Intervention, Sterilization, and Monetary Control in Korea and Taiwan

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This paper uses a four-variable vector autoregression model to explore how monetary authorities responded to shocks in Korea and Taiwan over the period 1981.1–1994.12. The analysis reveals that sterilization is an important element of the response to shocks to foreign assets in both economies. In particular, monetary authorities do not appear to be prepared to accept fluctuations in the exchange rate and the money supply that may result from changes in foreign assets, but more readily accept fluctuations in these variables that result from domestic credit shocks. There are also differences in the responses of Korea and Taiwan that suggest that the former may be more insulated from extrernal shocks.

In recent years, the monetary effects of sharp increases in central bank foreign assets—associated with large current account surpluses and capital inflow surges—have attracted much attention, particularly in Asian economies. As discussed by Glick and Moreno (1995), these changes in central bank foreign asset holdings, resulting from efforts to stabilize the exchange rate, have adversely affected monetary control.

In spite of the interest in this subject, there has been relatively little empirical analysis of the characteristics of shocks to foreign assets and the implications for monetary control (an exception is the comparison of Germany and Japan by Glick and Hutchison 1994). Such an analysis can be used to shed light on a number of interesting questions. In particular, it is of interest to inquire how monetary authorities respond to shocks in countries that seek to stabilize the exchange rate. This includes assessing the relative importance of foreign and domestic influence in explaining fluctuations in foreign assets, the degree of sterilization and its effectiveness in limiting the monetary impact of shocks, and how foreign assets respond to changes in domestic credit.

This paper seeks to shed light on these questions by estimating vector autoregression models of Korea and Taiwan. The rest of the paper is organized as follows. Section I motivates the empirical analysis by highlighting the implications of certain balance of payments and central bank accounting identities. Section II discusses model estimation and identification. Section III discusses the results of the model. Section IV provides conclusions and indicates possible areas for future research.

I. Intervention, Sterilization, and Monetary Reserves

To motivate the empirical analysis that follows, it is useful to recall two identities. First, the balance of payments identity implies that the sum of the current (trade) and the capital account balance equals the change in the (net) foreign assets of the central bank.

$$CA + CAP = \Delta FA \tag{1}$$

where Δ is the first difference operator. To illustrate how balance of payments disequilibria can come about, consider

an economy in which at the prevailing exchange rate (holding everything else constant) the current account is balanced ($CA = 0$). However, the expected returns on this economy's domestic assets are larger than the expected return on other countries' domestic assets, so there is a tendency for capital inflows in a foreign currency (U.S. dollars). This puts pressure on the exchange rate to appreciate, as holders of U.S. dollars seek to convert to acquire domestic assets. If the local central bank wants to prevent currency appreciation, it will intervene in the foreign exchange market by purchasing U.S. dollars, thus increasing its holding of foreign assets. The outcome is positive capital inflows and an increase in foreign assets ($CAP > 0$, $\Delta FA > 0$). If the central bank does not intervene, the exchange rate will appreciate freely to the point where it is unprofitable for capital to flow in. In this case, balance of payments equilibrium is achieved with $CAP = 0$ and $\Delta FA = 0$. It is apparent from the preceding that changes in foreign assets of the central bank reflect the balance of payments conditions (current account and capital account) of a country and its exchange rate policies.

Second, the simplest version of the central bank balance sheet implies that a change in reserve money (H), or the (monetary) liabilities of the central bank, is identically equal to the change in its assets, which in turn equals the sum of changes in domestic credit (DC) and in foreign assets (FA) of the central bank.

$$\Delta H \equiv \Delta DC + \Delta FA. \tag{2}$$

Equation (2) implies that a change in foreign assets tends to change the supply of money. In many countries, central banks attempt to prevent changes in foreign assets from affecting reserve money by implementing offsetting changes in domestic credit, a policy known as *sterilization*. For example, Asian countries in the 1980s and 1990s responded to large increases in foreign asset holdings by implementing sharp reductions in domestic credit (see Glick and Moreno 1995). Sterilization can also work the other way. In 1994, the Mexican central bank offset the monetary contraction caused by declining foreign asset holdings by increasing domestic credit.[1] In the discussion that follows, foreign assets and domestic credit will at times be described as "monetary variables" because of their close relationship to reserve money.

