will be decumulation of private sector assets ($\dot{w} < 0$ according to Eq. (5)). This means that private agents lose financial wealth and the rate of time preference falls below the real after-tax rate of interest. Following a decline in consumption, the growth rate of consumption rises, a real appreciation ensues, foreign debt increases again (as the current account deteriorates), the process is repeated and the system diverges.

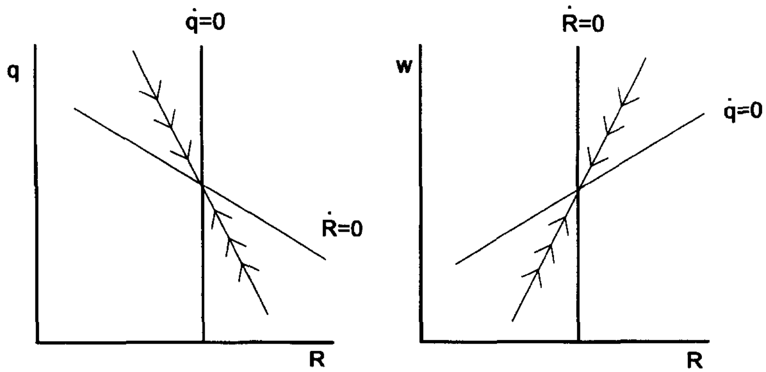

Fig. 1. The dynamic system.

We have thus seen that the dynamic structure of the economy imposes restrictions on capital controls policy if it is to be sustainable.

3.2. The convergent path and the steady state

The dynamics of the economy are given by the system (17). Using the above policy rule (Eqs. (18)–(20)) we note that

$$\dot{q}_w, \dot{w}_w, \dot{R}_q, \dot{R}_R > 0, \;\; \dot{q}_R < 0,$$

while the sign of $\dot{w}_q, \dot{w}_R$ remains ambiguous. We proceed by making the following two plausible assumptions:

(i) $\dot{w}_q > 0$. This assumption means that when there is a real depreciation, asset accumulation through the improved current account dominates the loss of resources generated by both the depreciation in the value of savings of the home good and the increase in the inflation tax.

(ii) $\dot{w}_R > 0$. The economic interpretation here is that a decline in capital controls due to an increase in foreign assets causes the private sector to accumulate assets. This occurs as interest receipts increase and inflation tax payments fall. These two effects are assumed to dominate an offsetting effect of a real appreciation (ensuing from the rise in foreign assets) which decreases the real value of bonds.

These assumptions enable us to characterize the system described by (17) as saddle path stable,[11] with q and w being the 'jumping' variables placing the economy on its unique convergent path. Fig. 1 shows the phase diagram for this

[11] See the appendix.

dynamic analysis. We use two graphs to depict the course of all three dynamic variables.

The dynamics induced by the τ policy described above pertain to two time dimensions:

(i) *Intra*temporally τ influences portfolio allocation (see Eq. (8b)): any change in controls will induce a shift between bonds and money. This shift generates a change in the real value of financial wealth (w) because money loses value in real terms while bonds accrue interest. This leads to intertemporal effects.

(ii) *Inter*temporally the change in τ and in w generate consumption and current account effects. Altering the relationship between the endogenous rate of time preference ($\rho[(z(\bar{w})])$ and the rate of interest ($i^* - \tau + \hat{E}$), causes a change in consumption growth according to Eq. (8). The latter induces changes in the real exchange rate (see Eq. (14)) and hence generates changes in current account flows. These affect the level of foreign assets or debt and in turn induce a further change in τ.

Capital controls have therefore dynamic repercussions for both the financial sector (portfolio re-allocation) and the real sector (consumption and current account flows). The feature which drives these dynamics is the distortionary tax aspect of the controls: the fact that the optimal portfolio decision (8b) and the optimal intertemporal consumption decision (8c) are distorted by τ underlies these dynamics.

These dynamics are depicted graphically in the saddle path of Fig. 1 and algebraically in system (17).

Setting $\dot{w} = \dot{q} = \dot{R} = 0$ in (17) we obtain the following three equations, the solution of which gives the steady-state values of w, q and R:

$$\rho[(z(\bar{w})] = i^* - \tau(\bar{R}), \tag{21a}$$

$$Y^{\mathrm{T}}(\bar{q}) - C^{\mathrm{T}}(\bar{q}, G^{\mathrm{H}}) - G^{\mathrm{T}} = -i^*\bar{R}, \tag{21b}$$

$$\bar{q}^{\alpha-1}[Y^{\mathrm{H}}(\bar{q}) - C^{\mathrm{H}}(\bar{q}, G^{\mathrm{H}})] + \bar{q}^{\alpha}[Y^{\mathrm{T}}(\bar{q}) - C^{\mathrm{T}}(\bar{q}, G^{\mathrm{H}})] + [i^* - \tau(\bar{R})]\bar{w}$$
$$- [i^* + \hat{E} - \tau(\bar{R})]m\{\bar{q}, \tau(\bar{R})\hat{E}, i^*, G^{\mathrm{H}}\} = 0. \tag{21c}$$

