Exchange Controls, Capital Controls, and International Financial Markets

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EXCHANGE CONTROLS, CAPITAL CONTROLS, AND INTERNATIONAL FINANCIAL MARKETS*

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Introduction

This paper analyzes the effects on prices and resource allocation of taxes and quantitative restrictions on international financial transactions. We employ a general-equilibrium rational-expectations model of two-country world economy to examine the connections between the effects of these taxes or quantitative restrictions and portfolio allocation on international financial markets. We study these issues in a model with complete asset markets, some of which may be restricted or taxed by governments. A key theme of the paper is that *prospective* changes in government policies affect portfolio allocations in such a way that, if these prospective policy changes subsequently occur, their effects on prices and resource allocation can be radically different than if financial markets had been seriously limited.

We examine the effects of controls or taxation on purchases of foreign currency--which we call *exchange controls*--and controls or differential taxation on the income from foreign interest-bearing assets--which we call *capital controls*. We show that the effects of exchange and capital controls depend critically on the availability of international financial markets in ways that have been largely overlooked. The results of the paper can also be applied to dual exchange rates (which amount to taxes on foreign-exchange transactions that depend upon the source or use of the foreign currency).

The effects of government policies in economic models are usually obtained by treating government policy as a parameter of the model and using comparative statics. However, Lucas (1976) explained that this gives "no useful information" about the effects of policy. Lucas argued that policies such as the investment tax credit should be treated as outcomes of the *model* of policy. That model may include stochastic elements, or a deterministic feedback rule from other variables that are themselves stochastic. Then government policy will be modeled as a stochastic process. (Future government policies could be perfectly predictable, although this would preclude the economist from examining the effects of unforeseen changes in policy.) The effects of changes in policy, then, should be determined by examining the effects of alternative realizations of that stochastic process.

The method of comparative statics allows the economist to compare two distinct economies, each with a different level of an exogenous variable. Economists frequently use this method to try to determine the effects (in real time) of a change in an exogenous variable within a single economy. These are, however, two very different questions: within a single economy, knowledge that an exogenous variable may change in the future often alters the behavior of households and firms in ways that lead an actual change in the exogenous variable to have effects that differ from the comparative statics results. This point is fairly general, and does not require expectations to be formed rationally. However, if expectations are rational and well-developed financial markets are available, the point becomes particularly important (as this paper will show).

Lucas applied this point to exogenous changes in government policy, such as the investment tax credit and income-supplementing transfer payments. Future government policies are usually uncertain, sometimes because of randomness in the results of the political process or uncertainty about the future behavior of the individuals or party in power. Uncertainty about future government policies may be related to the inability of governments to commit themselves currently to future policies. Cooley, LeRoy and Raymon (1984a, b) have developed Lucas' point and argued that the effects of government policies should always be examined by treating policies as the outcome of a model. If that model is stochastic, i.e., if changes in policy are not perfectly predictable, then future values of policy variables should be modeled as drawings from the probability distribution that actually characterized future policies.[1] Cooley, LeRoy, and Raymon have applied this method of "rational-expectations policy evaluation" to changes in money growth and inflation. Sims (1982, 1985) has also made this argument, and has suggested that it eliminates one common criticism of VAR models. Sargent (1984) also discusses this argument and its implications for normative economics. Other applications (not always explicit) include work on balance-of-payment crises (Flood and Garber 1983), and optimal taxation over time (Lucas and Stokey, 1983, Persson and Svensson, 1984).

This argument has received little attention in international economics. But when rational-expectations policy evaluation is applied to a model of the international economy, the effects of policies are found to depend critically on international financial markets. Uncertainty about future government policy affects the portfolio-allocation decisions of households and (simultaneously) asset prices and returns. The attempt by households to hedge against adverse policies (of their own or the other government) causes actual policies to have effects on prices and resource allocation that differ from the effects obtained if no asset markets were available for such hedging behavior. With well-developed asset markets, the implications about the effects of government policies derived from stochastic models--that explicitly treat future policies as random variables--may differ substantially from comparative-statics implications of nonstochastic models.

Stockman and Dellas (1985) used rational-expectations policy evaluation to examine the effects of tariffs. The current paper applies the method to taxation of (or controls on) financial markets. Our analysis makes use of the relation between financial markets and goods markets implied by a transactions demand for money with domestic currency used for domestic transactions and foreign money for foreign transactions. (The foreign money may actually be used only by importers who then resell the good on domestic markets for domestic money.) Because the transactions demand for money creates a link between income from financial assets and purchases of goods, taxation of income from financial assets is similar to taxation of the goods that are purchased with the income from those assets (just as income taxes and consumption taxes are related, wtih a differential effect only on savings). This analogy with the tariff problem makes it useful to outline the results on tariffs before proceeding to exchange controls and capital controls.

