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ABSTRACT

This paper develops a new technique for measuring changes in the degree of capital mobility confronting a developing country that has restrictions on capital flows and official ceilings on domestic interest rates. Because such official controls rule out the use of traditional interest rate parity conditions to measure changes in the degree of capital mobility, the analysis first examines an intertemporal model of an open economy. This model describes the linkages between the cost of undertaking disguised capital flows, the current account, capital controls, domestic and external financial market conditions, and the authorities' foreign exchange market interventions. The model suggests a means of measuring changes in the cost of undertaking disguised capital flows, based on the past history of differentials between external interest rates (adjusted for exchange rate changes) and domestic ceiling interest rates, provided that the authorities' foreign exchange market activities are incorporated into the analysis. Parameter estimates for Korea, Mexico, and the Philippines indicate that the real cost of undertaking disguised capital flows declined on average by nearly 70 percent between the early 1970s and the late 1980s.

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I. INTRODUCTION

This paper examines the issue of how to measure changes in the degree of capital mobility confronting a developing country which has restrictions on capital flows and official ceilings on domestic interest rates. One of the key problems in measuring changes in the degree of integration between domestic and international financial markets for most developing countries using traditional open or covered interest rate parity conditions is that, for at least some portion of the past two or three decades, domestic interest rates were typically subject to official ceilings and not market determined. In addition, countries used capital controls designed to limit capital flows, especially of a short-term nature. While a number of econometric techniques have been proposed to overcome these difficulties, we have argued elsewhere (Dooley and Mathieson (1994)) that these methods are subject to some shortcomings, especially when they do not address the issues raised by the authorities' exchange market intervention activities. This paper suggests an alternative measure of the cost of undertaking private international capital flows and provides empirical estimates of these costs for three emerging markets which maintained both extensive capital controls and, for all or part of the sample period, controls on domestic interest rates.

In the next section we review previous studies of how to measure changes in the degree of capital mobility confronting developing countries, considers the shortcomings of existing measures, and summarizes our alternative approach to measuring the cost of undertaking private capital flows. Section III discusses an intertemporal model which describes the linkages between the current account, capital controls, domestic and external

financial market conditions, the cost of disguised capital flows, and the authorities' foreign exchange market intervention strategy. The objective is to identify how the measured current account balance should behave when there are disguised capital flows and the degree of integration between domestic and external financial markets increases over time. The model also allows us to distinguish between changes in the cost of undertaking disguised capital flows and changes in the authorities' foreign exchange market intervention activities. Section IV describes the instrumental variables, Kalman filter econometric technique used in our empirical analysis, and Section V discusses the empirical results that were obtained using data from Korea, the Philippines, and Mexico for the period since the 1970s. Section VI summarizes our main conclusions.

II. PREVIOUS STUDIES OF THE DEGREE OF CAPITAL

A. Mobility Confronting Developing Countries

Montiel (1993) noted that four different approaches have been used to measure changes in the degree of capital mobility confronting developing countries. These include examining the magnitude of gross capital flows, interest parity conditions, the effectiveness of sterilization (or monetary autonomy), and saving and investment correlations.

To the degree that large gross capital inflows and outflows are indicative of growing linkages between domestic and external financial markets, then evidence on the time series behavior of the gross stocks of financial claims between developing countries and external

financial markets has been used to access the degree of openness of developing countries.

Much of the literature has focused on the experiences of middle income developing countries

with the accumulation of large external debts and capital flight during the 1970s and early

1980s and the more recent resurgence of capital inflows during the early 1990s. In the earlier

period, it was generally concluded that the sharp increase in external debt, primarily by the

public sector, was accompanied by a corresponding increase in the holdings of external assets

by the private sector.[1] This situation reflected the willingness of international banks to

increase their exposure to developing countries, the desire of the authorities to finance fiscal

deficits and external payments imbalances through external borrowing, and the strong

incentives created by unstable macroeconomic and financial conditions and confiscation risk

for the residents of developing countries to move funds offshore. In contrast, the experience

of the early 1990s encompassed both an increase in public and private sector external liabilities

(arising primarily out of foreign direct investment and bond issuance) and a net reduction in

holdings of private external assets. In part, this reflected the return of capital flight due to

both improved domestic macroeconomic and financial market conditions and lower rates of

return on offshore assets.[2]

While the evidence on gross capital flows is indicative of a substantial degree of

financial openness for many middle income developing countries, it does not provide

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[1] These experiences are discussed by Cuddington (1986), Dooley (1986) and Rojas-Suarez (1991).

[2] See Calvo, Leiderman and Reinhart (1993).

information on a number of important issues. First, this evidence is generally limited to the experiences of only middle income developing countries. In addition, this evidence provides relatively little information about whether the degree of integration between domestic and offshore markets is increasing over time. Finally, large gross capital flows may actually be associated with a low, rather than a high, degree of financial integration. For example, trading of some benchmark U.S. government securities often takes place both inside and outside the United States. An unanticipated event (such as an increase in the Federal Reserve's discount rate) can trigger any immediate adjustment of the prices of these securities without any capital flows or even any transactions occurring. Capital flows between countries are likely to occur only if participants in the different markets have conflicting views on the effects of the unanticipated event.

To overcome the shortcomings of gross capital flows as a measure of the degree of capital market integration, a number of studies have focused on interest rate parity conditions which imply that the returns (adjusted for some measure of exchange rate risk) on comparable domestic and external financial instruments should be equalized with a high degree of capital mobility. Three alternative parity conditions have been explored: covered and uncovered nominal interest rate parity and real interest rate parity. The covered interest rate differential (CIP) is defined as the difference between the interest rates on instruments issued by comparable borrowers but denominated in different currencies, adjusted for the cost of

forward cover in the foreign exchange market.[3] Sustained covered interest rate differentials

are traditionally taken as indicating the existence of a country or "political" risk premium.[4]

One problem associated with the analysis of covered interest rate differentials in developing

countries is the absence of forward or futures markets for foreign exchange, as well as market

determined interest rates. As a result, empirical tests have often examined whether uncovered

interest rate parity (UIP) has been achieved. In this formulation, the cost of forward cover is

replaced by some measure of the expected rate of change in the exchange rate.[5] Testing for

UIP naturally requires some assumptions about how expectations about future exchange rates

are formulated. Capital market integration can also be measured in terms of real interest

parity.[6] However, this requires assumptions about the formulation of expectations regarding

both domestic and foreign inflation, as well as about exchange rates.

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[3]If F is the forward exchange rate for the delivery of foreign exchange rate in n periods, and S
is the current spot exchange rate (in units of domestic currency per unit of foreign currency),
then the forward premium (if positive) or discount (if negative) on the foreign currency will be
$d = (F-S)/S$. Moreover, if i is the nominal interest rate in the domestic country (with an
asterisk indicating the foreign country) on an instrument maturing in n periods, then the
covered interest rate differential is
$i - i^* - d$.

[4]For example, see Dooley and Isard (1980).

[5]In terms of the definitions used in the preceding footnote, the uncovered interest rate
differential (u) would given by $u = i - i^* -$
$(S^e - S)/S$, where S^e is the spot exchange rate in n periods.

[6]The real interest rate spread can be measured as the sum of the uncovered interest rate spread
and the expected rate of real exchange rate depreciation. If r is the real interest rate, the real
interest rate differential can be written as $r - r^* = (i - \pi^e) - (i^* - \pi^{e*}) = (i - i^*)$
$- (\pi^e - \pi^{e*})$, where π^e is the expected rate of inflation. By adding and subtracting the expected
rate of depreciation of the home currency (e^e), then $r - r^* = (i - i^* - e^e) + (e^e - \pi + \pi^*)$.

While the empirical tests of CIP and UIP for developing countries have been based on the procedures originally employed to study financial arbitrage in industrial economies, they have often been modified to reflect the differences between the institutional structures in the two sets of countries. As already noted, most developing countries lack forward and futures markets for foreign exchange, and they have had more extensive capital controls than in most industrial countries. As a result, most early studies of developing countries focused on tests of UIP rather than CIP;[7] and they generally concluded that standard tests implied the rejection of UIP and CIP due to the existence of capital controls that made domestic and foreign assets imperfect substitutes. However, more recent tests, which focused on countries which were open capital accounts and market determined interest rates, (e.g., Khor and Rojas-Suarez (1991)) found a higher degree of integration for some countries.

In order to more fully reflect the institutional differences between industrial and developing countries, several studies adopted a methodology that viewed domestic monetary conditions as influenced by both UIP and domestic money supply and demand considerations. In Edwards and Khan (1985), for example, the unobserved, market clearing domestic interest rate (i) in a developing country is taken as reflecting a weighted average of the external UIP

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[7]Lizondo (1983) was able to test for both CIP and UIP for Mexico using monthly data for the period 1977-80. His tests rejected the joint hypothesis of rational expectations and either CIP or UIP. Nonetheless, he did not interpret his results as invalidating UIP because of the possibility of the "peso problem" (i.e., the perception of market participants that there is small but finite probability of a large discrete change in the exchange rate). Moreover, Lizondo was able to account for the rejection of CIP because of the existence of capital controls and taxes.

interest rate (i^*) and the domestic interest rate that would prevail in a completely closed economy (i), or

$$i + \psi i^* + (1 - \psi) i' \qquad 0 \leq \psi \leq 1 \qquad (1)$$

serves as an index of capital mobility with a higher ψ indicating a higher degree of capital mobility. For relatively open developing countries (e.g., Singapore), they found that only the UIP interest rate mattered; but, for countries with capital control (e.g., Columbia), both UIP and domestic monetary conditions were important. Haque and Montiel (1991) extended the Edwards-Khan methodology to situations where financial repression encompassed administered, rather than market determined, interest rates. While they continued to view the (unobserved) domestic market-clearing interest rate as a weighted average of the UIP rate and closed economy rate, they estimated the relevant weights by first substituting the expression for the market clearing interest rate into the demand for money and then estimating resulting reduced-form equation. For a sample of 15 developing countries in the period 1969-87, their results were consistent with a relatively high degree of integration with external capital markets.

This approach implicitly has assumed that all components of the money stock except for private capital flows are set exogenously by the central bank. This allows the interpretation of i' as the domestic interest rate that would have prevailed if the capital account was completely closed. If, however, the authorities react to private capital inflows during the time period in order, for example, to maintain a yield differential in favor of domestic assets, then the estimated value of i' will be higher than the "true" closed economy value. Thus, to

identify the exogenous or closed economy portion of the monetary base it would be necessary to add a reaction or sterilization function to the model.

In addition, the measure of the degree of capital mobility (ψ) implicitly represents the average degree of capital mobility over the sample period. This formulation also does not allow the degree of capital mobility to vary over time. However, there is considerable anecdotal evidence that the degree of capital mobility for many developing countries has increased over time (Mathieson and Rojas-Suárez (1993)).