Eq. (21a) says that the rate of time preference used to discount utility is equal to the after-tax rate of interest. Eq. (21b) implies that the current account net of interest payments equals the latter flow. Eq. (21c) is the steady-state budget constraint of the private sector. It implies that all nominal quantities, except linked debt, increase at the policy determined rate of depreciation, i.e. $\mu = \hat{E} = \pi$, so that

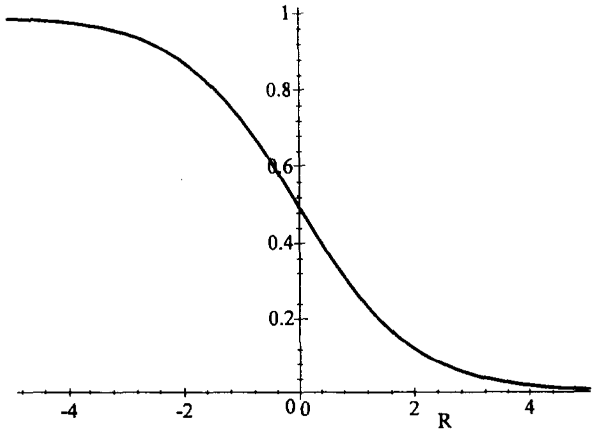

Fig. 2. The Υ function.

private sector assets remain at level $\bar{w}$. Graphically, the steady-state values are given by the intersection points in Fig. 1 above.

3.3. A parametric example

The following parametric example illustrates a plausible case of the policy rule derived above:

$$\tau = k\Upsilon(R)i^*,$$

where

$$\Upsilon(R) = \frac{e^{(-R)}}{1+e^{(-R)}}, \quad 0 < \Upsilon(R) < 1$$

and k is a positive number which acts as a 'scaling' factor.

This rule is straightforward and easy to implement:

(i) it makes the capital controls tax to be a certain percentage of the exogenous foreign interest rate (i^*),

(ii) this percentage depends negatively on net foreign assets R,

(iii) this rule works well for any absolute value of i^* and R because of the logistic function used as illustrated by Fig. 2 showing the Υ function.

Note that

$$\frac{\partial \Upsilon}{\partial R} = \frac{\partial\left(\frac{e^{(-R)}}{1+e^{(-R)}}\right)}{\partial R} = -\frac{e^{-R}}{1+e^{-R}} + \frac{e^{2(-R)}}{(1+e^{-R})^2}$$

is bounded between 0 and −0.25. Thus, the requirement that the marginal change in the tax rate be bounded is naturally satisfied using this function and an appropriate choice of the scaling parameter k.[12]

4. Capital controls and exchange rate policy

When coming to study monetary policy in the present context of a small open economy with exchange rate management the relevant question is that of policy with respect to the managed rate of depreciation. As noted this formulation encompasses several type of regimes such as crawling and fixed pegs. In particular, we shall look at the case whereby the rate of depreciation is lowered. In recent years such exchange rate policy has played a key role in inflation stabilization programs, particularly in economies of the type studied here. Major examples are Latin American countries: it was used in several plans implemented in Bolivia, Chile, Argentina, Brazil and Mexico.

The rate of depreciation is the long-run rate of inflation and therefore determines steady-state inflation tax revenues. Looking at the government budget constraint[13] we see that expenditures and interest payments are financed by the inflation tax ($\hat{E}m$ in the long run) and by revenue from capital controls (τf in the first case; $\tau i^* R^{\mathrm{p}} q^{\alpha}$ in the second case). The essential point of the analysis then is to investigate whether there exists a tradeoff between these two distortionary taxes or, equivalently, between the rate of inflation and the degree of capital controls. Note that there need not always be a tradeoff: changing the rate of inflation has repercussions on the real exchange rate and on wealth; hence, the real value of government expenditures and interest payments are affected. In some cases the latter decrease when the rate of depreciation is lowered and so the inflation tax and capital controls may be reduced simultaneously.

We therefore investigate two issues:

(i) What are the implications of exchange rate led stabilization for capital controls? In particular, does the degree of controls increase or decrease? This is an essential question as the government, in stabilizing, may be motivated

[12] The following condition for k defines this choice so as to satisfy all the constraints given by Eqs. (18)–(20):

$$0 < k < \min\left[\frac{1}{\Upsilon(R)}, \frac{1}{|\frac{\partial \Upsilon}{\partial R}|}\frac{\dot{w}_q \rho_w}{(Y_q^{\mathrm{T}} - C_q^{\mathrm{T}})\{\rho_w(w-m) + \rho_w(i^* + \hat{E} - \tau)m_\tau + i^* - \tau\}}\right].$$

The scaling factor may either be variable and change with the value of the variables on the RHS or may stay fixed if the lower bound of the last term on the RHS is used (and exploiting the fact that $|\partial\Upsilon/\partial R|$ is bounded).

[13] The flow constraint is given by Eq. (3) or (11). The long-run constraint is obtained by combining (21b) and (21c).

by the perception that inflation is costly and unpopular. However capital controls are distortionary and unpopular as well. Thus, the natural question which emerges is under what conditions does a tradeoff exist between these two distortions.

(ii) What are the real effects of inflation stabilization? How are these generated and what is the role played by capital controls in this context?

In order to answer these questions, we examine the dynamic and long-run consequences of an exchange rate led stabilization policy (5.1) and discuss the policy implications of the analysis, looking at its real-world relevance (5.2).

