IMF WORKING PAPER

WP/88/74

INTERNATIONAL MONETARY FUND

European and Research Departments

Macroeconomic Interdependence under Capital Controls: A Two-Country Model of Dual Exchange Rates

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August 1, 1988

Abstract

This paper studies the transmission of monetary and fiscal disturbances under capital controls that are implemented via dual exchange rates. The results are contrasted with those under fixed exchange rates and perfect capital mobility. While under perfect capital mobility, permanent policy disturbances have no real effects abroad and the adjustment is instantaneous, under dual exchange rates, these disturbances are transmitted abroad and adjustment is gradual. The co-movement of both domestic and foreign consumption and domestic and foreign real interest rates is negative during the transition period, independently of the type of disturbance.

JEL Classification:
431

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* An earlier version of this paper was presented at the annual meetings of the Eastern Economic Association, held in Boston in March 1988. The authors are grateful to Jagdeep Bhandari, Bernard Delbecque, Robert Flood, Mohsin Khan, Saul Lizondo, Robert Murphy, Carmen Reinhart, and Erich Spitäller for helpful comments and suggestions. The authors retain responsibility, however, for any remaining errors.

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I. Introduction

The international transmission of monetary and fiscal policies has received considerable attention in the literature. 1/ Furthermore, the interest in how policy actions of national governments generate effects in the rest of the world has grown with the increasing interdependence of the world economy. Earlier work focused on the effectiveness of monetary and fiscal policies under fixed and flexible exchange rates. During the 1970's the attention shifted to the international transmission of monetary policy in view of the high rates of inflation experienced by major industrial countries (for example, Darby et. al. (1983)). The 1980's, on the other hand, have witnessed a renewed interest in the transmission of fiscal imbalances due to growing concern over the impact of large and unsynchronised changes in the fiscal stance of major industrial economies (see Persson (1985), Frenkel and Razin (1987a), and Frenkel (1988), among others).

A common feature of the literature on the transmission of macroeconomic policies has been the assumption of perfect capital mobility. However, as pointed out by Greenwood and Kimbrough (1985), capital controls (i.e., quantitative restrictions on the international flow of capital) have been a prevalent feature of several major industrial economies. As shown in Table 1, which updates evidence presented by Greenwood and Kimbrough (1985), France and Italy have had capital controls during most of the period 1966-86, while Japan and the United Kingdom had capital controls up to 1978. Even though financial markets have become more integrated in recent years, the discussion over the role and desirability of capital controls remains a central issue, especially in light of the discussion concerning the projected elimination of all such controls in the context of the European Monetary System (EMS). Both Wyplosz (1987) and Basevi (1987), for instance, argue in favor of retaining some sort of capital controls within the EMS. Wyplosz (1987) points out that, if monetary policies do not fully converge, the elimination of all capital controls would lead to the breakdown of the EMS, since devaluing countries usually rely on capital controls to preserve the reserves necessary to back the post-devaluation parity.

1/ See, for instance, Dornbusch (1980), Frenkel and Mussa (1985), Frenkel and Razin (1987a), Marston (1985), and Mussa (1979).

TABLE 1. Capital Controls in Seven Industrial Countries: 1966-1986

Country	Years Capital Controls in Place (as of December 31)
Canada	none
France	1968-86
Germany	none
Italy	1966-82, 1986
Japan	1966-78
United Kingdom	1966-78
United States	none

SOURCE: International Monetary Fund, Annual Report on Exchange Arrangements and Exchange Restrictions, 1967-87 issues.

Given the actual and potential role of capital controls in major industrial countries, it seems relevant to incorporate them into the analysis of the transmission of macroeconomic policies. The purpose of this paper is thus to study the international transmission of monetary and fiscal policies, as well as the nature of the co-movement of domestic and foreign variables, under capital controls. A first attempt in this direction is presented in Greenwood and Kimbrough (1985) who study the transmission of fiscal policies in a two-country real model of capital controls. The fact that theirs is a *real* model of capital controls is a key feature; the absence of money implies that if the capital account is regulated so is the current account, since there is no money account. Hence, it is only if the change in fiscal policy involves an effective relaxation of capital controls (for instance, an increase in government spending financed by borrowing in world financial markets), that the disturbance will be transmitted to the rest of the world. On the other hand, in a monetary model of capital controls, the presence of the money account implies that the current account is not a regulated variable. As a result, a tax-financed increase in government spending, for instance, which would have no effect abroad in a real model of capital controls, is transmitted to the rest of the world. Capital controls are also likely to have important implications for the transmission of monetary policy, since instantaneous portfolio adjustments that would take place under perfect capital mobility cannot occur.

Capital controls may take different forms. This paper examines the case in which capital controls are implemented via a regime of dual

exchange rates. 1/ This choice is based on the following reasons. First, as pointed out by Gardner (1985), a dual exchange rate regime, whereby there is a fixed exchange rate for current account transactions and a floating exchange rate for financial transactions, is equivalent to a fixed exchange rate regime where private capital transactions between residents and non-residents are totally prohibited. In this context, assuming that there is no leakage between the two markets, the financial exchange rate is simply reinterpreted as the price of foreign assets traded between residents. 2/ While this case represents an extreme form of capital controls, the idea is to concentrate on fundamentals and isolate the essential features introduced by the presence of capital controls as regards the transmission of monetary and fiscal policies. Henceforth, therefore, the terms dual exchange rates and capital controls will be used interchangeably. Second, dual exchange rate regimes have been receiving increasing attention in the literature. However, all analysis have been cast in the context of small open economies. Given that the presence of dual exchange rates has certainly not been confined to small open economies (for instance, United Kingdom (1947-1979), France (1971-1974), and Italy (1973-1974)) and that the introduction of dual exchange rates has been suggested as a viable alternative for the EMS (Basevi (1987)), it is important to extend the analysis of dual exchange rates to a two-country setting where general equilibrium effects are taken into account. The analysis of dual exchange rates in this paper is of particular interest as regards the following questions: first, how does a large economy with dual exchange rates respond to domestic disturbances, such as a devaluation of the commercial rate and changes in monetary and fiscal policies? Second, what are the insulation properties of dual exchange rates compared to alternative exchange rate regimes? 3/

The paper proceeds as follows. Section II presents a two-country model with fixed exchange rates and perfect capital mobility and analyzes the response of the world economy to unanticipated and permanent changes in domestic fiscal and monetary policies. This model provides a useful benchmark case because it serves to highlight the key features that are introduced by dual rates. Three specific domestic disturbances are considered: an increase in domestic government spending, a devaluation, and a decrease in the stock of domestic credit. The essential

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1/ Bhandari (1988), in discussing the implications of trade reform in the presence of capital account restrictions, also uses a dual exchange markets framework.

2/ Adams and Greenwood (1985) show that, when the financial rate is managed, dual exchange rates and non-totally-prohibitive capital controls are equivalent.

3/ Adams and Greenwood (1985), Aizenman (1983), Cumby (1984), Dornbusch (1978), Flood and Marion (1982), Gardner (1986), Guidotti (1987a, 1987b), Kaminsky (1987), Kiguel (1986), Marion (1981), Obstfeld (1986), and Tornell (1988), among others, deal with these issues in the context of small open economies.

characteristic of the model of this section is that the adjustment to any of these disturbances is instantaneous and that real foreign variables are not affected by domestic disturbances. It is the presence of perfect capital mobility that allows for an instantaneous adjustment; the world money supply is redistributed between the two countries through the capital markets.

