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CAPITAL CONTROLS AND INTERNATIONAL TRADE FINANCE

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ABSTRACT

This paper studies the effects of prohibiting individuals from holding foreign assets, and of allowing firms to trade in foreign assets only up to what is needed to finance export and import activities. Although firms can perform arbitrage between domestic and foreign financial markets, the distortions in asset markets are not fully arbitrated away but instead they are transmitted to domestic goods market. The paper discusses the effects of shocks in foreign financial markets and in domestic fiscal policy. We show that the dynamics and steady states are crucially affected by capital controls.

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# 1 Introduction

Controls on international trade in assets are a pervasive phenomenon in the world economy. Despite the free-trade philosophy of the institutions of the post-second-world war, like GATT, the IMF and the World Bank, controls on international capital flows have never been discouraged by international institutions, at least until very recently.<sup>1</sup> Indeed, the first version of the IMF Articles of Agreement explicitly allowed the use of restrictions on international capital flows for the purpose of stemming temporary balance-of-payments crises.

In the economics literature, capital controls have recently been formally analyzed by many authors.<sup>2</sup> Unlike analyses of restrictions on goods trade, like tariffs and quotas, however, there has never been a generally acceptable specification of the *forms* of controls of international capital flows. This absence of a general specification is justified, in part, by the variety of types of restrictions imposed on international asset transactions. Hence among existing models, we find descriptions of dual exchange rates regimes (Adams and Greenwood (1985), Bhandari and Decaluwe (1987), Dornbusch (1986), Flood and Marion (1982,1989) and Obstfeld (1986)), analyses of taxes on international borrowing and lending (Edwards and Ostry (1989) and van Wijnbergen (1989)), analyses of a quota on international borrowing (Greenwood and Kimbrough (1985)), and taxes on the acquisition of foreign means of payments (Stockman and Hernandez (1988)).

In this paper, we discuss the effects of imposing different types of controls on different agents in the economy. Countries do not find it possible to prohibit all domestic residents from trades in the foreign assets without discrimination. The reason is that international trading firms need to access international financial markets for financing their trade activity. In other words, trade finance is an integral part of international trade in goods. Prohibiting trading firms from accessing international financial markets to fi-

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<sup>1</sup>The project of elimination of physical, fiscal and technical barriers in Europe after 1992, however, explicitly mentions the removal of barriers to international capital flows as an important condition for the integration.

<sup>2</sup>Surveys appear in Dornbusch (1986) and Edwards (1989).

nance international trade flows would end up disrupting export and import flows, and, possibly, jeopardizing the competitiveness of national export industries in the world markets. We discuss the macro implications of a regime which prohibits *individual consumers* to trade in assets with the rest of the world, but allows firms to carry it out *only up to what is needed to finance import and export activities*. A simplified version of this model was first proposed by Giavazzi and Giovannini (1989), who argued that it best describes the controls used in European countries like France and Italy.

According to the IMF Annual Report on Exchange Arrangements and Exchange Restrictions (1988), most countries which have restrictions on payments for capital transactions impose restrictions on the proceeds from international trade. Out of 151 IMF member countries, 117 have both restrictions on international portfolio diversification and restrictions on the financing of international trade.<sup>3</sup> In the absence of controls on trade credits, firms involved in international trade would take large positions in foreign assets by adjusting the size and maturity of trade credits whenever there is a discrepancy between the domestic interest rate and the world interest rate, causing the large capital movement.<sup>4</sup> Hence countries which restrict international financial transactions by individuals find it necessary to impose restrictions on firms' financing of international trade.

The regime we study raises a number of interesting questions. They include:

- The degree of insulation of domestic financial markets from foreign disturbances. In particular, we want to ask whether the ability of firms to carry out arbitrage between domestic and foreign financial markets renders these controls ineffective over some time horizon, and whether the insulation of domestic financial markets decreases or increases the volatility of domestic interest rates in response to foreign shocks.

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<sup>3</sup>See page 544 of the Annual Report (1988). For example, in Korea, as of December 31, 1987, the foreign exchange proceeds from exports are required to be surrendered to a foreign exchange bank at its posted customer rate.

<sup>4</sup>Hansen (1961) and Einzig (1968) provide discussions of these techniques.

- The impact of fiscal policies on domestic real interest rates and the current account. In particular, we are interested in the distortions arising from government financial policies when domestic and international financial markets are not perfectly integrated, as we described above.

The structure of this paper is as follows. Section 2 describes the overlapping-generations model of a small open economy with capital controls and derives the dynamic system of the economy. Section 3 discusses the steady state effects of capital controls on the domestic real interest rate and the foreign asset holdings. Using numerical simulations, sections 4 and 5 study the dynamic responses of the economy to a foreign interest rate shock and to a fiscal policy shock, respectively. Section 6 contains concluding remarks.

## 2 The Model

We study an economy where, besides the absence of trading opportunities between existing generations and future generations, there are no distortions. Since we are pursuing a *positive* analysis of controls, not a normative analysis, we ignore those distortions that might justify the imposition of capital controls. This allows us to isolate their macroeconomic effects.

The benchmark model is the standard overlapping-generations model of a small open economy studied, among others, by Blanchard (1985), Buitier (1986), Frenkel and Razin (1987), Giovannini (1989) and Matsuyama (1989).<sup>5</sup> Every period, a new cohort (consisting of many individuals) is born. Individuals face a given probability of survival, independent of age. Their utility is defined over consumption of two goods, a domestic good (good 1) and an import good (good 2). Every period, they receive an endowment of the domestic good, which they exchange with the rest of the world through trading firms. The assumption of a fixed endowment simplifies our analysis considerably, without affecting the

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<sup>5</sup>See also Obstfeld(1989).

basic results in any important way.<sup>6</sup> Consumers hold shares in the trading firms, and government bonds. The derivation of aggregate consumption functions—which follows standard treatments of this problem, like Frenkel and Razin (1987)—is relegated in Appendix A. The aggregate consumption functions are:

$$p_t C_{1t} = \alpha(1 - s_t)W_t \quad (1)$$

$$q_t^d C_{2t} = (1 - \alpha)(1 - s_t)W_t \quad (2)$$

where:

$$(1 - s_t) = \left\{ \sum_{j=0}^{\infty} (\gamma\beta)^j \left[ \beta^j \left( \frac{R_t}{R_{t+j}} \right) \left( \frac{p_t}{p_{t+j}} \right)^\alpha \left( \frac{q_t^d}{q_{t+j}^d} \right)^{1-\alpha} \right]^{\frac{1-\theta}{\theta}} \right\}^{-1} \quad (3)$$

represents the propensity to consume out of wealth.  $1/\theta$  represents the elasticity of intertemporal substitution and  $R_t$  denotes the compounded present value factor from period zero up to period  $t$ , i.e.,

$$R_t = \prod_{k=0}^{t-1} (1 + r_k)^{-1} \quad (4)$$

where  $r_t$  is the domestic real interest rate from period  $t$  to  $t + 1$ . Note that  $R_t/R_{t+1}$  is  $1 + r_t$ .  $p_t$  is the domestic price of good 1, expressed in terms of our numeraire—the world price of good 1.  $p_t$  can, in equilibrium, diverge from 1 because consumers do not have direct access to world goods markets. As we show below, trading firms “pass on” to goods prices the marginal costs and benefits of financial markets arbitrage.  $q_t^d$  is the domestic price of good 2, the imported good.  $W_t$  is total wealth of consumers, whose components and evolution is described by the three equations below:

$$W_t = H_t + A_t \quad (5)$$

$$H_t = p_t y - T_t + \left( \frac{\gamma}{1 + r_t} \right) H_{t+1} \quad (6)$$

$$A_t = p_t C_{1t} + q_t^d C_{2t} + T_t - p_t y + \frac{A_{t+1}}{1 + r_t} \quad (7)$$

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<sup>6</sup>An equivalent structure would have individuals endowed with a fixed number of man-hours, used by firms to produce the domestic good.