4.1. Short-run and long-run consequences of exchange rate led stabilization

Formally, we consider a lowering of the rate of devaluation (lowering $\hat{E}$). Total differentiation of (21), holding all policy parameters fixed except for $\hat{E}$, gives the following long run changes:

$$\frac{\mathrm{d}\bar{q}}{\mathrm{d}\hat{E}} = -\frac{\dot{w}_{\hat{E}}}{\Delta}, \qquad \frac{\mathrm{d}\bar{R}}{\mathrm{d}\hat{E}} = -K_1\frac{\mathrm{d}\bar{q}}{\mathrm{d}\hat{E}}, \qquad \frac{\mathrm{d}\bar{w}}{\mathrm{d}\hat{E}} = K_2\frac{\mathrm{d}\bar{R}}{\mathrm{d}\hat{E}}, \tag{22}$$

where

$$\Delta = \frac{\dot{w}_q\dot{R}_R\dot{q}_w - \dot{R}_q\dot{w}_R\dot{q}_w + \dot{R}_q\dot{w}_w\dot{q}_R}{\dot{R}_R\dot{q}_w} > 0,$$

$$K_1 = \frac{\dot{R}_q}{\dot{R}_R} > 0, \qquad K_2 = -\frac{\tau_R}{\rho_w} > 0.$$

Eqs. (22) imply that the sign of $\dot{w}_{\hat{E}}$ is crucial for the determination of long-run equilibrium. This derivative ($\dot{w}_{\hat{E}}$) represents the effect of the exchange rate policy on the private sector budget constraint (Eq. (5)):

$$\dot{w}_{\hat{E}} = -[m + \hat{E}m_{\hat{E}}] - (i^* - \tau)m_{\hat{E}}. \tag{23}$$

The reduction in $\hat{E}$ constitutes a change in returns and induces a portfolio shift from bonds (f) to money (m). The first term on the RHS represents the ensuing decrease in inflation tax payments (assuming, as usual, that the elasticity of m with respect to $\hat{E}$ is less than unity). The second term represents the reduction in net interest receipts on bonds. In the case of no private holdings of foreign assets, this term also represents the reduction in government interest payments on foreign-linked debt. If the latter effect – reduced interest receipts – is dominant

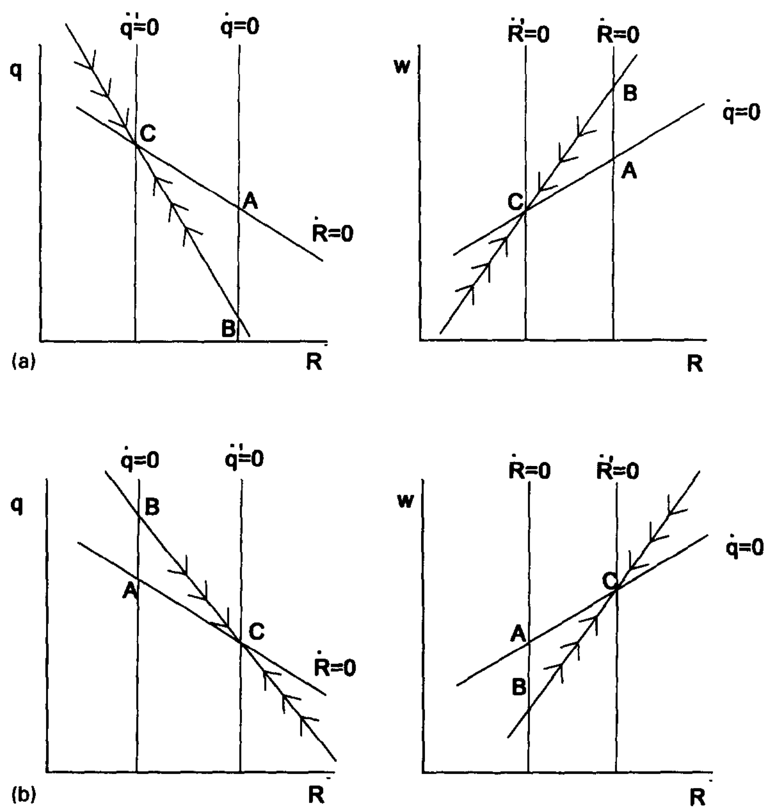

Fig. 3. Exchange rate stabilization.

private sector net asset accumulation decreases: starting out from steady-state (where it is zero) private sector net asset accumulation becomes negative as interest receipts go down by more than inflation tax payments. Therefore, $\dot{w} < 0$ following stabilization. If the former effect – less inflation tax payments – is dominant, net private sector receipts increase so that asset accumulation is positive i.e. $\dot{w} > 0$ following stabilization. Fig. 3 illustrates these two cases, using the phase diagram shown in Fig. 1. Panel (a) shows the outcome when the interest receipts flow dominates and panel (b) the case of dominant inflation tax payments.

As Eqs. (22) and Fig. 3 show this policy leads to two possible, contradictory outcomes. Both the short-run and the long-run behaviour of any given variable follow opposite courses in the two cases.