Section III assumes that dual exchange rates are in place in the domestic economy. The presence of capital controls introduces substantial modifications in the international transmission of monetary and fiscal disturbances. Capital controls prevent capital markets from instantaneously redistributing the world money stock in response to a fiscal or monetary disturbance. This redistribution has to be effected through the current account. Domestic disturbances thus have an impact on the foreign economy. Independently of the type of disturbance, the co-movement of domestic and foreign consumption, as well as that of domestic and foreign real interest rates, during the adjustment period is negative. 1/ Concerning the insulation properties of dual exchange rates, the analysis suggests that, as far as permanent changes in policies are concerned, fixed exchange rates insulate the economy from foreign disturbances while dual exchange rates do not. 2/

Section IV deals with the extension of the model to a crawling-peg regime: the exchange rate (or the commercial rate under dual rates), although fixed at any instant in time, is devalued at a constant rate. Section V contains some concluding remarks.

1/ As discussed by Greenwood and Kimbrough (1985), empirical evidence presented by Morgenstern (1959) suggests that the presence of capital controls in industrial countries during the period 1919-1932 was related to negative co-movements between economic aggregates.

2/ Although the analysis concentrates on fixed exchange rates, the same conclusion would apply to the case of flexible exchange rates; the adjustment would be instantaneous and foreign policy changes would not be transmitted to the domestic economy.

II. Fixed Exchange Rates

This section considers a two-country world with perfect capital mobility and fixed exchange rates. There exists only one (tradable and nonstorable) good. The domestic (foreign) endowment of the good is denoted by y (y^*). (Throughout, an asterisk refers to variables pertaining to the foreign country.) There exist three assets: domestic and foreign currency (M and M^*) and an internationally traded bond, which is denominated in foreign currency (the foreign country is taken to be the reserve currency country). Private real holdings of the bond are denoted by b and b^*. Perfect capital mobility ensures that there exists a unique world real interest rate, r. Free movement of the good implies that the law of one price holds; namely, $P=EP^*$, where E is the price of foreign currency in terms of domestic currency and P and P^* denote the domestic and foreign price level. Both governments face an exogenously given path of spending, g and g^*, assumed to be constant over time. The stocks of domestic credit are denoted by D and D^*. Both economies are subjected to a cash-in-advance constraint; namely $M_{t-} \geq \alpha P_t c_t$ and $M^*_{t-} \geq \alpha^* P^*_t c^*_t$, where c and c^* denote consumption of the good. 1/ The parameters α and α^* can be interpreted as the length of time that money must be held to finance consumption. 2/ For simplicity, it will be assumed that $\alpha=\alpha^*$.

The domestic representative consumer faces the following optimization problem:

$$\underset{\{c_t, m_t\}_{t=o}^{\infty}}{\text{Maximize}} \int_o^{\infty} U(c_t)\exp(-\delta t)dt$$

subject to:

1/ Feenstra (1985) and Calvo (1986, 1987) use cash-in-advance constraints in continuous-time models. Since this is a one-good model, the cash-in-advance constraint applies to the buyer's currency.

2/ See Feenstra (1985) for the derivation of cash-in-advance constraints in continuous-time models.

$$(1)\quad \int_0^{\infty}(c_t+i_t m_t+\tau_t)\exp[-\int_0^t r_s ds]dt = m_o + b_o + \int_0^{\infty} y_t \exp[-\int_0^t r_s ds]dt$$

$$(2)\quad m_t \geq \alpha c_t \qquad\qquad t=0,1,..$$

where the utility function, U(.), is assumed to be increasing, twice continuously differentiable, and strictly concave; δ denotes the positive and constant rate of time preference; $m=M/P$ is the stock of domestic real money balances; $i=r+\pi$ is the domestic nominal interest rate, where π is the expected (and actual, given the assumption of perfect foresight) domestic inflation rate; τ stands for real lump-sum taxes; and m_o and b_o denote initial holdings of real money balances and bonds, respectively. The foreign representative consumer faces an analogous problem where his initial holdings of real bonds are such that $b_o^*+b_o=0$. The endowment of the good is assumed to be constant over time, so that $y_t=y$ and $y_t^*=y^*$. The world's resource constraint, for any period, is thus $c_t+c_t^*+g+g^*=y+y^*$. 1/

The resource constraint of the domestic government is given by $\tau_t=g-r_t R_t$, where R_t denotes the real stock of reserves, so that τ_t adjusts so as to balance the budget. 2/ The sources of revenue are taxes and interest on reserves (i.e., there is no debt financing). Similarly, the foreign government has to satisfy $\tau_t^*=g^*+r_t R_t$. 3/ The domestic and foreign money supplies are given by $M=PR+D$ and $M^*=-P^*R+D^*$. The world nominal supply of money (in domestic currency terms), $M+EM^*$, equals $D+ED^*$.

The necessary conditions for an interior solution include: 4/

$$(3)\quad m_t=\alpha c_t,$$

$$(4)\quad U_c(c_t) = \mu_o(1+\alpha\delta),$$

1/ It will also be assumed that $\delta=\delta^*$. As is well known, this is a necessary assumption to ensure the existence of a steady state where both δ and δ^* equal r.

2/ As in Obstfeld (1986), it is assumed that reserves earn interest.

3/ Note that, in the absence of gold or other outside assets, $R^*+R=0$.

4/ As it is shown in the Appendix, the equilibrium real interest rate is constant over time (and equal to δ), given the assumed paths of the exogenous variables.

where a subscript to a dependent variable denotes partial differentiation and μ_o is the multiplier associated with constraint (1) and is interpreted as the shadow value of wealth. Equation (3) states that the cash-in-advance constraint is binding. Given that, as shown below, the inflation rate is zero the nominal interest rate is always positive (and equal to δ). Equation (4) is the familiar condition equating the marginal utility of consumption to the product of the price of the good and the marginal utility of wealth. The "price" of the good is its direct cost (equal to unity) plus the opportunity cost of holding the α units of money needed to purchase one unit of the good, $\alpha\delta$. Equations (3) and (4) imply that c_t and m_t remain constant over time. Noting that equations (3) and (4) define c_t and m_t as a function of μ_o and δ and making use of (1) and the government budget constraint, the following obtains:

$$(5) \quad c(\mu_o,\delta)/\delta + g/\delta = b_o + R_o + y/\delta$$

which implicitly defines the equilibrium shadow value of wealth, $\tilde{\mu}_o$:

$$(6) \quad \tilde{\mu}_o = \tilde{\mu}_o(b_o+R_o,\ g,\ y,\ \delta)$$
$$\qquad\qquad\quad (-)\ \ (+)(-)(-)$$

where a sign under an argument denotes the sign of the corresponding partial derivative. Analogous conditions to (3), (4), and (6), hold for the foreign country, namely:

$$(7) \quad U^*_{c^*}(c_t^*) = \mu_o^*(1+\alpha\delta),$$

$$(8) \quad m_t^* = \alpha c_t^*,$$

$$(9) \quad \mu_o^* = \mu_o^*(b_o^*-R_o,\ g^*,\ y^*,\ \delta^*).$$
$$\qquad\qquad\quad (-)\ \ (+)\ (-)\ (-)$$

It follows from equations (7) and (8) that c_t^* and m_t^* are also constant over time.