To deal with the problems created by the authorities' response to capital flows, a number of empirical studies have examined either saving-investment correlations (as a means of gauging the overall linkages between domestic and foreign financial markets) or attempted to explicitly model the authorities intervention function. The saving-investment studies that have encompassed developing countries in their samples (e.g., Dooley, Frankel and Mathieson (1987), Summers (1988) and Wong (1988)) have generally found a lower correlation between saving and investment in developing countries than in industrial countries. This was an unexpected result since it suggested that developing countries were more integrated with international capital markets that were industrial countries.[8] Moreover, these studies did not find any systematic increase in the degree of capital mobility (as implied by a lower

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[8]This result holds even when the studies have employed an instrumental variables approach to allow for the fact that the authorities attempt to offset current account imbalances in a systematic manner (Dooley, Frenkel and Mathieson (1987)).

correlation) using average ratios of saving and investment to GDP for the 1960s and early 1970s versus the late 1970s and 1980s.

Analyses of the authorities intervention activities have focused on examining the degree to which changes in central bank net domestic assets have been offset by changes in the balance of payments. Most of this work concluded that developing countries retained significant amounts of monetary autonomy in the sense either that changes in net domestic credit were offset slowly (Cumby and Obstfeld (1984) and Bini (1982)) or that real domestic interest rates were not influenced significantly by foreign real interest rates (Boschen and Newman (1989)).

Overall, empirical studies of the degree of capital mobility suggested that domestic financial market conditions in most developing countries, even those with extensive capital controls, were influenced by external financial market developments. However, these studies were not clear about whether the degree of capital market integration had increased over time. Indeed, the evidence from some recent studies is quite mixed. For example, Reisen and Yeches (1991) applied the Haque-Montiel methodology using quarterly data for the 1980s (including curb market interest rates) for Korea and Taiwan Province of China. Kalman filter estimates suggested that the degree of financial market integration for Korea peaked during the early 1980s and remained constant thereafter and was relatively constant throughout the period for Taiwan Province of China. In contrast, Faruqee (1991) found evidence that the degree of integration between interest rates in the money markets in Korea, Malaysia,

Singapore and Thailand and the offshore three-month Japanese yen LIBOR rate had increased between the 1980s and 1990s.

Despite the conflicting results, these studies indicate that the institutional characteristics of developing countries need to be reflected in any study of how the degree of capital market integration confronting developing countries has evolved over time. First, since most developing countries do not have completely flexible exchange rates, the study must distinguish between the effects of changes in the degree of capital mobility and changes in sterilization policies. Second, since financial repression characterized many developing countries during the 1970s and 1980s, any empirical analysis must allow for the fact that domestic interest rate time series will often not represent market-clearing interest rates. Third, most developing countries have maintained capital controls throughout the post World War II period; and, as a result, many developing country capital flows have been disguised as trade transactions.[9] One of the key empirical issues is whether the cost of undertaking these disguised capital flows has diminished over time. If these costs have declined significantly over time, then the linkages between domestic and external financial markets could have increased sharply even in countries that have maintained capital controls and interest rate ceilings.

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[9]Kamin (1991) discusses the implications of such disguised capital flows for the behavior of the measure current account balance during a stabilization program.

In this paper, we attempt to obtain more reliable empirical estimates of the degree of capital mobility by making two modifications to earlier analyses. The first innovation is to develop an intertemporal maximizing model in which domestic residents must incur costs when undertaking disguised capital flows in order to adjust their external asset position because of the pressures of capital controls. This allows us to test the hypothesis that the cost of adjusting the stock of external assets during a given time period is a nonlinear function of the real value of the size of the disguised capital flow.

The second innovation is to modify the conventional specification of the money-supply process. As already noted, the implicit assumption in many earlier studies was that the central bank sets a target for some monetary aggregate (the monetary base, narrow money or broad money) at the beginning of the period and then does not react to private capital flows during the period. The observed money supply at the end of the period would therefore differ from the beginning-of-the-period policy target by the observed net-private capital flow during the period. One problem with this approach is that, for some monetary aggregate targets, large capital inflows can imply a "policy target" that could be negative. For example, Figure 1 shows the results that would be obtained if a monetary base target was used for Korea, Mexico and the Philippines. Since a base money specification can lead to implausible results for the monetary target, empirical studies have typically assumed that the narrow (M1) or broad (M2) money supply is the policy target. In the absence of sterilization of capital inflows during the period, the policy target in this case would be missed not by the amount of the capital inflows, but by that amount times the money multiplier. The conventional assumption

Figure 1. Difference Between Base Money and Private Capital Flows
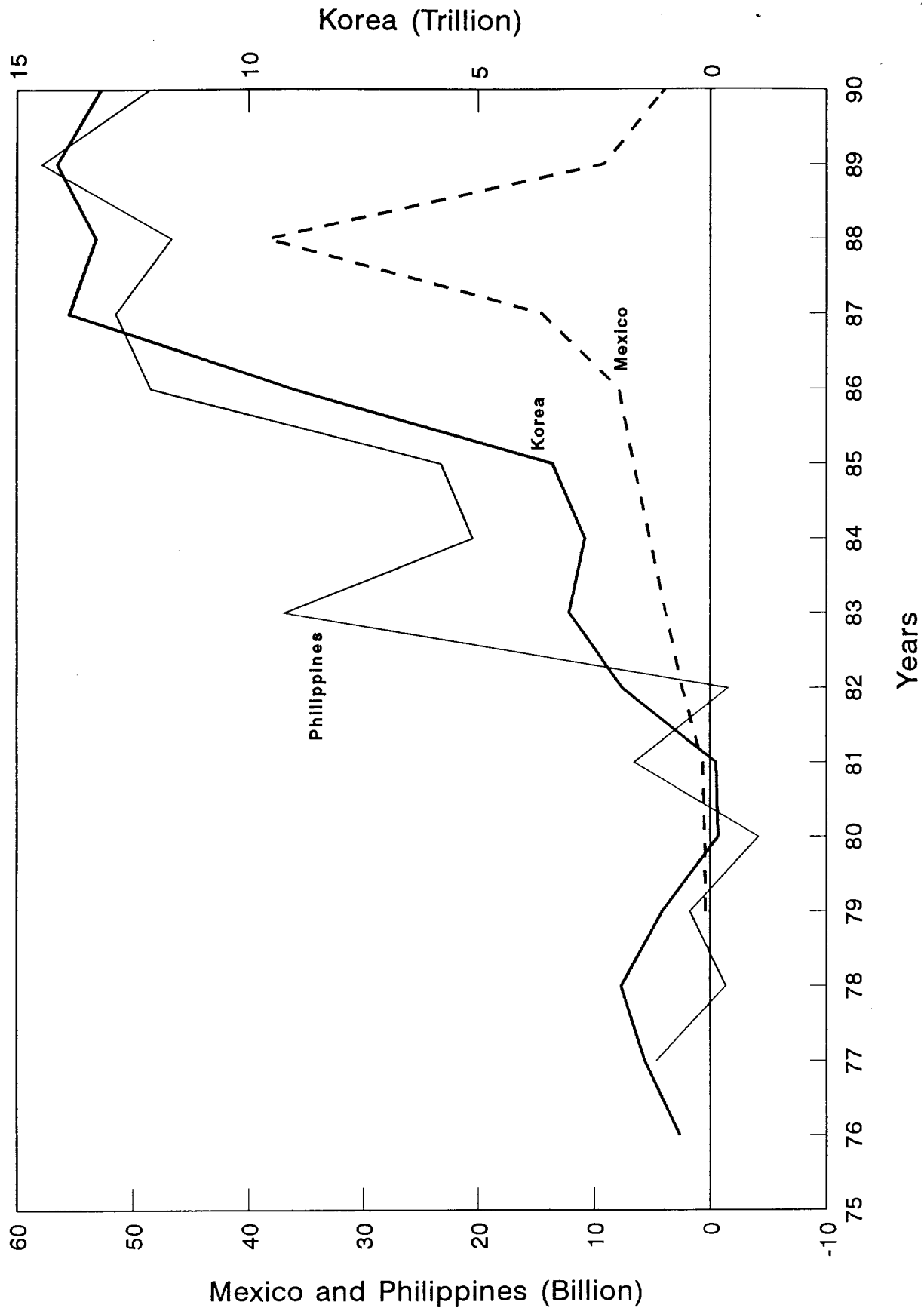
is that the central bank mechanically "sterilizes" the capital inflows effect on the monetary base so that the change in money supply generated by the capital inflow is equal to the capital inflow. The implications of this assumption for the "sterilized" money for the countries in our sample are given in Figure 2 (for narrow money) and Figure 3 (for broad money).

In order to overcome the shortcomings of such a highly stylized view of what sterilization activities are carried out by the central bank, our second innovation is to allow for a more general formulation in which the central bank is allowed to react to contemporaneous movements in exchange rates, reserves, inflation and output gaps. Moreover, we employ instrumental variables, Kalman filter estimates, both to correct for potential simultaneous equation bias and to allow parameters in the central bank's intervention to vary over time.

The structure of our analysis can be illustrated as follows (Figure 4). Assume the government sets a ceiling deposit-interest rate at r_B and the beginning of the period broad money supply at M_0^s. For a given world-interest rate r_F, the solution to the maximization problem in our model implies a money-demand curve M_0^d evaluated where capital flight, $DCF_t^0=0$. This is obviously a disequilibrium in that the money demand is less than supply. As residents engage in capital flight, the cost of moving funds increases, which thereby reduces the yield on foreign assets relative to domestic deposits, shifting the money demand curve right to M_d^1 evaluated at $DCF_t^1>0$. The associated decline in reserves, depreciation of the exchange rate and increase in domestic prices and economic activity cause the central bank to allow a decline in the money supply. That is, sterilization is less than complete. The final

