

Sterilization of Capital Inflows through the Banking Sector: Evidence from Asia

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This paper develops an open-economy version of the Bernanke-Blinder model which indicates that sterilization efforts through increases in reserve requirements will have limited impact if viable financial alternatives to the commercial banking sector exist. I then examine the capital inflow surge experiences of seven developing Asian nations. Our analysis yields three stylized conclusions: First, the timing of capital inflow surges indicates a causal role for both domestic and foreign factors. Second, there is little general rule as to the most effective sterilization instrument. Finally, the experiences of the developing nations during their capital inflow surge period largely coincide with the predictions of the model. Korea, the country with the largest nonbank financial sector, had the least success in stemming the impact of capital inflow surges despite intervention through both open market operations and increased reserve requirements.

The magnitude of recent capital inflows into developing countries in the Pacific Basin has been staggering. During the period from 1990 to 1993, Asian developing nations received a net capital inflow of \$151 billion. These flows were large relative to the countries as a whole. Capital inflows reached 13 percent of GDP in Thailand and Malaysia, 10 percent of GDP in Singapore, 6 percent in the Philippines, and 5 percent in Indonesia (Glick and Moreno 1994). The source of these surges in capital inflows is controversial. Calvo, Leiderman, and Reinhart (1993) present evidence that external factors played a dominant role in the pattern of capital inflows in Latin America. However, Schadler (1994) stresses that external developments did not always coincide with surges in inflows, and that domestic factors must have played a role as well. Among these, she stresses structural changes that improved potential productivity, improved fiscal policies, and a tightening of domestic credit policies. Chuhan, Claessens, and Mamingi (1993) also find that while the foreign environment matters, domestic factors were the primary determinants of the magnitude of Asian capital inflows in their study.

A large literature has emerged analyzing the implications of these capital inflows, and in particular, investigating the contention that the extremely large magnitudes of the inflows can be disruptive to a nation's economy, resulting in the desire to mitigate their influence. It has been suggested that while capital inflows may be desirable because the marginal product of capital is larger in developing countries, rapid reversals of these flows can lead to domestic liquidity problems. Bercuson and Koenig (1993) question whether large increases in financial flows can be handled efficiently by the financial system, suggesting that flows of sufficient magnitude may jeopardize the safety of the banking system. In addition, the real exchange rate appreciations that often accompany these capital inflows can lead to undesirable resource reallocation, particularly if the reallocation of resources motivated by the capital inflow surge is likely to be temporary.

Asian developing country governments in particular have responded to these capital inflows with aggressive attempts at sterilization. In 1993, one-third of the \$100 billion in net capital inflows into Asia Pacific Economic

Cooperation Forum (APEC) nations was absorbed by central banks as foreign currency reserves. By the end of 1993, the stock of reserves of the Asian region equalled \$261 billion, far exceeding the combined total of all the developing nations and nations in transition in the rest of the world.

While sterilized intervention through open market operations appears to be the most common response to capital inflows, its use appears to diminish over the course of an extended capital inflow episode. In Asia, for example, the share of capital inflows which became increases in reserves has declined over time (Khan and Reinhart 1994). This may reflect the problems associated with prolonged sterilized intervention noted by Calvo, Leiderman and Reinhart (1993). First, sterilization requires governments to purchase low-yielding foreign securities despite the fact that they are often paying high interest rates on external debt. This process obviously places a burden on the recipient country government. These "quasi-fiscal costs" have been estimated to amount to up to one-half percent of GDP in Latin America (Kiguel and Leiderman 1993). Second, by preventing a decrease in the interest rate differential between domestic and foreign assets, sterilized intervention fails to eradicate the conditions which led to the capital inflow.

As nations become dissatisfied with the costs or the effectiveness of sterilized intervention through open market operations, they turn towards other, less standard sterilization instruments. In this paper, we examine an alternative policy response to capital inflows which has been particularly popular in Southeast Asia, increases in commercial bank reserve requirements.¹ This policy attempts to limit the impact of foreign capital inflows by reducing the magnitude of capital which flows into the banking sector. Banking institutions retain a significant role as financial intermediaries in developing countries in Asia. Consequently, a significant portion of the capital which flows into these countries either enters directly into, or finds its way into, the developing country banking system.

Most of the portfolio inflows into APEC developing countries in recent years have been bonds issued by APEC borrowers in foreign currencies (Folkerts-Landau, et al., 1994). However, the potential for an increase in bank lending resulting from this form of inflow is similar. If the local bond issuer deposits his capital in a domestic bank, it is the same as if the domestic bank had issued a foreign li-

ability itself. Consequently, regardless of the form of the capital inflow, the impact is likely to be an expansion of the domestic financial system.²

Policymakers may also have particular interest in limiting the activities of their banking sector during capital inflow surges. Large and volatile capital flows can contribute to bank problems by causing large swings in bank liquidity. Calvo, Leiderman, and Reinhart (1993) discuss the possibility of capital inflows leading to "improper intermediation." These could result from a variety of sources, including improperly priced government deposit insurance, either explicit or implicit. The problem with addressing the improper intermediation through a mandatory deposit insurance scheme, according to Calvo, Leiderman, and Reinhart, is that such a scheme would need to be highly sophisticated, incorporating the loss associated with a reversal in the flow of capital. The authors argue that "...in the short run, it may be more practical simply to preclude banks from intermediating much of the new capital inflow by increasing required reserve ratios" (p. 144). They argue that by limiting the investments of banks in markets prone to speculative bubbles, such as real estate and equity markets, the country's banking system will be less exposed when the bubble bursts.

However, placing the burden of sterilizing the capital inflow surge on the commercial banking sector is not a costless policy. Folkerts-Landau, et al. (1994) identify two primary disadvantages of sterilization through increases in bank reserve requirements. First, since reserves do not earn market rates of return, an increase in reserve requirements distorts the share of intermediation handled by the banking sector. Second, raising reserve requirements may not be effective at addressing capital inflows which are intermediated outside the banking system. These include bond and equity markets which have been growing rapidly in these countries over the previous decade and the informal lending or "curb markets" prevalent in many Asian developing countries. Raising reserve requirements will put banks at a competitive disadvantage relative to these non-bank institutions and lead to disintermediation.

Below, we develop a simple model which can analyze the implications of enhanced capital inflows on the domestic credit markets of the capital recipient countries. Our model is an open-economy Mundell-Fleming version of the Bernanke-Blinder (1987) model. The Bernanke-Blinder model introduces an explicit banking sector into a standard IS-LM macro model. Our "open economy" extension is essentially the introduction of a balance of payments equation. This extension allows us to trace out the

1. While the Pacific Basin countries have been particularly active in using reserve requirements as the instrument for limiting capital inflows, they have not been alone. In 1992, for example, Chile levied a 30 percent reserve requirement on foreign credits, while Mexico imposed a 10 percent limit on the share of foreign currency liabilities (Folkerts-Landau, et al., 1994).

2. The exception would be if the capital immediately flowed back out of the nation to support a current account deficit.

implications of a surge in capital inflows and a reserve requirement increase policy response.³

We then examine the empirical experiences of seven Asian developing countries over this period. These nations experienced a variety of capital inflow episodes and responded to them with an assortment of government policies, including a variety of policies designed to curtail the activities of the banking sector.

Both our theoretical analysis and our empirical evidence demonstrates that the effectiveness of sterilization policies, including those specifically targeted at the banking sector, depends on the ability of the nonbank sector to play a substitute role for intermediation. The greater is the degree to which foreign investors can substitute nonbank for banking sector investments, and the greater is the degree to which these nonbank investments influence the level of aggregate demand, the lesser is the ability of the recipient country's government to mitigate the impact of capital inflows through the use of reserve requirements.

The remainder of this paper is organized into four sections. Section 1 introduces an open-economy version of the Bernanke-Blinder model. Section 2 conducts comparative static exercises concerning the implications of a decrease in the foreign rate of interest for this model and the impact of policy responses through either an increase in reserve requirements or a decrease in the stock of high-powered money. Section 3 examines the experiences of seven Asian countries during the period of relatively large capital inflows. Finally, Section 4 concludes.

I. A SIMPLE MODEL OF THE MACROECONOMIC IMPACTS OF CAPITAL INFLOWS

Assumptions

There are three domestic assets, as in the Bernanke-Blinder (1987) augmented IS-LM framework: money, bonds, and bank loans. Domestic bank loans pay interest rate r , as do bank deposits, while domestic bonds pay interest rate i . The real side of the economy is assumed to be similar to a standard Mundell-Fleming model. Domestic aggregate demand follows a standard IS-LM pattern:

$$(1) \quad A = A(i, r)$$

where $A_i < 0$ and $A_r < 0$. Income is equal to domestic aggregate demand plus the net trade surplus:

$$(2) \quad Y = A + T$$

where T represents the trade balance. We assume throughout that prices are fixed and that the monetary authority maintains a pegged exchange rate regime. For the purposes of this paper, we also implicitly hold foreign income levels constant and express T solely as a function of Y :

$$(3) \quad T = T(Y)$$

where $T_Y < 0$.