The reduced form for the domestic price level can be easily derived:

$$(10) \quad P_t = \frac{D + ED^*}{\alpha(y + y^* - g - g^*)}$$

As is typical of cash-in-advance models, the price level follows from quantity-theory-of-money considerations with velocity equal to $(1/\alpha)$. Constant world resources and constant world money supply ensure that the

price level is constant over time so that it will adjust instantaneously in response to any unanticipated shock. 1/

It follows from the analysis that one important characteristic of the model is that there are no intrinsic dynamics (in the sense of Obstfeld and Stockman (1985)). Accordingly, if the exogenous variables remain constant over time and undergo only once-and-for-all unexpected changes, the world economy adjusts instantaneously to the new equilibrium. Intuitively, note that since the world endowment (net of public consumption) is constant over time, domestic and foreign consumption have to either remain constant or move in opposite directions. Given that capital is perfectly mobile, however, domestic and foreign consumers face the *same* (and constant) real interest rate, which implies that both domestic and foreign consumption have to remain unchanged over time. This, through the cash-in-advance constraints, implies that real money balances are constant over time which, given that the price level remains unchanged over time as well, means that the nominal stocks of money also remain constant over time. In contrast, under dual exchange rates, as discussed later, the preceding argument breaks down because the domestic and foreign consumer face *different* real interest rates due to the existence of capital controls.

1. An increase in domestic government spending

Consider the effects of an unanticipated and permanent increase in domestic government spending. Differentiation of equation (10) yields:

$$(11)\quad \hat{P} = \frac{g}{y + y^{*} - g - g^{*}}\,\hat{g},$$

where a "^" over a variable denotes proportional change. An increase in domestic government spending causes the price level to rise. The foreign

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1/ In the general case in which $\alpha \neq \alpha^{*}$, expression (10) becomes

$$P_t = \frac{D + ED^{*}}{\alpha(y + y^{*} - g - g^{*}) + (\alpha^{*} - \alpha)[y^{*} - g^{*} - \delta(b+R)_o]}$$

Since, as will become clear below, total domestic foreign assets, $(b+R)_t$, are invariant with respect to permanent changes in policy and thus always equal their initial value, given by $(b+R)_o$, this last expression shows that the price level will also adjust instantaneously in response to any unanticipated disturbance.

price level rises by the same proportion as domestic prices because, from the law of one price, $\hat{P}^{*}=\hat{P}$, given that the exchange rate is fixed. Equation (5) indicates that domestic consumption falls by the same amount that government spending increases, while (9) shows that foreign consumption is not affected. Taking into account that foreign consumption remains constant, it can be readily shown that

$$\hat{P} = - \frac{c}{c+c^{*}} \hat{c}$$

which shows that domestic consumption falls by more, in proportional terms, than the price level rises. This implies, by the cash-in-advance constraint, that there is an incipient excess supply of money in the domestic country. In the foreign country, since the price level rises but consumption remains constant, there is an incipient excess demand for money. As a consequence, capital flows from the foreign to the domestic country. The fact that the world money supply remains unchanged implies that $\Delta(EM^{*})=-\Delta M$ (where Δ denotes a discrete change). Free capital mobility allows an instantaneous redistribution of the world money supply: in the domestic country, a surplus in the capital account is matched by a deficit in the money account while the opposite is true in the foreign country. Conceptually, the instantaneous adjustment of the world economy to the increase in domestic government spending can thus be viewed as comprising two steps. The first is the rise in the price level; the second is the redistribution of the world money supply. The first step, being a goods-market phenomenon, will also be present when dual exchange rates are in place. However, the instantaneous redistribution of the world money supply cannot take place in the presence of capital controls. The redistribution of the world money supply will have to be effected through the current account, thus altering significantly the adjustment patterns of the world economy to an increase in government spending.

2. Devaluation

Consider now the effects of an unanticipated and permanent devaluation (i.e., an increase in E). Equation (10) indicates that $\hat{P}=(1-\gamma)\hat{E}$, where $\gamma=D/(D+ED^{*})$. Hence, $\hat{P}^{*}=-\gamma\hat{E}$. The larger the domestic economy (as represented by a higher γ), the lower the effect on the price level. Equations (6) and (9) indicate that there is no effect on the shadow values of wealth and thus no change in either consumption or real money balances. Immediately after the devaluation, there is an incipient excess supply of money in the foreign country and an incipient excess demand for money in the domestic country. The resulting flow of capital from the domestic to the foreign country redistributes the increase in the world money supply (in domestic currency terms) caused by the

devaluation. 1/ The devaluation is neutral due to the fact that reserves earn interest, so that national income does not depend on the division of external assets between private and public holdings. 2/

3. A decrease in the stock of domestic credit

Compared to the effects of a devaluation of the commercial rate, a decrease in the stock of domestic credit still produces an instantaneous redistribution of the world money supply from the foreign country to the domestic country but the domestic price level falls (see equation (10)) instead of rising, as is the case in the event of a devaluation. This is simply because a devaluation increases the world nominal stock of money (in terms of domestic currency) while a decrease in the stock of domestic credit decreases it.

For further reference, let us highlight the most relevant features in the response of the world economy to the three domestic disturbances considered: an increase in government spending, a devaluation, and a decrease in the stock of domestic credit. First, the adjustment is always instantaneous. Second, foreign consumption is not affected by any of these disturbances. Third, an increase in government spending translates itself into a one-for-one reduction in domestic private consumption. 3/ The introduction of dual exchange rates will change all these implications.

III. Dual Exchange Rates

We now modify the previous model by assuming that dual exchange rates are in place in the domestic economy. The dual system examined in this paper consists of a pegged commercial rate (E) and a freely floating financial rate (Q). Domestic residents are prohibited from transacting in

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1/ Clearly, from a conceptual point of view, the mechanism at work is the same emphasized by the monetary approach to the balance of payments; see, for instance, Frenkel and Johnson (1976) and International Monetary Fund (1977). However, in the present two-country formulation, the adjustment is instantaneous unlike previous two-country studies where the adjustment to a devaluation occurs gradually over time, even in the presence of perfect capital mobility (Frenkel (1976)).

2/ The point that a devaluation is neutral if reserves earn interest has been made by Obstfeld (1986) in the context of a small open economy.

3/ It should be noted that, under flexible exchange rates, these three characteristics would remain unchanged.

world capital markets and since the domestic Central Bank does not intervene in the financial markets, domestic bond holdings are fixed and given by $\bar{b}$. 1/ The non-intervention policy of the domestic Central Bank also implies that foreign bond holdings are fixed at $\bar{b}^*$. The key feature introduced by the presence of dual exchange rates is that nominal money supplies are now given at any moment in time and can only change over time through the current account. Naturally, this has important implications for the adjustment patterns and for the transmission of fiscal and monetary disturbances.

The optimization problem faced by the domestic consumer is given by:

$$\text{Maximize} \quad \int_0^\infty U(c_t)\exp(-\delta t)dt$$
$$\{c_t, m_t, b_t\}_{t=0}^{\infty}$$

subject to:

$$(12) \quad \dot{a} = y + q_t b_t \rho_t - c_t - \tau_t - \pi_t m_t$$

$$(13) \quad m_t \geq \alpha c_t$$

$$(14) \quad a_t \equiv m_t + q_t b_t$$

where a dot over a variable denotes its time derivative; $q \equiv Q/E$ is the ratio of the financial to the commercial exchange rate (and can be interpreted as the real price of bonds in the domestic economy); and $\rho_t \equiv (r+\dot{q})/q$ is the domestic real interest rate. 2/ The return on the bond now includes the capital gains due to the real depreciation of the financial rate. The foreign consumer faces the same optimization problem as in the fixed-rate case; however, foreign bond holdings are now fixed in the aggregate. The foreign real rate of interest is still denoted by r.