The preceding discussion illustrates how efforts to stabilize the exchange rate when the balance of payments is not in equilibrium can adversely affect monetary control. It is worth noting, however, that the extent to which balance of payment disequilibria will arise and be reflected in changes in foreign assets depends in part on the degree of capital mobility. In some cases, capital controls may limit balance of payments imbalances and their monetary effects. For example, returning to our previous example, an exchange rate peg that raises the expected return on a country's domestic assets above the foreign rate may not result in capital inflows and increases in central bank foreign assets if capital controls prevent foreigners from investing in domestic assets.[2]

Korea and Taiwan: Policies and Experiences

As discussed above, the extent to which an economy is exposed to balance of payments imbalances, and concomitant pressures on the money supply, will depend on a country's exchange rate policies and the characteristics of capital controls.

Exchange rate policies may range from a rigid peg to a single currency to more flexible basket pegs or managed floats, the latter being closer to the policies adopted in Korea and Taiwan. Korea maintained a multi-currency basket peg until March 1990, when it switched to a market average exchange rate system. Taiwan maintained a managed float for most of the 1980s, also using a market average system.[3] It switched to a pure float for transactions exceeding a minimum amount in April 1989.

1. There is an extensive literature on whether sterilized intervention in foreign exchange markets is effective in stabilizing the exchange rate (this requires that domestic and foreign assets not be perfect substitutes). However, this question is not the focus of the present study.

2. In other cases, however, capital or foreign exchange controls may accentuate balance of payment imbalances. For example, suppose capital controls require exporters to surrender their foreign exchange earnings and prevent domestic residents from investing abroad. If there is a current account surplus at the current exchange rate targeted by the government, the government will in effect purchase the foreign assets accumulated by the economy's trade sector. Foreign exchange controls in this case result in a tendency for the money supply to increase.

3. In Korea, since the introduction of a market average rate (MAR) system on March 2, 1990, the won–U.S. dollar rate has been determined on the basis of the weighted average of interbank rates for won–U.S. dollar spot transactions of the previous day. During each business day, the Korean won–U.S. dollar exchange rate in the interbank market is allowed to fluctuate within fixed margins of plus or minus 1% against the MAR of the previous day. The exchange rates of the won against currencies other than the U.S. dollar are determined in relation to the exchange rate of the U.S. dollar against these currencies in the international market. The buying and selling rates offered to customers are set freely by foreign exchange banks. In Taiwan, the spot central rate of the U.S. dollar against the NT dollar was set daily on the basis of the weighted average of interbank transaction rates on the previous business day. Daily adjustment of the spot rate was limited to 2.25% of the central rate on the previous business day.

Although exchange rate policies allowed some flexibility in currency movements, both economies appear to have been exposed to shocks that contributed to balance of payments disequilibria and complicated efforts at monetary control. For example, the U.S. dollar depreciation against major industrial country currencies in the second half of the 1980s was associated with increases in the current account balances of both economies, in spite of significant appreciation in both the Korean won and the NT dollar against the U.S. dollar. In the case of Taiwan, the expansionary monetary effects of current account surpluses were exacerbated by speculative short-term capital inflows. As is well known, declining U.S. interest rates in the early 1990s were associated with a surge in capital flows to emerging market economies.

The vulnerability of these economies to shocks was to some extent influenced by policies affecting capital mobility in the two economies, which are described in some detail in the Appendix to Moreno (1993). It seems accurate to describe Korea's capital controls as being generally more restrictive than Taiwan's. However, while foreign exchange controls have been very gradually and steadily liberalized in Korea, in Taiwan, the path to liberalization has included some significant policy reversals.

At the beginning of the 1980s, Korea and Taiwan both had restrictions affecting capital flows, including controls on foreign exchange availability for current account transactions, controls on capital flows, restrictions on foreign exchange market transactions (such as forward or futures transactions, swaps or options) and restrictions on foreign access to the domestic financial sector. However, there are at least two important differences. First, in Taiwan, restrictions on current account transactions were eliminated in 1987. In Korea, licenses are still required to obtain foreign currency for current account transactions, and there are limits on the foreign currency holdings of firms (proportional to the size of their international trade activities).