We make the simplifying assumption that all foreign capital inflows come directly into the domestic banking sector in the form of foreign deposits, which we term D^* . The supply of foreign capital to the domestic banking sector is assumed to be increasing in the spread between domestic bank interest rates and the risk-free foreign rate of interest, r^* :

$$(4) \quad D^* = D^*(r - r^*)$$

where $D^*_{r-r^*} > 0$. We assume that domestic agents only hold domestic assets for simplicity, and thus rule out the possibility of capital flight.

We assume that when foreign source deposits enter the commercial banking system, the central bank, in order to maintain the exchange rate peg, issues enough reserves to match these assets one for one in domestic currency. Define τ as the bank reserve requirement, $0 < \tau < 1$. Assuming that banks hold no excess reserves and letting R^* represent the reserves issued to monetize foreign capital inflows, the central bank issues reserves such that

$$(5) \quad D^*(r - r^*) = R^*/\tau.$$

Note that this component of high-powered money is not discretionary to the monetary authority. Under free capital mobility, this change in the stock of high-powered money is required to defend the nominal exchange rate peg. We examine the implications of monetary policy below by examining changes in the discretionary component of the monetary base, R , the high-powered money issued to underlie domestic credit.

We next turn to the market for bank loans. Banks hold reserves equal to $\tau(D + D^*)$ and divide up their remaining assets between bank loans and bank holdings of bonds. Define $\lambda(r, i)$, $\lambda_r > 0$, $\lambda_i < 0$, as the share of free assets banks hold as loans. The bank loan supply curve then satisfies $L^S = \lambda(r, i)(D + D^*)(1 - \tau)$. We specify a standard loan demand curve, $L^D = L(r, i, Y)$, $L_r < 0$, $L_i > 0$, $L_Y > 0$. Equilibrium in the market for bank loans then satisfies:

3. Chinn and Dooley (1995) use a similar model to explain inconsistencies found in the literature concerning the degree of capital mobility in Pacific Rim economies. Their argument is that studies based on money market rates ignore that "bank credit is special." Their empirical finding that capital inflows positively affect bank lending for a group of Pacific Rim countries is also consistent with the predictions of the open-economy Bernanke-Blinder model.

$$(6) \quad L(r, i, Y) = \lambda(r, i)(D + D^*)(1 - \tau) .$$

Finally, we derive the equilibrium condition in the money market.⁴ Since banks do not hold excess reserves, the supply of deposits is equal to the stock of high-powered money divided by reserve requirements, $(R + R^*)/\tau$. Following Bernanke and Blinder, we specify the demand for money as a function of the bond rate and income $D = D(i, Y)$, $D_i < 0$, $D_Y > 0$. The equilibrium condition in the money market then takes on the characteristics of a standard LM curve:⁵

$$(7) \quad D^*(r - r^*) + D(i, Y) = (R + R^*)/\tau .$$

By (5), equation (7) simplifies to

$$(7') \quad D(i, Y) = R/\tau .$$

Using equation (7') to substitute for D in equation (6) yields the equilibrium condition in the bank loan market as

$$(8) \quad L(r, i, Y) = \lambda(r, i)[R/\tau + D^*(r - r^*)](1 - \tau) .$$

Equation (8) suggests that we can express the bank loan rate r as a function of the world interest rate, r^* , the required reserve ratio, τ , the size of the monetary base underlying domestic deposits, R , the bond market interest rate, i , and the level of income, Y :

$$(9) \quad r = \phi(r^*, \tau, R, i, Y)$$

where $\phi_{r^*} > 0$, $\phi_\tau > 0$, $\phi_R < 0$, $\phi_i > 0$, and $\phi_Y > 0$. We demonstrate these comparative static relationships in the appendix.

In addition, we obtain the result that $dr/d\tau$ is decreasing in the absolute value of both L_r and λ_r . Intuitively, these relationships reflect the fact that the degree to which an increase in reserve requirements results in an increase in the bank loan rate depends on the elasticity of bank loan demand and supply. In particular, the ability of banks to pass their additional cost of funds on to its borrowers will depend on the elasticity of demand for bank loans, which presumably depends on the ability of bank loan customers to obtain funds elsewhere. Similarly, the willingness of substitute bonds for bank loans in their portfolio depends on the quality of alternative investment instruments available. Consequently, the relatively poorer are the alternative potential sources of funds, the greater is the bank loan rate response to an increase in bank reserve requirements.

Substituting (9) into equation (2) yields:

$$(10) \quad Y = A[i, \phi(r^*, \tau, R, i, Y)] + T(Y) .$$

We can refer to equation (10) as the "CX curve." The curve should be thought of as a variant of the standard IS curve, along which domestic and external goods markets are in equilibrium, which also defines equilibrium in the bank loan market. Like a standard IS curve, the CX curve is negatively sloped. However, the introduction of a bank loan market allows the CX curve to shift due to credit market shocks, such as policy changes in R or τ , as in the Bernanke-Blinder model. In addition, the external sector can provide a source of foreign shocks, proxied simply here by changes in r^* .

Our CX curve reduces to a standard Mundell-Fleming "XX curve," where aggregate supply is equal to domestic absorption plus the net trade balance, if loans and bonds are perfect substitutes to either lender or borrowers.⁶ Similarly, the CX curve becomes flat if foreign and domestic assets are perfect substitutes under our maintained small-country assumption. Of course, as in the standard IS-LM model, the LM curve becomes flat if money and bonds are perfect substitutes.

While the CX curve measures equilibrium in the goods market, it does not imply a balance of payments equilibrium. The balance of payments is equal to the sum of net exports and capital inflows. As in the standard Mundell-Fleming model, we define the "BP curve" as the locus of points where the balance of payments is equal to zero. The BP curve therefore satisfies

$$(11) \quad T(Y) = -D^*(r - r^*) .$$

We then have our model as shown in Figure 1. Note that the BP curve is upward-sloping reflecting our assumption that foreigners consider their deposits imperfect substitutes for their domestic deposits. The intersection of all three curves implies that the goods market, the money market, and the balance of payments are all in equilibrium.

II. COMPARATIVE STATICS

*Implications of a Decrease in r^**

Many authors, such as Calvo, Leiderman, and Reinhart (1993), attribute the surge of capital inflows into Latin America to a change in the relative demand for these assets due to a fall in developed nation interest rates. We can express the system in balance of payments equilibrium by substituting for T in equation (10) by using equation (11),

4. Satisfaction of equilibrium in the goods, bank loans, and money markets implies satisfaction of equilibrium in the bond market by Walras' law.

5. The demand for money should also be a function of total wealth. As in Bernanke and Blinder, we assume that this is constant and suppress it.

6. This is analogous to the fact that the Bernanke-Blinder CC curve reverts to a normal IS curve under the same conditions. Closing the economy to foreign capital inflows would obviously result in the CX curve reverting to the standard Bernanke-Blinder CC curve.

FIGURE 1

OPEN ECONOMY BERNANKE-BLINDER MODEL

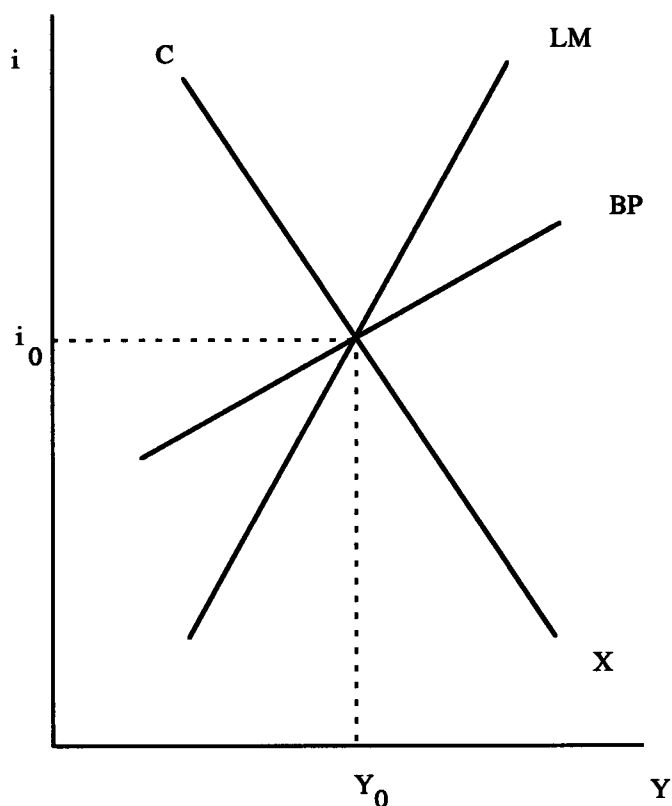
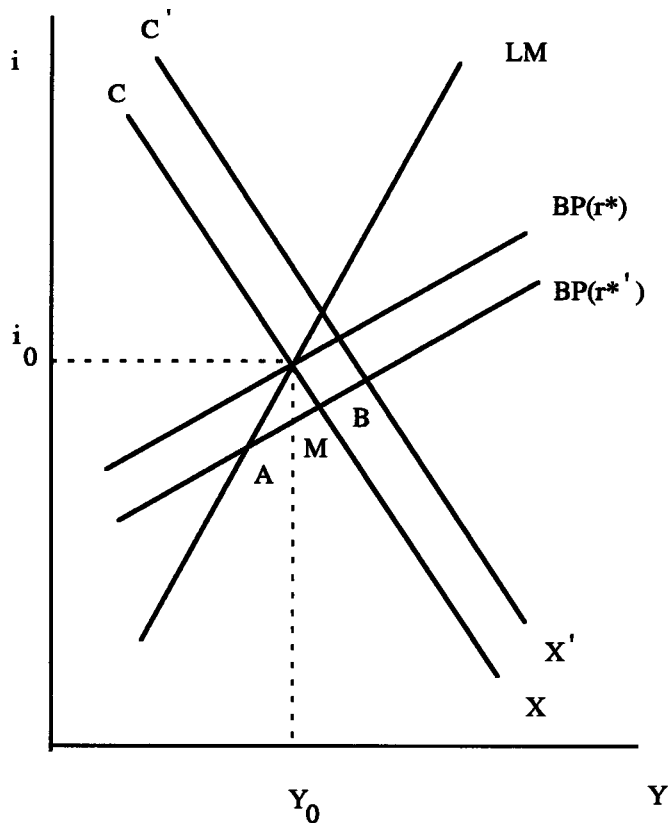