Using standard optimal control techniques, taking into account the government constraints, and imposing the asset markets equilibrium

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1/ Bonds are assumed to be indexed. Therefore, the presence of dual exchange rates fixes their real, rather than nominal, value. The main results would not change if bonds were not indexed.

2/ It has been assumed that interest payments, being a current account item, are repatriated at the commercial exchange rate.

conditions $b_t=\bar{b}$ and $b^*_t=\bar{b}^*$, the following characterization of the perfect foresight equilibrium for the world economy obtains:

$$(15a)\quad \dot{\lambda} = \lambda(\delta-\rho) \qquad (15b)\quad \dot{\lambda}^* = \lambda^*(\delta-r)$$

$$(16a)\quad U_c(c)=\lambda(1+\alpha\rho) \qquad (16b)\quad U^*_{c^*}(c^*)=\lambda^*(1+\alpha r)$$

$$(17a)\quad \dot{(M/P)} = y - g - (1/\alpha)(M/P) + r[\bar{b}+(M/P)-(D/P)]$$

$$(17b)\quad \dot{(M^*/P^*)} = y^* - g^* - (1/\alpha)(M^*/P^*) + r[\bar{b}^*-(M^*/P^*)+(D^*/P^*)]$$

where λ is the multiplier associated with constraint (12) and λ^* is its foreign counterpart. Equations (15) describe the evolution of the shadow values of wealth. The intuition behind equations (16) is the same that applies to equation (4). Equations (17) are the balance of payments equations. For instance, the first term in the right-hand-side of (17a) represents real income; the second and third terms stand for public and private consumption, respectively; and the fourth term shows interest earnings on the economy's net foreign assets.

In the steady state, equations (15) imply that $\rho=r=\delta$. Given that, in the steady state, $\rho=r/q$, it follows that $q=1$ or $Q=E$; namely, the financial rate equals the pegged commercial rate. 1/ This is an appealing feature of the model since it conforms with the intuitive notion that any divergence between the commercial and the financial rate is not sustainable in the long run (see Frenkel and Razin (1986)). 2/ The reduced form for the price level is given by equation (10). The price level

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1/ Note that, unlike the fixed-rate case, the assumption $\delta=\delta^*$ is no longer necessary to ensure the existence of a steady state. If $\delta\neq\delta^*$, the steady state value of q is (δ^*/δ). The assumption $\delta=\delta^*$, however, in addition to appear as the the natural one to make, would become necessary if the model were used to study the issue of reunification of the dual markets. Otherwise, once a unified market is restored, the system would not converge to a new steady state if $\delta\neq\delta^*$.

2/ This result also suggests that the presence of incomplete market separation would have the effect of speeding the convergence to the steady state without altering its nature. Analysis of dual exchange rates that incorporate incomplete market separation can be found in Bhandari and Decaluwe (1987), Guidotti (1987a), Gros (1987), Lizondo (1987a, 1987b), and Tornell (1988), among others.

behaves in exactly the same way as it does in the fixed-rate case. 1/ Expressions for steady state money balances and consumption can be found in the Appendix.

On the real side of the world economy, the key features of the adjustment process toward the steady state under dual rates are the negative co-movement of domestic and foreign consumption on the one hand and of domestic and foreign real interest rates on the other. This negative co-movement is a characteristic of the saddle path of the dynamic system and is, therefore, independent of the type of disturbance under consideration. Since goods-market equilibrium implies that if there is any co-movement at all in consumption, it has to be negative, the question boils down to why the adjustment to some permanent disturbance is not instantaneous under dual rates. This is because dual rates prevent capital markets from bringing about an instantaneous redistribution of the world money supply. The redistribution of the world money stock has to take place through the current account. In other words, capital controls imply that the current account bears all the burden of the adjustment. Furthermore, by its very nature, the process of redistributing money through the current account can only be accomplished over time, as opposed to instantaneously. Varying consumption over time implies, in turn, that real interest rates will also be changing over time to induce consumers to choose those consumption patterns that are consistent with available world resources. A declining real interest rate induces rising consumption for two reasons. First, consumption becomes relatively cheaper as time goes by. Second, the real interest rate is also the opportunity cost of holding money for consumption purposes and is part of the cost of consuming (recall equations (16)); therefore, a declining real interest rate implies that consumption becomes cheaper due to the fact that the consumer suffers smaller losses from holding money balances. Similarly, an increasing real interest rate induces declining consumption over time. Therefore, the co-movement between the domestic

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1/ This statement is true only if $\alpha=\alpha^*$. If $\alpha\neq\alpha^*$, the price level will be changing over time, as can be inferred from the following expression:

$$P_t = \frac{D + ED^* - [1-(\alpha/\alpha^*)]EM_t^*}{\alpha(y^* + y - g^* - g)}$$

Since M_t^* will be changing over time, P_t will not remain constant during the adjustment path. Different velocities imply, due to well-known transfer-problem criteria, a changing price level in response to inflationary (deflationary) pressures on the goods market, as money flows from the low (high) velocity country to the high (low) velocity country; see, for example, Frenkel and Razin (1987a).

and the foreign real interest rates is also negative. 1/ Since the price level remains constant over the adjustment process, the cash-in-advance constraints imply that the nominal stocks of money move in the same direction that consumption does.

Formally, as shown in the Appendix, the dynamic system characterizing the behavior of the world economy is block recursive and can be reduced to a system of two differential equations in M and r that exhibits saddle-path stability.

$$\dot{M} = P(y-g) - (1/\alpha)M + r(\bar{b}P+M-D)$$

$$\dot{r} = (\alpha\lambda)^{-1}\{-(U_{cc}/\alpha P)\dot{M} - U_c(\delta-r)\}$$

where time subscripts have been dropped for notational simplicity. Figure I illustrates the dynamics of the adjustment. 2/ It can be seen that M and r move in the same direction along the saddlepath. This comes as no surprise: if domestic consumption is, say, rising, the stock of domestic money will be increasing. On the other hand, increasing domestic consumption means falling foreign consumption and rising foreign real interest rate. Hence, the stock of domestic money and the foreign real interest rate have positive co-movements. Finally, as shown in the Appendix, M co-moves negatively with ρ along the saddle path while q co-moves negatively with the domestic real interest rate. Since q is the real price of bonds in the domestic market, this is to be expected.

1/ Greenwood and Kimbrough (1985) make the point that capital controls may also cause negative co-movements in consumption and real interest rates in the context of a real model. However, the underlying rationale seems to differ from the one presented here. As suggested earlier, since theirs is a real model, the current account is also a regulated variable. Therefore, it is only when the government borrows in the international markets that any co-movement can take place. When this occurs, the foreign real interest rises. On the domestic credit market, the newly available credit (it is as though the capital controls had been relaxed) puts downward pressure on the domestic real interest rate. On the other hand, if the economy is a net debtor (creditor), the wealth effect associated with a rising foreign real interest rate reinforces (offsets) the previous effect. Hence, a net-debtor status ensures negative co-movement of real interest rates.

2/ This is only one of three possible configurations; M and r, however, always move in the same direction.