Stockman and Dellas examined a very simple two-country world equilibrium barter model in which (exogenous) tariff policy involves some uncertainty and in which there are complete international capital markets. The paper presented an example in which the effect of tariffs on consumption is the opposite from the usual "textbook" analysis. That usual analysis shows that a small tariff (given the behavior of the other country) can improve welfare by raising consumption of the exportable even if consumption of the importable falls. For a sufficiently small tariff, the wealth effect (from an improvement in the terms of trade) creates a larger increse in welfare than the loss from the substitution effect (associated with a distortion in the internal relative price). The usual model implicitly relies on one of two assumptions. Either households (and firms) expect the exisitng tariff rates to remain permanently in effect with probability one (so that comparative statics is appropriate), despite the fact that the economist then goes on to examine the effect of a <u>change</u> in the tariff rate (so that expectations, which placed a zero probability on this event, were irrational). Or <u>no</u> international capital markets are available to household and firms (in which case, it turns out, expectations may not matter). If people know that the existing tariff structure will remain unchanged with some probability, but may also change with some positive probability, and if there are <u>some</u> international financial markets, then people will use these markets to attempt to diversify the risk associated with possible changes in policies. (Households need not have direct access to international financial markets; diversification can be accompanied indirectly with firms as financial intermediaries.) If international financial markets permit trade in assets whose returns are affected by changes in policies (which, one presumes, most returns will be), then the effects of those policies will be altered. In the presence of complete international financial markets, some effects of a small tariff are <u>reversed</u>. In an endowment model, with additively-separable utility, complete asset markets, and two countries with equal wealth and identical tastes, a small domestic tariff--that would unambiguously raise domestic consumption of exportables and improve domestic welfare in the absence of international financial markets--unambiguously reduces domestic consumption of importables and has no effect at all on consumption of exportables. The tariff unambiguously lowers ex-post utility. This result is obtained irrespective of the size of the tariff. The difference arises not from any peculiar aspect of the model but because households treat future government policy as uncertain and use asset markets to try to insure against adverse events. Intuitively, households spread income optimally across states of the world. When asset markets are complete, there is no wealth effect when a tariff is changed. The only remaining effect of a tariff change is the substitution effect, which reduces consumption of the good on which the tariff is imposed.

While international financial markets have expanded greatly in the past decades, governments frequently impose taxes and quantitative restrictions on these markets, and effectively tax earnings from foreign assets at different rates than earnings from doemstic assets. The effects of these taxes and restrictions--in the forms of foreign exchange controls, capital controls, dual exchange rates--has been the subject of much recent work, e.g., Flood (1978), Cumby (1984), Obstfeld (1984), Adams and Greenwood (1985), Mussa (1985), and Greenwood and Kimbrough (1985a, b). Adams and Greenwood demonstrated an equivalence between dual exchange rates and capital controls while Greenwood and Kimbrough showed that there is an equivalence between exchange controls and taxes or controls on trade, and examined the effects of fiscal policy in the presence of capital and exchange controls.

We limit ourselves in this paper to a positive (rather than normative) analysis, and we treat government policies as exogenous. Our model is written in terms of taxes, but quantitative restrictions can replace taxes in the analysis by choosing restrictions that are equivalent to taxes on a state-by-state basis.

II. Optimization Problems of Representative Households and Firms

We will examine a model with two countries, each with a representative risk-averse household that consumes two perishable goods, X and Y. These goods are endowed to (supplied perfectly inelastically in) the two countries; we assume that there is complete specialization in endowments and that these endowments are fixed over time.[2] Trade occurs because of different endowments and/or different tastes across countries. By convention, the domestic country exports X. We assume that all households are price-takers who maximize discounted expected utility over an infinite horizon.

There are two moneys, M and N, which are introduced with cash-in-advance constraints; we also assume that sellers' currencies are used for all transactions.[3] These constraints require purchases of goods each period to be financed with money held by households prior to receipt of income from current sales of goods (or dividends paid by firms from current receipts). See Stockman (1980), Lucas (1980, 1982), Helpman (1981), Helpman and Razin (1982, 1984), Svensson (1985a), or Stockman and Svensson (1985) for further discussion.

There are complete (or at least Pareto-efficient) international asset markets except for the restriction that assets may <u>not</u> pay interest (or principal) or dividends directly as goods: they may only pay moneys (or other assets). If assets were permitted to pay interest as physical goods, then households could engage in complete contingent contracting that would eliminate any need for subsequent transactions; without transactions, there cannot be a transactions demand for money, and there would be no monetary equilibrium. We will use the term "quasi-complete" to describe our assumption on asset markets. It is the same assumption that is used in many of the papers just cited.