FIGURE 2

IMPACT OF A DECREASE IN r^*



which yields

$$(10') \quad Y = A[i, \phi(r^*, \tau, R, i, Y)] - D^*(r - r^*) .$$

Equations (7') and (10') form our basic system under balance of payments equilibrium of two equations in two endogenous variables, i and Y .

Graphically, we can see the effect of a decrease in r^* in Figure 2. The decrease in r^* leads to a downward shift in the BP curve. At a point like E_0 , there will be positive foreign capital inflows. To maintain the exchange rate peg, these foreign currency inflows must be monetized through the issue of R^* in reserves. This leads to an outward shift in the LM curve until a new equilibrium is reached. In a standard Mundell-Fleming model (where the CX curve fails to shift), the required intervention needed to maintain the nominal exchange rate peg leads us to point M, so labelled by Frankel (1994) due to its correspondence with the monetary approach to the balance of payments.

In our model, however, the impact of a decrease in foreign interest rates will also fall directly on the domestic goods market. By equation (10'), a decrease in r^* has an expansionary impact on aggregate demand by reducing

domestic interest rates. This implies an additional channel for the transmission of a decrease in the foreign interest rate through the positive impact the reduction in foreign interest rates has on bank loan interest rates. This leads us to point B (as in Bernanke and Blinder). This additional channel also implies that a larger degree of monetization is necessary to accommodate the now-larger magnitude of capital inflows. As in Bernanke and Blinder, the final impact on the level of interest in the nonbank financial sector is unclear because of the rise in the transactions demand for money associated with the increase in output.⁷ However, the level of r , the bank loan rate, must decrease.

In an international setting, equation (10') reminds us that there are forces at work which serve to dampen this effect. In particular, the reduction in foreign interest rates, by

7. Previous studies that have not included a "credit channel" have treated the widespread failure of interest rates to drop noticeably during the period of high capital inflows as an anomaly. For example, see Frankel and Okongwu (1995), who ascribe the failure of interest rates to fall in capital recipient countries during the 1989-1994 period to increased expectations of precipitous exchange rate devaluations.

generating capital inflows, must correspond to a reduction in net exports under balance of payments equilibrium. Differentiating the right-hand side of equation (10') with respect to r^* yields

$$(12) \quad A_{\phi} \phi_{r^*} - D_{r^*}^*.$$

The first term of (12) is negative, implying that a decrease in r^* shifts out the CX curve due to the expansionary effect on the banking market. However, the second term is positive reflecting the fact that a decrease in r^* results in increased capital inflows and a deterioration in the trade balance, which would shift in the CX curve. This can be seen in Figure 2. If the capital inflow were not monetized so that the LM curve was shifted outward, the final equilibrium would have to be at a point like A, implying that backward shifts in the CX curve, in response to deterioration of the trade balance, would have to do the work of bringing the balance of payments back into balance. We proceed under the assumption that (12) is negative, implying that the CX curve indeed shifts out in response to a reduction in r^* .

Given this assumption, we show in the appendix that the comparative statics of the model with respect to r^* satisfy

$$(13a) \quad di/dr^* = -D_Y(A_{r^*} - D_{r^*}^*)/\Lambda > 0$$

$$(13b) \quad dY/dr^* = D_i(A_{r^*} - D_{r^*}^*)/\Lambda < 0$$

where Λ represents the determinant of the system, shown to be negative in the appendix. As suggested, a decrease in the foreign interest rate is expansionary, leading to an increase in Y and a decrease in i (as well as a decrease in r by equation (9)).

Central Bank Policy Responses

We next turn towards the impact of policy responses to the capital inflows. As we discussed above, the balance of payments equilibrium in this model subsequent to a drop in r^* corresponds to point B. Any effort to deviate from this equilibrium through monetary policy will eventually be thwarted by capital inflows or outflows which require adjustments in reserves. In other words, monetary policy cannot take us indefinitely off the BP curve. Nevertheless, countries sometimes do attempt to sterilize their intervention through offsetting reductions in domestic credit. In our model, this corresponds to shifting back both the LM curve and the CX curve towards a point above the BP curve. At this point, since the domestic interest rate still lies above the world rate of interest, the position must be defended by an accommodating change in the reserve position of the central bank, and further pressure will be experienced in the future. Nevertheless, we can examine

the "short run" implication of a sterilization effort by examining the comparative statics in equations (7') and (10) (instead of (10') above, which also indicates balance of payments equilibrium).

Increase in the Required Reserve Ratio. We first consider an increase in the level of the required reserve ratio, τ . The standard channel for the transmission mechanism of an increase in the required reserve ratio can be found in equation (7'). An increase in τ reduces the magnitude of domestic deposits, shifting the LM curve back.⁸

However, equation (10) demonstrates that there will also be a shift in the CX curve. An increase in τ , by increasing the rate of interest on bank loans, will reduce investment and shift the CX curve back. Moreover, consider the explicit sensitivity of the bank interest rate with respect to a change in τ derived in the appendix:

$$(14) \quad \frac{dr}{d\tau} = -\frac{\lambda[R(1-\tau)/\tau^2 + R/\tau + D^*]}{L_r - [\lambda_r(R/\tau + D^*) + \lambda D_r^*](1-\tau)} > 0.$$

Among other factors, it can be seen that the magnitude of $dr/d\tau$ is decreasing in the absolute value of both L_r , the interest rate sensitivity of the demand for bank loans, and λ_r , the interest rate sensitivity of the supply of bank loans. Holding all else equal, the greater is the ability of borrowers to turn to the nonbank financial sector to substitute for the intermediation provided by the banking sector, the smaller will be the decrease in aggregate demand resulting from a given increase in τ . The ability of a nation to use a given reserve requirement increase to stem the impact of capital inflows will therefore be less the greater is the ability of the nonbank financial sector to substitute as the channel of intermediation.

To see the overall impact of an increase in bank reserve requirements more clearly, consider the complete comparative static solutions for an increase in τ derived in the appendix:

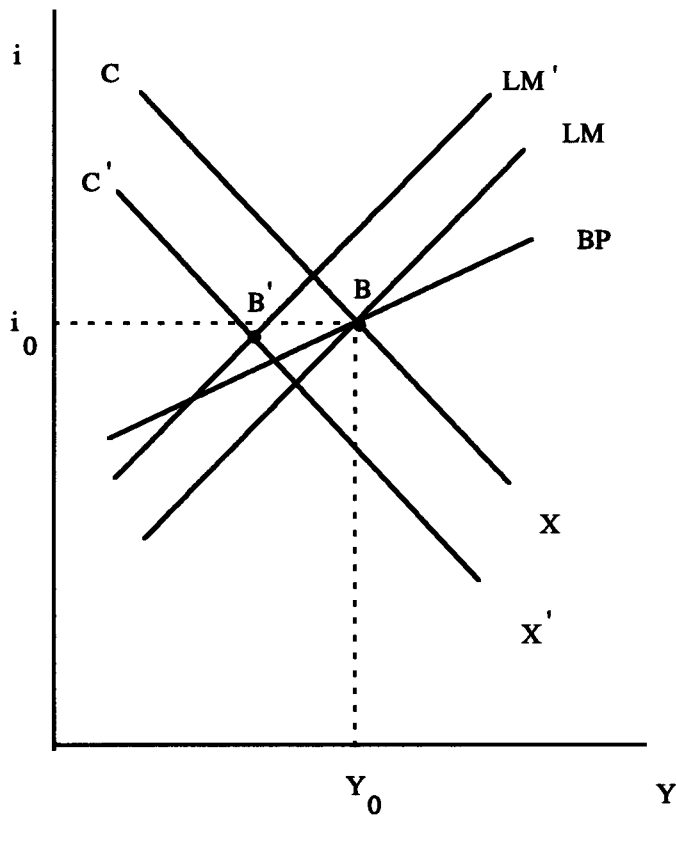
$$(15a) \quad di/d\tau = -[R(1 - A_Y - T_Y)/\tau^2 + A_{\tau}D_Y]/\Lambda$$

$$(15b) \quad dY/d\tau = [D_iA_{\tau} - A_iR/\tau^2]/\Lambda < 0.$$

See Figure 3. Beginning at point B, an increase in the required reserve ratio results in a backward shift of both the LM and the CX curves to a point like B'. The LM curve is shifted back through the standard channel, so that an increase in reserve requirements reduces the money multiplier and the resulting money supply. The CX curve also is shifted back through the credit channel. The increase in

8. Such an expansion in the amount of foreign deposits does not occur by equation (6), since R^* will now be increased to offset the reduction in τ .