$H_t$  represents human wealth at time  $t$ . It is the sum of the value of the endowment at domestic prices net of taxes  $T$ , plus the discounted value of expected next-period's human wealth. The expectation is equal to the probability of survival  $\gamma$  times the value of human wealth next period, discounted at the rate of interest,  $1/(1+r_t)$ . Equation (7) represents the evolution of aggregate financial wealth,  $A_t$ , which is equal to the present discounted value of next period's financial wealth, plus net dissaving at time  $t$ .

Domestic firms are not engaging in production of goods, but only in international trade. There exists a large number (normalized to 1) of identical domestic firms, acting competitively. This assumption allows us to apply the "representative firm" paradigm. International trade is financed both in the world and in the domestic capital markets. The firm's optimization problem is:

$$V_t = \max_{\{X_{1t}, X_{2t}\}} \sum_{t=0}^{\infty} \left( \frac{R_t}{R_0} \right) [(X_{1t} - F_t) + F_{t-1}(1 + r_{t-1}^*) - p_t X_{1t} - q_t X_{2t} + q_t^d X_{2t} - \frac{1}{2} \sum_{i=1}^2 \delta_i (X_{it} - X_{it-1})^2] \quad (8)$$

subject to:

if  $r_t^* \geq r_t$

$$F_t \leq \phi X_{1t}, \quad (9)$$

if  $r_t^* < r_t$

$$F_t \geq \phi X_{1t} \quad (10)$$

The first term in the square bracket on the right-hand side of equation (8) represents the cash flow from "cash" sales or purchases, equal to total exports or imports of good 1 minus the trade credits,  $F_t$ . The reason why we allow the domestic firm also to import good 1 is that, in this dynamic model, goods trade does not have to balance period-by-period since the country as a whole can finance, through trade credits, the excess of spending over income in world capital markets. In the steady state, however, good 1 can only be exported (see section 3 below). Trade credits are 1-period assets that the firm buys from— or sells to—foreign residents, yielding the world rate of interest  $r^*$ . Hence the second term in the square brackets represents the liquidation value of

trade credits from the previous period. The corresponding domestic cash flow from international trade in good 1 is represented by the third term in the bracket: the value of purchases from, or sales to, domestic residents, times the domestic price of the export good. Equations (9) and (10) represent the controls on capital flows imposed by the government. When the foreign interest rate exceeds the domestic interest rate, the firm is not allowed to purchase foreign assets in excess of a given fraction  $\phi$  of its exports of good 1. When the foreign interest rate is lower than the domestic interest rate, the firm cannot sell foreign assets beyond the same fraction of its imports of good 1. If  $r_t^* > r_t$ , the firm will try to maximize foreign asset holdings, and, if  $r_t^* < r_t$ , it will try to minimize them. Therefore the constraints (9) and (10) always bind and the foreign asset holdings of the firm are equal to  $\phi X_{1t}$ .

The firm is also engaged in the intermediation of the import good, good 2,<sup>7</sup> although, to simplify the analysis, we assume that all trade in the import market is settled by cash. Our main qualitative results would be unaffected in a more complete model where also imports could be financed by trade credits at the world rate of interest, *as long as* the constraints on maximum trade credits in the import market differ from those in the export market.<sup>8</sup> The firm buys the import good at the world price  $q$ , and sells it at home for  $q^d$  (where, as always, we use the world price of the export good as numeraire): hence the next two terms in the right-hand-side bracket of (8).

Finally, the last term of the firm's objective function represents costs of instantaneously adjusting import and export flows. These costs stand for the delays and problems in negotiating sources of supply, and the rigidities induced by the time lags in international transport.<sup>9</sup> Note that the opportunity cost of capital to the domestic firms ( the discount factor in the firm's maximization problem)

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<sup>7</sup>We label good 2 the "import" good since it is not produced at home. However, as our discussion above has made clear, good 1 could also be imported.

<sup>8</sup>When the constraints equal in the two markets the steady-state net asset position of the country is necessarily zero. In this sense the economy is perfectly insulated from the rest of the world. If some international trade is settled by cash, the steady-state net asset position depends on the trade credit restrictions and the proportion of cash versus credit trade. Our assumption that all imports are settled by cash allows us to study steady-state changes in net foreign assets.

<sup>9</sup>See Gagnon (1989) for evidence on the empirical magnitude of these costs.



is the domestic interest rate. The assumption here is that the domestic firm is held by domestic residents only. If foreigners were allowed to hold shares of the domestic firm, they would require a rate of return equal to the world rate of interest. In this case the firm could arbitrage between domestic and foreign financial markets by changing its capital structure.<sup>10</sup>

The first order conditions of (8) are:

$$X_{1t} - X_{1t-1} \equiv \Delta X_{1t} = \frac{1}{\delta_1} \left[ (1 - p_t) + \phi \left( \frac{r_t^* - r_t}{1 + r_t} \right) \right] + \frac{1}{1 + r_t} \Delta X_{1t+1} \quad (11)$$

$$X_{2t} - X_{2t-1} \equiv \Delta X_{2t} = \frac{1}{\delta_2} (q_t^d - q_t) + \frac{1}{1 + r_t} \Delta X_{2t+1} \quad (12)$$

The first-order condition with respect to  $X_{2t}$ , equation (12), says that the *change in* import flows depends on the profitability of imports trade (represented by the difference between the domestic and the world price of the import good), and the discounted future changes in imports. The smaller the costs of adjusting imports, *i.e.* the smaller  $\delta_2$ , the larger the response of import flows to price differences.<sup>11</sup> The equation is a straightforward implication of linear-quadratic structure of the firm's maximization problem: in the absence of adjustment costs there would be no difference between the domestic and world price of the import good.

The first order condition with respect to  $X_{1t}$ , equation (11) shows that the profitability of the export trade is not only represented by the difference between the world price (equal to unity) and the domestic price of the export good, but also by the added gains from the export trade, represented by the profits from financial arbitrage in the trade credits market. Any extra sale of a unit of the export good allows to acquire  $\phi$  units of foreign assets, which next period yield an arbitrage profit equal to  $r^* - r$ .<sup>12</sup> The

<sup>10</sup>For example, if foreign rates of interest were higher than domestic rates, the firm could raise large amounts of capital at home, and retire it abroad at the same time, thus effectively carrying out the arbitrage without constraints.

<sup>11</sup>As  $\delta_2 \rightarrow 0$  the incipient adjustment in import flows approaches infinity.

<sup>12</sup>The acquisition of foreign assets through trade credits is financed by borrowing in the domestic financial market.

difference between equation (11) and equation (12) is that, even in the absence of adjustment costs in the export market, the domestic price of the export good does not necessarily equal its world price, but reflects the difference between foreign and domestic interest rates.

To highlight the role of capital controls, consider the hypothetical case where the constraint (9) and (10) is absent, or, equivalently, where the firm can freely choose the proportion between exports and foreign assets,  $\phi$ . Under these circumstances, the firm would be able to take unbounded positions in foreign assets whenever there is a difference between foreign and domestic interest rates. In equilibrium foreign and domestic rates would have to be equal.<sup>13</sup>

The government is assumed to engage in the following transactions: (i) purchases of the domestic good; (ii) collection of lump-sum taxes from individuals; (iii) management of the public debt, which is composed of  $B$  units of a bond with a face value of 1, paying the domestic interest rate. Government bonds are sold to domestic residents only. The government budget constraint is thus:

$$B_{t+1} = (1 + r_t)(B_t + p_t G_t - T_t) \quad (13)$$

In each period the equilibrium condition for domestic and import goods market can be described as follows.

$$C_{1t} = y - G_t - X_{1t} \quad (14)$$

$$C_{2t} = X_{2t} \quad (15)$$

The equilibrium of asset markets is given by

$$A_t = B_t + V_t \quad (16)$$

The value of financial asset holdings of individuals equals the amount of government debt plus the value of the firm.

Table 1 contains the full set of dynamic equations in the model which summarizes the dynamic behavior of aggregate variables in

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<sup>13</sup>By the Modigliani-Miller theorem, firms are conducting the arbitrage for their shareholders, whose direct access to international financial markets is prohibited.

the economy. The balance of payments equilibrium condition in Table 1 is obtained by combining the budget constraints of individuals, the firm and the government.