"Firms" are defined as the recipients of the endowments in each country. As there are quasi-complete asset markets, shares of firms may be traded; we normalize the number of shares in domestic (foreign) firms at one (per capita, using the world population).

During each period households visit asset markets where assets are traded, interest or dividend payments are made, and taxes are paid or transfers received. Households, who leave asset markets with portfolios that include money to finance subsequent expenditures, then visit goods markets and purchase goods using money carried over from asset markets. The process then repeats itself, with firms paying as dividends (at subsequent asset markets) there money receipts from previous sales of goods.[4] (One can think of households as buying goods from vending machines--firms--that require money; the money then sits in machines--at the firms--until they are emptied at the time goods-markets close.)

Money supplies of each country are assumed to be fixed (and normalized at unity). The only government policy here is the proportional taxation of foreign currency and receipts of foreign currency from other sources, such as sales of goods abroad, dividends from foreign equities, and interest (and principal) from other foreign assets.[5] Government policies are partly "anticipated" in the sense that households have rational expectations and know the model and the true probability distributions that govern policies. The actual pattern of taxes over time arises from the equilibrium of a political system that is not explicitly modeled here. The political equilibrium each period is subject to some uncertainty, in that housholds are not able to predict perfectly future policies. Households are assumed, however, to have rational expectations regarding the formation of policy and the exogenous productivity shocks. The model permits policies to be correlated in any way over time and across countries. In order to avoid the additional notation (with little interesting economics) associated with corner solutions for some assets, the government is assumed to set the same tax rate on all acquisitions of foreign currency, regardless of the source. These tax rates may change over time, and will be treated here as exogenous. (See comments in footnote 1 regarding endogenous government policies.) Domestic (foreign) government revenue from taxes is assumed to be refunded through lump-sum transfers to domestic (foreign) residents.

The representative household in the home country maximizes discounted expected utility of consumption of the two goods, over an infinite horizon,

$$(1) \qquad E_0 \sum_{t=0}^{\infty} \beta^t \, U(x_t, y_t),$$

The utility function U has the standard properties and exhibits risk-aversion. In addition to the usual assumptions on utility functions, we assume throughout the paper that $U_{12}U^*_{12} < \min(U_{11}U^*_{22}, U^*_{11}U_{22})$, where U^* is the foreign utility function.[6]

Domestic households have initial assets A_0. The initial assets of foreign and domestic households must sum to the values of equities and moneys, but any arbitrary international distribution of wealth is permitted. Let M and N denote the quantities of domestic and foreign moneys held at the close of asset markets, P_M and P_N denote the (accounting) prices of these moneys, and τ denote the tax rate levied on acquisitions of foreign money. The tax revenue obtained by the government is refunded in a lump-sum form to domestic households as the transfer z.[7] H and K denote quantities of equities in domestic and foreign firms held at the close of asset markets, acquired at (accounting) prices P_H and P_K.[8] Finally, $B(s_t)$ and $F(s_t)$ are purchases of contingent claims to domestic and foreign moneys delivered in state s at time t. These claims are purchased today at (accounting) prices $P_B(s_t)$ and $P_F(s_t)$. Dividends from foreign equities and deliveries of foreign moneys from these other contingent assets will be subject to future (uncertain) taxation. The state vector is[9]

$$(2) \quad s_t \equiv (\tau_{st}, \tau^*_{st})$$

The budget constraint faced by households at asset markets at date 0 is

$$(3) \quad A_0 = P_{M0}M_0 + P_{N0}(1+\tau_0)N_0 + P_{H0}H + P_{K0}K - z_0 + \sum_{t=1}^{\infty}\int [P_B(s_t)B(s_t) + P_F(s_t)F(s_t)]ds_t$$

The domestic household is also constrained in its purchases of goods by

$$
(4) \quad \begin{aligned} m(s_t) &\equiv M(s_t) - p(s_t)x(s_t) \geq 0 \\ n(s_t) &\equiv N(s_t) - q(s_t)y(s_t) \geq 0 \end{aligned}
$$

where p and q are nominal prices (in domestic and foreign currencies) of the goods X and Y. These require purchases of each good at date t to be financed by money on hand at the close of asset markets at date t.