FIGURE 3
IMPACT OF AN INCREASE IN τ OR A DECREASE IN R



bank reserve requirements reduces the amount of bank transactions, reducing output, as shown in equation (15b), and hence the transactions demand for money.

It can be seen that in this model (15a), unlike the standard IS-LM model, the immediate impact on interest rates in the nonbank sector of such a policy is ambiguous. However, by equation (9), interest rates in the banking sector must rise. The additional shift in the CX curve implies that for a given level of income and interest rates subsequent to a capital inflow surge, the magnitude of reserve requirement increase necessary to restore pre-inflow income levels is smaller. However, such a conclusion is somewhat misleading, because the inflow itself leads to an outward shift in the CX curve and hence a larger level of income. Consequently, the addition of a credit channel does not imply that for a given capital surge caused by, for example, a reduction in the foreign rate of interest, the magnitude of increase in τ required to restore initial income levels is smaller.

Finally, we reiterate that our BP curve demonstrates that this sterilization effort is not consistent with long-run equilibrium because the high domestic interest rate will lead

to more capital inflows and further exchange rate appreciation pressure. Unless the foreign interest rate change is temporary, this alternative attempt at achieving independent monetary policy in a fixed exchange rate regime with an open capital market will be as susceptible to pressure from international capital markets as standard sterilization efforts.

Impact of an Decrease in the Stock of High-Powered Money. We next consider such a “standard” effort at sterilization, through a decrease in R , the stock of high-powered money underlying domestic assets. As in the case of an increase in τ , a decrease in R will also work through two channels in this model. A decrease in R shifts back the LM curve, through its impact on the stock of money underlying domestic deposits, and also shifts back the CX curve, through its impact on the bank loan rate and its subsequent impact on credit markets. Consequently, the qualitative picture corresponds to Figure 3. The comparative static results for a decrease in R derived in the appendix also look quite analogous to those above:

$$(16a) \quad di/dR = [(1 - A_Y - T_Y)/\tau - A_R D_Y] \Lambda$$

$$(16b) \quad dY/dR = [D_i A_R - A_i / \tau] / \Lambda > 0.$$

However, the graphical analysis masks some differences in the transmission mechanism underlying the two policies. To see this, consider the determinants of ϕ_R derived in the appendix:

$$(17) \quad \frac{dr}{dR} = \frac{\lambda(1 - \tau) / \tau}{L_r - [\lambda_r (R / \tau + D^*) + \lambda D_r^*] (1 - \tau)} < 0.$$

As in the case of an increase in reserve requirements, the impact of a given decrease in the stock of high-powered money will be greater the less desirable are alternative sources of intermediation, i.e., the greater is the absolute value of both L_r and λ_r . In other words, the lower is the elasticity of demand and supply of bank loans, the more effective are standard sterilization techniques as well. However, the absolute value of the numerator of (17) is smaller than that of (14). This is because a change in reserve requirements works through two channels not relevant to a change in the stock of high-powered money. While both policy instruments influence the money supply, increases in reserve requirements also reduce the level of intermediation by banks, both of domestic and foreign deposits. Define the elasticity of r with respect to τ as $\epsilon_{r,\tau} = (dr/r)/(d\tau/\tau)$, and define the elasticity of r with respect to R similarly. By (14) and (17):

$$(18a) \quad \epsilon_{r,\tau} = - \frac{\lambda[R/\tau + \tau D^*]}{r[L_r - [\lambda_r (R / \tau + D^*) + \lambda D_r^*] (1 - \tau)} > 0.$$

$$(18b) \quad \varepsilon_{r,R} = \frac{\lambda R(1 - \tau)/\tau}{r[L_r - [\lambda_r(R/\tau + D^*) + \lambda D^*_r](1 - \tau)} < 0.$$

Comparing (18a) and (18b), it can be seen that $\varepsilon_{r,\tau}$ is greater than $\varepsilon_{r,R}$ in absolute value. In addition to the larger first term in the numerator, the additional numerator term in (18a) represents the reduction in the rate of intermediation of foreign deposits which find their way into the banking system as a result of the increase in reserve requirements. It is this channel on which policymakers have concentrated in advocating reserve requirement increases as a mechanism for mitigating the impact of surges in capital inflows.

III. INDIVIDUAL COUNTRY EXPERIENCES

In this section, I summarize the experiences of seven Asian developing nations who experienced capital inflow surges between 1986 and 1993. As an informal "test" of the predictions of the model above, we pay particular attention to the nations who attempted sterilization through the banking sector.

Indonesia

As in a number of Asian developing nations, changes in domestic Indonesian policy also contributed to its capital inflow surges. Indonesia initially pursued a policy of reforms designed to encourage capital inflows. Between 1979 and 1991, the central bank conducted foreign currency swaps with banks on demand at forward premia which were below expected depreciation rates (Folkerts-Landau, et al., 1993). In addition, it pursued an aggressive policy of financial liberalization from 1988 to 1993. Prior to this liberalization period, Indonesian banks faced numerous ceilings on foreign borrowing. These were eased during the period of liberalization, as were restrictions on entry for domestic banks.

This liberalization was followed by a surge in capital inflows. Foreign-owned assets as a percent of GDP increased from 45 percent in 1988 to 74 percent in 1993. In addition, many of these found their way to the commercial banking sector. Commercial bank foreign liabilities as a percentage of GDP increased from 2 percent in 1988 to 7 percent in 1993. Looking at Table 1, we see that the Indonesian capital account balance plus net errors and omissions reached 3.8 percent of GDP during 1986 and 1987, fell somewhat during 1988 and 1989, and then topped 5 percent in both 1990 and 1991, and 4 percent in 1992. This surge then decreased to 2 percent of GDP in 1993.

Indonesia maintained a strong fiscal balance over the capital inflow period. Consequently, the 1990-1993 capital

inflow period coincided with a much more moderate real exchange rate appreciation, indicating success at sterilization. The surge in capital inflows also resulted in a rapid buildup of foreign liabilities of domestic banks, as well as a rapid expansion of the banking sector. Indonesia's asset ratio, the share of assets in the banking sector, increased from 60.87 percent in 1986 to 85.43 percent in 1992. Similarly, the "credit ratio," the ratio of commercial bank assets to domestic credit, increased from 84.26 percent to 93.27 percent.

Indonesia's rapid surge in foreign capital inflows coincided with a deterioration in the stability of the nation's financial sector. Nonperforming loans reached 16 percent of outstanding loans in the 1990s. Two major banks failed, bank Duta in 1990 and Bank Summa in 1992. These were followed by increased restrictions on the banking industry to reduce the growth of credit. It has been argued that these capital restrictions in 1991 became the primary instrument of monetary policy (Cole 1994). In addition, the two large bank failures were covered completely from assets obtained in the private sector. This strong stance towards owner liability also contributed to a slowdown in lending.

Indonesia also pursued sterilization activities. During the reform period, Indonesia sterilized capital inflows by requiring its public enterprises to convert commercial bank deposits to Bank Indonesia certificates, known as SBIs. From 1988 to 1993, the stock of SBIs increased from 8 to 34 percent of total liabilities. This policy placed the burden of limiting the expansion of liquidity on the public enterprises.

While Indonesian authorities did not increase reserve requirements as a form of sterilization, their tightening of financial policies in 1991 did reduce the pace of intermediation of these inflows. Folkerts-Landau, et al. (1994) suggest that Indonesia's initial unwillingness to sterilize through reserve requirements led to increased interest volatility. Given the initial interest rate reductions associated with the financial liberalization, when sterilization finally did take place, interest rates rose and asset quality declined. Nonperforming loans at large state-owned banks rose from 6 percent at the end of 1990 to 21 percent by October 1993. Indonesia responded by easing capital adequacy and loan deposit ratios in May of 1993.