The first equation in Table 1 represents the dynamics of capital flows. Since foreign assets at time  $t$  are equal to  $\phi X_{1t}$ , and individuals have no access to the world capital markets,  $\Delta X_{1t}$  is proportional—through the constant  $\phi$ —to capital flows. In other words, all capital flows are represented by trade credits. The equation shows the main determinants of capital flows in the presence of capital controls. The “modern view” on international capital flows, following the work of Branson and Hill (1971), assumes that they arise from a sequence of stock equilibria. In those models, desired asset stocks depend on the level of interest rates, and hence capital flows depend on the *first differences* of interest rates. Costs of adjusting international asset portfolios would drive a temporary wedge between domestic and foreign rates of interest. Our model, by contrast, implies that capital flows depend on the *levels* of domestic and foreign interest rates (with capital outflows increasing as foreign interest rates increase above domestic rates), on expected future capital flows, and on the difference between domestic and world prices of the export good. By explicitly specifying the objectives and constraints of goods and assets traders, we can justify the presence of adjustment costs in capital flows equations, and fully trace out their effects.<sup>14</sup>

### 3 Steady State Analysis: The Effects of Capital Controls.

The first order conditions of the firms' maximization problem have highlighted the role of adjustment costs. It is well known, however, that (given the structure of our model) these adjustment costs can only affect the short-run dynamic responses to shocks, but do not influence steady-state equilibria. The question then is whether in the steady state, when the price of the import good will be the same at home and abroad, a difference between domestic and foreign interest rates can be sustained by a difference between domestic

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<sup>14</sup>This feature is shared by the model of Giavazzi and Giovannini (1989).

and foreign prices of the export good.

The steady state equilibrium is described by the following equations:

- Firm's equilibrium conditions:

$$p = 1 + \phi \left( \frac{r^* - r}{1 + r} \right) \quad (17)$$

$$q^d = q \quad (18)$$

- Trade-credits constraint:

$$F = \phi X_1 \quad (19)$$

- Equilibrium condition in the market for good 1:

$$(y - X_1 - G)p = \alpha(1 - s)(H + A) \quad (20)$$

- Equilibrium condition in the market for good 2:

$$qX_2 = (1 - \alpha)(1 - s)(H + A) \quad (21)$$

- Human wealth:

$$H = \frac{1 + r}{1 + r - \gamma}(py - T) \quad (22)$$

- Financial wealth:

$$A = (1 + r^*)F + B \quad (23)$$

- Government budget constraint:

$$B = \frac{1 + r}{r}(T - pG) \quad (24)$$

- Current-account equilibrium condition:

$$X_1 - qX_2 + r^*F = 0 \quad (25)$$

where

$$s = \gamma\beta^{\frac{1}{\theta}}(1+r)^{\frac{1-\theta}{\theta}} \quad (26)$$

Equations (17) and (19) are both derived under the assumption that the constraint on trade credits binds in the steady state. Suppose that  $r < r^*$ . The firm tries to sell more of the domestic good abroad to acquire more foreign assets. This raises the price of the domestic good at home. If, by contrast,  $r > r^*$ , the firm tries to borrow from abroad by importing good 1. As equations (19) and (25) show, however, the steady state current account equilibrium condition does not allow the firm to import good 1. If  $X_1$  is negative, from equation (19),  $F$  is also negative and, since consumption of good 2 is always positive, equation (25) can not hold. Since in equilibrium domestic residents need to sell good 1, the fall in  $p$  has to be such to induce the firm to balance the capital markets arbitrage losses with goods markets arbitrage gains. Hence the only point where the trade credit constraint is not binding is  $r = r^*$ , which is, as we show below, a set of measure zero. All the other equations are self-explanatory. Notice that since the discount rate applied to future net-of-tax income in equation (22) takes into account the probability of dying, equations (22), (23) and (24) imply that government bonds affect, on net, total wealth.<sup>15</sup> The value of the firm is represented by the term  $(1+r^*)F$ , that is, the value of its total asset holdings.<sup>16</sup>

From now on we concentrate on the cases where  $\theta \leq 1$  (which imply relatively high substitution between present and future consumption).<sup>17</sup> Comparative steady-state analysis can be performed by studying the determinants of the domestic real interest rate and of foreign asset holdings by firms. We do so by collapsing the system (17) to (25) into two equations, describing, respectively, the current account equilibrium condition and the goods market equilibrium condition. The two corresponding schedules are plotted in Figure 1.

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<sup>15</sup> At every period  $t$ , the firm has the principal value of foreign assets accumulated from previous period,  $F_{t-1}$ , plus the interest accrued on that,  $r^*F_{t-1}$ . Hence  $(1+r^*)F$  is the steady state value of the firm's foreign asset holdings.

<sup>16</sup> In addition to trade credits the firm does not hold inventories or other types of investment.

<sup>17</sup> In practice, even widely different values of  $\theta$  do not affect the dynamics and steady states significantly.

The current account equilibrium condition is obtained by substituting equations (21) (22) and (23) into (25):

$$\left(\frac{1}{\phi} + r^*\right)F = (1 - \alpha)(1 - s(r))\left[\left(\frac{1 + r}{1 + r - \gamma}\right)(y - G)p(r, r^*) + (1 + r^*)F + \left(\frac{1 - \gamma}{1 + r - \gamma}\right)B\right] \quad (27)$$

where  $p(r, r^*)$  and  $s(r)$  denote the functions in equations (17) and (26). The corresponding schedule in Figure 1— $CC$ —is downward sloping. An increase in foreign assets increases income from abroad (both interest income and export income which is proportional to  $F$ )—the left hand side of equation (27)—but also increases the value of the firm and hence private wealth. As (27) shows, however, the increase in income from abroad exceeds the increase in import demand arising from higher private wealth. Thus an increase in  $F$  brings about a current account surplus. In order to reestablish equilibrium, the domestic real interest rate needs to fall, thereby raising human wealth, decreasing savings, and leading to higher demand for imports.

For goods market equilibrium, we concentrate only on the market for the “export” good, since, by Walras’s law, equilibrium in the current account implies that demand and supply for the import good are also equalized.<sup>18</sup> Substituting equation (22) (23) and (24) into (20), we obtain:

$$\left(y - \frac{F}{\phi} - G\right)p(r, r^*) = \alpha(1 - s(r))\left[\left(\frac{1 + r}{1 + r - \gamma}\right)(y - G)p(r, r^*) + (1 + r^*)F + \left(\frac{1 - \gamma}{1 + r - \gamma}\right)B\right] \quad (28)$$

An increase in foreign assets (proportional to an increase in exports) decreases the amount of domestic production available for consumption, and raises the value of the firm and private wealth. The resulting excess demand for the export good is offset by a change in the domestic rate of interest,  $r$ . An *increase* in  $r$  has three effects. On the demand side, it decreases the value of human wealth (the first term in brackets on the right-hand-side of

<sup>18</sup>Strictly speaking, then, equilibrium in the market for *both* goods occurs only at the intersection of the  $CC$  and the  $GG$  curves.

(28)) directly, but also by lowering the equilibrium price of the consumers' endowment  $p$ , and it increases the propensity to save. On the supply side it lowers the value of the domestic good. The net effect is ambiguous, and depends on parameters like the world rate of interest, the level of government spending, and the extent to which firms are allowed to arbitrage between domestic and foreign financial markets,  $\phi$ . We assume that the effect on wealth and demand exceeds the supply effect: this occurs under all reasonable parameter combinations we studied. Under this assumption, the steady-state goods market equilibrium schedule is upward sloping.

To interpret the effects of capital controls we consider also the case where the firm is not subject to the constraint (19): it can freely trade in assets with the rest of the world, *but private individuals cannot*. International portfolio diversification by the firm ensures that the domestic interest rate equals the world rate, and therefore there are no *steady state* distortions in the goods markets. In this sense, prohibiting individuals from international assets trade does not distort any of their decisions. The current account equilibrium condition, which contains all choice variables of the domestic firm (imports, exports, foreign asset holdings) is now horizontal: the firm would take unbounded positions in foreign asset whenever  $r \neq r^*$ .