In case (a), where the effect of reduced interest receipts dominates, upon impact there is a real appreciation and a fall in the rate of inflation to a level which is below the new stabilized rate. This implies that inflation will converge to its new level from below. An upward jump in the rate of time preference to above the after-tax real interest rate $(i^* - \tau)$ causes consumers to bring forward consumption. Along the adjustment path consumption is declining, there is a real depreciation, a gradual rise in inflation and a fall in the after-tax real interest rate. In the new steady state, when the economy has achieved its stabilized level of inflation, capital controls are higher and thus there exists a tradeoff between inflation and capital controls. Consequently, the after-tax real interest rate is lower (the private sector gets less return due to higher controls). The real exchange rate is higher so the current account improves and thus foreign debt in the steady state is bigger.

Case (b) depicts the opposite course for all variables. Thus, in this case capital controls decrease – there is no tradeoff between inflation and capital controls; inflation converges to its new long-run equilibrium from above; there is an immediate real depreciation followed by real appreciation; consumption initially falls and gradually increases along the dynamic path; as the current account worsens in the long run, the stock of foreign debt declines.

We have seen that a government which stabilizes inflation in the circumstances of case (a) will end up by having more severe capital controls, facing a tradeoff between the rate of inflation and the degree of controls. The underlying intuition is as follows: by lowering the rate of depreciation the government has lowered the return on bonds. This induces a portfolio shift from bonds to money which in turn leads to changes in consumption patterns. Consequently, relative prices change and the foreign sector is affected. The feedback rule for capital controls (τ) generates an additional effect on bonds rate of return, further lowering this return. The result is lower private consumption on both goods, an improved current account due to traded good output expansion, a contraction of home good production and higher foreign debt in the new steady state. Case (b) has all these effects reversed.

4.2. Policy implications

A central message for policy making is that by stabilizing inflation the government is inducing a portfolio shift which affects consumption. Many currency-substitution models [which followed the seminal contribution by Calvo and Rodriguez (1977)] do not cater for the link between portfolio changes and consumption changes. Thus, they lack the explicit consideration of real effects. Such real effects may have 'political economy' repercussions; case (a) is a good example whereby certain effects may be highly undesirable for the government such as bigger capital controls, a contraction of home good output and lower private consumption in the steady state.

Another implication relates to the relationship of the foregoing analysis to the 'Tobin tax.' This well-known and widely discussed case of capital controls policy was proposed in Tobin (1978). The τ policy outlined above resembles Tobin's suggestion as it creates a wedge between the foreign and domestic interest rates. Reinhart (1991) has analyzed the effect of the Tobin tax in an extension of the

Calvo and Rodriguez (1977) model. The current analysis is similar to his in that increases in the tax cause a portfolio shift away from foreign assets. The two analyses also share the feature whereby there is a reduction in the rate of money creation by the government as capital controls generate more revenue (see case (a) above). These lead in both models to short-run changes in the real exchange rate (upon impact there is an appreciation followed by depreciation along the adjustment path) and consequently to a sequence of trade deficits. However there are important differences between the models: first, the Tobin tax is not a function of foreign debt. In the current model, were capital controls (τ) a policy parameter independent of foreign debt (or assets), the stock of private sector assets (w) and the real exchange rate (q) would 'jump' to the steady state. In such a case foreign debt would grow or decline indefinitely (as $\dot{R}_R > 0$). Technically, this means that $\dot{w}_R = \dot{q}_R = 0$ and that the sub-system of w and q converges while R does not. For a similar discussion in a closed-economy context, see McCallum (1981) and Calvo (1985). Second, and as a result of the first point, in the current model the tax is not an exogenous policy parameter but rather an endogenous one which adjusts to the foreign debt position of the economy. While the type of policy discussed here generates a tax change, this occcurs as an endogenous consequence of the exogenous change in exchange rate depreciation. In the Calvo–Rodriguez–Reinhart model monetary policy is exogenous and the exchange rate is endogenous. Third, along the lines discussed above, while in the currency substitution model there are no real effects in the long run to changes in the Tobin tax, here real effects ensue due to the linkages between agents' asset allocation and their consumption patterns both in the short and in the long run.

The analysis has indicated that the effect of the shift from bonds to money following stabilization may generate a totally different outcome than the one predicted by looking at the effect of a lower inflation tax alone. The question arises as to the empirical relevance of this effect. For the first type of capital controls – when the government issues foreign-linked bonds – some insight is gained by comparing the share in GDP (or GNP) of the government's inflation tax revenues and interest payments on domestic debt. This is reported in Table 1 for several relevant economies.

As can be seen from the table, interest payments on domestic debt are significant, often exceeding the inflation tax. Thus, there is reason to believe that case (a) discussed above may indeed be the relevant one for some real-world economies.

Case (a) evidently describes some non-standard dynamics, such as real appreciation following stabilization (upon impact one would expect a real depreciation). However, it is interesting to note that these dynamics resemble those analyzed in the literature on non-credible exchange rate based stabilization (see, for example, Calvo and Vegh, 1991): an initial consumption boom with real appreciation followed by falling consumption and real depreciation. In that literature the initial consumption boom is fueled by expectations of a future reverse of stabilization

Table 1
Inflation tax revenues and interest payments in the 1980s (% of GDP/GNP)

Country	Inflation Range	Tax Average	Interest Range	Payments Average
Argentina	2.3–15.4%	6.1%	0.1–3.9%	1.5%
Bolivia	2.1–15.1%	6.2%	2.9–7.1%	4.5%
Brazil	0.7–3.8%	1.7%	1.1–3.5%	2.3%
Mexico	−2.2–10.1%	3.1%	2.0–15.4%	7.7%
Israel	−5.5–5.7%	1.1%	2.6–8.0%	5.0%

Note: A negative number indicates that interest payments on the monetary base exceeded revenues.