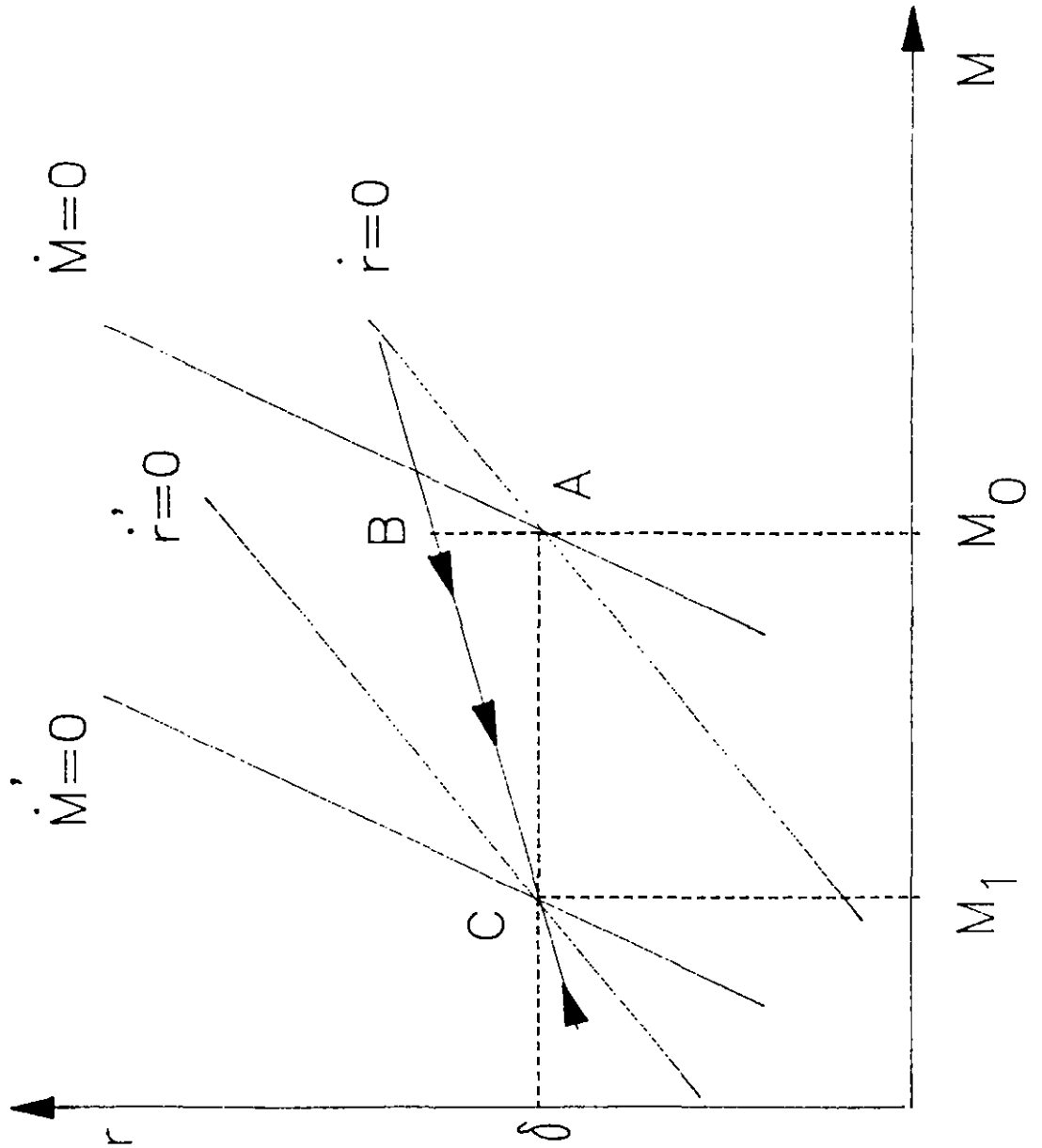

Figure I: Effects of an increase in government spending

1. An increase in domestic government spending

Consider the effects of an unanticipated and permanent rise in domestic government spending. The domestic price level jumps instantaneously according to expression (11) and remains constant thereafter. Naturally, the steady state values of both the domestic and the foreign real interest rate (which is δ) and that of q (which is unity) remain unaffected. The change in the steady state levels of consumption is given by:

$$\frac{\partial \bar{c}}{\partial g} = \frac{1-\alpha\delta\gamma}{1-\alpha\delta} < -1$$

$$\frac{\partial \bar{c}^*}{\partial g} = \frac{(1-\gamma)\alpha\delta}{1-\alpha\delta} > 0$$

where a "-" over a variable denotes its steady state value. Domestic consumption falls by more than government spending increases. This follows from the fact that, during the adjustment process, the domestic economy runs current account deficits. This is how the redistribution of the world money supply comes about. The deficits are financed, in the last instance, by lower steady state consumption. On the other hand, foreign consumption in the steady state increases. This is because the foreign economy runs current account surpluses during the adjustment process. Figure II depicts the fall in domestic steady state consumption as a function of the size of the domestic economy, γ. The larger the domestic economy, the smaller the fall in consumption. As γ approaches unity, consumption tends to fall by the same amount that government spending increases. The fall in consumption on impact, on the other hand, is larger the smaller is the economy. 1/ Foreign consumption increases in the steady state and falls on impact. The larger the domestic economy, the smaller the initial fall in foreign consumption. The counterpart of this is that the larger the domestic economy, the lower the current account deficits during the adjustment process. The behavior of the real money stock mirrors that of consumption in each country due to the cash-in-advance constraints. Thus, the real stock of foreign money rises. Since the foreign price level also rises, it follows that steady state foreign nominal money balances have to increase. The constancy of the world nominal stock of money implies that the steady state stock of nominal domestic money falls.

Consider next the dynamic behavior of M and r, depicted in Figure

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1/ The Appendix discusses the small-open-economy version of this model. In this case, the impact effect on consumption of an increase in domestic government spending is zero, while the negative long-run effect reaches its highest level.

III. Both schedules move leftward as a result of the increase in government spending. It is seen that the foreign real interest rate jumps upwards on impact (from A to B) and then falls over time (toward C). The stock of domestic money remains unchanged on impact but also decreases over time. This implies that the stock of foreign money rises over time. Given that the domestic and the foreign real interest rates co-move negatively along the saddle path and return to the same initial level, it must be the case that the domestic real interest rate jumps downwards on impact and rises over time. Domestic consumers try to buy bonds because they foresee a declining consumption path, thus bidding up the real price of domestic bonds, q. Foreign consumers, anticipating an increasing consumption path, try to sell bonds, thus bidding up the foreign real interest rate. Since the price level jumps upwards on impact, thus decreasing real money balances in the two countries, both domestic and foreign consumption decrease on impact. From the behavior of the money stocks, it follows that domestic consumption falls over time while foreign consumption rises.