A domestic firm is endowed with $\bar{x}$ which it sells at date t; it therefore earns $p(s)\bar{x}$ to pay as dividends during asset markets at t+1. A fraction H of these dividends are received by the representative domestic household, which owns H equities in domestic firms. Households also receive money payments from other assets, receive lump-sum refunds of tax revenues, and (possibly) carry over unspent money from previous goods-markets. So

$$
(5) \quad \begin{aligned} M(s_t) &= m(s_{t-1}) + p(s_{t-1})\bar{x}H + B(s_t) + z(s_t) \\ N(s_t) &= n(s_{t-1}) + [q(s_{t-1})\bar{Y}K + F(s_t)]/(1+\tau_{st}) \end{aligned}
$$

where the transfer

$$
(6) \qquad z(s_t) = \tau_{st}[q(s_{t-1})\bar{Y}K + F(s_t)]P_B(s_t)/P_F(s_t).
$$

is taken as given by the domestic household when it maximizes utility. Note that the exchange rate in state s at date t is $P_B(s_t)/P_F(s_t)$.

There is an analogous optimization problem for the representative household in the foreign country. The utility function of the foreign household may differ from that of the domestic household, though we assume rates of time-preference are the same. Using (4) to eliminate $x(s_t)$ and $y(s_t)$, the domestic household chooses M_0, N_0, H, K, $B(s_t)$, $F(s_t)$, $m(s_t)$, and $n(s_t)$ to maximize (1) subject to (3) and the inequalities (4). Necessary conditions for the domestic household's utility maximization are, in addition to the constraints,

(7a) $$U_1(x(s_0), y(s_0)) = p(s_0)\lambda P_{M0}$$

(7b) $$U_2(x(s_0), y(s_0)) = q(s_0)\lambda P_{N0}(1 + \tau_0)$$

(7c) $$\sum_{t=1}^{\infty} \beta^t E[U_1(x(s_t), y(s_t))p(s_{t-1})\bar{x}/p(s_t)] = \lambda P_{H0}$$

(7d) $$\sum_{t=1}^{\infty} \beta^t E[U_2(x(s_t), y(s_t))q(s_{t-1})\bar{Y}/q(s_t)(1 + \tau_{st})] = \lambda P_{K0}$$

(7e) $$f(s_t)\beta^t U_1(x(s_t), y(s_t) = p(s_t)\lambda P_B(s_t)$$

(7f) $$f(s_t)\beta^t U_2(x(s_t), y(s_t)) = q(s_t)(1+\tau_{st})\lambda P_F(s_t)$$

(7g) $$\mu(s_t) = U_1(x(s_t), y(s_t))/p(s_t) - \beta E[U_1(x(s_{t+1}), y(s_{t+1}))/p(s_{t+1})]$$

(7h) $$\nu(s_t) = U_2(x(s_t), y(s_t))/q(s_t) - \beta E[U_2(x(s_t), y(s_{t+1}))/q(s_{t+1})]$$

$$(7i)\quad m(s_t)\mu(s_t) = 0, \quad \mu(s_t) \geq 0$$

$$(7j)\quad n(s_t)\nu(s_t) = 0, \quad \nu(s_t) \geq 0.$$

where λ is the multiplier on the budget constraint (3). (7e)-(7j) hold for all t = 1, 2, ... Similarly, optimization by the foreign household implies an analogous set of conditions, among which are

$$(8)\quad \begin{aligned} f(s_t)\beta^{t-1}U_1^*(x^*(s_t),\ y^*(s_t)) &= p(s_t)(1+\tau^*_{st})\lambda^* P_B(s_t) \\ f(s_t)\beta^{t-1}U_2^*(x^*(s_t),\ y^*(s_t)) &= q(s_t)\lambda^* P_F(s_t) \end{aligned}$$

III. Equilibrium

Equilibrium requires that world demands and supplies of X and Y are equated in each state in each period. Equilibrium conditions, along with (7), its foreign counterpart, and an arbitrary choice of numeraire for the prices, determine all prices, consumptions, and productions as functions of these Lagrange multipliers. The multipliers, in turn, are determined through the budget constraints and transversality conditions, and are functions of the distribution of wealth between the two countries. It is convenient to choose a normalization so that the domestic multiplier is unity.[10] Then, loosely speaking, the domestic country is wealthier or less wealthy than the foreign country as λ^* is larger or smaller than one.

Combining (7e, f), (8), and equilibrium conditions for product markets yields

$$
(9)\quad
\begin{aligned}
U_1^*(\bar{x}-x(s_t),\ \bar{y}-y(s_t)) &= \lambda^*(1+\tau_{st}^*)U_1(x(s_t),\ y(s_t)) \\
U_2^*(\bar{x}-x(s_t),\ \bar{y}-y(s_t)) &= \lambda^* U_2(x(s_t),\ y(s_t))/(1+\tau_{st}).
\end{aligned}
$$

