Simon Benninga and Guenter Franke

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Policy Studies ★ 35
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INTRODUCTION

The Israeli experience with capital flight has been different from that of many of the Latin American countries, which have provided the background for most of the academic discussions on capital flight. Although Israelis (like citizens of other Third World countries with capital flight problems) presumably hold significant foreign assets in contravention to Israeli law, by far the most common form of capital flight in Israel is the substantial foreign currency cash balances held at home by many Israelis. These balances obviously earn no interest, and can be exchanged for shekels (the local currency) either on the black market (which exists quite openly) or at the bank.[1]

The Israeli nomenclature for the phenomenon is *Patam balattot*. This term is difficult to translate. Patam refers to Israeli shekel bank accounts which are indexed to a particular foreign currency. These accounts are available to any Israeli resident. Balattot are the stone floor tiles common in Israeli houses and apartments. Thus "Patam balattot" refers to "bank accounts" kept under the tiles. We have chosen to use "closet dollars" instead.

The phenomenon of closet dollars is made more interesting by the fact that Israelis have available a wide variety of indexed savings instruments. These include bonds whose principal and interest are indexed to the rate of inflation, bonds whose principal and interest are indexed to foreign exchange rates (primarily the U.S. dollar), and the so-called Patam savings accounts.

Since the Patam accounts provide the inspiration for our modeling of consumer deposits with the central bank, it is worth noting how these accounts actually work: Residents deposit Israeli shekels into Patam accounts at commercial banks and withdraw shekels from them. The initial deposit is indexed to a desired foreign currency (U.S. dollar, German mark, Swiss franc, Japanese yen, and others). The interest paid on these accounts is linked to (but generally lower than) the Euro rate on the same currency; interest is subject to a withholding tax of 35%. Israeli banks provide the Patam accounts and hedge them back-to-back with securities sold by the Bank of Israel. Thus the Patam accounts are effectively foreign-currency-indexed obligations of the Israeli government.[2]

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The size of the closet dollar phenomenon may be gauged from a Bank of Israel model of "capital leakage." The Bank of Israel estimates capital leakage using a model that compares reported receipts and expenses in foreign currency with estimated "true" receipts and expenses. The system does not measure capital flight that results from under- and overinvoicing of exports and imports. The underlying assumption of the model is that most capital leakage stems from disbursements and receipts that are inherently difficult to control, such as cash receipts from tourism or the sale of foreign currency to residents for foreign travel. The model is tolerably accurate in measuring a specific phenomenon, namely, the leakage of foreign receipts (especially from tourism) and of foreign currency purchase for foreign travel into a nonreported sector of the economy. In Table 1 we give statistics for "capital leakage" for the years 1983-1986.

TABLE 1

ISRAELI "CAPITAL LEAKAGE"
(in million $)

	1983	1984	1985	1986
Leakage from payments				
From outgoing tourism	700	80	-160	-400
From payments abroad	40	30	-40	-50
Total payment leakage	740	110	-200	-450
Leakage from receipts				
From incoming tourism	80	390	480	90
From transfers	10	80	120	0
From exchanges	0	40	80	-90
Total receipt leakage	90	510	680	0
TOTAL CAPITAL LEAKAGE	830	620	480	-450

Definitions:
From outgoing tourism: from foreign currency allotments for Israelis traveling abroad.
From exchanges: exchanges of shekels into dollars by tourists, new immigrants, and/or foreign residents.
Note: Negative figures indicate repatriation of "closet dollars."
Source: Bank of Israel, *Foreign Currency Payments and Receipts 1986*, April 1987. (Hebrew)

The existing literature on capital flight does not appear capable of explaining the closet dollar phenomenon. This literature has focused primarily on the physical flight of capital abroad. One strand of this literature stresses exchange rate overvaluation, the gap between real foreign and domestic interest rates, and the differential taxation of domestic and foreign interest income (Leite 1982, Dornbusch 1985, Cuddington 1986, Zedillo 1987). Another strand in the capital flight literature stresses the danger of the expropriation of domestic investment (Khan and Ul Haque 1985, Eaton 1987, Ize and Ortiz 1987). Neither of these sets of models seems appropriate to the Israeli experience.[3]

In this study we model the phenomenon of capital flight through closet dollars in a small economy like Israel. Consumers in our model can put their dollars in the closet or deposit them with the central bank, which acts as a financial intermediary. The central bank can borrow and lend dollars on the international capital market at the international interest rate. The deposit rate, offered by the central bank to domestic consumers, may differ from the international rate so that the central bank earns a surplus or a deficit that has to be spent through subsidies or covered by taxes, respectively. Thus the central bank has the power to redistribute wealth. We shall show that closet dollars are attractive only if there exists a positive probability that the central bank will pay negative rates of return. If these are associated with an increase in the depositor's tax bill, then the low-tax consumers are most attracted by the closet. This result will be shown to be true for various tax systems.

Thus capital flight in the form of closet dollars follows other economic principles than capital flight in the form of deposits abroad. For this type of capital flight, differentials in taxation of domestic versus foreign interest income matter.

Additional issues are raised when capital market imperfections such as potential central bank default and transaction costs are included in the analysis. Both tend to raise the volume of closet dollars since they reduce the rates of return on central bank deposits. Hence the political-instability hypothesis that has been discussed above is supported by the analysis.

The next section presents the economic setting of the analysis. In section 3 the impact of taxation on closet dollars will be analyzed. Central bank default is discussed in section 4, and transaction costs are discussed in section 5.