Second, Korea traditionally limited capital inflows as well as outflows (particularly via the banking sector), whereas until 1987, Taiwan restricted only outflows. For example, government approval was needed in Korea in the 1980s for any external borrowing by firms exceeding specified limits: US$200,000 before October 1982, and US $1,000,000 thereafter. There were no comparable limits in Taiwan until 1987, when a surge in speculative capital inflows prompted the government to freeze external bank borrowing. This ceiling on Taiwan banks' external liabilities was lifted gradually in the years that followed.

Differences in capital controls may have been reflected in the components of the balance of payments that led to changes in foreign assets and in the size of the imbalances. For example, as discussed by Glick and Moreno (1995), both Korea and Taiwan experienced increases in foreign assets in the second half of the 1980s as a result of current account surpluses. However, in Taiwan the increase in foreign assets was much larger than in Korea, partly because of significant short-term capital inflows in Taiwan that were interrupted only by the imposition of controls on capital inflows.

II. MODEL ESTIMATION AND IDENTIFICATION

In order to capture key elements of Korea's and Taiwan's balance of payments and monetary sectors, a vector autoregression (VAR) model for each economy was estimated using monthly data. As the primary focus of this study is to assess the implications of balance of payments imbalances for monetary control, the VAR model includes two macroeconomic variables that are likely to affect balance of payments conditions: the end-of-month nominal exchange rate in domestic currency units per U.S. dollar (an increase is a depreciation of the local currency, labeled *XR*, IMF International Financial Statistics (IFS) line ae), and the domestic *CPI* (IFS line 64). It also includes two central bank balance sheet variables that capture the actions of policymakers: foreign assets (labeled *FA*, IFS line 11), and a measure designed to capture the variation in domestic credit (labeled *DC*). The domestic credit measure was estimated by taking the difference between the log of central bank reserve money (IFS line 14) and the log of gross foreign assets (this corresponds to a ratio of the two series in levels).[4] All the other variables were entered in logs.

One potential disadvantage of the measure of foreign assets used is that it does not explicitly take into account changes in the valuation of foreign assets (which is measured in domestic currency) that result from changes in the

4. The measure of domestic credit is approximate for two reasons. First it is the difference of the log reserve money and log foreign assets, rather than the difference in the levels of these series implied by the central bank accounting identity. The measure used in this paper still captures the variation in domestic credit, but allows taking logs even when estimated domestic credit is negative. In the case of Korea, the correlation of the measure used in this paper with the log of the accounting measure over the periods when the accounting measure was positive is 86% (period 1981.1–1988.6) and 82% (1989.12–1994.12). In the case of Taiwan, the accounting measure is negative over most of the sample. However, if the accounting measure is scaled up by a constant to make all values positive and logs are then taken, the correlation with the measure used in this paper is 77%. Second, the measure includes the foreign liabilities of the central bank. However, foreign liabilities are small and vary less frequently in comparison to foreign assets in Asian economies, and do not always appear to be consistently reported; therefore I have chosen not to take them into account explicitly.

value of the exchange rate. This effect, discussed by Takagi (1991), could cloud the interpretation of some of the findings of the model. However, as reported later, the correlation between the residuals of the exchange rate and foreign asset equations is relatively small, which suggests that, on a monthly basis, the effect of changes in the exchange rate on the value of foreign assets is probably not very large. In addition, a similar model was also estimated using total reserves less gold, denominated in U.S. dollars, which are unaffected by changes in the domestic exchange rate vis-à-vis the U.S. dollar. The results do not appear to be too sensitive to this change in variable.[5]

The data span the period 1981.1–1994.12, when large swings in balance of payments conditions in these two economies, as well as in other economies (notably the United States and Japan), were observed. The data set begins in 1981, rather than 1980, to avoid Korea's transition from a fixed exchange rate to a multiple currency basket peg in 1980. As unit root test results are consistent with the data over the sample being trend stationary, the model was estimated using OLS with the series entered in levels, and a linear trend term added to each equation.