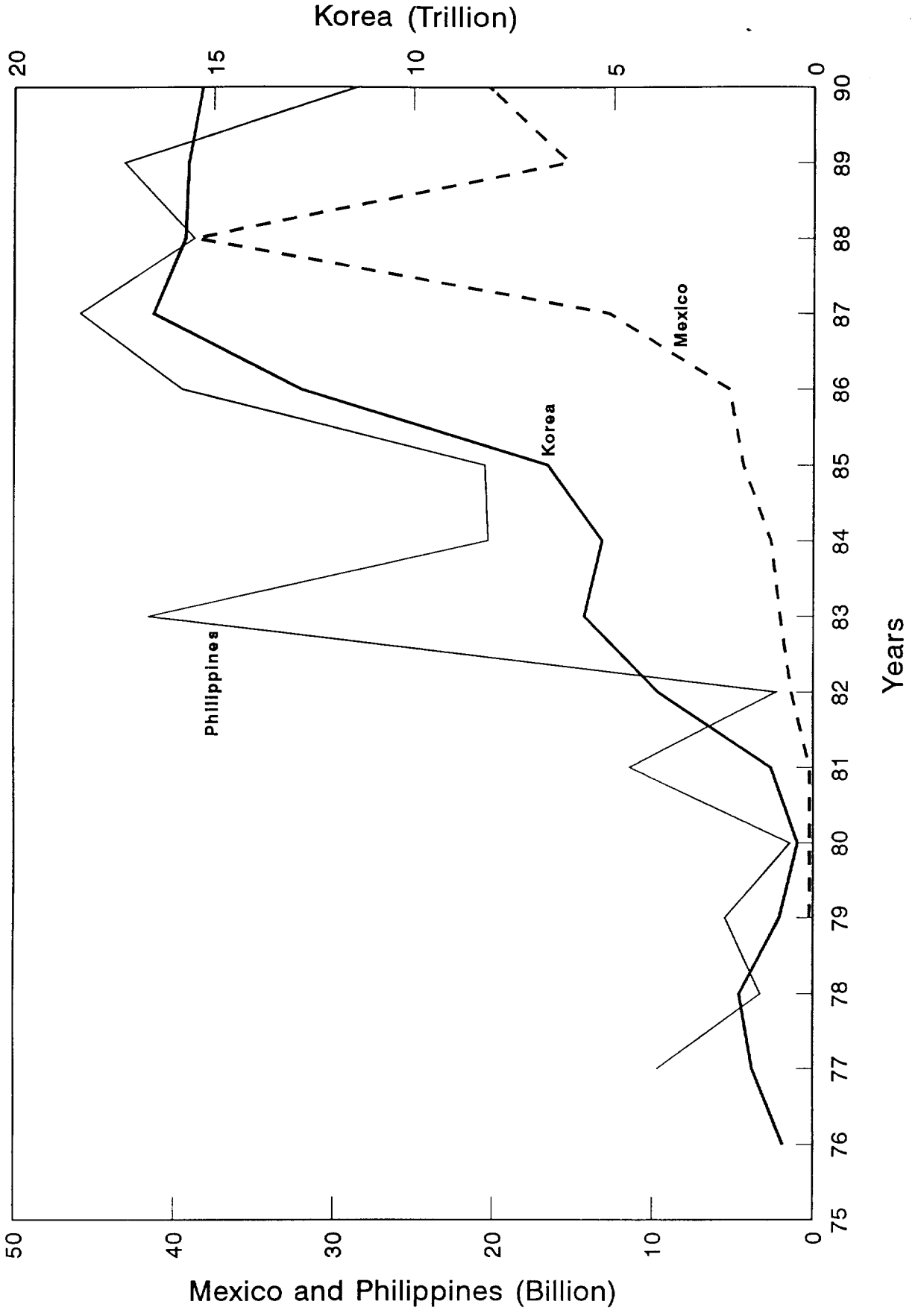Figure 2. Difference Between Narrow Money and Private Capital Flows

Figure 3.   Difference Between Broad Money and Private Capital Flows
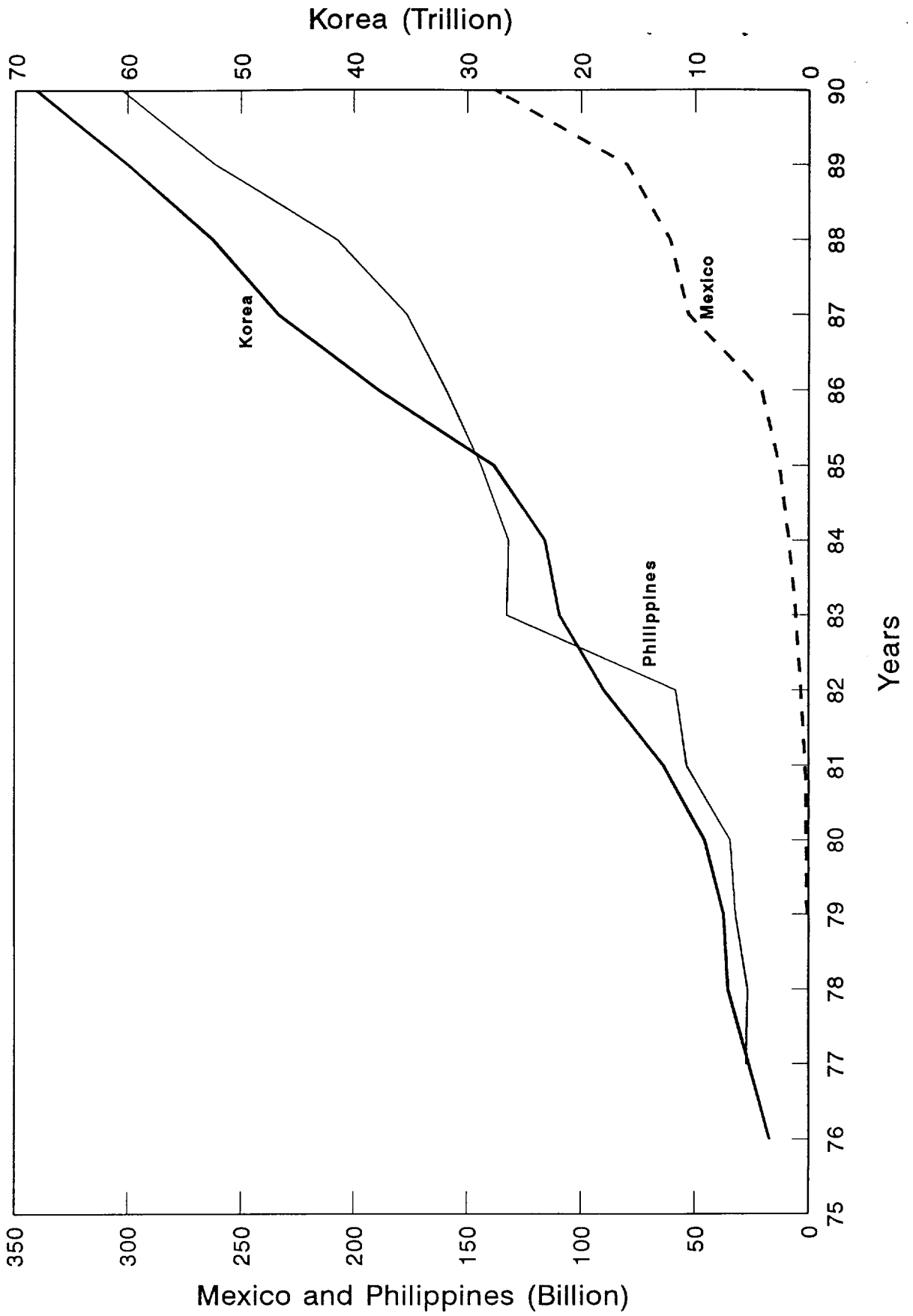
Figure 4. Money Demand and Supply
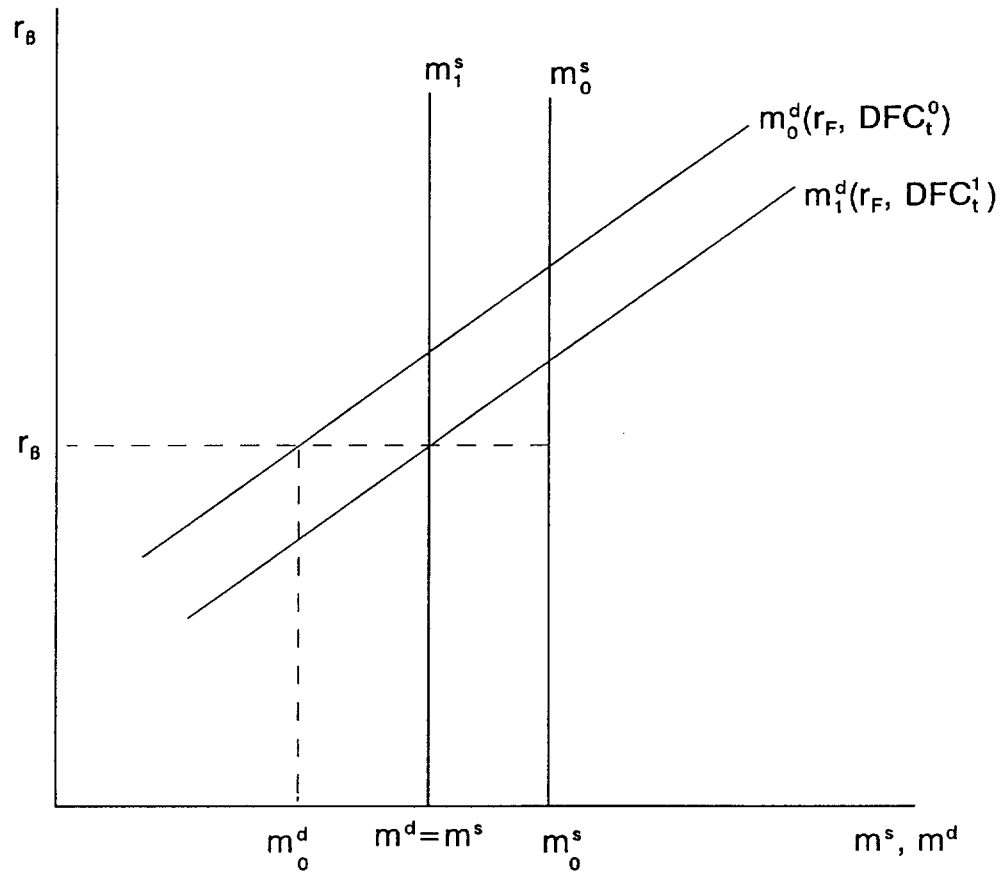
equilibrium will involve an observed interest differential between the administered domestic
interest rate and the world interest rate, a change in the stock of illegal capital exports. Other
things equal, a narrowing of the spread between international interest rates and "controlled"
domestic interest rates (adjusted for changes in exchange rates and the cost of disguised
capital flows) means that the central bank has been forced away from its policy target. In
turn, this is interpreted as evidence of a decline in the cost of private disguised capital flows.
The cost parameter can be derived assuming all these relationships are properly modeled, in
particular, the money-supply process.

Our empirical results imply that the central banks in all three countries appear to have
reacted to capital flows so the model of the money-supply process appears to be empirically
important. For Korea and Mexico, we find a dramatic decline in the costs of adjusting
international capital portfolios, while, for the Philippines, the costs were uniformly low during
the sample period. Our results suggest that Mexico was relatively closed in the mid-1970s,
but, by the end of the period, it was the most open of the economies in our sample. Although
Korea opened rapidly, it remained to be the country with the highest cost of undertaking
private capital flows at the end of the period. We cannot distinguish between intentional
opening due to government policy and opening due to market innovations. However, for
assessing sensitivity of domestic financial markets to external shocks, this distinction may not
be important.