Define $T = 1 + \tau$ and $T^* = 1 + \tau^*$. total differentiation of (9)--holding fixed λ^* for a comparison across states--gives

$$
(10)\quad
\begin{bmatrix} dx \\ \\ dy \end{bmatrix} = \frac{1}{\Delta}
\begin{bmatrix}
-\lambda^* U_2(U_{12}^* + \lambda^* T^* U_{12})/T^2 & -\lambda^* U_1(U_{22}^* + \lambda^* U_{22}/T) \\
\\
\lambda^* U_2(U_{11}^* + \lambda^* T^* U_{11})/T^2 & \lambda^* U_1(U_{12}^* + \lambda^* U_{12}/T)
\end{bmatrix}
\begin{bmatrix} d\tau \\ \\ d\tau^* \end{bmatrix}
$$

where $\Delta > 0$ is the determinant of the matrix on the right.[11] (10) implies that

$$
(11)\quad
\begin{aligned}
&\frac{\partial y(s_t)}{\partial \tau_{st}} < 0, \qquad \frac{\partial x(s_t)}{\partial \tau_{st}^*} > 0, \\
&\text{sign}\ \frac{\partial y(s_t)}{\partial \tau_{st}^*} = -\ \text{sign}\ \frac{\partial x(s_t)}{\partial \tau_{st}} = \text{sign}\left[U_{12}^* + \lambda^*(1+\tau_{st}^*)U_{12}\right].
\end{aligned}
$$

The results in (11) show that states and time periods with greater domestic taxes on income from foreign assets and purchases of foreign currency are associated with lower domestic consumption of foreign goods and lower, unchanged, or greater consumption of domestic goods as a weighted sum of U_{12} and U^*_{12} is greater than, equal to, or less than zero. This contrasts with the more common argument that taxation of foreign-currency acquisitions will have some expenditure-switching effects that will increase consumption of exportables (irrespective of the sign of U_{12}); that effect is present here only if U_{12} is negative. Furthermore, <u>ex post</u> utility is generally decreased by these taxes on acquisitions of foreign currency, since

$$(12) \qquad \frac{dU}{d\tau} = \frac{\lambda^* U_2}{\Delta T^2} \, [U_2(U^*_{11} + \lambda^* T^* U_{11}) - U_1(U^*_{12} + \lambda^* T^* U_{12})]$$

which is negative unless U_{12} and U^*_{12} are negative and very large.[12,13]

Note that only <u>current</u> taxes on foreign-currency acquisitions affect current consumptions. This is a result of an intertemporally separable utility function and of the absence of real investment in the model. In a more general model that relaxed these features, the <u>conditional</u> probability distribution of future taxes (given current taxes) would also affect current allocations and trade.

These results differ substantially from those obtained in models without contingent assets or in which households are assumed to ignore the possibility of changes in government policies. Without these features, higher domestic taxes on foreign-currency acquisitions not only lead domestic households to substitute away from foreign currency into domestic currency and other assets, but affects the distribution of wealth. Substitution out of foreign currency reduces the demand for the foreign good and lowers its relative price. This redistributes wealth from owners of foreign firms to owners of domestic firms. If equities are traded internationally, the effect on domestic versus foreign wealth depends upon portfolio shares. In a model like ours without any production shocks, ownership of equities would be indeterminate if households ignored potential changes in government policies, so the wealth effects of a change in taxes would be indeterminate. (This illustrates a problem with models in which households do not take into account potential changes in government policies when they allocate their portfolios. In general, potential changes in policies will affect these portfolio decisions as in our model.) If it is assumed that equities are all held domestically (e.g., because they cannot be traded) then the higher tax raises domestic wealth and lowers foreign wealth. The higher domestic tax, then, would raise domestic consumption of X even with separable utility, and, if the tax is small enough, would raise domestic utility (through an argument somewhat like that for an optimal tariff). In our model, in contrast, utility would fall.

The effects of exchange controls and capital controls on nominal prices and the exchange rate can be determined from the other necessary conditions and equilibrium conditions. Notice that the equilibrium allocations derived in the previous section are independent of the behavior of nominal prices. Given these allocations, and given λ^*, which depends upon the international distribution of wealth at date zero, we have a system of equations consisting of (7g, h, i, j) for every date t and state s, in the variables $m(s_t)$, $n(s_t)$, the multipliers from the finance constraints μ and ν, and the prices $p(s_t)$ and $q(s_t)$. We have an exactly analogous set of equations from the necessary conditions for the foreign optimization problem; the endogenous variables in those equations are $m^*(s_t)$, $n^*(s_t)$, the foreign multipliers μ^* and ν^*, and the prices $p(s_t)$ and $q(s_t)$. Finally, we have the equilibrium conditions for each money, which can be written as

$$\begin{aligned} (13) \qquad p(s_t) &= 1 - m(s_t) - m^*(s_t) \\ q(s_t) &= 1 - n(s_t) - n^*(s_t) \end{aligned}$$

The terms of trade are

$$(14) \qquad \frac{p(s_t)}{e(s_t)q(s_t)} = \frac{U_1(x(s_t), y(s_t))}{U_2(x(s_t), y(s_t))} (1 + \tau_{st})$$

The nominal exchange rate is determined from (14) once the nominal prices p and q are determined.