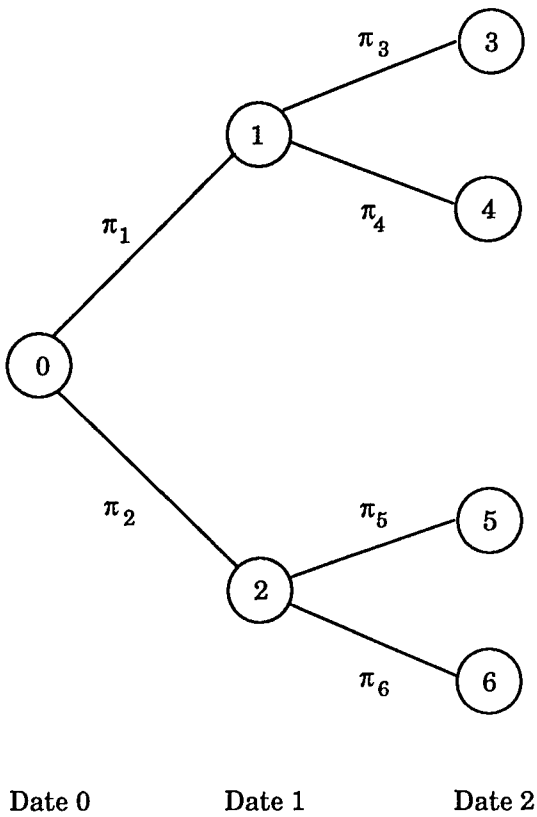
THE ECONOMIC SETTING

We consider a small economy like Israel, where the decisions of the consumers have no impact on rates of return and prices in the rest of the world.

Our framework is a nonmonetary, three-date (dates 0, 1, 2), binomial model as depicted in Figure 1. The probability π_s on a branch denotes the conditional probability of state s, given the preceding state (s-).[4]

FIGURE 1

THREE-DATE BINOMIAL TREES OF STATES OF NATURE WITH CONDITIONAL PROBABILITIES π_S



Consumers

A single imported good is used for consumption.[5] The \$-price of this good in state s is p_s. Without loss in generality, $p_0 \equiv 1$. In each state, consumer i has an endowment of \$-income, w_{is}. This may be income from tourism or a \$-transfer from abroad. The government cannot control whether this income is consumed, deposited in the banking system, or kept in the consumer's closet. Thus at each date each consumer decides how much of his \$-income to deposit in the central bank, how much to put in his closet, and how much to consume. Consumption between dates does not exist. Hence there is no need to keep cash balances between dates for transaction purposes. Dollars in the closet earn no interest; consumers may borrow and lend money from the central bank at the same rate without incurring any transaction costs.

Consider state 0. Consumer i spends C_{i0} dollars on consumption, lends $L_{i0}e_o$ shekels to the central bank, and puts $\$_{i0}$ dollars in his closet. e_0 is the exchange rate (shekels per dollar) at date 0. Given the \$-income w_{i0}, the consumer's budget constraint in nominal terms is[6]

$$C_{i0} = [w_{i0} - \$_{i0}] - L_{i0}. \tag{1a}$$

For state 1 the budget constraint in nominal terms is

$$\begin{aligned} C_{i1} &= [\$_{i0} + w_{i1} - \$_{i1}] + [L_{i0}e_0(1+i_0)/e_1 - L_{i1}] \\ &\equiv [\$_{i0} + w_{i1} - \$_{i1}] + [L_{i0}\Phi_1 - L_{i1}]. \end{aligned} \tag{1b}$$

$\Phi_1 \equiv e_0(1+i)/e_1$ is the nominal state 1 \$-rate of return on money lent to the central bank in state 0. The consumer lends L_{i0} dollars to the central bank, which converts them to shekels at the rate e_0, pays a nominal (shekel) interest rate i_0 in state 1, and reconverts the compounded shekels to dollars at the exchange rate e_1. For state 2 the budget constraint is the same, with index 1 being replaced by index 2.

In the terminal states s = 3, . . . , 6 the consumer consumes his whole wealth, so that no money can be put in the closet, borrowed, or lent; therefore, $L_{is} = \$_{is} \equiv 0$. Consumer i has to pay the terminal tax T_{is} in state s. This tax is levied by the central bank to cover its deficit. If the central bank has a surplus,

then the tax is negative. Marginal taxes on lending and borrowing are assumed to be greater than -100 percent and smaller than +100 percent. The consumer budget constraints in the terminal states are given by (s = 3, . . . , 6)

$$C_{is} = [\$_{i,s-} + w_{is}] + \Phi_s L_{i,s-} - T_{is}. \tag{1c}$$

where s- denotes the state that precedes state s, and $\Phi_s = e_{s-}(1+i_{s-})/e_s$ is the effective dollar interest rate paid on deposits with the central bank.

Each consumer i (i = 1, . . . I) maximizes the expected utility EV_i of his consumption of the imported good. Assuming time-additive utility, we can write

$$\begin{aligned} EV_i = U_i(C_{i0}) &+ \pi_1[U_{i1}(C_{i1}/p_1)+\pi_3 U_{i3}(C_{i3}/p_3)+\pi_4 U_{i4}(C_{i4}/p_4)] \\ &+ \pi_2[U_{i2}(C_{i2}/p_2)+\pi_5 U_{i5}(C_{i5}/p_5)+\pi_6 U_{i6}/p_6)] \end{aligned} \tag{2}$$

Marginal utility of consumption is assumed to be strictly positive and strictly decreasing.

The Central Bank

The central bank is a financial intermediary between the consumers of the small economy and the international capital market. The central bank can lend and borrow dollars in the international capital market at the gross rate R_s; i.e., R_s is one-plus the international interest rate. It lends (borrows) dollars internationally when the consumers in the aggregate lend (borrow) dollars to (from) the central bank. As the central bank chooses a rate of return Φ_s for its business with local consumers, which perhaps differs from R_s, the central bank can subsidize or penalize consumers doing business with it.

The central bank starts at date 0 with zero balances. At date 0 the central bank lends B_0 dollars internationally, which equal the aggregate lending of consumers to the central bank.

$$B_0 = \sum_i L_{i0}. \tag{3a}$$

In state s (s = 1, 2), the central bank's lending B_s equals the aggregate lending of consumers to the central bank plus the bank's first period gain.