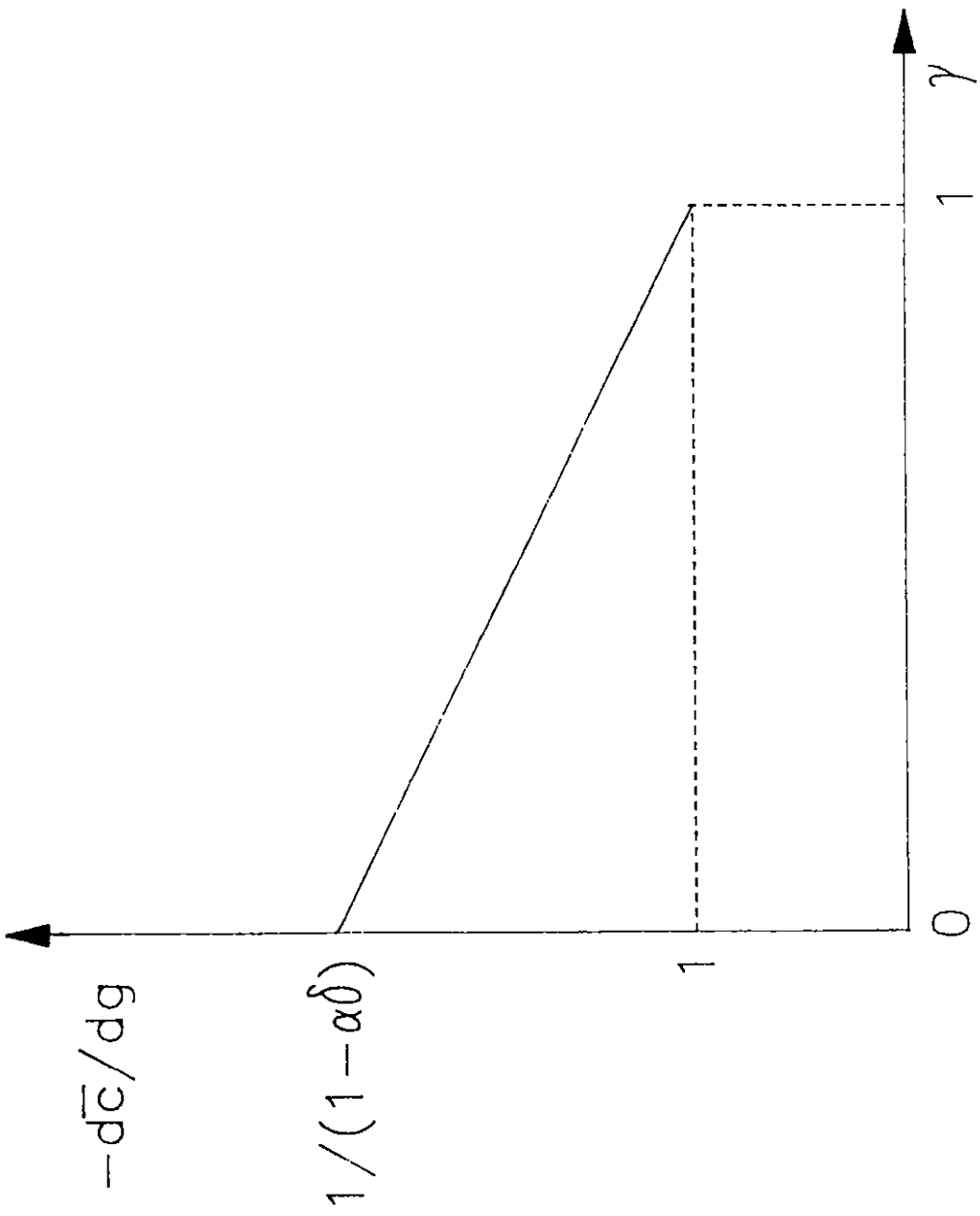
On impact, the current account deficit is given by:

$$(18) \quad d\left(\frac{\dot{M}}{P}\right) = - dg - (1/\alpha)dm$$

The impact effect of an increase in domestic government spending manifests itself in some combination of an increase in the price level and a current account deficit. Noticing that, on impact, $dm=-\alpha[M/(M+EM^{*})]dg$, it follows from equation (18) that the smaller the economy, in the sense of a lower ratio $[M/(M+EM^{*})]$, the lower is the second term and hence the larger is the current account deficit. In the small open economy case, this second term is zero and the increase in government spending translates itself one-to-one into a higher current account deficit.

It is interesting to contrast these results with those obtained by Greenwood and Kimbrough (1985) for the case of a tax-financed increase in domestic government spending. In Greenwood and Kimbrough's (1985) model, there is no trasmission at all to the foreign country of the domestic disturbance. This contrasts sharply with the results of the present model. As suggested earlier, the key lies in the fact that Greenwood and Kimbrough's model is a *real* model of capital controls. In that context, a regulated capital account implies a regulated current account due to the absence of a money account. Therefore, an increase in government spending financed from taxes has no effect abroad. However, in a monetary model of capital controls, the presence of the money account implies that, even if the capital account is regulated, the current account is not. In other words, the money account (or its mirror image, the current account) links the rest of the world to the domestic economy. In a real model of capital controls, all links to the rest of the world are severed; the effects of fiscal shocks financed from domestic sources are, therefore, the same that would obtain in a closed economy.

Figure II: Long run effect of government spending on consumption as a function of the size of the economy



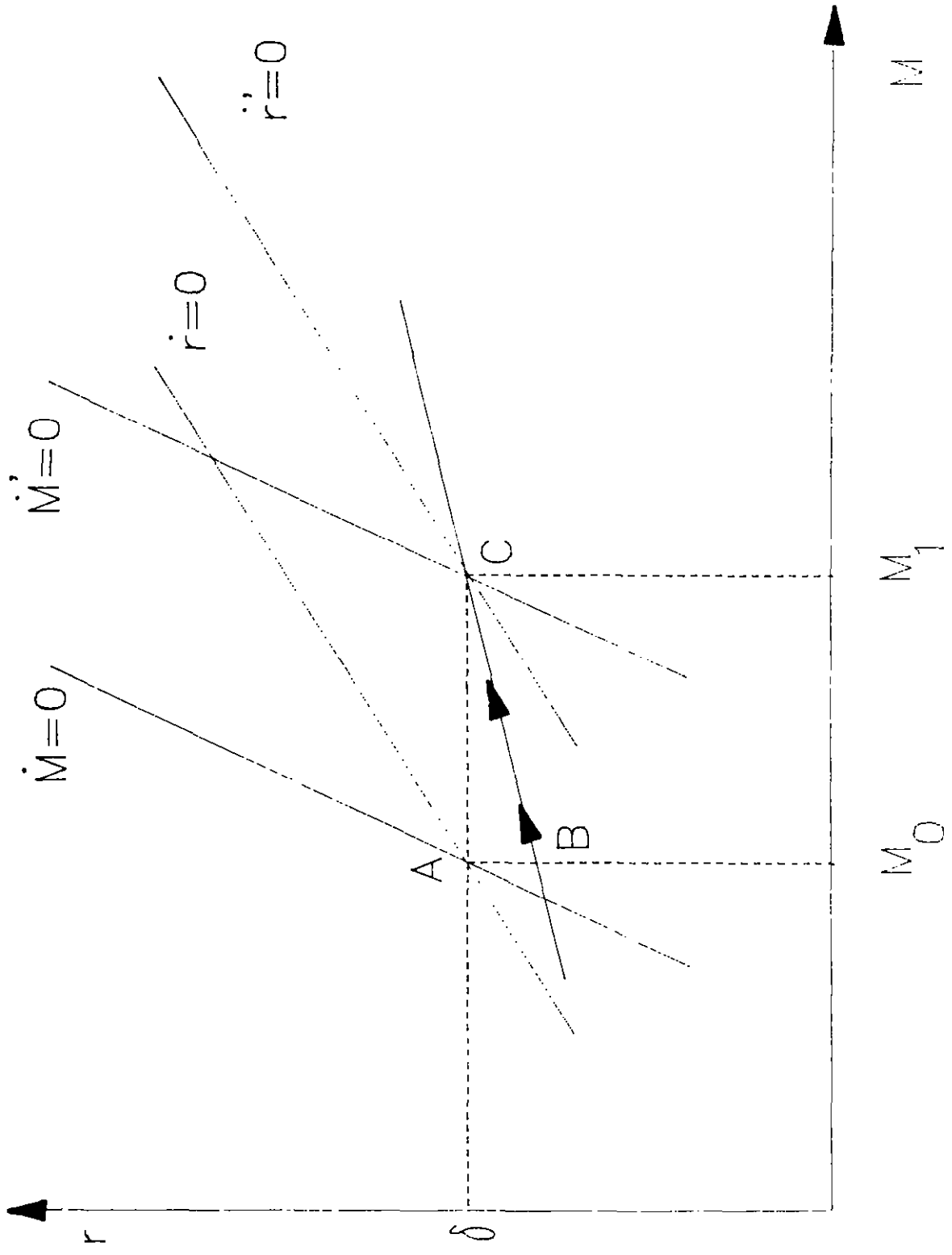


Figure III: Effects of a devaluation

The analysis suggests, then, that the transmission of an increase in government spending on consumption is positive on impact and negative in the steady state. 1/ During the convergence toward the steady state the transmission is negative. The transmission on the price level is positive. (There are no temporal distinctions in this case, since the price level adjusts instantaneously.)