III. THEORETICAL MODEL

A. Private Sector Behavior

Consider an economy whose residents maximize the expected utility of consumption over time and live in "periods" which have two subperiods: a "beginning" and an "end."[10] In the beginning of the period, goods markets open; and consumers can use cash[11] to purchase either traded or nontraded goods. For simplicity, let $C_{1,t}$ be a vector of traded goods consumed by the residents in period t and $P_{1,t}$ be the vector of the domestic prices of these trade goods.[12] Similar, $C_{2,t}$ would be the vector of nontraded goods consumed by the residents, and $P_{2,t}$ would be the corresponding vector of nontraded goods' prices. If M_{t-1} is the stock of cash which the resident has at the beginning of the period t,[13] then the cash-in-advance constraint confronting the resident is that

$$M_{t-1} \geq P_{1,t}C_{1,t} + P_{2,t}C_{2,t} \qquad (2)$$

This formulation of the cash-in-advance constraint implicitly assumes that there is current account convertibility and that residents can freely exchange domestic currency for foreign

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[10]This period structure is not vital for our results as long as consumers are subject to some form of cash-in-advance constraint.

[11]This would include currency and demand deposits but not time deposits.

[12]At this stage, it is easiest to thinks of each traded goods price in $P_{1,t}$ as the product of the world price for each trade good and the domestic exchange rate. We could also incorporate tariffs and export subsidies with little difficulty.

[13]M_{t-1} is thus the stock of cash held at the end of period t-1 which is "inherited" at the beginning of period t.

currency (at some prevailing exchange rate) in the amounts needed to purchase foreign goods.[14]

This constraint means that in selecting the optimal portfolio composition, a resident will want to ensure that her end of period holdings of cash are at least as large as her expected consumption expenditures in period t+1. Thus

$$M_t \geq E_t(P_{1,t+1}C_{1,t+1} + P_{2,t+1}C_{2,t+1}) \tag{3}$$

where E_t is the expectations operator.

It will be assumed that residents have utility functions defined over their levels of consumption of traded and nontraded goods. Moreover, utility will be taken as separable in the two types of consumption goods. Thus

$$U_t = U_t(C_{1,t}, C_{2,t})$$

with $\partial U_t/\partial C_{i,t} \geq 0,\ \partial^2 U_t/[(\partial U_t/\partial C_{i,t})(\partial U_t/\partial C_{j,t})] = 0, \tag{4}$

$$\partial^2 U_t/\partial^2 C_{i,t} \leq 0.$$

At the end of the period, residents receive their factor and interest incomes; and asset markets are open. Residents start the end of the period with some stock of cash (net of their purchases of consumption goods at the beginning of the period), a stock of time deposits in

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[14]While not explicitly modeled in our analysis, firms would also sell their exports and purchase any required imports at the beginning of the period. As will be discussed, we are also implicitly assuming that firms do not hold cash between periods. This would be true only if firms can meet their working capital needs by borrowing from banks (see Isard, Mathieson and Rojas-Suarez(1992) for an example of a model of such an economy). Moreover, as will be discussed, disguised capital flows through the current account) will also take place during the beginning of the period.

the domestic banking system (B_{t-1}), authorized net foreign assets ($\theta_t F^A_{t-1}$—where θ_t is the

exchange rate and F^A_{t-1} can be either positive [an asset position] or negative [external

borrowing]), and a net foreign position achieved through disguised capital flows ($\theta_t F^D_{t-1}$ +

$\theta_t DCF_t$, which can also be either positive or negative, with $\theta_t DCF_t$ being the level of disguised

capital flows through under- and overinvoicing of trade flows).[15] In addition to factor income

(Y_t), residents also receive income on their net asset positions (or pay interest expenses on

their liability positions). Interest income on domestic deposits equals $r_{B,t-1} B_{t-1}$, where $r_{B,t-1}$ is

the ceiling interest rate on domestic time deposits set by the authorities. Interest income (or

payments) on authorized net foreign assets (liabilities) equals $(1-\phi) r_{F,t-1} \theta_t F^A_{t-1}$, where $r_{F,t-1}$ is the

previous period's foreign interest rate and ϕ is the tax rate on foreign interest income (or

alternatively the tax deduction allowed on foreign interest expenses). The domestic currency

value of the authorized net foreign asset position will also be changed by the exchange rate

gains (or losses) equal to $((\theta_t - \theta_{t-1})/\theta_{t-1}) \theta_t F^A_{t-1}$. Residents' authorized net foreign asset position

will be assumed to be limited by the authorities' capital controls, and, as a result

$$F^A_t \leq \bar{F}^A_t \tag{5}$$

where $\bar{F}^A_t$ is the authorized stock of net foreign assets.

As a result of these capital controls, it will be assumed that residents have an excess

demand for net foreign assets (or net foreign borrowing). Residents will attempt to eliminate

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[15]Note that unauthorized net foreign assets increase at the beginning of the period when trade transactions take place.

this excess demand through disguised capital flows (DCF_t) that involve over- and under-invoicing of exports and imports. However, such disguised capital flows can only occur at the beginning of the period when goods markets are open and involve a cost (in terms of foregone consumption) equal to $P_{2,t}d_0 + P_{2,t}(d_1/2)(\theta_t DCF_t/P_{2,t})^2$.[16] When measured in terms of domestic currency, the stock of cumulative disguised capital flows at the end of period t ($\theta_t F_t^D$) will thus equal:

$$\theta_t F_t^D = \theta_t F_{t-1}^D + \theta_t DCF_t + (r_{F,t-1} + (\theta_t - \theta_{t-1})/\theta_{t-1}))\theta_t F_{t-1}^D \tag{6}$$

At the beginning of the period, residents will thus make decisions regarding their levels of consumption and disguised capital flows (undertaken at the beginning of the period) and their planned (at the end of the period) holdings of cash (M_t), time deposits (B_t), and authorized net foreign assets (F_t^A).[17] This maximization will be done subject to the constraints imposed by the cash-in-advance constraint (equation (2)), the authorities' capital controls (equation (5)), and the budget constraint. The budget constraint will be given by

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[16] Gros (1987) provides a rationale for a quadratic form of these costs.

[17] Given the previous period's cumulative stock of disguised capital flows and the associated interest income and capital gains generated by exchange rate movements, the selection of the level of disguised capital flows automatically implies the end of the period's cumulative stock of disguised capital flows (F_t^D).

$$M_t + B_t + \theta_t F_t^A + \theta_t F_t^D = M_{t-1} + B_{t-1} + \theta_t F_{t-1}^A + \theta_t F_{t-1}^D$$

$$+ r_{B,t-1} B_{t-1} + (r_{F,t-1} + (\theta_t - \theta_{t-1})/\theta_{t-1}))\theta_t F_{t-1}^D$$

$$+ ((1-\phi)r_{F,t-1} + (\theta_t - \theta_{t-1})/\theta_{t-1}))\theta_t F_{t-1}^A + Y_t$$

$$- P_{2,t} d_0 - P_{2,t}(d_1/2)(\theta DCF_t/P_{2,t})^2 \tag{7}$$

$$- P_{1,t} C_{1,t} - P_{2,t} C_{2,t}$$

As shown in Appendix I, a resident's optimal consumption and portfolio decisions can be obtained by maximizing the value function V(.t) given by

$$V(.t) = \max E_t \{ U_t + \beta V(.t+1)$$

$$+ \lambda_{1,t}[M_t/P_{2,t+1} - P_{1,t+1} C_{1,t+1}/P_{2,t+1} - C_{2,t+1}]$$

$$+ \lambda_{2,t}[\theta_t F_t^A/P_{2,t} - \theta_t F_t^A/P_{2,t}]$$

$$+ \lambda_{3,t}[M_t/P_{2,t} + B_t/P_{2,t} + \theta_t F_t^A/P_{2,t} + \theta_t F_t^D/P_{2,t}$$

$$- M_{t-1}/P_{2,t} - (\theta_t F_{t-1}^A/P_{2,t})(1 + r_{F,t-1}(1-\phi) + \epsilon_t)$$

$$- (1 + r_{B,t-1})B_{t-1}/P_{2,t} - Y_t/P_{2,t}$$

$$- (\theta_t F_{t-1}^D/P_{2,t})(1 + r_{F,t-1} + \epsilon_t) + d_0$$

$$+ (d_1/2)(\theta_t DCF_t/P_{2,t})^2 + (P_{1,t}/P_{2,t})C_{1,t} + C_{2,t}]$$

$$+ \lambda_{4,t}[\theta_t F_t^D/P_{2,t} - \theta_t F_{t-1}^D/P_{2,t} - \theta_t DCF_t/P_{2,t}$$

$$- (r_{F,t-1}+\epsilon_t)\theta_t F_{t-1}^D/P_{2,t}]\} \tag{8}$$

where β = resident's rate of time preference

$$\epsilon_t = (\theta_t - \theta_{t-1})/\theta_{t-1}$$

The first order conditions for the optimal values of $C_{1,t}$, $C_{2,t}$, $M_t/P_{2,t}$, $B_t/P_{2,t}$, $\theta_t DCF_t/P_{2,t}$

(or $\theta_t F_t^D/P_{2,t}$), and $\theta_t F_t^A/P_{2,t}$, along with the cash-in-advance constraint and the budget

constraint, can be used to derive the following consumption and portfolio demands. First, the

relative demand for traded and nontraded consumption goods will be given by[18]

$$(\partial U_t/\partial C_{1,t})/(\partial U_t/\partial C_{2,t}) = P_{1,t}/P_{2,t} \tag{9}$$

Second, the optimal level of disguised capital flows will be given by

$$E_t (\theta_t DCF_t/P_{2,t}) = E_t (-1/d_1 +(1+r_{F,t}+\epsilon_{t+1})(1+\epsilon_{t+1})/[d_1(1+r_{B,t})]) \tag{10}$$

---

[18]Since we have defined $C_{1,t}$ and $C_{2,t}$ as vectors of traded and nontraded goods, equation (9) implicitly holds for each pair of traded and nontraded goods. It must be remembered that within each category of traded and nontraded goods, relative prices are taken as fixed.

This implies that the optimal level of disguised capital flows is negatively related to both the cost of undertaking such flows (d_1) and the expected return on domestic time deposits ($1+r_{B,t}$) and is positively related to the expected return on foreign assets $(1+r_{F,t}+\epsilon_{t+1})$.[19]

Third, if the utility function is log linear (Appendix I), then the demand for real broad money will be given by

$$
\begin{aligned}
M_t/P_{2,t} + B_t/P_{2,t} = {} & (B_{t-1}/P_{2,t})(1+r_{B,t-1}) - \theta_t F^A_t/P_{2,t} \\
& + (\theta_t F^A_{t-1}/P_{2,t})(1+r_{F,t-1}(1+\phi)+\epsilon_t) + Y_t/P_{2,t} \\
& - \theta_t F^D_t/P_{2,t} + (\theta_t F^D_{t-1}/P_{2,t})(1+r_{F,t-1}+\epsilon_t) \\
& - d_0 - (d_1/2)(DCF_t\theta_t/P_{2,t})^2
\end{aligned}
\tag{11}
$$

In this relationship, the desired holdings of holdings of authorized net foreign assets ($\theta_t F^A_t/P_{2,t}$), the level of disguised capital flows ($\theta_t DCF_t/P_{2,t}$) and the desired stock of flight capital ($\theta_t F^D_t/P_{2,t}$) would be replaced by their optimal levels (Appendix I).