Korea

Korea experienced a capital inflow surge in 1991 and 1992 (Table 2). The Korean capital account balance plus net errors and omissions topped 2.5 percent in both years. However, this capital inflow was largely offset by a current account deficit, so that the overall balance was actually negative in 1991 and only 1.2 percent of GDP in 1992. In

TABLE 1
INDONESIA (1986–1993)

	1986	1987	1988	1989	1990	1991	1992	1993
MACROECONOMIC INDICATORS								
Growth of Real GDP	5.88	4.93	5.78	7.46	7.24	6.95	6.46	6.50
Inflation	5.83	9.28	8.04	6.42	7.81	9.41	7.53	9.23
Fiscal Balance	-3.53	-0.83	-3.09	-2.01	0.41	0.43	-0.42	0.67
Change in Real Eff. Exchange Rate	28.66	30.57	2.91	-0.90	2.64	-0.64	1.29	-1.96
Reserves (Bil of US\$)	4.05	5.59	5.05	5.45	7.46	9.26	10.45	11.26
Reserves to Imports	2.80	4.17	3.51	3.01	3.07	3.55	3.75	4.25
BALANCE OF PAYMENTS								
Balances of Goods, Services, and Private Transfers	-4.10 (-5.1)	-2.27 (-3.0)	-1.55 (-1.8)	-1.28 (-1.4)	-3.24 (-3.1)	-4.39 (-3.8)	-3.12 (-2.4)	-2.30 (-1.6)
Balance on Capital Account Plus Net Errors and Omissions	3.10 (3.9)	2.90 (3.8)	1.44 (1.7)	1.77 (1.9)	5.49 (5.2)	5.92 (5.1)	5.19 (4.1)	2.89 (2.0)
FINANCIAL SECTOR								
Foreign Liabilities (Bil of US\$)	0.33	0.46	0.67	1.78	6.65	5.99	7.86	NA
Deposit Bank Assets	16.77	20.62	26.77	37.47	55.43	63.12	66.69	NA
Asset Ratio (%)	60.87	62.09	62.73	74.58	78.02	84.47	85.43	NA
Credit Ratio (%)	84.26	84.57	86.62	89.72	92.37	93.84	93.27	NA

NOTE: Balance of payments data are in billions of U.S. dollars. Numbers in parentheses indicate component as a percentage of GDP. Variables are defined in the appendix.

contrast, in 1988 Korea's large current account surplus yielded a large surplus in the balance of payments. Korea responded to its capital inflows through a number of policies. Korea used "money stabilization bonds" to sterilize foreign capital inflows through open market operations. The quantity of these bonds outstanding increased from 9.6 percent of M2 in 1986 to 21 percent of M2 in 1992 (Folkerts-Landau, et al., 1994).

In addition, Korea raised reserve requirements and the degree of regulation on the banking sector. Reserve requirements for commercial banks were raised to 11.5 percent on demand and time deposits. Because of Korea's extensive nonbank financial sector, this policy shifted assets out of commercial banks. The share of deposits held by banks, which had been 70 percent in the 1970s, fell to 36 percent in 1992 (Folkerts-Landau, et al., 1994).

Korea grew very rapidly over the period, averaging about 10 percent growth over the period. Its sterilization effort also resulted in a large buildup of government reserves. The reserve to import ratio tripled from 0.77 to 2.42 between 1985 and 1994. Korea also experienced large real exchange rate appreciations in 1988 and 1989.

Korea had a unique financial sector experience. Foreign liabilities of the banking sector remained relatively unchanged from 1986 through 1993. However, deposit bank assets did triple over the period. Most interestingly, the relative share of the commercial banking sector fell by both the asset ratio and credit ratio measures. This demonstrates the existence of disintermediation in Korea over the period, in part presumably due to Korea's sterilization efforts through increases in reserve requirements.

Malaysia

Malaysia's capital inflows surged from 1991 to 1993. Looking at Table 3, we can see that the balance on its capital account plus net errors and omissions as a percentage of GDP reached unprecedented magnitudes even for a developing Asian nation. However, Malaysia is notable as a country which pursued an aggressive policy of sterilization, both through increased reserve requirements and through other instruments. Malaysia sold central bank securities to stem the impact of capital inflows. From 1989 to 1993, the value of government deposits increased by 72

TABLE 2

KOREA (1986–1993)

	1986	1987	1988	1989	1990	1991	1992	1993
MACROECONOMIC INDICATORS								
Growth of Real GDP	11.55	11.52	11.27	6.38	9.51	9.13	5.06	5.53
Inflation	2.75	3.05	7.15	5.70	8.58	9.30	6.24	4.80
Fiscal Balance	-0.09	0.43	1.51	0.19	-0.67	-1.62	-0.84	NA
Change in Real Eff. Exchange Rate	17.62	1.10	-8.21	-10.68	7.73	2.67	10.40	2.95
Reserves (Bil of US\$)	3.32	3.58	12.35	15.21	14.79	13.70	17.12	20.23
Reserves to Imports	1.01	0.83	2.53	2.71	2.29	2.01	2.49	2.71
BALANCE OF PAYMENTS								
Balances of Goods, Services, and Private Transfers	4.61 (4.2)	9.84 (7.2)	14.12 (7.8)	5.01 (2.3)	-2.18 (-0.9)	-8.55 (-2.9)	-4.50 (-1.5)	0.53 (0.2)
Balance on Capital Account Plus Net Errors and Omissions	-4.53 (-4.2)	-7.73 (-5.7)	-4.80 (-2.6)	-1.89 (-0.8)	0.97 (0.4)	7.45 (2.5)	8.23 (2.7)	2.48 (0.8)
FINANCIAL SECTOR								
Foreign Liabilities (Bil of US\$)	14.54	11.59	10.25	9.78	10.18	13.79	14.65	14.80
Deposit Bank Assets	58.13	72.50	94.79	117.78	139.86	158.21	171.20	188.2
Asset Ratio (%)	54.77	51.59	48.79	48.13	48.76	49.01	45.81	42.80
Credit Ratio (%)	62.00	57.81	53.37	51.36	51.96	51.88	48.98	45.57

NOTE: Balance of payments data are in billions of U.S. dollars. Numbers in parentheses indicate component as a percentage of GDP. Variables are defined in the appendix.

percent. In addition, Malaysia used the assets of its pension fund, the Employee Provident Fund, to sterilize capital inflows. The assets of the Employee Provident Fund and the government deposits were transferred to the central bank. The value of Federal and local deposits at the central bank increased from 3 to 19 percent of total deposits from 1989 to 1992 (Folkerts-Landau 1994).

Reserve requirements were raised three times. First, they were increased from 6.5 percent in 1991 to 7.5 percent. They were then raised again to 8.5 percent in 1993. Finally, they were further increased to 11.5 percent in 1994. Much of the impact of reserve requirement increases was passed on to depositors. The margin between borrowing and lending rates increased from 3.8 percent to 4.7 percent. The cost of maintaining reserves was estimated to have increased 23.5 percent over the period, while the margin increased almost as much, 22.7 percent (Folkerts-Landau, et al., 1994).

The financial industry also became subject to more extensive regulation. In 1993, Bank Negara Malaysia placed limits on banks' foreign liabilities. In the securities markets, residents were forbidden from selling short-term se-

curities to nonresidents for a few months in 1994. Foreign financial accounts in Malaysia had to be deposited in "vostro" accounts with the central bank. These did not pay interest and were subject to reserve requirements, effectively placing a tax on nonresident deposits. The reserve requirement on these accounts was lifted in May and the ban on the issue of short-term securities was lifted in August.

Malaysia's aggressive response to capital inflows was felt both in the financial sector and in the real side of the economy. Malaysia's banking sector experienced relatively subdued growth over the period. Nevertheless, the asset and credit ratio measures both indicate that the relative share of the commercial banking sector increased over this period. In addition, Malaysia had a relatively moderate real exchange rate appreciation during the 1990–1993 period.