(3b) $$B_s = \sum_i L_{is} + B_0(R_s - \Phi_s) = \sum_i L_{is} + \sum_i L_{is}(R_s - \Phi_s), \quad s = 1, 2.$$

In the terminal states s (s = 3, . . , 6) the central bank has to repay all its obligations and end up with zero balances. A terminal loss has to be covered by consumer taxes, and a terminal gain has to be distributed to consumers. Let T_s denote the terminal loss of the central bank (positive in the case of a loss, negative in the case of a gain); s = 3, . . , 6.

(3c) $$\begin{aligned} T_s &= \sum_i \Phi_s L_{i,s-} - R_s B_{s-} \\ &= \sum_i \Phi_s L_{i,s-} - [\sum_i L_{i,s-} + \sum_i (R_{s-} - \Phi_{s-}) R_s L_{i0} \\ &= \sum_i (\Phi_{s-} - R_{s-}) R_s L_{i0} + \sum_i (\Phi_s - R_s) L_{i,s-} \end{aligned}$$

Equation (3c) shows the central bank's compounded losses in dollars. If central bank default is ruled out, then these losses have to be covered by dollar taxes,

(4) $$T_s = \sum_i T_{is}, \quad s = 3, . . , 6.$$

If the central bank incurs compounded fixed administration costs A_s, then equation (4) is replaced by

(4') $$T_s + A_s = \sum_i T_{is}, \quad s = 3, . . , 6.$$

CAPITAL FLIGHT WITHOUT CENTRAL BANK DEFAULT

In this section the effects of central bank policy and taxation on capital flight will be analyzed assuming no central bank default. First optimal consumer decisions will be derived.

Optimal Consumer Decisions

In equilibrium without central bank default every consumer maximizes his expected utility under an exchange rate and tax regime that assures zero terminal wealth of the central bank. Define $U_{is}' \equiv \delta U_{is}/\delta C_{is}$. Then the first-order condition for L_{i0} is given by

$$\begin{aligned}&-U_{is}' + \pi_1 [U_{i1}'\Phi_1/p_1 - \pi_3 U_{i3}' (\delta T_{i3}/\delta L_{i0}) /p_3\\ &-\pi_4 U_{i4}' (\delta T_{i4}/\delta L_{i0})/p_4] + \pi_2 [U_{i2}'\Phi_2/p_2\\ &-\pi_5 U_{i5}' (\delta T_{i5}/\delta L_{i0})/p_5 - \pi_6 U_{i6}' (\delta T_{i6}/\delta L_{i0}) /p_6] = 0\end{aligned}$$

The probability-adjusted nominal rate of substitution, q_{is}, between two successive states is defined by

$$q_{is} \equiv \frac{\pi_s U_{is}'}{U_{i,s-}'} \frac{p_{s-}}{p_s'} \quad s = 1, \ldots, 6.$$

Note that this nominal rate of substitution is merely the probability-adjusted real rate of substitution, $\pi_s U_{is}'/U_{i,s-}'$, adjusted for the change in prices, p_{s-}/p_s.

Thus the first-order condition can be divided by U_{i1}' and rewritten as

$$\begin{aligned}(5) \qquad & q_{i1} [\Phi_1 - q_{i3} (\delta T_{i3}/\delta L_{i0}) - q_{i4} (\delta T_{i4}/\delta L_{i0})]\\ & + q_{i2} [\Phi_2 - q_{i5} (\delta T_{i5}/\delta L_{i0}) - q_{i6} (\delta T_{i6}/\delta L_{i0})] = 1.\end{aligned}$$

The first-order condition for L_{i1} is

$$(6) \qquad q_{i3} [\Phi_3 - \delta T_{i3}/\delta L_{i1}] + q_{i4} [\Phi_4 - \delta T_{i4}/\delta L_{i1}] = 1.$$

The first-order condition for L_{i2} is analogous. The first-order conditions for $\$_{i0}$, $\$_{i1}$, and $\$_{i2}$ are

(7) $$q_{i1} + q_{i2} \leq 1;\ q_{i3} + q_{i4} \leq 1;\ q_{i5} + q_{i6} \leq 1.$$

A strict inequality holds in (7) if no money is put in the closet. From these first-order conditions, sufficient conditions for zero closet money can be derived.

Proposition 1: a) Consider a tax regime with nonnegative marginal taxes on deposits. A sufficient condition for $\$_{i0}^* = \$_{i1}^* = \$_{i2}^* = 0$ is that the nominal after-tax rates of return on central bank deposits are positive in every state of nature, i.e.,

(8a) $$\Phi_1 - 1 > \max(\delta T_{i3}/\delta L_{i0}, \delta T_{i4}/\delta L_{i0}),$$

(8b) $$\Phi_2 - 1 > \max(\delta T_{i5}/\delta L_{i0}, \delta T_{i6}/\delta L_{i0}),$$

(8c) $$\Phi_s - 1 > \delta T_{is}/\delta L_{is},\ s = 3, \ldots, 6.$$

b) Consider a tax regime with possibly negative marginal taxes on deposits. Then conditions (8a) and (8b) are not sufficient for $\$_{i0}^* = 0$, while condition (8c) still implies $\$_{i1}^* = \$_{i2}^* = 0$.

Proof: a) First, assume nonnegative marginal taxes on deposits. By definition, $q_{is} > 0$; $s = 1, \ldots, 6$. Insert condition (8c) in equation (6) and obtain

(9) $$q_{i3} + q_{i4} < 1.$$

Hence, by (7), $\$_{i1}^* = 0$. The same argument proves $\$_{i2}^* = 0$.

From condition (8a) and inequality (9) follows

(10) $$q_{i3}(\delta T_{i3}/\delta L_{i0}) + q_{i4}(\delta T_{i4}/\delta L_{i0}) < \max(\delta T_{i3}/\delta L_{i0}, \delta T_{i4}/\delta L_{i0}) < \Phi_1 - 1,$$

since, by assumption, $\delta T_{is}/\delta L_{i0} \geq 0$; $s = 3, 4$.