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[19]As shown in Appendix I, the "extra" $(1+\epsilon_{t+1})$ term arises as part of the process of discounting period t+1 income to period t.

B. Official Behavior

Since the structure of capital controls was discussed in the previous section, this section focuses on modeling the authorities' exchange market intervention function. We will also link the authorities' intervention activities to the expansion of the monetary base and the stock of broad money.

The authorities' intervention function describes the relationship between the overall balance of payments and the change in domestic monetary aggregates. In any economy, the change in the stock of base money (ΔH_t) must equal the sum of the changes the in the central bank's net domestic assets (ΔD_t) and its purchases of foreign exchange ($\theta_t \Delta R_t$):

$$\Delta H_t = \Delta D_t + \theta_t \Delta R_t \tag{12}$$

The authorities' intervention function can be specified in terms of how changes in the central bank's stock of net domestic assets are related to either the state of the balance of payments, exchange rate movements (if the authorities are not fixing the exchange rate), and other variables of interest to the authorities (e.g., the rate of inflation). For simplicity, we will assume that the authorities change net domestic assets of the central bank in response to only

four variables: the overall measured balance of payments, the gap between current and trend output (GAP_t)[20] and the rate of inflation (π_t), and the real exchange rate (REX_t). Thus

$$\Delta D_t/P_{2,t} = \alpha_0 - \alpha_1\theta_t\Delta R_t/P_{2,t} - \alpha_2 GAP_t - \alpha_3\pi_t - \alpha_4 REX_t \qquad (13)$$

This implies that the authorities sterilize α_1 per cent of all purchases of foreign exchange by the central bank and reduce the growth of central bank purchases of domestic assets whenever output rises relative to trend, inflation increases, or prices of nontraded goods begin to rise relative to traded goods (i.e., the real exchange rate appreciates due to domestic inflation).

The change in the stock of broad money (ΔM_t^B) will equal the sum of (1) the change in the stock of base money (ΔH_t) multiplied by the broad money multiplier (m_t^B) and (2) the change in the broad money multiplier multiplied by the stock of broad money. Thus

$$\Delta M_t^B/P_{2,t} = m_t^B\Delta H_t/P_{2,t} + (H_t/P_{2,t})\Delta m_t^B \qquad (14)$$

Finally, the measured balance of payments position [21] will equal the sum of the current balance (CA_t) [22] and authorized capital flows (ΔF_t^A). Thus [23]

---

[20]In our empirical analysis, the trend output is defined to equal the predicted value of the regression of the log of output on time for the period 1973-1989.

[21]This will be equivalent to the authorities' net accumulation of foreign exchange reserves.

[22]In our empirical analysis, this will be defined to equal the sum of the trade balance, net investment and factor income, and errors and omission.

[23]It should be noted that not all disguised capital flows will affect the authorities' foreign exchange position. For example, if an exporter underinvoices her exports and surrenders

$$\theta_t \Delta R_t = \theta_t CA_t + \theta_t \Delta F_t^A \tag{15}$$

C. Money Market Equilibrium, the Current Account and Disguised Capital Flows

Equations (11)-(15) can be used to derive an empirically testable relationship about the linkages between monetary equilibrium and the behavior of the current account when the authorities sterilize exchange market interventions and the private sector undertakes disguised capital flows. Using the fact that $\Delta M_t^B = M_t + B_t - M_{t-1} - B_{t-1}$, we will have

$$- [m_t^B(\alpha_0 + d_0)] - (H_t/P_{2,t})\Delta m_t^B + (Y_t/P_{2,t})$$

$$- \{(\theta_t F_t^A/P_{2,t}) - (\theta_t F_{t-1}^A/P_{2,t})\} - (M_{t-1}/P_{2,t})$$

$$+ (\theta_t F_{t-1}^A/P_{2,t})(r_{F,t-1}(1-\phi)+\epsilon_t) + r_{B,t-1}(B_{t-1}/P_{2,t})$$

$$- (\theta_t DCF_t/P_{2,t}) + d_1(\theta_t DCF_t/P_{2,t})^2/2$$

$$+ (\theta_t F_{t-1}^D/P_{2,t})(r_{F,t-1}+\epsilon_t) =$$

---

[23](...continued)
foreign exchange proceeds equal to only the stated invoice amount, then her holdings of external assets could rise without any corresponding loss of foreign exchange reserves by the authorities. In contrast, if an importer overinvoices her imports and obtains foreign exchange from the central bank (directly or indirectly if the central bank is stabilizing the exchange rate), then the authorities will lose reserves equal to the sum of the true imports and the importers disguised capital outflow.

$$\{(1-\alpha_1)m_t^B[\theta_t CA_t/P_{2,t} + \theta_t F_t^A/P2,t$$

$$- (\theta_t/\theta_{t-1})(P_{2,t-1}/P_{2,t})(\theta_{t-1}F_{t-2}^A/P_{2,t-1})]\}$$

$$- m_t^B \alpha_2 \, GAP_t$$

$$- m_t^B \alpha_3 \, \pi_t$$

$$- m_t^B \alpha_4 \, (REX_t) \tag{16}$$

In equation (16), the left-hand side variable is the increase in the real demand for broad money (net of the effect of the cost of moving funds abroad, which has been moved to the right-hand side of the equation.)

On the right-hand side of equation (16), there are five parameters of interest: the cost of undertaking disguised capital flows (d_1), the sterilization coefficient (α_1), the authorities' responses to the output gap (α_2), inflation (α_3), and real exchange rate movements (α_4). Since many of the variables on both sides of equation (16) are contemporaneously determined, it is clear that a simultaneous equation estimator will be needed. In addition, since we are concerned with changes in the degree of capital mobility confronting the economy, we will need a estimator which allows parameters to vary over time.

IV. ESTIMATION TECHNIQUE AND DATA

This section will first describe the econometric technique used in our analysis, and then

consider the nature of the data used in our empirical analysis of Korea, the Philippines and

Mexico. Section V discusses our estimation results for these three countries.

A. Kalman Estimator

To estimate equation (16), a procedure based on the McNeils and Neftci (1992) two-

stage, instrumental variables Kalman filter estimator was used. Defining Y1 as the left side of

equation (16) (apart from the term associated with the d_1 parameter) and Y2 as the terms

inside the { } on the right hand side of equation (16), we can rewrite equation (16) as

$$Y_1 = \beta_0 + \beta_1 \, Y_2 + \beta_2 \left(\frac{\theta_t / DCF_t}{P_{2,t}} \right)^2 m_t^B \, GAP_t - \beta_4 m_t^B \, \pi_t - \beta_5 \, m_t^B REX_t \tag{17}$$

In estimating the parameters in equation (17), simultaneous equation bias can arise

because the right hand side (rhs) of equation (17) contains both endogenous and exogenous

variables. To eliminate this basis, an instrumental variables approach was used. In particular,

all the endogenous variables on the rhs of equation (17) were first regressed on a set of

instrumental variables which we took as the lagged values of the endogenous variables, a

constant, a time trend and the real level of US GDP (expressed in terms of the domestic

currency).[24] The values of the endogenous variables on the rhs of the equation were then replaced by the predicted values from the instrument variables regressions.

This instrumental variables approach is also consistent with Wickens'(1982) errors-in-variable approach to estimating rational expectations models with forward looking expectations. In particular, the expected rate of inflation and the expected rate of change in the exchange rate are replaced by their corresponding one period ahead values.

A second step involves dealing with the potential problems caused by serially correlated errors in equation (17). Since the Kalman filter is a linear projection estimator, serial correlation of the residual can lead to inefficient estimates. To deal with this problem, we utilize the approach suggested by McNeils and Neftci (1992). Following McNeils and Neftci (MN), it is assumed that the error term in equation (17) follows a first order autoregressive pattern ($\mu_t = \rho\mu_{t-1} + \phi_t$). To obtain an estimate of the ρ, the parameters in equation (16) (including ρ) are first estimated[25] for the sample period using the Cochrane-Orcutt method. It is then assumed that the values of ρ remain constant over time when the

---

[24]In particular, the set of variable

$X2 = \theta_t F_t^A/P_{2,t}$, $X3 = M_t^B/P_{2,t}$, $X4 = M_t^B/P_{2,t}$, $X5 = M_t'/P_{2,t}$ (real narrow money) $X6 = Y_t/P_{t,t}$, $X7 = r_{F,t}$, $X8 = \pi_t$ (rate of inflation), $X9 = r_{Bt}$, $X10 = \theta_t F_t^D/P_{2,t}$, $X11 = \epsilon_t$ (rate of depreciation of the exchange rate), and $X12 = REX_t$ was regressed on $X2(-1)$; $X3(-1)$; $X4(-1)$; $X5(-1)$; $X6(-1)$; $X7(-1)$; $X8(-1)$; $X9(-1)$; $X10(-1)$; a constant; a time trend; and $\theta_t Y_{US}/P_{US}$ (where Y_{US} = nominal US GDP and P_{US} = US CPI).

[25]This estimation is done after replacing the rhs variable with their instrumental values.

Kalman filter is estimated.[26] Before applying the Kalman filter, the rhs variables are first

transformed using the operator 1 - $\hat{\rho}$L where L is the lag operator.[27] [28]

B. Korean, Philippines and Mexican Data

The data for Korea, Mexico and the Philippines are taken primarily from the

International Financial Statistics (IFS), with the exceptions of data for the real effective

exchange rate, deposit interest rates and the stock of flight capital. The real effective

exchange rate series is that calculated by the Fund's Policy Development and Review

Department. The measure of the stock of flight capital is based on the relationship between

disguised capital flows and the returns on foreign and domestic assets given in equation (10).

This relationship implies that the stock of flight capital at any time t will be a function of the

past history of the returns on domestic and foreign assets. One problem associated with

representing the past history of returns is that we have relatively little information about the

yields before the late 1960s, especially for Korean and Philippine domestic financial assets. As

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[26]MN discuss the implications and reasonableness of this assumption.