The goods market equilibrium condition is derived as follows. From the intertemporal budget constraint of individuals we know that the annuity value of their assets should finance the excess of consumption over disposable endowment income:

$$A = \left( \frac{1+r}{r} \right) [C_1 + qC_2 - (y - T)] \quad (29)$$

Substituting from the GNP equation, we have:

$$A = \left( \frac{1+r}{r} \right) [qX_2 - X_1 + T - G] \quad (30)$$

Asset markets equilibrium requires that  $A = B + V = \frac{1+r}{r}(T - G) + (1 + r^*)F$ . Hence,

$$qX_2 - X_1 = r \left( \frac{1+r^*}{1+r} \right) F \quad (31)$$

To obtain the  $GG$  curve, we substitute this relation into the GNP equation:

$$y = (1 - s(r))\left[\left(\frac{1+r}{1+r-\gamma}\right)(y - G) + (1+r^*)F + \left(\frac{1-\gamma}{1+r-\gamma}\right)B\right] + G - r\left(\frac{1+r^*}{1+r}\right)F \quad (32)$$

An increase in domestic real interest rate decreases wealth and spending. An increase in  $F$  restores equilibrium if  $s(1+r) < 1$  (a standard stability condition in these models: see Frenkel and Razin (1988)).

Figures 1 and 2 highlight an important feature of our model. The steady state domestic interest rate does not have to equal the foreign rate of interest (this result is further highlighted by the analysis of shocks performed in the following two sections). Although firms can perform arbitrage between the domestic and foreign financial markets, the domestic interest rate never reaches the world rate of interest, and the domestic financial markets are permanently isolated from the world financial markets. The intuition for this result is as follows. From equation (17) we know that firms can increase their foreign asset holdings whenever individual residents are induced to sell more of good 1 to the rest of the world. Individual residents are induced to consume less of the good 1 by an increase in its price,  $p$ . Hence the distortion in the asset markets cannot be fully arbitrated away, but is simply transmitted to the domestic goods market. In the next sections we discuss how these distortions are affected by shocks in the world rate of interest and fiscal policy shocks. The asset market distortion—the interest rate differential—produces a larger distortion in the goods market (other things equal) the larger the proportion of exports that can be financed by trade credits,  $\phi$ . Notice that, with  $\phi = 0$ , the firm is prevented from acquiring foreign assets and has to settle all transactions on a cash basis. In this case, the distortion in the asset markets, which comes from prohibiting all agents from borrowing or lending at the world rate of interest, is not transmitted into the goods market by the firm's activities.



## 4 Foreign Interest-Rate Shocks

An increase in the foreign interest rate has ambiguous effects on the long run equilibrium. Consider the  $CC$  schedule first. A higher  $r^*$  increases income from abroad, but also increases spending, since the value of the firm and human wealth both go up. The net effect is not known a priori. Similarly, the shift in the  $GG$  schedule is ambiguous, since the value of the supply of good 1 increases with  $r^*$  (since  $p$  goes up), but demand goes up as well through the wealth effects mentioned above.

By contrast, Figure 3 shows that, in the absence of controls on trade credits, an increase in the foreign rate of interest shifts the two curves unambiguously. The vertical shift in  $CC$  is obvious. The  $GG$  curve also shifts upwards, since the increase in wealth due to higher foreign interest rates has to be matched by higher interest rates at home to decrease spending. Whether or not foreign asset holdings increase (which of the two curves has a larger vertical shift) depends on the offsetting income and substitution effects of the increase in  $r^*$ .

We study the dynamic responses to a foreign interest rate shock using numerical simulations, since the dynamic system which describes the model's equilibrium over time is both "too large" and highly nonlinear. In the simulations we apply the algorithm of Fair and Taylor (1983).<sup>19</sup> The algorithm works as follows. (i) An arbitrary terminal period  $T$  is selected (the number of periods in the simulation is  $T - t$ ) and the values of the jumping variables from  $t + 1$  to  $T$  are guessed. A jumping variable is a variable whose value depends on the future path of the economy. (ii) Using this initial guess of the future path of jumping variables, the model is solved forward from  $t$  to  $T$ , generating the values of all endogenous variables which include jumping variables. (iii) The initial guess of the path of the jumping variables is then compared to the one generated by step (ii) and updated if the absolute value of the difference between the two paths is not less than a prescribed convergence level. The model is solved again using this updated guess. (iv) Step (iii) is repeated until the convergence criterion is

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<sup>19</sup>This algorithm is implemented in a Gauss Program by W. and J. McKibbin, whom we thank for making it available to us.

satisfied. (v) Once the updated and actual path of the jumping variables become close enough to satisfy the convergence criterion, the terminal period is extended to test the sensitivity of the solution to the length of the forecasting horizon.

We report simulation results conditional on the following parameters. The intertemporal elasticity of substitution equals 2 (i.e.,  $\theta = .5$ ), the rate of time preference equals 2 percent per annum and the share of good 1 in the expenditure of individuals,  $\alpha$ , equals 0.7. The value of  $\gamma$  is chosen such that the expected life span of individuals is 65 years. Finally, we assume that the government purchases are 15 percent of the total endowment, and that the government debt is kept at the constant level which equals one third of the total endowment. These parameters are chosen to resemble broadly the size of government purchases and government debt in actual economies. The taste parameters are chosen to insure a relatively high response of savings to the rate of interest. While the empirical evidence on intertemporal substitution suggests lower values, we found that the simulations are practically unaffected by the choice of widely different values for this parameter.

Figures 4, 5 and 6 report the dynamic responses of the domestic real interest rate, the current account and the domestic price of the export good, respectively, after a change in the foreign rate from 4 percent to 8 percent (in annual terms) in quarter 1. The parameter we vary is  $\phi$ , which determines the "tightness" of controls on trade credits. If  $\phi$  is large, the stock of foreign asset holdings at the initial steady state is high. Hence an increase in the foreign interest rate brings about a higher capital gain by the firm, reflected by a larger increase in the value of the firm. Higher wealth induces domestic residents to spend more. The incipient increase in spending generates an increase in the domestic rate of interest coupled with a current account deficit. The striking result in Figure 4 is that the domestic interest rate actually increases more than the foreign rate of interest. Furthermore, as we pointed out above, the new steady-state domestic rate of interest (2.3 percent) is still below the world rate (8 percent), and hardly changes from the initial steady state. Figure 6 illustrates the transmission of the asset-market dis-

tortion into goods prices. With a higher steady-state differential between domestic and foreign interest rates, the domestic price of the export good increases. Its increase is proportional to the firm's incentive to arbitrage,  $\phi$ .

The figures also illustrate the effects of tighter capital controls. Restricting the access of domestic firms to world financial markets (lowering  $\phi$ ) limits the capital gains to firms originating from world interest rate fluctuations, and hence dampen the fluctuations of private wealth in response to  $r^*$ . Smaller fluctuations of private wealth induce smaller changes in the domestic rate of interest and the current account balance.

## 5 Fiscal Policy Shocks

We now turn to the analysis of a permanent increase in government expenditure, accompanied by an increase in taxes, and no change in government debt. Figures 7 and 8 show the steady-state responses of foreign assets and the domestic interest rate, by comparing the regime of capital controls with the case of perfect capital mobility. In the presence of capital controls (Figure 7), an increase in  $G$  accompanied by higher taxes decreases the expected value of after-tax endowment income, and spending. The current account equilibrium schedule of equation (27) shifts down and to the left. In the market for domestic good, the contractionary effect of higher present and future taxes is balanced by the increase in demand for good 1 (we assume that government spending is only on the domestic good). While the net effect on excess demand is ambiguous, we find it reasonable to assume that the demand for good 1 *increases* with the increase in government spending: hence the  $GG$  schedule (in equation (28)) shifts up and to the left. The shift in the  $CC$  schedule is smaller, the smaller the value of  $\phi$ : the decrease in imports associated with higher  $G$  has to be matched by a decrease in exports and foreign interest income. When  $\phi$  is small, a small decrease in  $F$  corresponds to a large decrease in exports, hence the equilibrium leftward shift in  $CC$  has to be small. The smaller is the shift in  $CC$  relative to that of  $GG$ , the larger is the increase in the domestic interest rate. In general, however,

the steady-state change in the real rate of interest is ambiguous. Figure 8 illustrates, for comparison, the case of perfect international capital mobility. In this case, since the real interest rate is pegged at the world level and there is no relative price effect, the required crowding out of private spending can only occur through cumulative current account deficits.