2. Devaluation

Consider now the effects of a permanent and unanticipated devaluation of the commercial rate. The steady state changes in consumption are given by

$$\frac{\partial \bar{c}}{\partial E} = \frac{\alpha\delta}{1-\alpha\delta}\,(y+y^{*}-g-g^{*})\,\frac{DD^{*}}{D+ED^{*}} > 0$$

$$\frac{\partial \bar{c}^{*}}{\partial E} = -\frac{\partial \bar{c}}{\partial E} < 0$$

In the steady state, domestic consumption increases while foreign consumption decreases. The domestic price level adjusts upwards instantaneously, as indicated by equation (10). Since domestic consumption is higher in the new steady state, real domestic balances also have to be higher. The rise in the price level implies that domestic nominal money balances are also higher in the new steady state. Therefore, the domestic economy runs current account surpluses during the adjustment path. The foreign price level falls, as in the fixed-rate case. The foreign economy runs current account deficits during the adjustment process, inducing a decrease in steady state foreign money balances. 2/ Figure III illustrates the path of domestic money balances and the foreign real interest rate. Both schedules move rightward when the devaluation occurs. On impact, the real foreign interest rate falls (from A to B), and it rises over time (toward C). As already discussed, domestic money balances fall over time. The domestic real interest rates rises on impact and decreases over time. The real price of domestic

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1/ Positive (negative) transmission refers to a positive (negative) correlation between domestic and foreign variables.

2/ This monetary adjustment is, naturally, the same that takes place in traditional analysis of a devaluation in a context of no capital mobility (see Dornbusch (1980)).

bonds, q, falls on impact and rises over time. Therefore, the financial rate depreciates proportionately less than the commercial rate on impact, and only in the long run catches up with the new level of the commercial rate. 1/ Domestic consumption falls on impact and increases over time. The opposite is true of foreign consumption.

3. A decrease in the stock of domestic credit

An unanticipated and permanent decrease in the domestic stock of domestic credit has similar, though not identical, consequences as a devaluation. The difference lies in the response of the domestic price level. The domestic price level decreases, instead of increasing as it does in the case of a devaluation. The real effects are the same: domestic consumption falls on impact and rises over time and the opposite is true of foreign consumption. The behavior of the real interest rate and the ratio of the financial to the commercial rate is also the same. The different response of the domestic price level follows from the fact that while a devaluation increases the world supply of money in domestic currency terms, a decrease in the stock of domestic credit reduces it.

Let us briefly summarize the results that have been obtained. In terms of its effects on consumption, the transmission of fiscal policy is positive on impact and negative in the steady state. The transmission of monetary policy (a devaluation or an decrease in the stock of domestic credit) is negative both on impact and in the steady state. Real interest rates always co-move negatively, both on impact and during the adjustment path; in the steady state they are always equal. The ratio of the financial to the commercial rate always co-moves positively with the foreign real interest rate and negatively with the domestic real interest rate.

As suggested in the Introduction, the two-country model presented in this paper has interesting implications concerning the issue of whether dual exchange rates insulate the domestic economy better than alternative exchange rate regimes. The analysis suggests that, as far as permanent changes in policy are concerned, fixed exchange rates (or flexible exchange rates) provide better insulation of the domestic economy than dual rates. In the presence of capital controls, the current account has

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1/ Lizondo (1987a), in the context of a small open economy model where a different dual exchange rate regime from the one considered in this paper is in place (he assumes that some current account transactions take place at the financial rate), also obtains the result that the differential between the financial and the commercial exchange rate falls immediately following a devaluation and returns to its original level afterwards.

to bear all the burden of the adjustment process, thus transmitting disturbances across countries. Therefore, under dual exchange rates, foreign fiscal and monetary disturbances are transmitted to the domestic economy through the creation of current account imbalances. This is in contrast to what occurs under fixed rates where perfect capital mobility enables an instantaneous adjustment, thus preventing any transmission to the domestic economy of foreign disturbances.

It is also worth mentioning the effect of dual rates on the ability of policy-makers to insulate the economy by reacting to foreign disturbances. Consider the effect of an increase in the foreign stock of domestic credit. Under fixed rates, the only effect on the domestic economy is a rise in the price level. By appropiately reducing its stock of domestic credit, the domestic country can totally insulate the economy. If dual exchange rates are in effect in the domestic economy, an increase in the foreign stock of domestic credit provokes, on impact, a fall in domestic consumption and a rise in the domestic price level. These repercussions cannot be avoided by manipulating the stock of domestic credit. An increase in the stock of domestic credit would insulate domestic consumption but would reinforce the increase in the price level while a decrease would counteract the effect on the price level but would exacerbate the fall in domestic consumption. A second policy instrument, fiscal policy, would be needed to insulate the domestic economy.

IV. The Crawling Peg Case

The analysis has concentrated on a fixed exchange rate (or fixed commercial rate, in the dual rate regime) and given stocks of domestic credit because this allows for a clearer presentation of the issues involved. However, nothing essential would change if the domestic and foreign stocks of domestic credit, as well as the nominal stock of reserves, were to grow at rates ϕ and ϕ^*, respectively, while the exchange rate, though given at any moment in time, were to change at the rate ϵ. The response of real variables to different shocks remains unchanged in both the fixed and the dual-rate cases. The only difference lies in the fact that it is now the rate of change of nominal variables, rather than their level, which is constant over time. It can be easily shown that, along the perfect foresight path, $\pi^*=\phi^*$ and $\pi=\phi$. On impact, it is still the case that the price level jumps according to equation (10). During the adjustment process, any changes in the real stock of monies must come through the current account. A point worth noticing is that existence of a steady state requires the additional condition that $\phi=\phi^*+\epsilon$. This condition is trivially met when $\phi=\phi^*=\epsilon=0$. A crawling-peg world is feasible in the long run only if both countries pursue domestic credit policies wich are consistent with the devaluation rate.

It is interesting to point out that, while the crawling-peg case is a rather straightforward modification from a technical point of view, it has one important policy implication for exchange rate systems such as the EMS. Under perfect capital mobility and fixed exchange rates, it is implicitly required that both countries converge in terms of monetary policy; under crawling parities, however, the two countries may have different inflation rates without affecting in any substantial way the workings of the system. In particular, the choice of a given steady-state inflation rate by the domestic economy has no real effects on the foreign economy. 1/

V. Conclusions

This paper has analyzed the international transmission of fiscal and monetary policies under dual exchange rates. In order to highlight the essential features introduced by the presence of dual rates, the response of the world economy to permanent policy disturbances under both perfect capital mobility (fixed rates) and capital controls (dual rates) has been examined. The main implications of the analysis are:

1. The presence of dual exchange rates, by putting all the burden of the adjustment on the current account, has the implication that any permanent domestic disturbance is transmitted to the rest of the world and vice versa. This is in contrast to what occurs under perfect capital mobility and fixed or flexible exchange rates where there is no transmission at all.