[27]The estimated version of equation (17) was thus

$$Y1 = \hat{\rho} LY1 + \beta_0 + \beta_1 (1-\hat{\rho}L)Y2$$

$$+ \beta_2(1-\hat{\rho}L) \left(\frac{\theta_t DCF_t}{P_{2,t}} \right)^2 - \beta_3(1-\hat{\rho}L) \ m_t^B \ GAP_t - \beta_4(1-\hat{\rho}L) \ m_t^B \ \pi_t$$

$$- \beta_5(1-\hat{\rho}L) \ m_t^B \ REX_t$$

[28]The MN procedure implicitly assumes that the transformed variable
have the same order of integration as the left hand side variable in equation (17). We used
augmented Dickey-Fuller to test to see if this assumption is appropriate.

a result, the past history of yields is represented by the sum of the first three principal

components of the yield on foreign assets (the sum of the US Treasury bill rate and the one

period ahead rate of depreciation of the domestic currency relative to the US dollar) in the

period from 1953 to 1990. In the case of Mexico, however, it was possible to build a

domestic interest rate series for the period from 1953 to 1990.[29] As a result, the past history

of the yield differential in the Mexican case is represented by the differential between the yield

on foreign assets as defined above, and the yield on domestic financial instruments).

The variables included in the analysis are as follows:

$\theta_t CA_t$ = current account balance (in domestic currency),

Y_t = gross domestic product (in domestic currency),

M_t = currency plus demand deposits (in domestic currency),

B_t = time deposits (in domestic currency),

H_t = base money—(currency plus reserves in the banking system —in domestic currency),

$r_{B,t}$ = time deposit interest rate,

$r_{F,t}$ = US Treasury bill rate,

ϵ_t = rate of depreciation of the domestic currency relative to the U.S. dollar,

$P_{2,t}$ = gross domestic product deflator,

REX_t = real effective exchange rate,

---

[29]The nature of the series will be discussed in Section V3.

F_t^A =   authorized net foreign asset position (cumulative sum of direct foreign investment, private portfolio investments, and other capital movements by deposit money banks and other (nongovernment) sectors.

F_t^D =   stock of disguised capital flows defined as the sum of the first three principal components of the time series $[(1+r_{F,t}+\epsilon_{t+1})/(1+r_{B,t})]$.

V. ESTIMATION RESULTS

A. Korea

For Korea equation (17) was estimated using annual data for the period 1973-89. In estimating the equation (17) for Korea, a slightly different structure for the cost of moving funds abroad through disguised channels than that given in equation (7) was found to provide better explanatory power (i.e., provided a higher value of the log likelihood function for the Kalman filter estimator). In particular, the cost structure was taken to equal

$$costs = d_o + \frac{d_1}{2}\left[\frac{\theta_t DCF_t}{P_{2,t}}\right]^2 + \frac{d_2}{2}\left[\frac{\theta_t DCF_t}{\sum\limits_{j=t}^{\infty}|\theta_j DCF_j|}\right]^2$$

The third term is designed to capture the fact that the cost of moving a given amount of funds abroad is conditioned by residents' experience with capital flight. The "experience" with capital flight is assumed to be represented by the cumulative sum of the disguised capital flows (using the absolute value of all inflows or outflows). The last term in (18) indicates that undertaking a given level of disguised capital flows will be less costly the more experience that residents have with such arbitrage activity.

The parameter estimates for Korea are reported in Table 1.[30][31]

These results indicated that: (1) the estimates of α_1 (as implied by the estimate of β_1) imply that there has been a consistently high level of sterilization of balance of payments flows, (2) the authorities systematically responded to increases in inflation by reducing domestic credit creation, and (3) the cost of disguised capital flows (when measured in real domestic currency terms) has declined sharply over the sample period. In particular, the real cost of undertaking a given scale of disguised capital flows (when measured in domestic currency) would have declined by 85 percent from 1976 to 1989.[32]

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[30]The estimates were derived using the Kalman filter estimates in TSP.

[31]To test for whether all variables in the estimated equation were of the same order of integration, augmented Dickey-Fuller tests were run on the transformed (i.e., multiplied by

$1-\hat{\rho}L$) values of Y1, Y2, $\quad \theta_f DCf/\left(\sum_{j=t}^{-\infty} |\theta_j \, DCF_j|\right)^2$, m_t^B, $m_t^B \, \pi_t$, and $m_t^B \, REX_t$.

For each variable, two regressions were run. First, the change (dY1 = Y1 - Y1(-1)) in the variable was regressed against a constant, a time trend and the one period lagged value of the variable. Then, the second difference (e.g., dY2 = dY1 -dY1(-1)) was regressed on a constant, a time trend, and the one period lagged value of the change in the variable (dY1 (-1)). These results suggest that, for the variables included in the estimated equation, we can reject the hypothesis of a unit root. The ADF value for $(1-\hat{\rho}L)YZ$ was significant at about the 6 percent level. However, further differencing did not lead to a larger negative value for the ADF statistic which also suggests that an I(0) characterization is most appropriate.

[32]This was calculated by using the estimated values of β_2 a multiplying them by the

values $(\theta_f DCf/P_{2,t})^2$ and $(\theta_f DCf/P_{2,t})^2$ and $(\theta_f DCF_t \left[\sum_{j=t}^{-\infty} |\theta_f DCF_j|\right]^2$ in 1976 and 1989 respectively, and summing the two products in each of the years.

Table 1. Kalman Filter Estimator for Korea

Dependable Variable: $(1-\hat{\rho}L)Y1$
Sample Period: 1976-89
Variance of Residuals: .0044

Log of Likelihood
Function = 24.37
$\hat{\rho}$ = 0.93
$\hat{\rho}$ standard error = 0.10

Variable	Parameter	Estimated Coefficient	Standard Error	t-statistic
Constant	(β_0)	10.03	0.20	51.2
$(1-\hat{\rho}L)Y2$	(β_1)	-0.02	0.003	-7.6
$(1-\hat{\rho}L)\left(\dfrac{\theta_t DCF_t}{P_{2,t}}\right)^2$	(β_2)	-0.19	0.19	-0.5
$(1-\hat{\rho}L)\, m_t^B\, GAP_t$	(β_3)	-	-	-
$(1-\hat{\rho}L)\, m_t^B\, \pi_t$	(β_4)	12.51	0.26	8.4
$(1-\hat{\rho}L)\, m_t^B\, REX_t$	(β_5)	-	-	-
$(1-\hat{\rho}L)\left(\dfrac{\theta_t DCF_t}{\sum\limits_{j=t}^{-\infty}|\theta_j\, DCF_j|}\right)^2$	(β_6)	41.17	0.80	51.7

Table 1. Kalman Filter Estimator for Korea (continued)

	Constant	(β_1)	(β_2)	(β_3)	(β_4)	(β_5)	(β_6)
	10.3	0.19	-0.13	-	2.17	-	-41.24

Smoothed State Vectors

1976	10.03	0.19	-0.13	-	2.17	-	-41.24
1977	10.03	0.19	-0.13	-	2.17	-	-41.24
1978	10.03	0.19	-0.13	-	2.17	-	41.24
1979	10.03	0.19	-0.13	-	2.17	-	41.24
1980	10.03	0.19	-0.13	-	2.17	-	41.24
1981	10.03	0.19	-0.13	-	2.15	-	41.24
1982	10.02	0.07	-0.09	-	2.15	-	41.17
1983	10.02	0.15	-0.10	-	2.15	-	41.17
1984	10.02	0.14	-0.10	-	2.15	-	41.17
1985	10.03	0.08	-0.10	-	2.15	-	41.17
1986	10.03	0.10	-0.09	-	2.15	-	41.17
1987	10.03	0.10	-0.09	-	2.15	-	41.17
1988	10.03	0.03	-0.09	-	2.15	-	41.17
1989	10.03	-0.02	-0.09	-	2.15	-	41.17

Table 1. Kalman Filter Estimator for Korea (concluded)

	Direct Residuals
1976	0.0
1977	0.0
1978	0.0
1979	0.0
1980	0.0
1981	0.0
1982	-0.0042
1983	-0.0025
1984	0.0011
1985	0.0012
1986	0.0001
1987	0.0007
1988	-0.0002
1989	0.0004

B. The Philippines

The version of equation (17) that was estimated for the Philippines differed from that of Korea in two respects. First, the cost of disguised capital flows was taken as that original specified in equation (16) rather than that in equation (18). Second, the maximum value of the log likelihood function was obtained when the authorities intervention function was defined to include responses to both the level and the change in the real exchange rate. This would imply, for example, that the authorities slow the rate of domestic credit expansion when domestic inflation exceeds international inflation and leads to a real appreciation of the domestic currency.

The estimation results for the Philippines are given in Table 2.[33] As in the case of Korea, there appears to have been a high degree of sterilization of balance of payments flows. Second, the authorities' intervention was influenced significantly by both the level and change in the real exchange rate. Finally, in contrast to the results for Korea, there does not seem to have been a decline in the cost of moving funds through disguised channels (when measured in real domestic currency units). However, as will be discussed, the cost of moving funds has been much lower in the Philippines than in Korea.

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[33]Augmented Dickey-Fuller tests for the variables included in the estimation equation for the Philippines suggested that we could reject the hypothesis of a unit root at the 5 percent level of significance.

Table 2. Kalman Filter Estimator for Korea

Dependable Variable: $(1-\rho L)Y1$ Sample Period: 1974-89 Variance of Residuals: 0.1052	Log of Likelihood Function = -8.32 $\hat{\rho} = 0.06$ $\hat{\rho}$ standard error = 0.25

Variable	Parameter	Estimated Coefficient	Standard Error	t-statistic
Constant	(β_0)	9.80	0.13	75.8
$(1-\rho L)Y2$	(β_1)	-0.05	0.03	-1.8
$(1-\rho L)\,Y2 \left(\dfrac{\theta_t DCF_t}{P_{2,t}}\right)^2$	(β_2)	0.002	0.0006	4.0
$(1-\rho L)\,m_t^B\, GAP_t$	(β_3)	...	...	...
$(1-\rho L)\,m_t^B\, \pi_t$	(β_4)	...	...	...
$(1-\rho L)\,m_t^B\, REX_t$	(β_5)	0.96	0.9	10.7
$(1-\rho L) \left(\dfrac{\theta_t DCF_t}{\sum_{j=t}^{-\infty} |\theta_j\, DCF_j|}\right)^2$	(β_6)	...	...	...
$(1-\rho L)\,m_t^B\, (REX_t - REX_{t-1})$	(β_7)	0.86	0.28	3.1
Dummy 1 (β_8) 1/		2.16	0.07	31.0
Dummy 2 (β_9) 2/		2.75	0.005	53.7

Table 2. Kalman Filter Estimator for Korea (continued)