The dynamic analysis of the system is reported in figures 9, 10 and 11 (containing the responses of the real interest rate, the current account, and the domestic price of good 1, respectively). In the simulations, we assume that the foreign rate of interest is equal to 4 percent and government spending increases permanently from 15 percent of GDP to 16 percent of GDP. Figures 9 and 10 illustrate our previous argument: the nature of crowding out of private spending depends on the tightness of capital controls. When  $\phi$  equals only to 0.1, the fiscal expansion is accompanied by an increase in the domestic real interest rate both in the short run and in the long run. The worsening of the current account is in this case relatively small. By contrast, when  $\phi$  is large most of the adjustment occurs through the current account: the real rate of interest decreases in the short run due to the negative wealth effects of the large current account deficits, but does not change significantly in the steady state.

## 6 Concluding Remarks

This paper studies the effects of prohibiting private families from trade in assets with the rest of the world, and of allowing firms to borrow and lend at the world rate of interest, but only to finance their own international trade activity. These restrictions on the volume of financial transactions, that occur via the financing of foreign trade, differ from those studied in the literature, which concentrate on taxing international interest payments or on restricting exogenously the stocks of foreign assets or, finally, on taxing the acquisition of foreign means of payments.

Our finding is that the distortions in the financial markets are transmitted by firms to the goods markets. The extent of this spillover depends in an important way on the “tightness” of capi-

tal controls. Furthermore, although firms can always carry out—at least to some extent—arbitrage between domestic and foreign financial markets, capital controls remain effective even in the long run. This occurs because there is always a “cost” of financial arbitrage, represented by the scarcity of domestic goods available for export when foreign interest rates are higher than the domestic ones, or by the limited size of the domestic market for imports, when foreign interest rates are lower than the domestic ones.

Controls on international trade credits do not necessarily isolate, in the short run, domestic interest rates from foreign financial disturbances: increases in foreign rates of interest can give rise to large fluctuations of domestic interest rates whenever they affect significantly the present discounted value of trading firms’ profits. This occurs when controls on trade credits are relatively “loose”, and as a results firms’ foreign asset holdings are large. Finally, we find that the effects of fiscal expansions on the current account and interest rates are also crucially affected by these controls. The tighter are the controls on trade credits, the larger are the (positive) effects of a fiscal expansion on domestic rates of interest rates, and symmetrically, the smaller are its effects on the current account.

## Appendix A Individual Consumption and its Aggregation

Each period a cohort of a large number of individuals is born and every individual receives  $y$  units of good 1, the domestic good, independently of his age. We assume that a newly born individual has no financial wealth.

Let  $c_{i\nu,s}$  denote the level of consumption of good  $i$  in period  $\nu$  of an individual who was born in period  $s$  ( $\nu \geq s$ ). Assume that in period  $t$  an individual who was born in period  $s$  ( $t \geq s$ ) has the following utility function over his current and future consumption

$$\frac{1}{1-\theta} \sum_{\nu=t}^{\infty} \beta^{\nu-t} (c_{1\nu}^{\alpha} c_{2\nu}^{1-\alpha})^{1-\theta} \quad (\text{A.1})$$

where  $\beta$  denotes the subjective discount factor,  $\theta$  is the reciprocal of the intertemporal elasticity of substitution and  $\alpha$  represents the expenditure share of good 1, the domestic good.

Since we assume that each individual faces the constant probability of death,  $(1-\gamma)$  in each period, the probability, as of period  $t$ , that he will be alive and able to consume in period  $\nu$  is  $\gamma^{\nu-t}$ . Hence the expected utility is

$$\frac{1}{1-\theta} \sum_{\nu=t}^{\infty} (\gamma\beta)^{\nu-t} (c_{1\nu}^{\alpha} c_{2\nu}^{1-\alpha})^{1-\theta} \quad (\text{A.2})$$

Let  $R_t$  denote present value factor from period 0 to period  $t$ , i.e.,

$$R_t = \prod_{k=0}^{t-1} (1+r_k)^{-1} \quad (\text{A.3})$$

The budget constraint in period  $t$  for this individual is

$$a_{t+1,s} = \frac{R_t}{\gamma R_{t+1}} (a_{t,s} + p_t y - t_t - p_t c_{1t,s} - q_t^d c_{2t,s}) \quad (\text{A.4})$$

where  $a_{t,s}$  denotes the value of financial asset at the beginning of period  $t$ . We assume there exist a number of competitive financial intermediaries which issue actuarial bonds in the economy. Individuals can lend to or borrow from these intermediaries and these

claims are cancelled upon the death of the borrowers or lenders. The large number of individuals and the fixed probability of death make this form of financial intermediation riskless. Therefore the effective interest rate faced by individuals is  $\frac{R_t}{\gamma R_{t+1}}$ , i.e.,  $(1 + r_t)/\gamma$  which is higher than the market interest factor.

Under the standard transversality condition that

$$\lim_{t \rightarrow \infty} \gamma^t R_t a_{t,s} = 0 \quad (\text{A.5})$$

we can consolidate (A.4) as follows

$$\sum_{\nu=t}^{\infty} \frac{\gamma^\nu R_\nu}{\gamma^t R_t} (p_\nu c_{1\nu,s} + q_\nu^d c_{2\nu,s}) = \sum_{\nu=t}^{\infty} \frac{\gamma^\nu R_\nu}{\gamma^t R_t} (p_\nu y - t_\nu) + a_{t,s} \equiv w_{t,s} \quad (\text{A.6})$$

where  $w_{t,s}$  is the total wealth, at the beginning of period  $t$ , of an individual who was born in period  $s$ .

Maximization of (A.2) subject to (A.6) yields

$$p_t c_{1t,s} = \alpha(1 - s_t)w_{t,s} \quad (\text{A.7})$$

$$q_t^d c_{2t,s} = (1 - \alpha)(1 - s_t)w_{t,s} \quad (\text{A.8})$$

where

$$(1 - s_t)^{-1} = \sum_{j=0}^{\infty} (\gamma\beta)^j \left[ \beta^j \left( \frac{R_t}{R_{t+j}} \right) \left( \frac{p_t}{p_{t+j}} \right)^\alpha \left( \frac{q_t^d}{q_{t+j}^d} \right)^{1-\alpha} \right]^{\frac{1-\theta}{\theta}} \quad (\text{A.9})$$

Together with (A.6), equations (A.7) and (A.8) describe consumption and saving decision of an individual whose age is  $(t - s)$  in period  $t$ .

The size of population is normalized so that every cohort born with  $(1 - \gamma)$  individuals. Then, from the law of large numbers, at the beginning of period  $t$ ,  $(1 - \gamma)\gamma^{t-s}$  individuals will be alive among those who were born in period  $s$ . Therefore the size of the population is

$$\sum_{s=-\infty}^t (1 - \gamma)\gamma^{t-s} = 1 \quad (\text{A.10})$$

Let  $C_{it}$  denote aggregate consumption of good  $i$  in period  $t$  which is the sum of consumption of individuals from all cohorts,

i.e.,

$$C_{it} = \sum_{s=-\infty}^t (1 - \gamma)\gamma^{t-s} c_{it,s} \quad (\text{A.11})$$

substituting (A.7) and (A.8) into (A.11), we can derive aggregate consumption function as follows

$$p_t C_{1t} = \alpha(1 - s_t)W_t \quad (\text{A.12})$$

$$q_t^d C_{2t} = (1 - \alpha)(1 - s_t)W_t \quad (\text{A.13})$$

where

$$W_t = H_t + A_t \quad (\text{A.14})$$

$$H_t = \sum_{\nu=t}^{\infty} \frac{\gamma^{\nu} R_{\nu}}{\gamma^t R_t} (p_{\nu} y - t_{\nu}) \quad (\text{A.15})$$

$$A_t = \sum_{s=-\infty}^t (1 - \gamma)\gamma^{t-s} a_{t,s} \quad (\text{A.16})$$