2. The adjustment process under dual rates is characterized by negative co-movements between domestic and foreign consumption and domestic and foreign real interest rates.

3. The monetary nature of the model is crucial. In real models of capital controls, fiscal disturbances have no effect abroad (unless they effectively relax the borrowing constraint). In a monetary model of capital controls, the same fiscal shock is transmitted to the rest of the world through the current account.

4. An increase in domestic government spending or a devaluation have no real effects abroad under fixed rates. Under dual rates, the transmission, on impact, of an increase in government spending is positive while that of a devaluation is negative. In the steady state, both a fiscal expansion and a devaluation are negatively transmitted.

1/ This conclusion does not depend on the assumption of fixed velocity and would also hold in, say, a Sidrausky-type model.

While the assumption of cash-in-advance constraints implies that effects derived from a variable velocity are not taken into account, it allows for a simple and tractable framework in which it is possible to undertake a rigorous treatment of the effects of capital controls in a two-country model where savings-consumption decisions are based on intertemporal and utility-maximizing considerations. The simplicity of the model leaves room for useful extensions. First, by introducing home goods, the behavior of the real exchange rate could be analyzed. The relationship between fiscal disturbances and the real exchange rate and the co-movements of real exchange rates seem particularly interesting issues at the present time. Second, the consequences of reunifying the exchange markets deserves attention. A comparison with other analysis of reunification in small open economies [for instance, Lizondo (1987b)] would seem relevant.

APPENDIX

1. Fixed exchange rates

In this section, it is shown that, in equilibrium, the world real interest rate is constant and equal to the common rate of time preference.

Equilibrium in the world goods-market implies that $\dot{c}=-\dot{c}^*$. From the maximization problem of the domestic consumer and that of the foreign consumer, it follows that

$$(A.1)\quad U_{cc}\,\dot{c} = U_c(\delta - r) + \mu\alpha\dot{r}$$

$$(A.2)\quad U^*_{cc}\,\dot{c}^* = -U^*_c(\delta - r) + \mu^*\alpha\dot{r}$$

whence it follows that $\text{sign}(\dot{c})=\text{sign}(\dot{c}^*)$. Therefore, $\dot{c}=\dot{c}^*=0$. Differentiating the optimality condition $U_c=\mu(1+\alpha r)$ and taking into account that $\dot{c}=0$, it can be shown that

$$(A.3)\quad \dot{r}=(1+\alpha r/\alpha)(\delta - r).$$

The positive root of this differential equation in r, δ, is unstable. Hence, under rational expectations, r is constant and equal to δ.

2. Dual exchange rates

The dynamic behavior of the two-country world economy under perfect foresight is completely characterized by equations (A.4), for the domestic economy, (A.5), for the foreign economy, and the goods-market equilibrium condition, (A.6):

$$(A.4)\quad \dot{\lambda} = \lambda(\delta - \rho)$$

$$U_c = \lambda(1+\alpha\rho)$$

$$\dot{q} = \rho q - r$$

$$M = \alpha P c$$

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$$\dot{M} = P(y-g) + r(M-D+P\bar{b}) - Pc$$

(A.5)
$$\dot{\lambda}^* = \lambda^*(\delta - r)$$
$$U_c^* = \lambda^*(1+\alpha r)$$
$$M^* = \alpha P^* c^*$$
$$\dot{M}^* = P^*(y^* - g^*) + r(M^* - D^* - P^*\bar{b}) - P^* c^*$$

(A.6)
$$y + y^* = c + c^* + g + g^*$$

Equations (A.3)-(A.6) can be reduced to a system of four differential equations in M, r, q and ρ. Furthermore, this system, linearized around its steady state equilibrium, is block recursive, which allows to characterize independently the following subsystem in M and r:

(A.7)
$$\begin{bmatrix} \dot{M} \\ \dot{r} \end{bmatrix} = \begin{bmatrix} -(1/\alpha)+r & P\bar{b}+PR \\ (U_{cc}^*/\lambda^*\alpha^2 P)[(1/\alpha)-r] & (U_c^*/\lambda^*\alpha) - (U_{cc}^*/\lambda^*\alpha^2 P)(P\bar{b}+PR) \end{bmatrix} \begin{bmatrix} \bar{M}-M \\ r-\bar{r} \end{bmatrix}$$

where $\bar{M} = [P/(1/\alpha)-\delta][(1-\delta\gamma\alpha)(y-g) - \delta\gamma\alpha(y^*-g^*) + \delta\bar{b}]$ and $\bar{c} = (1/\alpha)(\bar{M}/P)$. Assuming that $(1/\alpha)>r$, the system (A.7) has a negative and a positive characteristic root, thus exhibiting saddlepath stability. Furthermore, M and r move in opposite directions along the perfect foresight path. Defining ϑ to be the only negative characteristic root of the system and $w=(w_{11}, w_{21})$ an eigenvector associated with ϑ, the solution to (A.7) is given by:

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(A.8) $M - \bar{M} = w_{11} k e^{\vartheta t}$

(A.9) $r - \delta = w_{21} k e^{\vartheta t}$

where k is a constant.

Given (A.8) and (A.9), M and r can now be considered as predetermined variables for the rest of the system. Therefore, a second subsystem in ρ and M obtains:

$$(A.10) \quad \begin{bmatrix} \dot{\rho} \\ \dot{M} \end{bmatrix} = \begin{bmatrix} (U_c/\lambda\alpha) & (U_{cc}\vartheta/\lambda\alpha^2 P) \\ 0 & \vartheta \end{bmatrix} \begin{bmatrix} \rho - \delta \\ M - \bar{M} \end{bmatrix}$$

From the subsystem (A 10) it follows that ρ and M move in opposite directions along the perfect foresight path. The solution for ρ is given by:

(A.11) $\rho - \delta = w_{31} k e^{\vartheta t}$

Given (A.9) and (A.11), the last subsystem that characterizes the behavior of q obtains:

$$(A.12) \quad \begin{bmatrix} \dot{q} \\ \dot{\rho} \end{bmatrix} = \begin{bmatrix} \rho & 1 - (w_{21}/w_{31}) \\ 0 & \vartheta \end{bmatrix} \begin{bmatrix} q - 1 \\ \rho - \delta \end{bmatrix}$$

From (A.12), where $(w_{21}/w_{31})<0$, it is easily seen that q and ρ move in opposite directions along the perfect foresight path.

APPENDIX

3. The small open economy

The characterization of the dynamic behavior of a small open economy under dual exchange rates is straightforward, given the two country model provided in section 2 of this appendix. A small open economy faces a given foreign price level P^* as well as a given foreign interest rate, r. Using equations (A.4), the economy is described by a system of three differential equations in M, q and ρ, which, linearized around the steady state equilibrium, is block recursive. The balance of payments equation:

$$(A.13) \quad \dot{M} = -[(1/\alpha)-r](M - \bar{M})$$

can be solved independently. Assuming $(1/\alpha)>r$, (A.13) provides the only negative root of the system. Proceeding as in the previous section, it is easy to show that ρ and M, as well as ρ and q, move in opposite directions along the unique perfect foresight path.

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