The same argument applies to Φ_2. Hence each of the two bracketed terms in equation (5) exceeds 1. Therefore equation (5) implies $q_{i1} + q_{i2} < 1$, and, by equation (7), $\$_{i0}^* = 0$.

c) Now consider a tax regime with possibly negative marginal taxes on deposits. Then condition (8c) still implies $\$_{i1}^* = \$_{i2}^* = 0$. But condition (8a) does not imply $\Phi_1 - q_{i3}(\delta T_{i3}/\delta L_{i0}) - q_{i4}(\delta T_{i4}/\delta L_{i0}) > 1$, as $q_{i3} + q_{i4} < 1$, by inequality (9). Hence condition (8a) does not rule out a negative after-tax rate of return on central bank deposits. The same is true of condition (8b) so that $\$_{i0}^* > 0$ is not ruled out.

The intuition behind proposition 1 is simply that positive after-tax returns on central bank deposits dominate zero returns on closet money so that no money is put in the closet. This result is independent of dollar inflation since inflation affects central bank deposits and closet money in the same way. In the following, proposition 1 will be illustrated by a lump sum-tax system and by an interest income-tax system.

A Lump Sum-Tax System

In a lump sum-tax system taxes are not levied on the interest income of consumers, but on other tax bases. Let α_{is} be the fraction of the terminal central bank loss in state s that has to be paid by consumer i, $\alpha_{is} \varepsilon [0, 1)$. Then

$$T_{is} = \alpha_{is} T_s \text{ and } \sum_i \alpha_{is} = 1, s = 3, \ldots, 6.$$

Hence from equation (3c) it follows that

(11a) $$\frac{\delta T_{is}}{\delta L_{i0}} = \alpha_{is}(\Phi_{s-} - R_{s-}) R_s, \quad s = 3, \ldots, 6,$$

(11b) $$\frac{\delta T_{is}}{\delta L_{i,s-}} = \alpha_{is}(\Phi_s - R_s), \quad s = 3, \ldots, 6.$$

Then condition (8a) yields

(8a′) $$\Phi_1 - 1 > \max(\alpha_{i3}(\Phi_1 - R_1) R_3, \ \alpha_{i4}(\Phi_1 - R_1) R_4)$$

Condition (8c) yields

(8c′) $$\Phi_s - 1 > \alpha_{is}(\Phi_s - R_s), \quad s = 3, \ldots, 6.$$

First, consider a central bank policy that exactly pays the international rate on consumer deposits, $\Phi_s = R_s$; $s = 1, \ldots, 6$. Under this regime the central bank neither subsidizes nor penalizes consumers so that no marginal taxes are levied. Hence conditions (8) simplify to $\Phi_s = R_s > 1$; $s = 1, \ldots, 6$. If the gross before tax-rates of return exceed 1 all over the world, then closet money is avoided.

Second, consider a regime in which the central bank subsidizes consumer deposits, $\Phi_s > R_s$, $s = 1, \ldots, 6$. Hence marginal taxes on lending are positive. Then condition (8c') can be rewritten as

(8c″) $$\frac{\Phi_s - 1}{\Phi_s - R_s} > \alpha_{is}, \quad s = 3, \ldots, 6.$$

This condition holds if $R_s \geq 1$ and $\alpha_{is} \varepsilon [0, 1)$; $s = 3, \ldots, 6$. Similarly, condition (8a') holds if $R_1 \geq 1$ and $\alpha_{is} \varepsilon [0, 1)$, $s = 3, 4$. The analogue is true of condition (8b). In order to see this, consider equations (6) and (11b). Rewrite equation (6)

(12) $$q_{i3}[(1-\alpha_{i3})\Phi_3 + \alpha_{i3}R_3] + q_{i4}[(1-\alpha_{i4})\Phi_4 + \alpha_{i4}R_4] = 1.$$

Then $\Phi_s > R_s \geq 1$ ($s = 3, 4$) implies for $\alpha_{is} \varepsilon [0, 1)$ that the bracketed terms exceed R_3 and R_4, respectively. Hence $q_{i3}R_3 + q_{i4}R_4 < 1$. similarly, $q_{i5}R_5 + q_{i6}R_6 < 1$. Insert equation (11a) in equation (5). Then the preceding argument shows that the compounding of the marginal central bank loss by R_s is more than outweighed by the discounting through the marginal rates of substitution q_{is}. Thus in a regime that subsidizes central bank deposits no consumer will put money in the closet.

Finally, consider a regime in which the central bank penalizes central bank deposits, $\Phi_s < R_s$, $s = 1, \ldots, 6$. As noted in the introduction, this is usually the case in Israel for Patam accounts. Hence marginal taxes are negative so

that the after tax-return exceeds the before tax-return. Equation (8c) then can be rewritten

(8c''')
$$\alpha_{is} > \frac{1 - \Phi_s}{R_s - \Phi_s}, \quad s = 3, \ldots, 6.$$

This inequality always holds if $\Phi_s \geq 1$. But it is restrictive if $\Phi_s < 1$. Then it is satisfied for high tax-consumers, but violated for low tax-consumers. Hence the latter may put their money in the closet, while the former prefer central bank deposits. The reason is that after tax returns of high tax-consumers exceed those of low tax-consumers.

For illustration, consider a country with an exchange rate pegged to the dollar. The country may adjust the exchange rate infrequently, so that over some years there is no adjustment and then a big adjustment occurs. If the domestic currency is devalued considerably, then the dollar return (Φ_s-1) is negative. Of course, (Φ_3-1) and (Φ_4-1) cannot both be negative because then after tax-returns would be negative for zero tax-consumers. Hence these consumers could earn an arbitrage profit by borrowing dollars from the central bank and putting them in the closet.

Suppose, for example, that in state 1 a substantial devaluation risk exists ($\Phi_3 \ll 1; \Phi_4 > 1$). Consider a high-tax consumer whose α_{is} is close to 1 (s = 3, 4). This high-tax consumer earns close to the international rate on central bank deposits and is relatively unaffected by devaluation. The limiting case of α_{is} = 1 (s = 3, . . , 6) is an application of the Ricardian equivalence (Barro 1974). In this case the consumer with $\alpha = 1$ earns exactly the international rate (R_s-1). He first receives a subsidy (Φ_s-R_s) or pays a penalty (R_s-Φ_s) and then is taxed to repay precisely the subsidy or gets back the penalty, compounded at the international rate. Hence central bank policy is irrelevant for this consumer.