We have been able to say something more about nominal prices only for a special case of (a) a two-period version of the model, and (b) ex ante symmetry of the two countries. The symmetry assumption means that the two countries have equal initial assets and equal endowments, $\bar{x} = \bar{y}$, that they have symmetric tastes in the sense that

$$(15) \qquad U(x, y) = U^*(y, x)$$

for all x, y, that foreign and domestic taxes at date zero are equal, and that foreign and domestic tax rates are interchangeable in the probability distribution function over future tax rates, i.e.,

$$(16) \qquad \Psi(\tau_{st}, \tau^*_{st}) \equiv \Psi(\tau^*_{st}, \tau_{st})$$

The assumption (15) permits tastes to differ across countries, but if domestic households have a preference, in any sense of the word, for one of the two goods, then foreign households have the <u>same</u> preference for the <u>other</u> good The assumption (16) means that the conditional probability distribution of domestic taxes (given foreign taxes) is identical to the conditional distribution of foreign taxes (given domestic taxes).

With these assumptions, the two countries are fully symmetric. For any state of the world s there is another state $\mathfrak{s}$ with equal probability such that

$$\begin{aligned}
&(17a) \qquad (\tau_{st}, \tau^*_{st}) = (\tau^*_{\mathfrak{s}t}, \tau_{\mathfrak{s}t}) \\
&\quad (b) \qquad m^*(s_t) = n(\mathfrak{s}_t) \\
&\quad (c) \qquad n^*(s_t) = m(\mathfrak{s}_t) \\
&\quad (d) \qquad \mu^*(s_t) = \nu(\mathfrak{s}_t) \\
&\quad (e) \qquad \nu^*(s_t) = \mu(\mathfrak{s}_t)
\end{aligned}$$

The necessary conditions (7a, b), the analogous foreign conditions, the symmetry conditions (15) and (17), and the equilibrium conditions imply that

$$(18) \qquad \begin{aligned} x(s_t) &= g(T^*_t) \\ y(s_t) &= \bar{x} - g(T_t) \end{aligned}$$

where the function g is defined by

$$g^{-1}(z) \equiv U_2(z, \bar{x} - z)/U_1(z, \bar{x} - z). \tag{19}$$

The symmetry conditions imply that (7g, h) are identical to their foreign counterparts. In this special case they can be written, using (13) and (16), as

$$\begin{aligned} \frac{U_1(x_0, y_0)}{1 - m - n} &= \beta E U_1(x_1, y_1) + \mu \\ \frac{U_2(x_0, y_0)}{1 - m - n} &= \beta E U_2(x_1, y_1) + \nu. \end{aligned} \tag{20}$$

Also, we have

$$\mu m = 0, \quad \mu \geq 0, \quad m \geq 0$$

$$\nu n = 0, \quad \nu \geq 0, \quad n \geq 0$$

Once we solve for m and n, prices are given by (13).

Symmetry implies that foreign and domestic prices are equal. Nominal prices are trivially equal to unity in the second period (which is what makes this two-period example easy). The level of nominal prices in the first period depends upon the level of current taxation of foreign-currency acquisitions (which, by the symmetry assumptions, is equal in the two countries). There are two critical levels of taxation that depend only on tastes, production, and the probability distribution of future taxes. These critical values have the properties that, (1) if actual current taxes are below the first (lowest) critical level, nominal prices are less than unity and rising in the level of taxation; (2) if taxes are above the first critical level but below the second critical level, nominal prices are unity (this corresponds to unit velocity of money with output and the money supplies normalized to unity); and (3) if taxes are above the second critical level, nominal prices are again smaller than unity and falling in the level of taxes. The nonmonotonic behavior of prices (as taxes vary) reflects the anticipatory behavior of households, who may wish to accumulate foreign currency in anticipation of taxes on future foreign-currency acquisitions.