The evolution of aggregate human wealth can be derived from (A.15) by leading it by one period

$$H_t = p_t y - T_t + \left(\frac{\gamma}{1 + r_t}\right) H_{t+1} \quad (\text{A.17})$$

where  $T_t$  is aggregate tax payment which is equal to  $t_t$  since the size of total population is normalized to 1. Finally, the evolution of nonhuman wealth can be obtained by substituting (A.4) into (A.16)

$$A_t = p_t C_{1t} + q_t^d C_{2t} + T_t - p_t y + \frac{A_{t+1}}{1 + r_t} \quad (\text{A.18})$$



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**Table 1: The Dynamic Equations in the Model**

- Firm's Equilibrium Conditions:

$$\begin{aligned}
 X_{1t} - X_{1t-1} \equiv \Delta X_{1t} &= \frac{1}{\delta_1} \left[ (1 - p_t) + \phi \left( \frac{r_t^* - r_t}{1 + r_t} \right) \right] \\
 &\quad + \frac{1}{1 + r_t} \Delta X_{1t+1} \\
 X_{2t} - X_{2t-1} \equiv \Delta X_{2t} &= \frac{1}{\delta_2} (q_t^d - q_t) + \frac{1}{1 + r_t} \Delta X_{2t+1}
 \end{aligned}$$

- Goods Market Equilibrium Conditions:

$$\begin{aligned}
 (y - X_{1t} - G_t)p_t &= \alpha(1 - s_t)(H_t + A_t) \\
 q_t^d X_{2t} &= (1 - \alpha)(1 - s_t)(H_t + A_t)
 \end{aligned}$$

- Evolution of Human Wealth:

$$H_t = p_t y - T_t + \left( \frac{\gamma}{1 + r_t} \right) H_{t+1}$$

- Evolution of Financial Wealth:

$$A_t = (q_t^d X_{2t} - p_t X_{1t}) + (T_t - p_t G_t) + \frac{A_{t+1}}{1 + r_t}$$

- Government Budget Constraint:

$$B_{t+1} = (1 + r_t)(B_t + p_t G_t - T_t)$$

- Balance of Payments Equilibrium Condition:

$$X_{1t} - q_t X_{2t} + r_{t-1}^* F_{t-1} = \Delta F_t + \frac{1}{2} \sum_{i=1}^2 \delta_i \Delta X_{it}^2$$

- Trade-Credits Constraint:

$$F_t = \phi X_{1t}$$

FIGURE 1

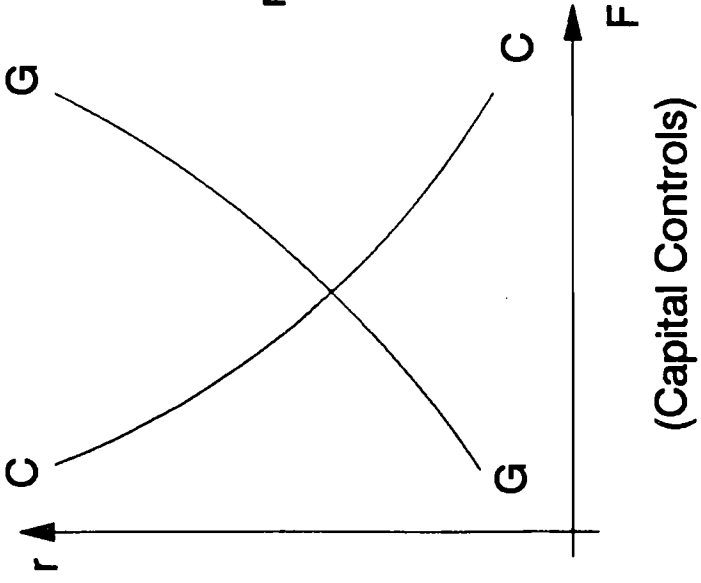


FIGURE 2

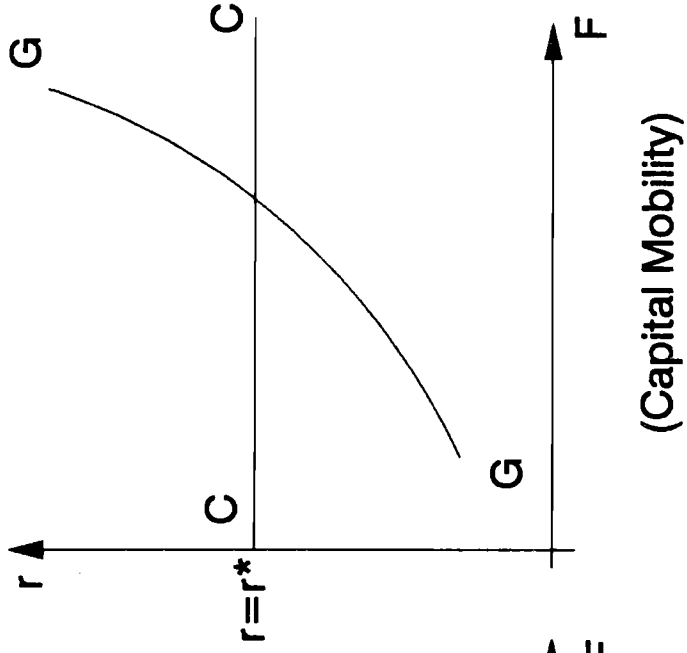
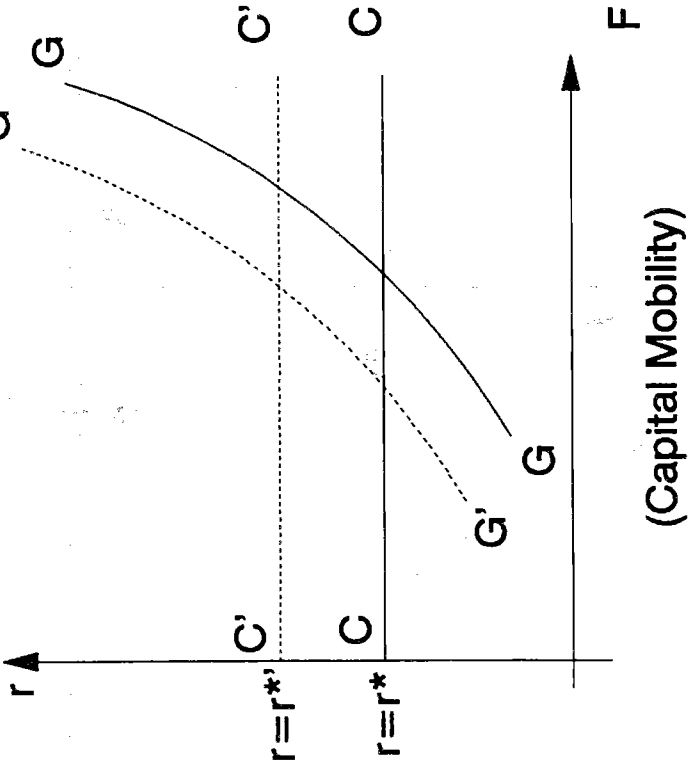