	Constant	(β_1)	(β_2)	(β_3)	(β_4)	(β_5)	(β_6)	(β_7)	(β_8)	(β_9)
				β priors						
	9.80	-0.11	0.003	-	-	1.26	-	0.35	2.16	2.77
				Smoothed State Vectors						
1974	9.80	-0.10	0.003	-	-	1.21	-	0.60	2.16	2.77
1975	9.80	-0.10	0.003	-	-	1.18	-	0.63	2.16	2.77
1976	9.79	-0.10	0.003	-	-	1.70	-	0.64	2.26	2.77
1977	9.79	-0.10	0.003	-	-	1.14	-	0.65	2.26	2.77
1978	9.79	-0.09	0.003	-	-	1.13	-	0.66	2.26	2.77
1979	9.80	-0.08	0.002	-	-	1.11	-	0.68	2.26	2.77
1980	9.80	-0.08	0.002	-	-	1.09	-	0.70	2.26	2.77
1981	9.79	-0.07	0.002	-	-	1.06	-	0.73	2.26	2.77
1982	9.79	-0.07	0.002	-	-	1.04	-	0.75	2.16	2.77
1983	9.79	-0.07	0.002	-	-	1.05	-	0.73	2.16	2.77
1984	9.79	-0.07	0.002	-	-	1.06	-	0.73	2.16	2.77
1985	9.79	-0.07	0.002	-	-	1.03	-	0.76	2.16	2.77
1986	9.80	-0.06	0.002	-	-	0.98	-	0.83	2.16	2.77
1987	9.80	-0.06	0.002	-	-	0.98	-	0.83	2.16	2.77
1988	9.80	-0.05	0.002	-	-	0.97	-	0.84	2.16	2.77
1989	9.80	-0.05	0.002	-	-	0.96	-	0.86	2.16	2.77

Table 2. Kalman Filter Estimator for the Philippines (concluded)

	Direct Residuals
1974	0.5540
1975	0.3224
1976	-0.2060
1977	0.1696
1978	-0.1693
1979	0.1641
1980	-0.2741
1981	0.1136
1982	0.4438
1983	-0.0141
1985	0.0012
1984	-0.3783
1985	0.0121
1986	-0.1479
1987	0.3858
1988	-0.1551
1989	0.2896

1/ This dummy variable takes on the value of 1 in 1986 to reflect political instability.

2/ This dummy variable takes on the value -1 in 1974-75 to reflect the effects of the first oil price shock in 1973.

C. Mexico

The version of equation (17) that was estimated for Mexico differed from the standard

equation in two respects. First, the cost of disguised capital flows was taken to be

represented by the third term in equation (18) which assumes that the cost of undertaking a

given capital flow is conditioned by residents' experience with capital flight. Second, the value

of the likelihood function was maximized when the government reaction function was

specified so that it included responses to inflation, the real exchange rate, and the charge in the

gap between potential and actual output.[34]

The estimation results for Mexico are given in Table 3.[35][36] These estimates are consistent

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[34]As will be discussed, the change in the output gap rather than the level of the output gap is used because the Dickey-Fuller tests suggest that the level of the gap was I(1) rather than I(O).

[35]To test whether all variables in the estimated equation were of
the same order of integration, augmented Dickey-Fuller test were run on
the transformed (i.e., multiplied by $1-\hat{\rho}L$) values of Y1, Y2,

$(\theta_t DCF_t / \left(\sum_{j=t}^{-\infty} |\theta_j DCF_j| \right)$ $m_t^B GAP - m_t^{B-1} GAP_{t-1}$, $m_t^B \pi_t$, and $m_t^B REX_t)$. The results suggested

that we can reject the hypothesis of a unit root for all of the variables included in the regression. In contrast, the test statistics for $(1-\hat{\rho}L)$ $m_t^B GAP_t$ implied that we could not reject the hypothesis of a unit root at even the 5 percent level. As a result, the change in the output gap, rather than its level, was included in the regression equation.

[36]The principal component definition of flight capital used in the Mexican case differed from that used in the cases of Korea and the Philippines. As noted earlier, the absence of an extended domestic interest rate series for the latter two countries meant that the first three principal components of the interest rate differential series was calculated by using the current and first five lagged values on the U.S. Treasury bill rate plus the rate of depreciation of the exchange vis-à-vis the U.S. dollar. In the case of Mexico, it was possible to construct a series on domestic interest rates for the period from 1946 to 1989 by combining a series on the return on financial bonds (bonos financieros) for the period 1946 to 1973 and the return on 90 to 175 day deposits for the period 1974 to 1989. For much of the period, these interest rates were ceiling interest rates established by the authorities. As a result, the principal components series for Mexico were based on the difference between the return on external assets (as

Table 3. Kalman Filter Estimator for Korea

Dependable Variable: $(1-\hat{\rho}L)Y1$ Sample Period: 1978-89 Variance of Residuals: 0.20	Log of Likelihood Function = - 34.32 $\hat{\rho}$ = 0.74 $\hat{\rho}$ standard error = 0.19

Variable	Parameter	Estimated Coefficient	Standard Error	t-statistic
Constant	(β_0)	28.17	5.90	4.77
$(1-\hat{\rho}L) Y2$	(β_1)	-0.49	0.58	-0.85
$(1-\hat{\rho}L) \left(\dfrac{\theta_t DCF_t}{P_{2,t}} \right)^2$	(β_2)	...	...	...
$(1-\hat{\rho}L) \{m_t^B GAP_t - m_{t-1}^B GAP_{t-1}\}$	(β_3)	66.16	12.26	5.40
$(1-\hat{\rho}L) m_t^B \pi_t$	(β_4)	66.11	9.96	6.64
$(1-\hat{\rho}L) m_t^B REX_t$	(β_5)	0.46	0.08	6.00
$(1-\hat{\rho}L) \left(\dfrac{\theta_t DCF_t}{\sum\limits_{j=t}^{-\infty} |\theta_j DCF_j|} \right)^2$	(β_6)	31.34	5.26	5.96
1/ Dummy 1	(β_8)	104.10	3.15	33.03
2/ Dummy 2	(β_9)	0.01	0.99	0.01

Table 3. Kalman Filter Estimator for Mexico (continued)

	Constant	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	β_9
	32.75	-0.53	-	75.82	74.06	0.05	33.97	-	101.81	0.00
1977	32.75	-0.53	-	75.82	74.06	0.05	33.97	-	101.81	0.00
1978	32.75	-0.53	-	75.82	74.06	0.05	33.97	-	101.81	0.00
1979	32.75	-0.53	-	75.82	74.06	0.05	33.97	-	101.81	0.00
1980	32.75	-0.53	-	75.82	74.06	0.05	33.97	-	101.81	0.00
1981	32.75	-0.53	-	75.82	74.06	0.05	33.97	-	101.81	0.00
1982	32.75	-0.53	-	75.82	74.06	0.05	33.97	-	101.81	0.00
1983	32.75	-0.53	-	75.82	74.06	0.05	31.34	-	104.10	0.00
1984	32.75	-0.53	-	75.82	74.06	0.05	31.34	-	104.10	0.00
1985	28.17	-0.30	-	66.15	66.15	0.01	31.34	-	104.10	0.01
1986	28.17	-0.38	-	66.16	66.14	-0.29	31.34	-	104.10	0.01
1987	28.17	-0.46	-	66.16	66.12	-0.66	31.34	-	104.10	0.01
1988	28.17	-0.44	-	66.16	66.11	-0.13	31.34	-	104.10	0.01
1989	28.17	-0.49	-	66.16	66.11	0.46	31.34	-	104.10	0.01

Table 3. Kalman Filter Estimator for Mexico (concluded)

	Direct Residuals
1977	0.0
1978	0.0
1979	0.0
1980	0.0
1981	0.0
1982	0.0
1983	0.0
1984	0.0
1985	-0.0034
1986	-0.0002
1987	0.0026
1988	0.0015
1989	-0.0024

1/ This dummy variable takes on the value of 1 in 1982 to reflect the onset on Mexico's external debt service problems.

2/ This dummy variable takes on the value 1 in 1987 to reflect the first year in which the Pact for Economic Solidarity between the government, labor and business was introduced.

with those obtained for Korea and the Philippines. In particular, there is further evidence of:
(1) a high degree of sterilization of balance of payments flows and (2) the cost of disguised
capital flows has declined sharply during the sample period (i.e., the real cost of undertaking
such flow in 1989 was only a hundredth of the cost in 1977).[37] In addition, the authorities
altered their domestic credit policy in response to movements in the rate of inflation and real
exchange rate, as well as to changes in the gap between actual and potential output.

We can consider how the cost of disguised capital flows has evolved over time in
different countries by examining the cost of undertaking the capital flows that would be
generated by a given interest rate differential table 3 at different points in time. In particular,
we can examine the response to a one unit increase in our principal component measure of the
history of interest rate differentials.[38] The cost of undertaking the associated disguised flows
(in real domestic currency terms) in 1976 was 16.99 million won in Korea and .0022 million

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[36](...continued)
represented by the sum of the yield on U.S. Treasury bills plus the rate of depreciation of the
Mexican peso) and the domestic interest rate).

[37]In particular, a unit (measured in real domestic currency terms) of disguised capital flow
would have cost 2.30 pesos in 1977 versus 0.02 pesos in 1989. This sharp decline in the cost
of moving funds also reflects the liberalization of restrictions on capital account transactions in
Mexico.

[38]A l-unit value of our principal component measure of flight capital corresponds to a
percentage point in the interest rate differential. As noted by Dhrymes (1970, pp. 53-65), the
principal components are not independent of the units of the underlying time series. However,
they are comparable across countries in our case because the underlying time series for each
country is measured in percent. In particular, the underlying time series are the current and
five lagged values of either the rate of return earned by holding external assets (the U.S.
treasury bill rate plus the percentage change in the exchange rate vis-à-vis the U.S. dollar in
the cases of Korea and the Philippines) or the differential between the rate of return on
holding foreign and domestic assets (in the case of Mexico). Thus a doubling of the
underlying interest rate series would imply a doubling of the principal components measure.
Note that the scale of flows that would be associated with a unit increase in our principal
component measure could be quite different across countries.

pesos in the Philippines.[39] By 1990, the respective costs were 6.29 million won and

.0023 million pesos for Korea and the Philippines, respectively. Over the period between

1977 and 1989, the estimation results for Mexico indicate that the cost (measure in real

domestic currency) of undertaking the disguised capital flows associated with a one unit

increase in our principal component measure declined from .0230 million pesos to

.00022 million pesos. However, it must be noted that, even if these costs were converted to

a common currency (e.g., the U.S. dollar), they would not be directly comparable since the

underlying capital flows generated by a given interest rate differential could differ across

countries. Nonetheless, converting to U.S. dollars does allow us to compare how the cost of

undertaking a given level of disguised capital flows (measured in terms of an international unit

of account) had evolved over time within a given country. For Korea, the won/dollar rate was

484 and 708 in 1976 and 1990 respectively; whereas, for the Philippines the peso/dollar rate

was 7.44 and 24.31 in 1976 and 1990, respectively. This implies that the cost indices become

$.0351 million (in 1976) and $.0089 million (in 1990) for Korea and $.00031 million (in 1976)

and $.00009 million (in 1990) for the Philippines (Table 4). The comparison implies that,

between 1976 and 1990, the cost of disguised capital flows (measured in U.S. dollar terms)

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[39]These comparisons were calculated as follows. For Korea, the estimated real cost of disguised capital flows is given by (from Table 1).

$$-.024 \left(\frac{\theta_j DCF_t}{P_{2,t}} \right)^2 + 41.17 \; (\theta_j DCF_t / \sum_{j=t}^{-\infty} |\theta_j DCF_j|)^2$$

For the Philippines, the corresponding cost function is given by

$$.0023 \left(\frac{\theta_j DCF_t}{P_{2,t}} \right).$$ We then let $\left(\frac{\theta_j DCF_t}{P_{2,t}} \right) = 1.$ For Korea, the variable

$\sum_{j=t}^{-\infty} |\theta_j \; DCF_j|$ takes on the values 2.42 and 6.29 in 1976 and 1990 respectively.