Philippines

The Philippines' surge in capital inflows was also preceded by a period of liberalization. From 1986 to 1993, the Philippines undertook major trade, financial, and foreign ex-

TABLE 3

MALAYSIA (1986–1993)

	1986	1987	1988	1989	1990	1991	1992	1993
MACROECONOMIC INDICATORS								
Growth of Real GDP	1.05	5.39	8.94	9.21	9.73	8.66	7.81	8.46
Inflation	0.74	0.29	2.56	2.81	2.62	4.36	4.77	3.54
Fiscal Balance	-10.48	-7.73	-4.28	-5.13	-4.76	-4.35	-4.22	-5.21
Change in Real Eff. Exchange Rate	22.23	6.55	12.05	2.45	2.93	1.04	-6.93	-2.82
Reserves (Bil of US\$)	6.03	7.44	6.53	7.78	9.75	10.89	17.23	27.25
Reserves to Imports	6.16	6.10	4.22	3.82	3.49	3.58	4.98	6.61
BALANCE OF PAYMENTS								
Balances of Goods, Services, and Private Transfers	-0.18 (-0.6)	2.47 (7.8)	1.73 (5.0)	0.16 (0.4)	-0.97 (-2.3)	-4.24 (-9.0)	-1.93 (-3.3)	-2.54 (-3.9)
Balance on Capital Account Plus Net Errors and Omissions	1.63 (5.9)	-1.35 (-4.3)	-2.16 (-6.2)	1.07 (2.8)	2.92 (6.8)	5.48 (11.6)	8.56 (14.8)	13.88 (21.5)
FINANCIAL SECTOR								
Foreign Liabilities (Bil of US\$)	2.37	2.00	1.87	2.34	3.01	4.32	7.15	11.66
Deposit Bank Assets	24.22	26.51	25.85	30.88	36.30	43.06	49.77	52.49
Asset Ratio (%)	55.02	53.47	51.51	93.46	97.34	98.65	71.23	64.85
Credit Ratio (%)	69.36	66.16	63.90	96.15	97.34	98.65	95.67	95.58

NOTE: Balance of payments data are in billions of U.S. dollars. Numbers in parentheses indicate component as a percentage of GDP. Variables are defined in the appendix.

change liberalizations (Lamberte 1994). In addition, the Philippines liberalized the rules for foreign investment in the 1991 Foreign Investment Act. As in other countries where liberalizations preceded the capital inflow surge, it is difficult to assess the share of capital inflows attributable to domestic and foreign factors.

Looking at Table 4, we can see that the Philippines' capital account plus net errors and omissions has been large and growing since 1988. The Philippines case is unique, however, because in addition to standard capital account inflows, their surge in capital inflows also came from the nonmerchandise portion of the current account. Most notably, this includes remittances of overseas workers and withdrawals of foreign currency deposits. 1993 remittances equaled \$2.3 billion or 4 percent of GDP. The foreign currency deposit withdrawals may be considered capital flight repatriation.

The Philippines responded to its capital inflow surge with a myriad of instruments, including high reserve requirements. Reserve requirements have been very high, averaging 22 percent between 1987 and 1992. In addition, the Philip-

ppines responded by reducing its request to the Paris Club for loan rescheduling, and lifting the restrictions on repatriation of foreign investments. It also allowed outward investment to increase from \$1 million to \$6 million per year. Finally, the Philippines also used sterilized intervention to increase the demand for foreign exchange. From 1991 to 1994, the Central Bank purchased \$6.6 billion U.S. dollars.

The Philippines did not experience large capital inflows relative to the magnitude of its current account deficit until 1992. As a consequence, there was little impact on domestic credit. Lamberte (1994) has shown that, during this latter period, "standard" sterilization policy in the Philippines through open market operations was relatively ineffective. Consequently, if sterilization efforts did play an important role in mitigating the impact of capital inflows on domestic credit levels, they must have stemmed from more "nonstandard" efforts, such as increases in reserve requirements, which directly affected the domestic banking sector.

This can be seen most clearly in Table 4 from the experience of the Philippines' real exchange rate. From 1988–

TABLE 4

PHILIPPINES (1986–1993)

	1986	1987	1988	1989	1990	1991	1992	1993
MACROECONOMIC INDICATORS								
Growth of Real GDP	3.42	4.31	6.75	6.21	3.04	-0.58	0.34	2.14
Inflation	0.75	3.79	8.76	12.21	14.14	18.71	8.92	7.59
Fiscal Balance	-5.03	-2.45	-2.91	-2.11	-3.45	-2.11	-1.18	-1.48
Change in Real Eff. Exchange Rate	26.76	3.59	-2.09	-5.68	6.07	3.15	-8.14	8.52
Reserves (Bil of US\$)	1.73	0.97	1.00	1.42	0.92	3.25	4.40	4.68
Reserves to Imports	3.91	1.45	1.47	1.54	0.84	3.06	3.13	2.79
BALANCE OF PAYMENTS								
Balances of Goods, Services, and Private Transfers	0.75 (2.5)	-0.64 (-1.9)	-0.67 (-1.8)	-1.81 (-4.3)	-3.05 (-6.9)	-1.39 (-3.1)	-1.34 (-2.5)	-3.59 (-6.6)
Balance on Capital Account Plus Net Errors and Omissions	0.39 (1.3)	0.58 (1.8)	1.34 (3.5)	2.11 (5.0)	3.01 (6.8)	3.14 (6.9)	3.03 (5.7)	3.88 (7.1)
FINANCIAL SECTOR								
Foreign Liabilities (Bil of US\$)	1.83	1.94	2.10	2.02	2.38	2.06	3.00	2.91
Deposit Bank Assets	6.26	7.23	8.65	10.38	10.40	11.67	15.65	18.88
Asset Ratio (%)	72.90	82.40	84.53	86.46	87.41	88.11	93.95	97.12
Credit Ratio (%)	63.20	70.17	75.63	79.94	82.76	85.24	79.65	62.55

NOTE: Balance of payments data are in billions of U.S. dollars. Numbers in parentheses indicate component as a percentage of GDP. Variables are defined in the appendix.

1993, the Philippines actually experienced a small net real exchange rate depreciation. The reserve to import ratio also tripled from 1985 to 1986, from 1.21 to 3.91 percent. However, this ratio subsequently decreased to 0.84 percent by 1990, only to triple again during the subsequent capital inflow surge period.

Despite its increases in reserve requirements, the share of the commercial banking sector in the Philippines grew dramatically over the studied period, as measured by our asset and credit ratios. In addition, foreign liabilities of Philippine commercial banks and the asset size of deposit banks also grew demonstratively.

As the surge in capital inflows cooled down, the Philippines weakened its policy to allow for the maintenance of a sustainable level of capital inflows. By August of 1994, reserve requirements had been reduced to 17 percent from a high of 24 percent in January 1993 (Lamberte 1994).

Singapore

Singapore has had a relatively volatile capital inflow experience over the period. Looking at Table 5, we can see that

the capital account balance plus net errors and omissions surged in 1985, 1987, 1990, and 1992–1993. These periods were separated by periods of relatively minor capital account balance surpluses. Despite this volatility, Singapore maintained a high and relatively stable rate of GDP growth and moderate inflation. In addition, Singapore's real exchange rate appreciation from 1989 through 1993 was moderate relative to other Asian developing countries.

Singapore took a relatively nonstandard approach to sterilize its capital inflow surge. First, it resisted any increase in bank reserve requirements. Second, because it lacked the government bonds to use in more standard sterilization efforts, it sterilized capital inflows through the assets in its large mandatory government pension fund, the Central Provident Fund. While its stock of reserves more than quadrupled over the period, its outward orientation and its high rate of GDP growth implied that the reserve to import ratio stayed relatively constant.

Singapore's policy response to its capital inflow surge had a relatively neutral impact on the share of the commercial banking sector, which stayed relatively constant at around 85 percent, according to the asset ratio and the

TABLE 5
SINGAPORE (1986–1993)

	1986	1987	1988	1989	1990	1991	1992	1993
MACROECONOMIC INDICATORS								
Growth of Real GDP	1.84	9.41	11.14	9.24	8.76	6.65	6.04	9.94
Inflation	-1.37	0.47	1.53	2.38	3.44	3.42	2.27	2.42
Fiscal Balance	1.45	-2.73	6.97	10.25	10.87	8.84	NA	NA
Change in Real Eff. Exchange Rate	18.60	8.29	0.75	-5.65	-4.52	-2.38	-2.48	-0.85
Reserves (Bil of US\$)	12.94	15.23	17.07	20.35	27.75	34.13	39.89	48.36
Reserves to Imports	5.71	4.61	4.02	4.70	4.81	6.19	5.55	6.16
BALANCE OF PAYMENTS								
Balances of Goods, Services, and Private Transfers	0.33 (1.9)	-0.09 (-0.5)	0.98 (3.9)	2.91 (9.9)	2.26 (6.2)	4.16 (9.8)	3.94 (8.1)	2.25 (4.1)
Balance on Capital Account Plus Net Errors and Omissions	0.21 (1.2)	1.19 (5.9)	0.68 (2.7)	-0.17 (-0.6)	3.17 (8.7)	0.05 (0.1)	2.16 (4.5)	5.32 (9.7)
FINANCIAL SECTOR								
Foreign Liabilities (Bil of US\$)	13.44	15.37	17.36	23.95	24.94	24.57	29.45	32.08
Deposit Bank Assets	17.68	21.01	23.74	29.34	36.53	44.46	48.90	57.24
Asset Ratio (%)	85.48	85.35	84.45	84.26	84.60	84.82	84.72	84.02
Credit Ratio (%)	85.46	85.33	84.44	84.25	84.60	84.81	84.71	84.01

NOTE: Balance of payments data are in billions of U.S. dollars. Numbers in parentheses indicate component as a percentage of GDP. Variables are defined in the appendix.

credit ratio. There was, however, some moderate growth in foreign commercial bank liabilities and the deposit bank assets grew at a robust pace. Of course, this was necessary over the period to keep pace with the rest of the economy.