FIGURE 3



**FIGURE 4**  
**Domestic Real Interest Rate**

**Effects of an Increase in the Foreign Interest Rate**

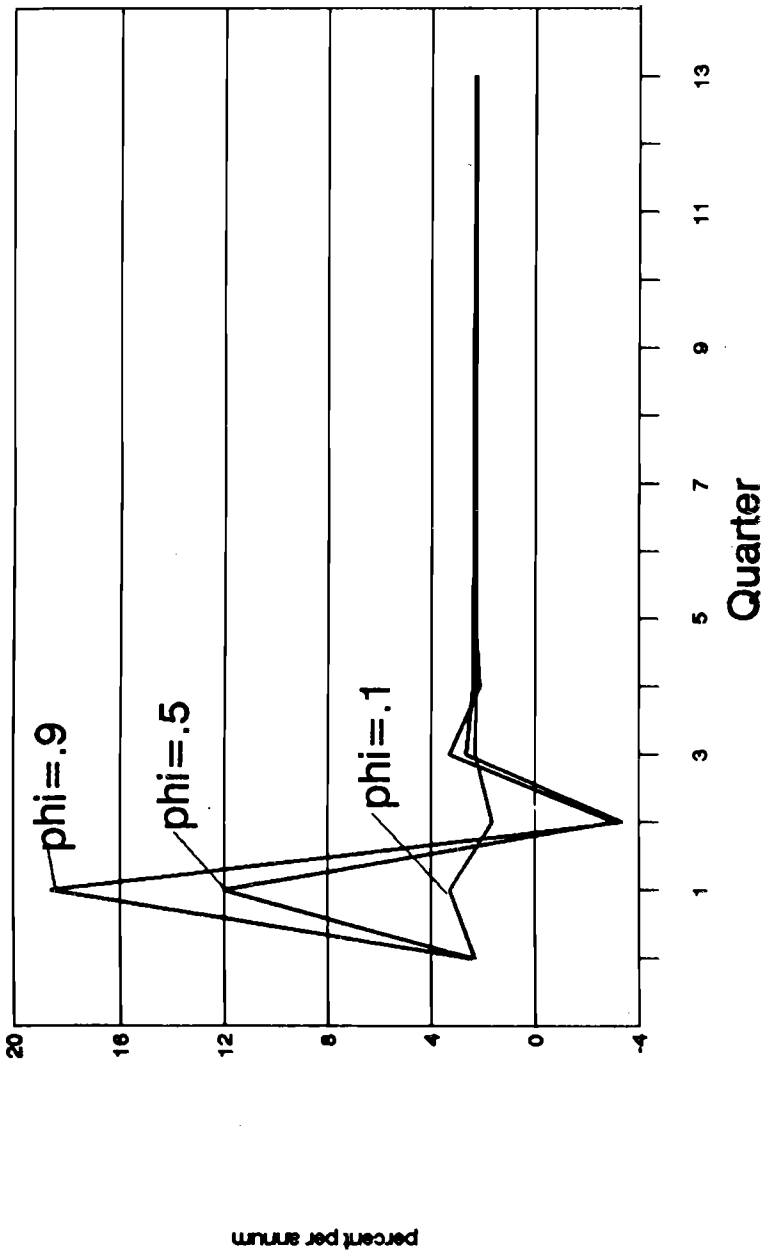


FIGURE 5

Current Account  
Effects of an Increase in the Foreign Interest Rate

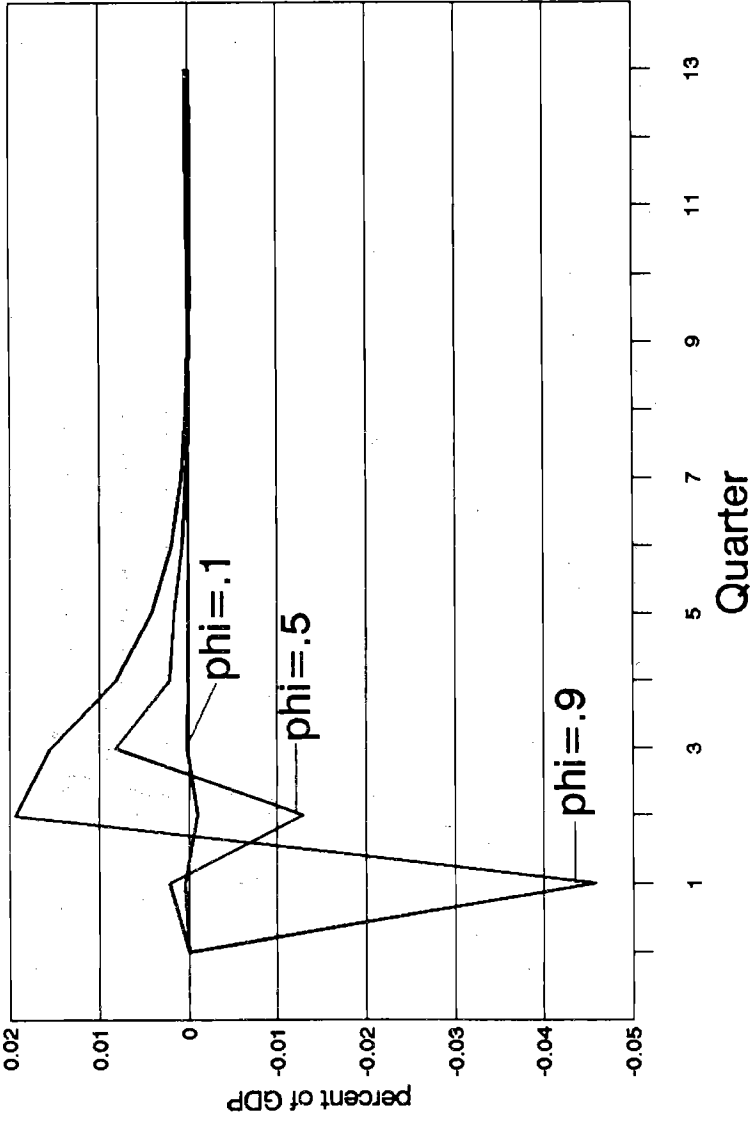




FIGURE 6

Price of the Export Good  
Effects of an Increase in the Foreign Interest Rate

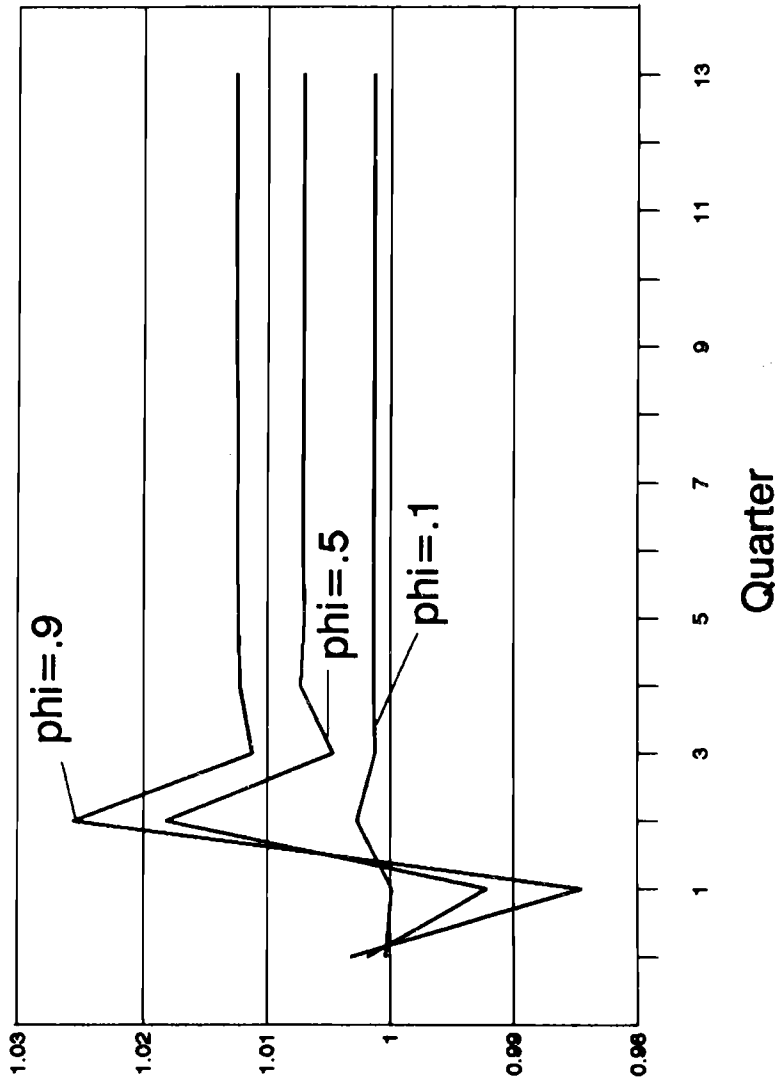
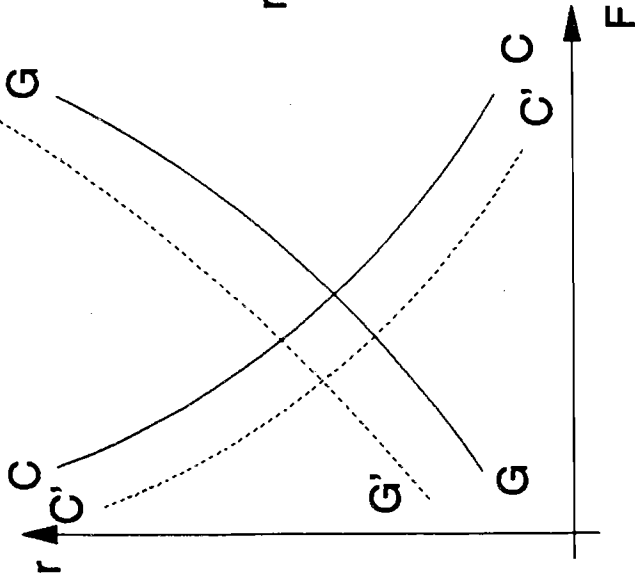
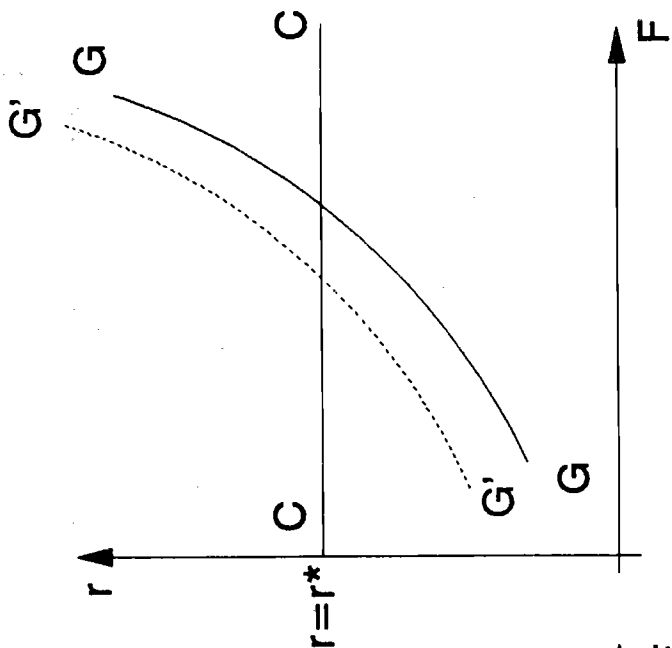