Table 4. Real Cost of Undertaking Disguised Capital Flows 1/

(In millions of U.S. dollars)

Year	Korea	Mexico	The Philippines
1976	.0351	..	0.0031
1977	..	1.150	..
1978	..	..	..
1989	..	.00007	..
1990	0.0089	..	0.00009

1/ This is the cost of undertaking one unit (measured in real domestic currency terms) of disguised capital flows.

fell by 75 percent in Korea and by 70 percent in the Philippines. In terms of the U.S. dollar, Mexican costs declined from $1.15 million to $.00007 million, which represents a larger percentage decline than in either Korea or the Philippines.

VI. CONCLUSION

This paper has examined an alternative measure of the degree of capital mobility confronting a developing country which has restrictions on capital flows and official ceilings on domestic interest rates. The analysis first developed an intertemporal model which described the linkages between the current account, capital controls, domestic and external financial market conditions, the cost of disguised capital flows, and the authorities' foreign exchange market intervention strategy. This model was used to identify how the measured current account balance behaves when there are disguised capital flows and the degree of integration between domestic and international financial markets increased over time. In addition, the model suggested a means of distinguishing between changes in the cost of undertaking disguised capital flows and changes in the authorities' foreign exchange market intervention activities. Empirical estimates of the models key parameters using data from Korea, Mexico and the Philippines for the period since the 1970s suggested that the real cost of disguised capital flows has fallen by at least 70 percent during the sample period.

OPTIMAL CONSUMPTION AND PORTFOLIO DECISIONS

This appendix examines the representative resident's optimal consumption and portfolio decisions. Using equation (8) of the main text, the resident's optimal consumption and portfolio decisions will be given by:

$$\partial V(.t)/\partial C_{1,t} = 0 = E_t \{\partial U_t/\partial C_{1,t} + \lambda_{3,t}(P_{1,t}/P_{2,t})\} \tag{A1}$$

$$\partial V(.t)/\partial C_{2,t} = 0 = E_t \{\partial U_t/\partial C_{2,t} + \lambda_{3,t}\} \tag{A2}$$

$$\partial V(.t)/\partial (M_t/P_{2,t}) = 0 = E_t \{\beta(\partial V(.t+1)/\partial(.t+1))(P_{2,t}/P_{2,t+1}) + \lambda_{1,t}(P_{2,t}/P_{2,t+1}) + \lambda_{3,t}\} \tag{A3}$$

$$\partial V(.t)/\partial (B_t/P_{2,t}) = 0 = E_t \{\beta(\partial V(.t+1)/\partial(.t+1))(P_{2,t}/P_{2,t+1})(1+r_{B,t}) + \lambda_{3,t}\} \tag{A4}$$

$$\partial V(.t)/\partial (\theta_t DCF_t/P_{2,t}) = 0 = E_t \{\lambda_{3,t} d_1(\theta_t DCF_t/P_{2,t}) - \lambda_{4,t}\} \tag{A5}$$

$$\partial V(.t)/\partial (\theta_t F_t^D/P_{2,t}) = 0 = E_t \{\beta(\partial V(.t+1)/\partial(.t+1))(P_{2,t}/P_{2,t+1})$$
$$(1+r_{F,t}+\epsilon_{t+1})(\theta_{t+1}/\theta_t) + \lambda_{3,t} + \lambda_{4,t}\} \tag{A6}$$

$$\partial V(.t)/\partial (\theta_t F_t^A/P_{2,t}) = 0 = E_t \{\beta(\partial V(.t+1)/\partial(.t+1))(P_{2,t}/P_{2,t+1})$$
$$(1+(1-\phi_{t+1})r_{F,t}+\epsilon_{t+1})(\theta_{t+1}/\theta_t) + \lambda_{2,t} + \lambda_{3,t}\} \tag{A7}$$

These results use the fact that:

$$(.t) = (P_{1,t}/P_{2,t})C_{1,t} + C_{2,t} + \theta_t F_t^A/P_{2,t} + \theta_t F_t^D/P_{2,t} + B_t/P_{2,t} + M_t/P_{2,t} \qquad (A8)$$

$$(.t+1) = (P_{1,t+1}/P_{2,t+1})C_{1,t+1} + C_{2,t+1} + \theta_{t+1}F_t^A/P_{2,t+1} + \theta_{t+1}F_t^D/P_{2,t+1} + B_{t+1}/P_{2,t+1} + M_{t+1}/P_{2,t+1}$$

$$= M_t/P_{2,t+1} + (\theta_{t+1}F_t^A/P_{2,t+1})(1+r_{F,t}(1-\phi_{t+1})+\epsilon_{t+1}) + (1+r_{B,t})B_t/P_{2,t+1} \qquad (A9)$$

$$+ (\theta_{t+1}F_t^D/P_{2,t+1})(1+r_{F,t}+\epsilon_{t+1}) - d_0 - (d_1/2)(\theta_{t+1}DCF_{t+1}/P_{2,t+1})^2$$

$$\partial V(.t+1)/\partial(.t+1) = \partial U_{t+1}/\partial C_{2,t+1} \qquad (A10)$$

(the Benveniste-Scheinkman condition, as discussed by Sargent (1987), p. 21-22).

The optimal consumption and portfolio specifications used in equations (9)-(11) of the main text are derived as follows. Equation (9) is derived using equation (A1) and (A2). Equation (10) is derived by first using equation (A4) to solve for $\lambda_{3,t}$, and then substituting that value of $\lambda_{3,t}$ into equation (A6) to solve for $\lambda_{4,t}$. These values of $\lambda_{3,t}$ and $\lambda_{4,t}$ were then substituted into equation (A5) to obtain equation (9).

The derivation of the optimal holdings of narrow money involves the following steps. First, assume that utility is log linear (i.e., $U_t = \ln C_{1,t} + \ln C_{2,t}$). The cash-in-advance constraint then implies that $E_t\{(M_t/P_{2,t})(P_{2,t}/P_{2,t+1})\} = E_t\{(P_{1,t+1}/P_{2,t+1})C_{1,t+1} + C_{2,t+1}\}$. Equation (7) and the log linear utility function further imply that $E_t\{(\partial U_t/\partial C_{1,t})/(\partial U_t/\partial C_{2,t})\} = C_{2,t}/C_{1,t} = P_{1,t}/P_{2,t}$. Thus,

$E_t(C_{2,t+1}/C_{1,t+1}) = E_t(P_{1,t+1}/P_{2,t+1})$. As a result,

$$E_t\{(M_t/P_{2,t})(P_{2,t}/P_{2,t+1})\} = E_t\{(C_{2,t+1}/C_{1,t+1})C_{1,t+1} + C_{2,t+1}) = 2E_t C_{2,t+1}.$$

Thus

$$E_t(M_t/P_{2,t}) = 2E_t\{(P_{2,t+1}/P_{2,t})C_{2,t+1}$$

$$(A11)$$

Next, combining equations (A1), (I,2) and (A4), we will have

$$0 = E_t \{\beta(\partial U_{t+1}/\partial C_{2,t+1})(P_{2,t}/P_{2,t+1})(1+r_{B,t}) - \partial U_t/\partial C_t\}$$

$$= E_t \{\beta(1+r_{B,t})/(C_{2,t+1}(1+\pi_{2,t+1})) - 1/C_{2,t}\}$$

$$= E_t (C_{2,t+1}/C_{2,t}) = \beta E_t \{(1+r_{B,t})/(1+\pi_{2,t+1})\}$$

where $1+\pi_{2,t+1} = P_{2,t+1}/P_{2,t}$

Combining this relationship with equation (A11) yields

$$E_t (C_{2,t+1}/C_{2,t}) = E_t\{[M_t/P_{2,t}][P_{2,t}/P_{2,t+1}]/[M_{t-1}/P_{2,t-1}][P_{2,t-1}/P_{2,t}]\}$$

$$= \beta E_t \{(1+r_{B,t})/(1+\pi_{2,t+1})\}$$

$$\text{or } E_t\{[M_t/P_{2,t}]/[1+\pi_{2,t+1}]\} =$$

$$\beta E_t \{[(1+r_{B,t})][M_{t-1}/P_{2,t-1}]/[(1+\pi_{2,t+1})(1+\pi_{2,t})]\}$$

or

$$E_t[M_t/P_{2,t}] = \beta E_t \{[(1+r_{B,t})][M_{t-1}/P_{2,t-1}]/(1+\pi_{2,t})\}$$ (A12)

The derivation of equation (11) in the text follows directly from the budget constraint (equation (7)), the cash-in-advance constraint (equation (2)), the optimal (or constrained) holdings of authorized net foreign assets and the optimal level of disguised capital flows. Since $M_{t-1}/P_{2,t} = (P_{1,t}/P_{2,t})C_{1,t} + C_{2,t}$, we will have by the budget constraint that optimal holdings of time deposits will be given by

$$B_t/P_{2,t} = - M_t/P_{2,t} - \theta_t F_t^A/P_{2,t} - \theta_t F_t^D/P_{2,t}$$

$$- M_{t-1}/P_{2,t} + (\theta_t F_{t-1}^A/P_{2,t})(1+r_{F,t-1}(1-\phi)+\epsilon_t)$$

$$+ (1+r_{B,t-1})B_{t-1}/P_{2,t} + Y_t/P_{2,t}$$

$$+ (\theta_t F_{t-1}^D/P_{2,t})(1+r_{F,t-1}+\epsilon_t) - d_0$$

$$- (d_1/2)(\theta_t DCF_t/P_{2,t})^2$$

Real holdings of broad money (equation (11)) will be given by

$$B_t/P_{2,t} + M_t/P_{2,t} = - \theta_t F_t^A/P_{2,t} - \theta_t F_t^D/P_{2,t}$$

$$- M_{t-1}/P_{2,t} + (\theta_t F_{t-1}^A/P_{2,t})(1+r_{F,t-1}(1-\phi)+\epsilon_t)$$

$$+ (1+r_{B,t-1})B_{t-1}/P_{2,t} + Y_t/P_{2,t}$$

$$+ (\theta_t F^D_{t-1}/P_{2,t})(1+r_{F,t-1}+\epsilon_t) - d_0$$

$$- (d_1/2)(\theta_t DCF_t/P_{2,t})^2$$

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