Now consider a low-tax consumer, one whose a_{is} is close to 0 (s = 3, 4). This low tax-consumer has to bear the full devaluation risk if he lends to the central bank, and thus he is inclined to put his money in the closet. The preceding results are summarized in proposition 2.

Proposition 2: Assume $R_s > 1$ (s = 1, . . , 6) and a lump sum tax system with α_{is} ε [0, 1) for every consumer i and s = 3, . . , 6.

a) Then no money is put in the closet if $\Phi_s \geq 1$ (s = 1, . . , 6), that is, if the central bank pays nonnegative dollar interest rates on deposits.

b) If there exists a devaluation risk such that the dollar interest rate is negative in one successive state and positive in the other state, then high tax-consumers strictly prefer central bank deposits to closet money while low tax-consumers may prefer a portfolio of closet money and central bank deposits.

Proposition 2b) has been proved for capital flight in the form of closet money. The literature argues (e.g., Lessard and Williamson 1987) that capital flight in the form of financial investments abroad is supported by preferential tax treatment as compared to domestic deposits. Domestic deposit returns are taxed, for example, while returns on investments abroad are not taxed. The standard example is that domestic deposits earn a before tax rate of return (Φ-1) which reduces to (Φ-1) (1-T_i') after taxes. T_i' denotes consumer i's marginal tax rate. If this return is lower than the international rate (R-1), then investments abroad are more profitable. Suppose (Φ-1) and (R-1) are positive, then investments abroad are preferred if

$$T_i' > \frac{\Phi\text{-}R}{\Phi\text{-}1}$$

Hence high tax-consumers for which this inequality holds prefer investments abroad. For closet money this argument is not valid since R has to be replaced by 1 so that $T_i' > 1$ follows, which is ruled out by assumption.

But even for capital flight in the form of investments abroad proposition 2b) may be true. If substantial devaluation risk exists, then a low tax-consumer has to bear most of the devaluation losses and thus may prefer the closet. But a high tax-consumer is compensated for devaluation losses to a large extent by a tax reduction so that he may prefer central bank deposits. Essential for this result is that negative interest income is deductible from the consumer's taxable income.

Interest Income Taxation

The preceding results do not change profoundly when the lump sum-tax system is replaced by a tax system that also taxes interest income. Again, all

tax payments together have to equal the central bank deficit (equation (4')). The tax share of consumer i is now endogenous depending on his interest income. Again assume that all taxes are paid in dollars at the end of the second period. Consumer i's tax base D_{is} is defined as

$$D_{is} = D_{is}^{*} + (\Phi_{s-} -1)\, L_{i0} + (\Phi_{s} -1)\, L_{i,s-}, \quad s = 3, \ldots, 6. \tag{13}$$

D_{is} defines the fixed tax base which is exogenously given. The other terms on the r.h.s. of equation (13) represent the taxable interest income. There exist several ways to measure this income. Here it is measured as the dollar wealth increment from lending to the central bank. Such a tax base exists if the taxable income, measured in domestic currency, is adjusted for inflation such that the dollar is the numeraire. The first period interest income is not compounded in the tax base since interest on interest can only be gained through deposits in the second period.

Consumer's i's tax T_{is} is a function of his tax base D_{is}. This function is the same for all consumers. Moreover, it is assumed to be increasing and progressive, i.e., $T_{is}' \equiv dT_{is}/dD_{is} \geq 0$ and $T_{is}'' \equiv d^2T_{is}/dD_{is}^2 \geq 0$; $s = 3, \ldots, 6$.

Marginal taxes on deposits are given by

$$\frac{\delta T_{is}}{\delta L_{i0}} = (\Phi_{s-} -1)\, T_{is}', \; s = 3, \ldots, 6. \tag{14a}$$

$$\frac{\delta T_{is}}{\delta L_{i,s-}} = (\Phi_{s} -1)\, T_{is}', \; s = 3, \ldots, 6. \tag{14b}$$

Marginal taxes on deposits according to equations (14a) and (14b) are different from marginal central bank losses on deposits which are given by the partial derivatives of equation (3c). We assume that the marginal differences are covered by marginal changes in the tax bases D_{is}^{*} (i=1, . . , I) and that these changes are split among all consumers such that the individual consumer's share in these differences is negligible. In a lump sum-tax system this is tantamount to assuming that $\alpha_{is} \rightarrow 0$ for every consumer, which appears realistic in a society with a million taxpayers or more. From equations (14) and proposition 1a) follows immediately:

Proposition 3: In a tax system with interest income taxation $\$_{i0}^* = \$_{i1}^* = \$_{i2}^* = 0$ if $\Phi_s > 1$ for s = 1, . . , 6 and $T_{is}' \varepsilon [0, 1)$ for s = 3, . . , 6.

Proposition 3 is similar to Proposition 2a), but the international rates become irrelevant now since their effect on individual taxes is assumed to be negligible. The effects of devaluation risk can be seen from inserting equation (14b) into equation (6).

$$q_{i3} [\Phi_3 (1-T_{i3}') + T_{i3}'] + q_{i4} [\Phi_4 (1-T_{i4}') + T_{i4}'] = 1. \tag{15}$$

For $T_{is}' \rightarrow 1$, the after tax-rates of return approach zero, the closet rate of return. Hence this tax also reduces the devaluation loss. For $T_{is}' \rightarrow 0$, the after tax-rates of return approach the before tax-rates of return. This motivates proposition 4.