Coverage and Sources:
Argentina-coverage 1984–1989; Heymann Table 4 in Bruno et al. (1991, p. 107), Dornbusch and de Pablo (1989, Table 2.8).
Bolivia-coverage 1984–1988; Morales Table 2.2 in Bruno et al. (1991, p. 20).
Brazil-coverage 1982–1987; Cardoso (1991, Tables 4a and 5a).
Mexico-coverage 1980–1989; Alberro-Semerana (1991, Tables 2.4 and 2.6).
Israel-coverage 1980–1990; Bank of Israel Annual Report (1990, Tables 5.1 and 5.2).

policy. In the present analysis the real appreciation is necessitated by the long-run real depreciation. Thus, similar dynamics may be observed for a perfectly credible and sustainable policy as well as for an unsustainable stabilization policy.

The analysis has other implications for policy: recently there has been much interest in post-stabilization capital inflows and the appropriate policy response to them (see, for example, Calvo et al., 1993). The foregoing discussion shows that in case (a) capital inflows indeed occur after stabilization and foreign debt increases. The analysis implies that in order for government stabilization policy to be sustainable, capital controls should be increased.

5. Capital controls and fiscal policy

In this section we look at the interaction between capital controls and fiscal policy. We examine the cases of a fiscal contraction on traded goods (6.1) and on home goods (6.2) consumption. Such policy has sometimes accompanied – or has been recommended to accompany – stabilization plans of the type discussed in the previous section. On the face of it, a reduction in expenditures may be expected to lead to a reduction in taxes – the inflation tax and the tax induced by capital controls. However, the relationship between expenditures and taxation turns out to be complex. An expenditure reduction affects private consumption and relative prices inducing current account flows. These in turn have repercussions on foreign debt and hence on interest payments and capital controls. In what follows we discuss these different effects and outline both the resulting dynamics and the new steady state.

5.1. A cut in expenditures on traded goods

First consider a cut in expenditure on the traded good, i.e. lowering G^{T}. The steady-state effects are given by the following expressions using Eq. (21):

$$\frac{\mathrm{d}\bar{q}}{\mathrm{d}G^{\mathrm{T}}} = -\frac{A}{\dot{R}_R \Delta} < 0,$$
$$\frac{\mathrm{d}\bar{R}}{\mathrm{d}G^{\mathrm{T}}} = \frac{1}{\dot{R}_R}\left(1 - \dot{R}_q \frac{\mathrm{d}\bar{q}}{\mathrm{d}G^{\mathrm{T}}}\right) > 0, \tag{24}$$
$$\frac{\mathrm{d}\bar{w}}{\mathrm{d}G^{\mathrm{T}}} = K_2 \frac{\mathrm{d}\bar{R}}{\mathrm{d}G^{\mathrm{T}}} > 0,$$

where

$$\Delta = \frac{\dot{w}_q \dot{R}_R \dot{q}_w - \dot{R}_q \dot{w}_R \dot{q}_w + \dot{R}_q \dot{w}_w \dot{q}_R}{\dot{R}_R \dot{q}_w} > 0,$$
$$A = \dot{w}_R - \frac{\tau_R}{\rho_w}\dot{w}_w > 0, \qquad K_2 = -\frac{\tau_R}{\rho_w} > 0.$$

A cut in government expenditure on the traded good means more foreign interest payments are accommodated in the long run as the current account improves. Note that the decrease in G^{T} per se does not lead to a change in relative prices because of the offsetting foreign interest flow. Nevertheless, in this model, in contrast with the results of other models of the small, open economy with utility-maximizing agents (such as Obstfeld, 1981; Penati, 1987), real effects ensue. This happens as relative prices are affected by the intertemporal reaction of consumption to the change in capital controls: a higher level of foreign debt implies bigger capital controls, which lead to loss of financial wealth by the private sector and to a decrease in consumption along the adjustment path. This in turn leads to real depreciation.

This type of fiscal contraction has contractionary effects on the economy: there is a contraction of output and private consumption in the home good sector and a contraction of private consumption in the traded good sector. As to distortionary taxation the following emerges: with the accumulation of capital inflows, there is an increase in foreign debt and consequently an increase in capital controls. Along the adjustment path the rate of inflation is lower than its long run rate (which remains unchanged). Therefore, a government that accompanies an exchange rate led stabilization with a cut on traded goods consumption exacerbates the increase in capital controls in case (a) of the preceding section and lessens the reduction in capital controls in case (b) above.