Divide the two equations in (20). Assume there are tax rate $\hat{\tau}_1$ such that $\nu = n = 0$, and $\hat{\tau}_2$ such that $m = \mu = 0$. Then

$$1 + \hat{\tau}_2 = g^{-1}(g(1 + \hat{\tau}_2)) + \frac{EU_2(x_1, y_1) + \nu}{EU_1(x_1, y_1)}$$

and

$$1 + \hat{\tau}_1 = g^{-1}(g(1 + \hat{\tau}_1)) = \frac{EU_2(x_1, y_1)}{EU_1(x_1, y_1) + \mu}.$$

Clearly, $\hat{\tau}_2 \geq \hat{\tau}_1$. For the moment, assume both critical values are positive. If $\tau < \hat{\tau}_1$, $\nu = 0$ and $n > 0$: current taxes are sufficiently low that it is worthwhile to acquire foreign currency now, in anticipation of possible exchange and capital controls in the future. But higher levels of taxes reduce the acquisition of foreign currency by domestic residents (and acquisition of domestic currency for foreigners) and therefore raise nominal prices.

If current taxes exceed $\hat{\tau}_1$ but are smaller than $\hat{\tau}_2$, then prices are unity (i.e., velocity is unity). If current taxes exceed $\hat{\tau}_2$ then it is not worthwhile to acquire foreign currency, but it is worthwhile to acquire and hold domestic currency. Velocity is less than unity. High current taxes reduce domestic consumption of the foreign good and lead domestic households to try to substitute into current domestic goods and future goods. Foreign households, similarly, try to substitute out of domestic into foreign goods and future goods. The current relative price of foreign and domestic goods is unaffected, but the attempt by all households to substitute into future goods drives down the interest rate. When $\tau < \hat{\tau}_2$, $m > 0$ and prices are less than one. Higher taxes raise m and reduce nominal prices.

All of this discussion was conducted under the assumption that $\hat{\tau}_1 > 0$. In fact, it is possible that $\hat{\tau}_1, \hat{\tau}_2 < 0$. (If foreign and domestic tastes are identical, then $\hat{\tau}_2$ must be positive.) The same arguments apply, but some of the cases are then irrelevant.

The effect of a change in taxes on the exchange rate depends upon its effect on nominal prices and on the terms of trade. If $\hat{\tau}_1 < \tau < \hat{\tau}_2$ in our two-period example, then an increase in τ has no effect on nominal prices p and q, as noted above. Then (14) implies that domestic currency appreciates or depreciates as $U_1(x_t, y_t)(1 + \tau_t)/U_2(x_t, y_t)$ rises or falls. This magnitude can go either way, depending upon concavity of U and U_{12}; the currency is more likely to appreciate the more inelastic the demands. More generally, the effect of a change in taxes on the exchange rate will also depend, through (14), on its effect on nominal prices.

IV. Conclusions

Exchange controls an capital controls have been widespread; as Greenwood and Kimbrough (1985) note, 86% of all IMF-member countries had exchange controls at some time during the 1978-83 period. While the controls take many forms, many of them are similar to those we have assumed in this paper or could be analyzed in a similar way. Our assumption of complete markets is very special, but international financial markets are becoming increasingly sophisticated. Numerous assets can provide payments that are contingent upon various disturbances, including government policies to tax or quantitatively control asset markets. Some of these assets are traded on organized exchanges: besides stocks, bonds, and Eurodeposits (which, being nominal assets, have payoffs that are contingent on the price level), there are forward contracts, futures contracts, currency options, futures options, and now CPI-W futures in the U.S. Other assets, such as swaps, are not traded on organized exchanges but can offer virtually any contingent payoff. Finally, assets such as equities in multinational corporations or in firms that sell abroad or use imported inputs, can also provide payoffs that are contingent on international economic policies. This paper has examined the effects of restrictions or taxes on these markets. While taxes or quantitative controls on acquisitions of foreign currency can be used by a government to improve its terms of trade and reduce imports, the policies are not successful at shifting demand to domestic goods or improving welfare. These conclusions are analogous to the conclusions about the effects of direct trade restrictions in the presence of international financial markets.

Footnotes

[1]See Lucas (1976), e.g., his investment example, and Cooley, LeRoy, and Raymon (1984a, b). Also see Sims (1982) and Sargent (1984). It should also be noted that policy is treated as exogenous in this example only for simplicity. More generally, policy changes could be endogenous: if the model of policy-determination is deterministic, then households would have perfect foresight on actual policy in a rational expectations model; if the model of policy-determination involves some uncertainty (or limited information to households), then households would treat this uncertainty exactly as they treat uncertainty from technology shocks, etc., by treating actual policy as the outcome of a stochastic process (as in the examples in this proposal).

[2]Stochastic endowments can be added easily to the model. Nonspecialization and production can be incorporated into the real part of the model as in Stockman, 1985b; the cash-in-advance constraints must also be modified with incomplete specialization, as e.g., domestic money can be used to purchase both goods.