Proposition 4: Assume $\Phi_s < 1$ and $\Phi_{s+1} > 1$; s = 1, 3, 5. Consider a consumer with the following properties:

a) The consumer displays constant proportional risk aversion
b) The consumer splits his investment in state s into closet money and into central bank deposits such that he deposits the fraction $f_{is} \varepsilon [0, 1)$ into bank deposits, s = 0, 1, 2
c) The consumer's average and marginal tax rates on his interest income are state-dependent

Then a small increase in the consumer's average tax rate on his interest income raises his optimal central bank deposits, but neither changes his optimal consumption pattern nor his optimal investment pattern.

Proof: Since the consumer puts some money in the closet in states 0, 1, and 2, it follows from inequality (7) that $q_{is}+q_{i,s+1} = 1$; s = 1, 3, 5. Subtract $q_{i3}+q_{i4}$ from equation (15) and obtain for the state-independent marginal tax rates:

$$\frac{q_{i3}}{q_{i4}} = \frac{(\Phi_4-1)(1-T_{i4}')}{(1-\Phi_3)(1-T_{i3}')} = \frac{\Phi_4-1}{1-\Phi_3} = \frac{1-q_{i4}}{q_{i4}}. \tag{16}$$

Hence the marginal rate of substitution between states 3 and 4 is independent of the marginal tax rate. Therefore, constant proportional risk

aversion implies that C_{i3}/C_{i4} is independent of the marginal tax rates. The same is true for C_{i4}/C_{i6}. From equation (1c) it follows that if T_i° denotes the consumer's average tax rate on his interest income,

$$C_{is} = w_{is}^{T} - I_{i0}f_{i0}\,\Phi_{s-}T_i^\circ +$$
$$I_{i,s-}\,[1+f_{i,s-}\,\Phi_s\,(1-T_{ip})];\ s = 3, \ldots, 6,$$

where w_{is}^{T} denotes the consumer's dollar income after subtraction of taxes that are not related to interest income. $I_{i,s}$ is his investment in state s. Now consider a small increase in T_i°. Since $f_{i,s-} < 1$, the consumer can offset the effect of a small increase in T_i° by raising $f_{i,s-}$ correspondingly, so that $f_{i,s-}(1-T_i^\circ)$ remains the same. Large increases in T_i° would perhaps imply that $f_{i,s-}$ have to be raised above 1, which is impossible.

Now consider state 0. Since $q_{is}+q_{i,s+1} = 1$ for s = 1, 3, 5, equation (5) yields, for state-independent tax rates T_i'

(17) $$q_{i1}\,[\Phi_1 - T_i'\,(\Phi_1-1)] + q_{i2}\,[\Phi_2-T_i'\,(\Phi_2-1)] = 1,$$

or

(18) $$q_{i1}\,[\Phi_1\,(1-T_i') + T_i'] + q_{i2}\,[\Phi_2\,(1-T_i') + T_i'] = 1.$$

Equation (18) is the analogue to equation (15). Hence the same reasoning as above proves that a small increase in T_i° leads to an increase in f_{i0} such that $f_{i0}(1-T_i^\circ)$ remains the same. There is no need to discount the tax payments to date 1, since the existence of closet money implies a zero interest rate. Hence the optimal consumption and investment pattern remain the same.

Proposition 4 parallels early papers on portfolio theory and taxation, in which it was shown under similar assumptions that higher taxation raises investment in risky assets (Tobin 1958, pp. 80f). Proposition 4 shows that higher taxation need not raise capital flight, but may in fact lower it. Under the assumptions of the proposition, "rich" consumers with high tax rates would put lower fractions of their wealth in the closet than "poor" consumers with low tax rates. This effect is even more pronounced when the "rich" consumer always pays the highest existing marginal tax rate on his interest income and this tax rate equals the average tax rate on his interest income, but the "poor" consumer's tax rate rises with his interest income, such that:

(19)
$$T_{13}' < T_{14}',\ T_{13}^{\circ} < T_{14}^{\circ},$$
$$T_{15}' < T_{16}',\ T_{15}^{\circ} < T_{16}^{\circ},$$
$$q_{13}T_{13}' + (1-q_{13})\,T_{14}' < q_{15}T_{15}' + (1-q_{15})\,T_{16}',$$
$$q_{13}T_{13}^{\circ} + (1-q_{13})\,T_{14}^{\circ} < q_{15}T_{15}^{\circ} + (1-q_{15})\,T_{16}^{\circ}.$$

Thus deposits are less attractive for the "poor" consumer, so that the discrepancy in f between the "rich" and the "poor" consumer is reinforced. This proves proposition 5.

Proposition 5: The assumptions of proposition 4 hold. The "rich" consumer always pays the highest existing marginal tax rate on interest income. The "poor" consumer's marginal tax rate grows with his interest income as stated in (19). Then the "rich" consumer deposits higher fractions of his investments in the central bank in states 1 and 2 than the "poor" consumer. The same is true of state 0 if the "rich" consumer puts some money in the closet in states 1 and 2.

The intuition behind proposition 5 is similar to that of proposition 2b). The high tax-consumer bears a smaller part of a devaluation loss than a low tax-consumer. Therefore, central bank deposits are less risky for the high tax-consumer. This effect overcompensates the tax effect on expected deposit returns. Therefore, capital flight in the form of closet money is more attractive to the low tax-consumer.

CAPITAL FLIGHT WITH CENTRAL BANK DEFAULT

Until now central bank default has not been considered. It has been assumed that the central bank can always raise enough taxes to cover its deficit.[7] This assumption will be given up now.

Consider the following situation. There exists a state-independent tax function that is the same for all consumers. The fixed tax bases D_{is}^{*} are exogenously given for every consumer i and every state s = 3, 4, 5, 6. The

variable tax base is again the consumer's interest income (equation (13)). Now suppose that in some terminal state s the central bank would end up with a deficit before taking into account gains and taxes from intermediation in the last period, i.e., before $\sum (R_s - \Phi_s) L_{i,s-}$ and the associated tax revenue. Then the question is who bears the deficit.