5.2. A cut in expenditures on home goods

We now consider a cut in expenditures on the home good, i.e. lowering G^{H}:

$$\begin{aligned}
\frac{\mathrm{d}\bar{q}}{\mathrm{d}G^{\mathrm{H}}} &= \Delta^{-1}\left(-\dot{w}_{G^{\mathrm{H}}} + A\frac{\dot{R}_{G^{\mathrm{H}}}}{\dot{R}_R}\right),\\
\frac{\mathrm{d}\bar{R}}{\mathrm{d}G^{\mathrm{H}}} &= -K_1\frac{\mathrm{d}\bar{q}}{\mathrm{d}G^{\mathrm{H}}} - \frac{\dot{R}_{G^{\mathrm{H}}}}{\dot{R}_R},\\
\frac{\mathrm{d}\bar{w}}{\mathrm{d}G^{\mathrm{H}}} &= K_2\frac{\mathrm{d}\bar{R}}{\mathrm{d}G^{\mathrm{H}}}.
\end{aligned} \tag{25}$$

where

$$\Delta = \frac{\dot{w}_q\dot{R}_R\dot{q}_w - \dot{R}_q\dot{w}_R\dot{q}_w + \dot{R}_q\dot{w}_w\dot{q}_R}{\dot{R}_R\dot{q}_w} > 0,$$

$$A = \dot{w}_R - \frac{\tau_R}{\rho_w}\dot{w}_w > 0, \qquad \dot{w}_{G^{\mathrm{H}}} = q^{\alpha-1} - q^{\alpha}\frac{\partial C^{\mathrm{T}}}{\partial G^{\mathrm{H}}} - (i^* - \tau + \hat{E})\frac{\partial m}{\partial G^{\mathrm{H}}} > 0,$$

$$K_1 = \frac{\dot{R}_q}{\dot{R}_R} > 0, \qquad K_2 = -\frac{\tau_R}{\rho_w} > 0.$$

Here the results for all three variables are ambiguous, i.e. the sign of the above three expressions may be positive, zero or negative. The reason for the ambiguity is that there are multiple effects on output, relative prices and taxes which are induced by this type of fiscal contraction. We discuss the different mechanisms which operate here (6.2.1) and then consider their implications (6.2.2). Naturally, we stress throughout the role played by capital controls policy.

5.2.1. The underlying mechanisms

Three effects are at play here:

(i) The cut in home good expenditures frees resources for private sector consumption at a given level of prices (a 'crowding-in' effect).

(ii) The fiscal contraction affects relative prices. The decline in demand for the home good at a given level of private sector consumption operates to generate a real depreciation.

These two effects are 'traditional'. However, there is also a third effect which stems from capital controls:

(iii) The change in relative prices affects production and consumption in the foreign sector generating changes in current account flows. These in turn affect foreign debt and hence capital controls.

These effects generate three possible outcomes, as depicted in Fig. 4 in three panels:

The figures show that the real outcome of a fiscal cut is ambiguous: there may be a real depreciation in the long run (cases (a) and (b)) or a real appreciation

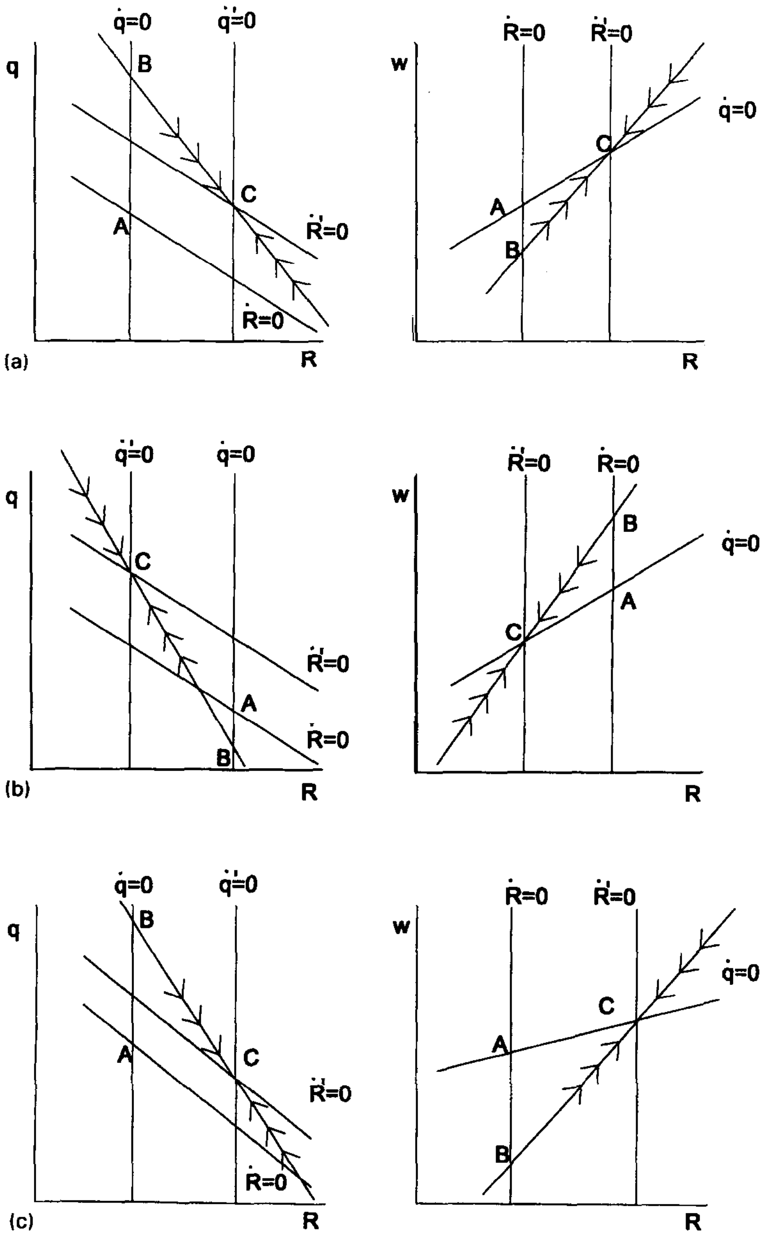

Fig. 4. Fiscal contraction.