FIGURE 7



(Capital Controls)

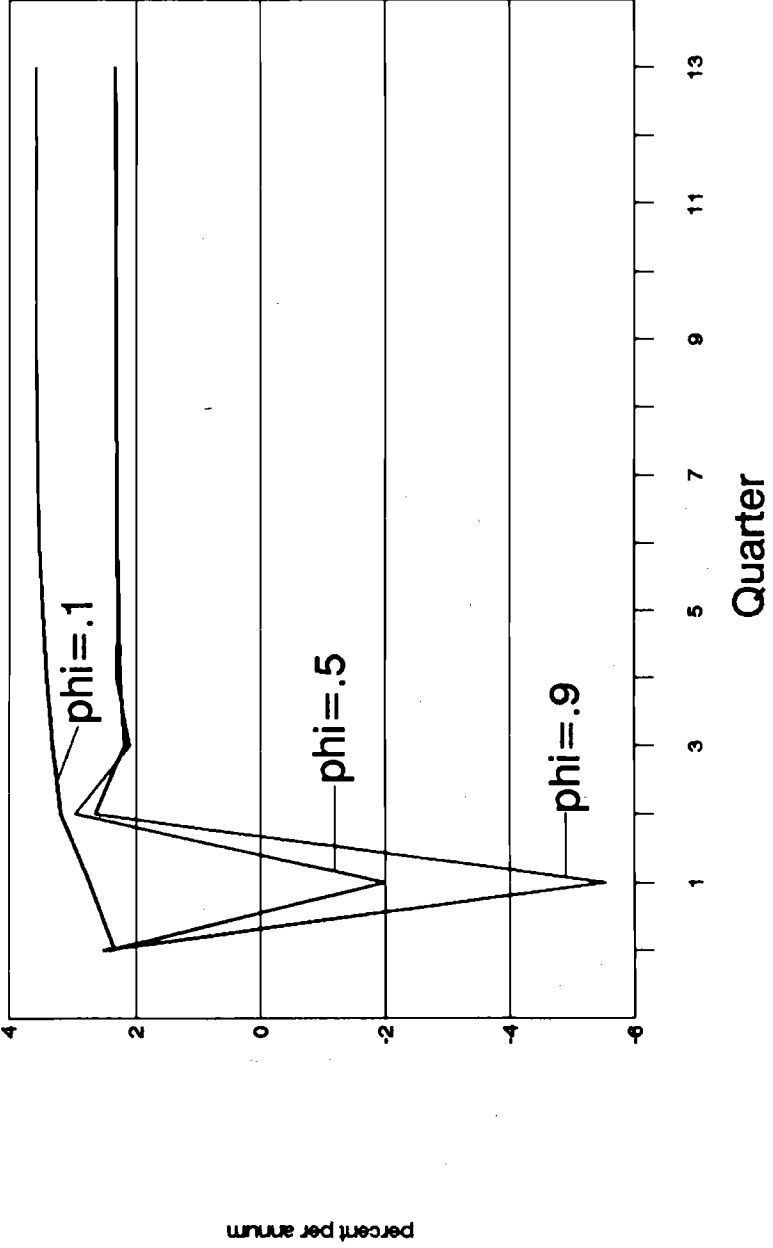
FIGURE 8



(Capital Mobility)

FIGURE 9

Domestic Real Interest Rate  
Effects of an Increase in Government Expenditure



**FIGURE 10**  
**Current Account**  
**Effects of an Increase in Government Expenditure**

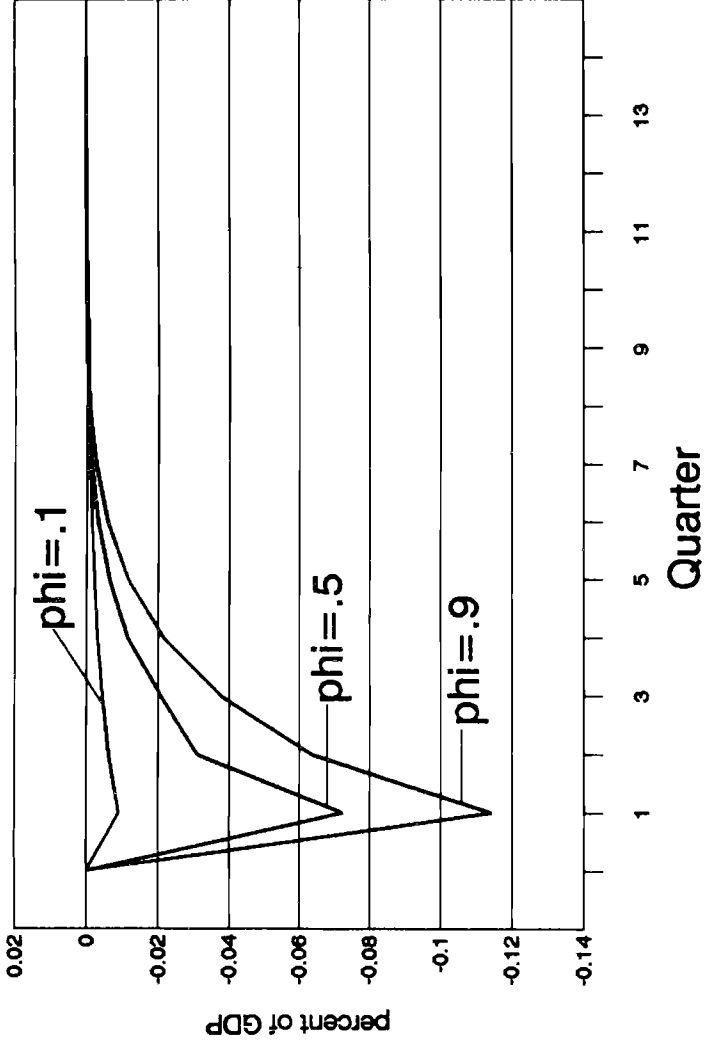


FIGURE 11

Price of the Export Good  
Effects of an Increase in Government Expenditure