Here we assume that the central bank serves the foreign creditors first. This assumption is questionable, as the discussion on debtor willingness-to-pay shows (Gersovitz 1985). Assuming willingness-to-pay such that foreigners are served first, suppose that $\sum L_{i,s-} > 0$ so that consumers are net lenders; then the central bank adjusts the exchange rate such that Φ_s is sufficiently low. If $\sum L_{i,s-} < 0$, then consumers are net borrowers. Then Φ_s can be raised to cover the deficit. There exist, however, limits to adjustments in Φ_s. If Φ_s is very low, then no consumer will lend any money to the central bank. If Φ_s is very high, then no consumer will borrow from the central bank. Hence it is possible that the highest possible central bank income from intermediation, including the associated tax revenue, is not sufficient to cover the central bank's deficit. Then the central bank would default on its foreign obligations, i.e., it would pay less than the promised rate R_s.

To make this argument more precise, consider equations (3c) and (4'). Without central bank default,

$$\begin{aligned} \sum_i T_{is} &= \sum_i (\Phi_{s-} - R_{s-}) R_s L_{i0} + \sum_i (\Phi_s - Rs) L_{i,s-} + A_s \\ &\equiv A_s^* + \sum_i (\Phi_s - R_s) L_{i,s-}; \quad s = 3, \ldots, 6. \end{aligned} \tag{20}$$

From equation (13) it follows that

$$\begin{aligned} T_{is}(D_{is}) &= T_{is}(D_{is}^* + (\Phi_{s-} - 1) L_{i0} + (\Phi_s - 1) L_{i,s-}) \\ &\equiv T_{is}^*(D_{is}^* + (\Phi_{s-} - 1) L_{i0}) + TT_{is}((\Phi_s - 1) L_{i,s-}) \end{aligned} \tag{21}$$

TT_{is} denotes the tax on second period interest income.

From equation (16) and (17) follows

$$\sum_i TT_{is}((\Phi_s - 1) L_{is-}) + \sum_i L_{is-}(R_s - \Phi_s) = A_s^* - \sum_i T_{is}^*, \quad s = 3, \ldots, 6. \tag{22}$$

Equation (22) says that the central bank's gain from financial intermediation and the associated tax revenue in state s must be equal to the deficit A_s^*

$-\Sigma T_{is}^*$ if default is to be avoided, s = 3, . . , 6. With exogenous international rates R_s, the central bank's gain from intermediation and the associated tax revenue depend on Φ_s and on $L_{i,s-}$ (i = 1, . . , I). As $L_{i,s-}$ depends on the central bank rates Φ_s in the states succeeding state s-, these rates determine intermediation effects. Define the central bank's opportunity set to avoid default in states 3 and 4 as

$$\Omega_1 = \{ (\Phi_3, \Phi_4) \mid \sum_i TT_{is} ((\Phi_s - 1) L_{i1}) + \sum_i L_{i1} (R_s - \Phi_s) \geq A_s^* - \sum_i T_{is}^*; s = 3, 4\}. \tag{23}$$

Define T'_{max} as the highest existing marginal tax rate; $T'_{max} < 1$.

Proposition 6: Assume that $R_s \geq 1$, s = 3, 4, and that the borrowers' tax rates on interest income are on average at least as high as those of the lenders. Then, with positive deficits $A_s^* - \Sigma T_{is}^*$, S = 3, 4, the central bank's opportunity set to avoid default, Ω_1, neither includes the set $\{ (\Phi_3, \Phi_4) \mid \Phi_3 \leq 1, \Phi_4 \leq 1, \Phi_3 \bullet \Phi_4 < 1\}$ nor the set $\{ (\Phi_3, \Phi_4) \ (R_s - 1) < (\Phi_s - 1)(1-T'_{max}); s = 3, 4; \sum L_{i1} (\Phi_3, \Phi_4) \geq 0\}$ since policies, being elements of these sets, create central bank losses from intermediation.

Proof: a) Consumers prefer closet money to central bank deposits if $\Phi_3 \leq 1$, $\Phi_4 \leq 1$, and $\Phi_3\Phi_4 < 1$. All consumers would borrow from the central bank and put the money in the closet. With $R_s \geq 1$; s = 3, 4; the central bank would end up with a loss, even with inclusion of associated taxes. Hence default could not be avoided.

b) Now consider a policy with $(R_s - 1) < (\Phi_s - 1)(1 - T'_{max})$; s = 3, 4. Then consumer lending creates a loss for the central bank since the bank earns $(R_s - 1)$ from lending a dollar on the international market and pays the consumer at least the after-tax-return $(\Phi_s - 1)(1 - T'_{max})$. The central bank would profit from consumer borrowing. This profit is the smaller, the higher the borrowers' tax rates on interest income are. Hence the central bank would end up with an overall loss if the borrowers' tax rates on interest income are on average at least as high as those of the lenders and if lending exceeds borrowing. Thus default cannot be avoided.

Proposition 6 shows that the central bank's opportunity set to avoid default is restricted to rates Φ_s (s = 3, 4), which are bounded from below and

from above. As the central bank's gain from intermediation plus the associated tax revenue is a continuous function in Φ_3 and Φ_4, it follows that the opportunity set Ω_1 is the smaller, the higher the deficits $(A_s^* - \Sigma T_{is}^*)$, s = 3, 4, are.[8]

With sufficiently high deficits, the opportunity set is empty. Then default is unavoidable. As a consequence, the central bank, serving foreigners' claims first, cannot offer attractive interest rates Φ_s (s = 3, 4) to consumers. Consequently consumers put all their money in the closet. Foreigners then have to bear part of the deficit. If they anticipate this, they will not offer credit unless they are somehow compensated for this loss.

This analysis also explains why capital flight is observed in highly indebted countries. In these countries the central bank cannot offer attractive interest rates if foreigners' claims are served first. Hence it seems unlikely that flight capital will be repatriated before public debt is reduced.

The preceding analysis is the key to determining the central bank's credibility when it offers interest rates Φ_3 and Φ_4 in state 1. If these rates are not an element of the opportunity set to avoid default, then the offer is not credible.