[3]The use of buyers' currencies is examined in Helpman and Razin, 1984, and in Stockman and Dellas, 1984. The cash-in-advance model of money is sometimes useful for introducing a transactions demand for money into a model. It does not answer the question of what is used as money or which of several alternative moneys are chosen for some purpose. Instead, the answers

to these important questions are solved by assumption. While this is not fully satisfactory, it does allow us to go on to other questions, in the hope that, in most cases, the neglect of the problem of what is chosen as money is unimportant. Other models of money face similar problems, and generally resort to assumptions about which money enters a utility function or production function, or which assets come in which denominations, etc. Note that the cash-in-advance model can be formulated so that the two moneys are perfect substitutes (so that a Kareken-Wallace type of result would follow, by allowing either good to be purchased with either money); that formulation is not used here, however. Also note that the cash-in-advance model is consistent with variable velocity, and velocity is endogenous in our model. Also see Svensson (1985a, b) and Stockman and Svensson (1985).

[4]The dating of time periods is completely arbitrary and makes no difference to the results. Also, as Svensson (1985a) has shown, asset trading can occur continuously in cash-in-advance models. Goods-markets are assumed to be open only at certain times; this plays the same role as explicit transactions costs in a Baumol-Tobin model and generates a positive demand for money.

[5]Taxation on income from domestic assets can be introduced easily, and is neglected for simplicity. We have defined exchange controls as taxes or quantitative controls on purchases of foreign currency an capital controls as differential taxation on income form foreign assets. In our model, there is a tax at rate τ on <u>all</u> acquisitions of foreign currency, regardless of

whether the foreign currency is purchased outright or obtained as interest or dividends on foreign assets. That is, capital controls (taxation on income from foreign equities) and exchange controls are imposed at the same rate. This prevents corner solutions or arbitrage opportunities. Alternative terminolgy for the controls we investigate would be "currency controls," because taxes are determined by the currency that is acquired.

[6]This assumption is slightly stronger than concavity of U and U^*, but reduces to the concavity assumption if foreign and domestic households are identical.

[7]The taxes on acquisitions of foreign currency may be equivalently thought of as paid to the government in units of domestic currency or in units of foreign currency. In the former case, households must acquire on foreign exchange markets the domestic currency needed to pay the tax; in the latter case, the government acquires domestic currency by selling the foreign currency. In either case, the lump-sum refund of tax revenue to households is paid in domestic currency.

[8]It is unnecesary in our model for households to alter their portfolios of equities over time, so we do not put time subscripts on H and K. Recall that equity supplies are each unity.

[9]A complete description of the state is actually $(s_t, s_{t-1}, s_{t-2}, \ldots)$ but is it simple to verify that all period-t allocations and prices are functions of s_t alone--see, e.g., (9).

[10]This normalization is permitted because all prices in (3) were "accounting" prices with units yet to be chosen. The normalization of money supplies to unity, mentioned in the previous section, amounts to choosing units to measure those moneys.

[11]The assumption mentioned below (1) is sufficient to ensure $\Delta > 0$.

[12]We have not been able to derive simple, interpretable necessary conditions for (12) to be negative. If the two countries are symmetric <u>ex ante</u> (as in the discussion at the end of this section) then $\frac{U_2}{U_1} \geq 1$ (because $TT^* \geq 1$). (12) is obviously negative if $U_{12} \geq 0$, $U^*_{12} \geq 0$. Suppose instead that $U_{12} < 0$, $U^*_{12} \leq 0$. (12) can be rewritten as

$$\frac{dU}{d\tau} = \frac{\lambda^* U_1 U_2}{\Delta T^2} \left\{ \frac{U_2}{U_1} [U^*_{11} - U^*_{12} + \lambda^* T^* (U_{11} - U_{12})] + (\frac{U_2}{U_1} - 1)(U^*_{12} + \lambda^* T^* U_{12}) \right\}.$$

The second of the two terms on the right is then negative. Sufficient conditions for (12) to be negative are then that $U_{11} - U_{12} \leq 0$ and $U^*_{11} - U^*_{12} \leq 0$.

[13]Our results in (10)-(12) can be used to calculate the approximate covariances of consumption and taxes implied by the model for any arbirtary (stationary) probability distribution on taxes, along the lines of Svensson (1985) and Stockman and Svensson (1985). For example, the covariance of x_t and τ_t is approximately

$$\operatorname{cov}(x_t, \tau_t) \approx \frac{-\lambda^* U_2}{\Delta T^2} (U_{12}^* + \lambda^* T^* U_{12})\sigma_\tau^2 - \frac{\lambda^* U_1}{\Delta} (U_{22}^* + \lambda^* U_{22}/T)\sigma_{\tau\tau*}$$

where σ_τ^2 is the variance of τ and $\sigma_{\tau\tau*}$ is the covariance of τ and $\tau*$.

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