(case (c)); output of the home good may decline and traded good production may increase (cases (a) and (b)) or home good production may increase while traded good output declines (case (c)); foreign debt declines (cases (a) and (c)) or increases (case (b)); consequently, capital controls may decline and so the after-tax real interest rate may increase (cases (a) and (c)) or capital controls may increase and so the after tax real interest rate declines (case (b)).

What are the reasons for these contradictory outcomes? Cases (a) and (b) differ because private consumption is affected by two opposing factors: the real depreciation operates to decrease consumption while the cut in government expenditures operates to increase it. In case (a) the latter, the 'crowding-in' effect, dominates. Therefore, the current account worsens and less foreign debt is accommodated in the long run. In case (b) the former effect, the relative price effect, dominates; consumption decreases, the current account improves and in the long-run more foreign debt is accommodated.

Case (c) has the third effect discussed above – that of capital controls – dominate. To understand the mechanism here consider case (a) as a benchmark. Suppose all changes in production and consumption have already taken place. This means that there is less foreign debt now and therefore controls are reduced. Thus, private agents are accumulating assets. Along the adjustment path their consumption is increasing generating a real appreciation. The latter induces further changes in production: now the home good sector expands while the traded good sector contracts. Consequently, there is further worsening of the current account which leads to even lower foreign debt in the long run. Capital controls thus expand the set of possible real outcomes.

5.2.2. Implications

One notable outcome is that this type of fiscal contraction may have expansionary effects. In cases (a) and (c) consumption increases following the cut in G^{H}. This happens because of the freeing of resources and because capital controls decrease. This outcome may explain the 'consumption puzzle' posed in the literature, i.e. the fact that contractionary fiscal policy sometimes generates an increase in private consumption. Real-world examples of this phenomenon are given by Giavazzi and Pagano (1990): they study the severe fiscal contraction undertaken in Denmark in 1982 and in Ireland in 1987–89 and find that they led to consumption increases.

Note too that one sector always expands production here: the traded good sector in cases (a) and (b) and the home good sector in case (c). The former is the 'traditional' result and happens as the fiscal cut generates a real depreciation. The latter, 'non-traditional' result is due to capital controls: there is a real appreciation in the long-run as consumption increases following the reduction in taxation induced by capital controls.

Another consequence pertains to inflation: in cases (a) and (c) following the initial jump where the real exchange rate overshoots its new long-run level there is a real appreciation along the dynamic path. Hence, price inflation is higher than the rate of devaluation and in this sense a fiscal contraction is 'inflationary'. The opposite is true for case (b). Once more the government is facing new dilemmas: in cases (a) and (c) there is a reduction in capital controls in both the short run and in the steady state but there is an inflationary effect along the adjustment path. In case (b) there is a decrease in inflation along the dynamic path but a permanent increase in capital controls.

6. Conclusions

The paper has derived a real-world conforming policy rule for capital controls modelling the constraints imposed upon it by the dynamics of the economy. It has investigated its interaction with fiscal and exchange rate (monetary) policies, showing that some significant real effects are generated. Studying several prevalent policy experiments, it has demonstrated that the use of controls enlarges the set of possible outcomes, generating some 'non-traditional' results.

Beyond the specific conclusions pointed out when discussing the various policy experiments, several general conclusions emerge:

(i) The analysis gives a new perspective on capital account liberalization. If the latter were defined as a decrease in τ, then this occurs endogenously in this model. Examples are case (b) of an exchange rate led stabilization and cases (a) and (c) of a fiscal contraction on non-traded goods. Note that a greater burden of controls is the endogenous consequence of the same policy moves when the other scenarios hold true, i.e. case (a) of an exchange rate led stabilization, a traded good fiscal contraction and case (b) of a home good fiscal contraction.

(ii) There sometimes exists, but not always, a tradeoff between the two distortionary taxes-inflation and capital controls. In case (b) of an exchange rate led stabilization both tax rates are reduced. This is so because the real appreciation necessitates a decrease in long-run debt and hence facilitates a reduction in the degree of controls. In case (a) of the same policy move, the real depreciation induces the opposite and hence the tradeoff.

(iii) The analysis has important implications with respect to combinations of policy measures: the analysis in Sections 4 and 5 allows one to determine the net effects of policy 'packages', i.e. policy plans that include a change in more than one policy parameter. For example, we have seen that a fiscal contraction on home goods may be inflationary. Thus, it may be useful to accompany such a contraction with a lower rate of exchange rate depreciation. Conversely, if a home good cut accompanies an exchange rate led stabilization policy, its short-run inflationary effects must be taken into account. Another example is a change in the government expenditure mix: if the government were to increase its consumption of the home good at the expense of the traded good, then the real depreciation effect of the reduction in G^{T} (and consequently the effects on production, consumption and the current account) may be mitigated if cases (a) and (b) of Section 6.2 are obtained; it shall be exacerbated, however, if case (c) is obtained.