In addition, this credibility aspect sheds some light on the dynamics of capital flight. Consider state 0. The central bank offers interest rates Φ_1 and Φ_2. Then consumers can predict on the basis of these rates the central bank deficits $(A_s^* - \Sigma T_{is}^*)$, s = 3, . . , 6.

This allows them, in addition, to predict the central bank's opportunity sets in states 1 and 2. If none of these sets is empty, then offered rates Φ_1 and Φ_2 are credible. If, however, one or both of these sets are empty, then credibility of Φ_1 and Φ_2 is questionable. The implications of this depend on foreign creditors' behavior.

Suppose, first, that the foreign creditors are ready to continue lending in the second period even if they anticipate problems of debt servicing. Then domestic creditors consider the offered rates Φ_1 and Φ_2 as credible and prefer central bank deposits to closet money if $\Phi_1 \geq 1$, $\Phi_2 \geq 1$, and $\Phi_1\Phi_2 > 1$. Thus no capital flight exists in the first period. But in the second period capital flight absorbs all consumer money whenever the opportunity set to avoid default is empty.

Now suppose that the foreign creditors anticipate default at the end of the second period and therefore stop lending at the end of the first period.

Consequently the central bank faces debt servicing problems already at the end of the first period. If foreigners' claims are served first, then rates Φ_1 and Φ_2 would not be credible, and consumers would revise these rates to credible levels. The revised rates may be sufficiently attractive for consumers to prefer central bank deposits to closet money, but they need not be. If they are not, then capital flight exists also in the first period.

Thus the dynamics of capital flight depend essentially on the behavior of foreign creditors. Lenient behavior allows the central bank to pay attractive interest rates in the first period to domestic consumers and postpone default at the expense of foreign creditors to the end of the second period. Consumers then switch from central bank deposits in the first period to closet money in the second period. Strict behavior of foreign creditors, however, rules out such a switching policy.

TRANSACTION COSTS

So far transaction costs have been ignored. With these costs, borrowing and lending rates differ. If the central bank autonomously sets both rates, then it has additional power to generate profits. But it cannot offer negative lending rates in all states if closet money is to be avoided. From the perspective of consumers the choice problem between central bank deposits and closet money remains the same if the consumer incurs no private transaction costs.

The situation is different when the consumer faces private transaction costs. Suppose, for example, that depositing L dollars with the central bank costs cL dollars so that only (1-c) L dollars earn interest and are repayable. Then, as is well known, the choice between deposits and closet money has also traits of an inventory problem (see, e.g., Eppen and Fama 1968). The gross before tax-return from a one period-deposit then is $\Phi_B(1\text{-}c)$, from a two period-deposit $\Phi_B\text{-}\Phi_B(1\text{-}c)$. Hence $\Phi_B(1\text{-}c) < 1$ and $\Phi_B\text{-}\Phi_B(1\text{-}c) > 1$ is possible although $\Phi_B > 1$. In other words, this type of transaction cost affects short-term deposits more than long-term deposits. Thus it is possible that a consumer who wants to spend some money at the next date, puts this money in the closet instead of depositing it while he deposits those amounts that he wants to spend after two periods. This argument is the same as that underlying the holding of cash balances for transaction purposes.

CONCLUSION

This study has discussed the economics of closet money. Closet money is a form of capital flight that is in some ways more harmful than financial investments abroad since closet money earns no interest. Closet money subsidizes the issuer of the notes put in the closet.

Usually it is argued in the literature that consumers with high marginal tax rates are the first to engage in capital flight. This is true if marginal taxes on deposits are nonnegative and if flight capital is not taxed. Deposits dominate closet money if after tax-returns on deposits are positive. Currency devaluations may, however, lead to negative before-tax returns on deposits. If the tax system acknowledges the corresponding loss as deductible from taxable income, then marginal taxes on deposits are negative. Thus, low-tax consumers bear a higher part of the devaluation loss than high-tax consumers. Therefore, low-tax consumers are more inclined to put money in the closet than high-tax consumers.

The rates of return that the central bank can offer credibly on deposits, depend on the central bank's deficit and the foreign creditors' behavior. The higher the central bank's deficit is, the smaller is the bank's opportunity set to avoid default. The consumers check whether or not the central bank can avoid default by an appropriate intermediation policy. If not and if the central bank serves foreign creditors first, then consumers prefer closet money to central bank deposits. Still, foreign creditors do not get the promised return in the case of default. If they anticipate this and react earlier by cutting off credits, then default occurs already earlier. If they do not react in this manner, then consumers may lend first to the central bank and then switch to closet money before foreign creditors cut off credits.

NOTES

1. During the large inflation of the late 1970s and early '80s, the black market exchange rate was substantially above the bank rate. Since the economic reform program of 1986, the black market rate differs very little from the official exchange rate, and is occasionally below it.

2. Note that the Patam accounts are different from the "dollarization" accounts that have been used in several Latin American countries (Dodsworth, El-Erian, and Hammann 1987). In "dollarization" accounts all transactions (initial deposits, withdrawals, payment of interest) are made in dollars. The central bank promises a deterministic dollar interest rate on dollar deposits. Several central banks ran out of dollars and converted the dollar claims into domestic currency claims at rates that have been unfavorable to creditors (Luke 1986).

3. For a review of the literature, see Lessard and Williamson (1987).

4. For notational simplicity, we shall assume that the probability assessments of all consumers are homogeneous. Since, as we shall show below, the equilibrium depends only on the probability-adjusted marginal rates of substitution, this assumption is not critical.

5. As long as the consumer's utility function is separable in domestic and imported goods, the restriction of the model to only imported goods is not serious.

6. We ignore shekel income and thus consumer exchange of shekels into dollars. Therefore, black market exchange rates are irrelevant although they play a major role in several countries (see, e.g., Dornbusch et al. 1983).

7. As Eaton, Gersovitz, and Stiglitz (1986, p. 500) note, there exists no rigid revenue constraint in reality. Although this is true, the implications of soft constraints appear to be similar.

8. As has been noted by Ize and Ortiz (1987), the overall debt of the public sector is important, not only the foreign currency-denominated debt.

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