Taiwan

Taiwan experienced a large episode of capital inflows in 1986 and 1987. In both years, the capital account balance plus net errors and omissions exceeded 9 percent of GDP. Nevertheless, this was followed by a seven-year period of capital outflows, from 1989 to 1994, as measured by this proxy. The net impact on domestic credit from this capital inflow surge was therefore relatively minimal.

Taiwan did engage in efforts subsequent to the initial capital inflow surge to limit the expansion of domestic credit. However, instead of raising reserve requirements, it required commercial banks to directly purchase treasury bills and central bank certificates of deposit. The government also shifted the assets of the postal system from the commercial banking sector to the central bank. As in the

case of Indonesia described above, therefore, the burden of sterilization that did take place was partly financed by the public sector.

Looking at Table 6, it can be seen that the period was one of rapid increase in GNP growth.⁹ In addition, we see that while Taiwan's real exchange rate did appreciate over the period 1987–1989, a prolonged spell of moderate depreciation from 1990–1993 mitigated the net real exchange rate movement. Taiwan also rapidly accumulated reserves over the period, particularly in 1986 and 1987. However, the country grew so rapidly that the reserve to import ratio was lower in 1994 than in 1985, despite a large initial increase.

Thailand

Unlike most capital-recipient countries, Thailand did not experience an increase in domestic rates prior to its capital inflow surge. This evidence has been used by proponents

9. GNP figures were used for Taiwan because GDP figures were not available.

TABLE 6
TAIWAN (1986–1993)

	1986	1987	1988	1989	1990	1991	1992	1993
MACROECONOMIC INDICATORS								
Growth of Real GDP	11.65	11.86	7.33	7.98	5.54	7.55	6.23	6.02
Inflation	0.70	0.50	1.28	4.46	4.06	3.60	4.54	2.86
Fiscal Balance	-0.77	0.13	0.76	0.92	1.64	-0.93	-2.45	-1.27
Change in Real Eff. Exchange Rate	9.79	-5.33	-3.54	-6.12	6.99	2.82	1.27	3.34
Reserves (Bil of US\$)	46.31	76.75	73.90	73.22	72.44	82.41	82.31	83.57
Reserves to Imports	19.95	20.17	18.87	17.59	14.84	15.57	13.96	12.90
BALANCE OF PAYMENTS								
Balances of Goods, Services, and Private Transfers	16.27 (21.6)	17.99 (17.7)	10.18 (8.3)	11.39 (7.6)	10.77 (6.7)	12.04 (6.7)	8.19 (4.1)	6.74 (2.9)
Balance on Capital Account Plus Net Errors and Omissions	7.05 (9.4)	10.10 (10.0)	1.60 (1.3)	-12.16 (-8.2)	-14.69 (-9.2)	-2.36 (-1.3)	-6.79 (-3.4)	-5.17 (-2.2)
FINANCIAL SECTOR								
Foreign Liabilities (Bil of US\$)	7.98	15.06	12.86	12.14	11.12	15.05	15.18	16.75
Deposit Bank Assets	58.99	85.37	119.72	167.66	186.13	239.03	310.18	352.3
Asset Ratio (%)	90.89	90.29	92.85	90.26	88.33	87.81	90.08	89.89
Credit Ratio (%)	91.76	91.46	92.43	91.91	90.98	90.61	92.07	91.84

NOTE: Balance of payments data are in billions of U.S. dollars. Numbers in parentheses indicate component as a percentage of GDP. Variables are defined in the appendix.

of external factors as the dominant cause of capital inflow surges over the period, such as Schadler, et al. (1993). In addition, it has been argued that Thailand's history of low inflation and outward-oriented policies may have enhanced its ability to weather its surge in capital inflows (Schadler, et al., 1993). Its capital inflows were extremely high: The capital account balance plus net errors and omissions averaged about 10 percent of GDP from 1988 through 1992 (see Table 7).

While it failed to engage in extensive sterilization, Thailand did pursue a variety of measures designed to mitigate the magnitude of capital inflows. These included encouraging capital outflows through early service of external debt and easing the restrictions on foreign capital outflows. In 1991, Thailand allowed individuals to open foreign exchange accounts up to \$500,000 and corporations to open accounts up to \$2 million. In addition, they eliminated the requirement for Bank of Thailand approval for repatriation of investment funds.

Thailand's macroeconomic indicators suggest that it weathered the capital inflow surge period well. It achieved

a high rate of GDP growth with minimal inflation and an increasing share of investment in GDP. Thailand experienced a very moderate real exchange rate appreciation from 1988–1993. Thailand's reserves also more than tripled from 1989 to 1994. However, its reserve to import ratio less than doubled over the period, due to its growth in GDP and outward orientation.

Thailand's capital inflows resulted in a rapid expansion of its domestic banking sector. This expansion included a large expansion in foreign liabilities. Foreign liabilities of the banking sector grew to twelve times their 1986 level by 1993, primarily due to borrowing from foreign financial institutions. Deposit bank assets also quadrupled over the same period. In addition, the share of the commercial banking sector grew according to both the asset ratio and credit ratio measures.

Summary

The experiences of the seven developing Asian nations in this study are summarized in Table 8. A number of pat-

TABLE 7

THAILAND (1986–1993)

	1986	1987	1988	1989	1990	1991	1992	1993
MACROECONOMIC INDICATORS								
Growth of Real GDP	5.53	9.52	13.29	12.29	11.57	7.88	NA	NA
Inflation	1.84	2.47	3.86	5.36	5.93	5.70	4.14	3.57
Fiscal Balance	-4.23	-2.23	6.80	2.95	4.53	4.73	2.94	NA
Change in Real Eff. Exchange Rate	17.64	6.47	-0.55	-2.93	0.28	-2.20	3.86	-1.35
Reserves (Bil of US\$)	2.80	4.01	6.10	9.52	13.31	17.52	20.36	24.47
Reserves to Imports	3.55	3.10	3.30	4.16	4.59	6.43	5.95	6.01
BALANCE OF PAYMENTS								
Balances of Goods, Services, and Private Transfers	0.86 (0.2)	-0.49 (-1.0)	-1.84 (-3.0)	-2.70 (-3.7)	-7.47 (-8.7)	-7.67 (-7.8)	-6.49 (-5.8)	-6.96 (NA)
Balance on Capital Account Plus Net Errors and Omissions	0.63 (1.5)	1.43 (2.8)	4.44 (7.2)	7.73 (10.7)	10.74 (12.5)	12.29 (12.5)	9.33 (8.5)	14.13 (NA)
FINANCIAL SECTOR								
Foreign Liabilities (Bil of US\$)	1.22	1.48	2.44	3.32	4.34	4.90	6.57	13.79
Deposit Bank Assets	25.15	31.79	39.13	48.46	63.53	75.89	89.38	109.1
Asset Ratio (%)	63.43	65.75	68.98	70.81	70.81	71.13	69.69	71.51
Credit Ratio (%)	76.56	78.93	84.64	87.61	89.19	91.19	92.95	94.35

NOTE: Balance of payments data are in billions of U.S. dollars. Numbers in parenthesis indicate component as a percentage of GDP. Variables are defined in the appendix.

terns are notable. First, not all of the Asian nations experienced capital inflow surges at the same time, although all except Taiwan experienced some capital inflow surge between 1991 and 1992. This indicates, as suggested by other authors (e.g., Schadler 1993), that internal factors also played a role in determining capital inflow surges. Nevertheless, the importance of external factors is demonstrated by the simultaneous capital inflow surge in the early 1990s.

Second, note that the policy response to the capital inflow surge varied widely across countries. The instruments used in “nonbank” sterilization ranged from standard open market operations by Korea to the use of pension funds by Malaysia and Singapore, to the use of increased external debt service by the Philippines and Thailand. Instruments used to sterilize the impact of the inflows in the banking sector were also diverse. While Korea, Malaysia, and the Philippines used increases in reserve requirements, Indonesia and Taiwan used a variety of measures designed to lower the assets of the commercial banking sector. All of these instruments had cases of successes and failures

which appear to be more closely related to the initial conditions in the country than the instrument of sterilization they chose.

The pattern of greatest relevance to the model concerns the relationship between the relative share of a country’s intermediation conducted ex-ante by the banking sector, which provides a coarse proxy for the elasticity of supply and demand for bank loans and its sterilization experience. Our model above suggests that the more developed is the nonbank financial sector, the less effective will be either standard sterilization policy through open market operations or through distorting the banking sector.