(iv) The model gives some insight regarding the use of indexed bonds together with capital controls. The government is offering the private sector some 'compensation' as it bars its access to foreign capital markets. The preceding discussion has amply demonstrated that such policy does not insulate the foreign sector from the rest of the economy. Whenever a policy change occurs there are real effects both in domestic markets and in the foreign sector, including repercussions on foreign debt. This happens because the policy's effects on the private sector portfolio induce a change in private consumption patterns of both the home and the traded good.

The essential mechanisms underlying these results are the effects of capital controls on financial assets returns and – via their tax role – on the government budget constraint. The change in controls affects private sector asset accumulation and induces portfolio reshuffles. These in turn generate intratemporal and intertemporal consumption effects and consequently a whole array of real outcomes.

Appendix. The derivation of the policy rule

The linear approximation of the dynamic system is

$$\begin{bmatrix} \dot{q} \\ \dot{w} \\ \dot{R} \end{bmatrix} = \begin{bmatrix} \dot{q}_q & \dot{q}_w & \dot{q}_R \\ \dot{w}_q & \dot{w}_w & \dot{w}_R \\ \dot{R}_q & \dot{R}_w & \dot{R}_R \end{bmatrix} \begin{bmatrix} q - \bar{q} \\ w - \bar{w} \\ R - \bar{R} \end{bmatrix}, \tag{A.1}$$

where

$$\begin{array}{lll} \dot{q}_q = 0, & \dot{w}_q ?, & \dot{R}_q = Y_q^{\mathrm{T}} - C_q^{\mathrm{T}} > 0, \\ \dot{q}_w = (U_{\mathrm{T}}/U_{\mathrm{T}q})\rho_w > 0, & \dot{w}_w = (i^* - \tau) + \alpha(\bar{w}/\bar{q})\dot{q}_w > 0, & \dot{R}_w = 0, \\ \dot{q}_R = (U_{\mathrm{T}}/U_{\mathrm{T}q})\tau_R < 0, & \dot{w}_R ?, & \dot{R}_R = i^* > 0. \end{array}$$

We have assumed (see Section 3.2):

(i) $\dot{w}_q = \{\alpha q^{\alpha-1}[Y^{\mathrm{T}} - C^{\mathrm{T}}] + q^{\alpha}[Y_q^{\mathrm{T}} - C_q^{\mathrm{T}}]\} + (\alpha - 1)q^{\alpha-2}(Y^{\mathrm{H}} - C^{\mathrm{H}}) - (i^* + \hat{E} - \tau)$ $m_q > 0$.

(ii) $\dot{w}_R = \tau_R[-f - (i^* + \hat{E} - \tau)m_\tau + \alpha(\bar{w}/\bar{q})(U_{\mathrm{T}}/U_{\mathrm{T}q})] > 0$.

In order to determine the stability of the system we check the sign of the trace and the determinant of the system's coefficient matrix. Denoting the three characteristic roots of the linear system by $\theta_1, \theta_2, \theta_3$:

Trace $= \theta_1 + \theta_2 + \theta_3 = 0 + \dot{w}_w + \dot{R}_R$,

Determinant $= \theta_1\theta_2\theta_3 = \dot{R}_q\dot{w}_R\dot{q}_w - \dot{R}_q\dot{w}_w\dot{q}_R - \dot{R}_R\dot{w}_q\dot{q}_w$.

If the following holds:

$$0 \leq \tau \leq i^*, \tag{A.2}$$

$$\tau = \tau(R), \quad \frac{\partial \tau}{\partial R} < 0, \tag{A.3}$$

then the trace is positive and the determinant is negative provided that the following holds too:

$$|\tau_R| < \frac{i^* \dot{w}_q \rho_w}{(Y_q^T - C_q^T)\{\rho_w(w-m) + \rho_w(i^* + \hat{E} - \tau)m_\tau + i^* - \tau\}}. \tag{A.4}$$

The negative determinant implies that there are either three roots with negative real parts or one such root. But the fact that the trace is positive rules out the former possibility. Thus, two roots have positive real parts and one has a negative real part. This proves that in the neighborhood of long-run equilibrium this is a saddle-path stable system.

The characterization of the unique convergent path is given as follows, denoting the system's sole negative root by θ_1 and by $v = [v_{11}, v_{21}, v_{31}]$ an eigenvector belonging to θ_1:

$$q - \bar{q} = v_{11}\, K e^{\theta_1 t},$$

$$w - \bar{w} = v_{21} e^{\theta_1 t},$$

$$R - \bar{R} = v_{31}\, K e^{\theta_1 t}.$$

K is a constant defined by the value of R at t_0

$$v_{31}/v_{11} = \dot{R}_R/(\theta_1 - i^*) < 0,$$

$$v_{21}/v_{11} = (\theta_1 \dot{q}_w + \dot{w}_q \dot{q}_R)/(\theta_1 \dot{q}_R + \dot{R}_R \dot{q}_w - \dot{w}_w \dot{q}_R) < 0.$$

Thus, the real exchange rate (q) moves in an opposite direction to the stock of foreign assets (R) and domestic assets (w) along the unique convergent path.

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