If this were the case, our model would predict that of the three countries which raised reserve requirements, the increase would lead to more disintermediation in Korea than in Malaysia or the Philippines. Because of the availability of other forms of financial intermediation, this would imply that the backwards shift in the CX curve would be smaller, as would the backward shift in the LM curve, due to the reduction in the money multiplier. This second effect from the existence of nonbank financial markets has

TABLE 8

SUMMARY OF CAPITAL INFLOW EXPERIENCES

COUNTRY	CAPITAL INFLOW SURGES	NONBANK STERILIZATION	BANK SECTOR STERILIZATION	REAL EXCHANGE RATE IMPACT	1986 RATIO OF BANKING ASSETS (%)	AVG. RATIO (%) FOR 1986–1993		1986–1993 AVG. ANNUAL CHANGE IN BANKING ASSETS RATIO (%)
						Asset	Credit	
Indonesia	1986–1987; 1990–1991	—	Increased regulatory restrictions Decreased public sector assets in commercial banks	Moderate real exchange rate appreciation	60.87	72.60*	98.24*	5.99*
Korea	1991;1992	Used “Money Stabilization Bonds” in open market operations	Increased reserve requirements	Large real exchange rate appreciation	54.77	48.71	52.87	–3.41
Malaysia	1991–1993	Used government and pension fund securities in open market operations	Increased reserve requirements Increased regulatory restrictions	Moderate real exchange rate appreciation	55.02	73.19	85.35	6.24
Philippines	1988–1993	Increased foreign debt service	Increased reserve requirements	Moderate real exchange rate depreciation	72.90	86.61	74.89	4.26
Singapore	1987, 1990, 1992–1993	Used pension funds in open market operations	—	Moderate real exchange rate appreciation	85.48	84.71	74.70	–0.24
Taiwan	1986–1987	—	Required commercial banks to directly purchase treasury bills and central bank certificates of deposit Decreased public sector assets in commercial banks	Moderate real exchange rate appreciation	90.89	90.05	91.63	–0.14
Thailand	1988–1992	Increased foreign debt service Eased restrictions on capital outflows	—	Moderate real exchange rate depreciation	63.43	69.01	86.93	1.75

*Average Banking Assets Ratio for Indonesia from 1986–1992.

been noted by Van Wijnbergen (1983). Holding all else equal, reserve requirements should then be less effective as an instrument for lessening the impact of capital inflow surges on the real side of the economy in Korea because of substitute avenues of intermediation.

The crude evidence appears to bear out this prediction. While Korea experienced a large real exchange rate appreciation over the period 1986–1993, the real exchange rate showed only moderate appreciation in Malaysia and actually showed moderate depreciation in the Philippines.

Consequently, the evidence suggests that reserve requirement increases are more effective at sterilization the more limited are a country's financial alternatives.

The model predicts a similar relationship for nations which used open market operations as the mechanism for sterilization. Table 8 demonstrates that the evidence is largely consistent with the model. Of the nations that used open market operations or enhanced foreign debt service as mechanisms of sterilization, Korea, the nation with the largest nonbank financial sector, experienced the greatest degree of real exchange rate appreciation. This occurred despite the fact that it engaged in both open market operations and increases in reserve requirements. Nations with large shares of assets in the commercial banking sector, such as the Philippines and Singapore, had no or moderate real exchange rate appreciation. In addition, Thailand, a nation with a relatively small share of assets in the commercial banking sector, also experienced very moderate real exchange rate appreciation.

IV. CONCLUSION

This paper develops an open-economy version of the Bernanke-Blinder model which demonstrates how foreign interest rate shocks can lead to an expansion through capital inflows. In addition, the model sheds light on the determinants of the impact of instruments commonly used for sterilization. In particular, the model claims that the ability to mitigate the impact of capital inflows by either sterilizing through open market operations or raising reserve requirements will be limited if viable financial alternatives to the commercial banking sector exist.

We then examine these predictions in the context of the capital inflow surge experiences of seven developing Asian nations. Our analysis yields three conclusions: First, the timing of capital inflow surges exhibited both similarities and differences, arguing for a role for both domestic and foreign factors in causing capital inflow surges. Second, there is little evidence of dominant sterilization instruments. Third, we demonstrated that in comparing the nations which used either increases in reserve requirements or open market operations over the period, the predictions of the model were borne out.

Of the nations which increased reserve requirements, Korea, the country with the largest nonbank financial sector, had the least success stemming the impact of capital inflow surges. A similar pattern was found in comparing the set of nations which pursued sterilization through open market operations. Of course, we held much constant when making these predictions. Nevertheless, the fact that Korea is both the country which experienced the greatest degree of disintermediation and the greatest real exchange rate appreciation fits the model rather well.

APPENDIX I

I. DERIVATION OF EQUATION (9)

Totally differentiating (8) with respect to r and τ , M , i , Y , and r^* yields

$$\frac{dr}{dr^*} = \frac{\lambda D_{r^*}^* L_r / (1 - \vartheta) - [\lambda_r (R/\tau + D^*) + \lambda D_{r^*}^*]}{I} > 0.$$

$$\frac{dr}{d\tau} = - \frac{\lambda [R(1 - \tau) / \tau^2 + D^*]}{L_r - \lambda_r [(R/\tau + D^*) + \lambda D_{r^*}^*] (1 - \vartheta)} > 0.$$

$$\frac{dr}{dR} = \frac{\lambda / \tau}{L_r / (1 - \vartheta) - [\lambda_r (R/\tau + D^*) + \lambda D_{r^*}^*]} < 0.$$

$$\frac{dr}{di} = - \frac{L_i - \lambda_i (R/\tau + D^*) (1 - \vartheta)}{L_r - [\lambda_r (R/\tau + D^*) + \lambda D_{r^*}^*] (1 - \vartheta)} > 0.$$

$$\frac{dr}{dY} = - \frac{L_Y}{L_r - [\lambda_r (R/\tau + D^*) + \lambda D_{r^*}^*] (1 - \vartheta)} > 0.$$

II. COMPARATIVE STATICS

Equations (7') and (10') yield the system of equations:

$$\begin{bmatrix} D_i & D_Y \\ -A_i D_i^* & 1 - A_Y + D_Y^* \end{bmatrix} \begin{bmatrix} di \\ dY \end{bmatrix} = \begin{bmatrix} 0 & -R/\tau^2 & 1/\tau \\ A_{r^*} - D_{r^*}^* & A_\tau - D_\tau^* & A_R - D_R^* \end{bmatrix} \begin{bmatrix} dr^* \\ d\tau \\ dR \end{bmatrix}.$$

The determinant of the system satisfies:

$$\Lambda = D_i (1 - A_Y - D_Y^*) + D_Y (A_i - D_i^*) < 0.$$

The comparative statics of the model satisfy:

$$di/dr^* = -D_Y (A_{r^*} - D_{r^*}^*) / \Lambda > 0$$

$$\text{and } dY/dr^* = D_i (A_{r^*} - D_{r^*}^*) / \Lambda < 0.$$

Equations (7) and (10) yield the system of equations

$$\begin{bmatrix} D_i & D_Y \\ -A_i & 1 - A_Y - T_Y \end{bmatrix} \begin{bmatrix} di \\ dY \end{bmatrix} = \begin{bmatrix} 0 & -R/\tau^2 & 1/\tau \\ A_{r^*} & A_\tau & A_R \end{bmatrix} \begin{bmatrix} dr^* \\ d\tau \\ dR \end{bmatrix}.$$

The determinant of the system satisfies

$$\Lambda = D_i (1 - A_v - T_v) + D_v A_i < 0.$$

The comparative statics of the model for policy changes satisfy

$$di/d\tau = - [R(1 - A_Y - T_Y)/\tau^2 + A_\tau D_Y]/\Lambda ,$$

$$dY/d\tau = [D_i A_\tau - A_i R/\tau^2]/\Lambda < 0 ,$$

$$di/dR = [(1 - A_Y - T_Y)/\tau - A_R D_Y]/\Lambda ,$$

and $dY/dR = [D_i A_R + A_i/\tau]/\Lambda > 0.$

APPENDIX 2

The data are from International Monetary Fund's *International Financial Statistics* and from *Financial Statistics*, Taiwan district, The Republic of China. The source of real effective exchange rate (1990 = 100) is JP Morgan.

Macroeconomic Indicators

Growth of real GDP (99b.p), inflation (64), and real effective exchange rate are calculated using changes over the previous year. Taiwan uses real GNP (99a). The fiscal balance (80) is expressed as percentage of nominal GDP (99b). Reserves (.1L.D) are in billions of U.S. dollars. The ratio of reserves to imports (71 for all countries except Indonesia which uses (71..d) are end-of-year ratios. Imports were converted to dollars using the exchange rate (rf).

Balance of Payments

The balance of goods, services, and private transfers is current account (77a.d) less unofficial unrequited transfers (77agd). The balance on capital account plus net errors and omissions is the sum of unofficial unrequited transfers (77agd), direct investment (77bad), portfolio investment (77bbd), other capital (77g.d), and net errors and omissions (77e.d).

Financial Sector

Foreign liabilities (26c) are in billions of U.S. dollars. Deposit bank assets is the sum of lines 22a-f of IFS. The asset ratio is the bank deposit assets divided by the sum of bank deposit assets, central bank assets (12a-f) and lines (42a-f). The credit ratio is the ratio of bank deposit assets to domestic credit, sum of lines (32a-f), where (32a) is approximated by the sum of (12a), (22a), and (42a).

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