Interpreting the VAR Model

Glick and Hutchison (1994) show how a model similar to that estimated in this paper can be derived as a reduced-form representation of an open economy portfolio model with sluggish portfolio adjustment, intervention, and sterilization. In their model, changes in foreign assets and domestic credit reflect changes in private asset demand (which may be attributable to factors such as changes in foreign interest rates) and in domestic credit. They also show that the contemporaneous correlations between foreign assets and domestic credit and the adjustment responses depend on private sector asset demand parameters, the asset speed of adjustment and central bank intervention parameters, as well as on the underlying disturbance. For example, consider a situation where the government seeks to dampen currency fluctuations and then sterilizes the monetary effects of intervention. Then if foreigners decide to acquire more domestic bonds, this will be associated with an initial increase in central bank holdings of foreign assets (due to intervention) and a fall in domestic credit (due to sterilization). The dynamics of convergence to the long-run equilibrium will depend on the various factors cited above.

5. The model in this case consisted of the following variables in logs: exchange rate, the CPI, total reserves less gold (in U.S. dollars), and reserve money.

Identification

The VAR model was identified by orthogonalizing the variance-covariance matrix of the residuals of the four equations using the Choleski decomposition. In performing the decomposition, the causal ordering *XR*, *CPI*, *FA*, *DC* was used. That is, in the current period, the exchange rate is assumed to affect the remaining variables but is unaffected by them; the CPI is affected contemporaneously by the exchange rate and affects foreign assets and domestic credit. Of particular importance is the assumption that shocks to *FA* contemporaneously affect *DC* rather than the other way around.

The sensitivity of the results to the ordering can be assessed by examining the contemporaneous correlations of the residuals. As can be seen in Table 1, correlations with *XR* and *CPI* are relatively small, suggesting that the results are not sensitive to the ordering. However, there is a strong negative correlation between foreign assets and domestic credit (–74 percent for Korea and –49 percent for Taiwan), so the results reported below are sensitive to the assumption that places foreign assets before domestic credit in the causal ordering.

The macroeconomic variables (*XR* and *CPI*) are placed first partly to reflect the focus of the paper on describing the responses of the central bank to shocks. However, this ordering may also be justified by considering the likely sources of contemporaneous covariation in the series. It is unlikely that much of the within-month variation of a highly volatile series like the exchange rate is the result of monthly changes in the CPI, which justifies ordering *XR*

TABLE 1

CONTEMPORANEOUS CORRELATIONS OF RESIDUALS IN PERCENT

	CPI	FOREIGN ASSETS	DOMESTIC CREDIT
KOREA			
Exchange Rate	–6.4	–17.2	13
CPI		–5.1	4.3
Foreign Assets			–74.1
TAIWAN			
Exchange Rate	–7	6.8	–22.9
CPI		6	–4.5
Foreign Assets			–48.9

before *CPI*. Placing *CPI* before *FA* and *DC* also is plausible, as the CPI generally responds to monetary variables with a lag, while policymakers may respond to CPI innovations in the same month. It is less obvious that *XR* should be ordered prior to *FA* and *DC*. However, due to the relatively low correlations of *XR* with these variables cited above, the results are not likely to be sensitive to this assumption.

Placing *FA* before *DC* is consistent with assuming that exogenous shocks to foreign assets lead to offsetting contemporaneous changes in domestic credit, reflecting sterilized intervention by central bankers (see the discussion above and the more formal exposition by Glick and Hutchison, 1994). This causal ordering can be justified by the observation that episodes of balance of payments imbalances in Korea and Taiwan appear to have been triggered by certain discernible international events. For example, in Taiwan, both the large dollar depreciation in the mid-1980s and the period of declining U.S. interest rates in the early 1990s appear to have been associated with unusually high foreign asset levels. In the reduced-form specification of the model such events would be captured in variations in foreign assets that would be contemporaneously associated with sterilization. In addition, in the case of Korea, it can be argued that restrictions on capital flows may make it less likely that policymakers would need to offset changes in domestic credit with changes in foreign assets contemporaneously.

However, the reader should bear in mind that an alternative interpretation of the correlation is that changes in domestic credit lead to changes in the exchange rate that the government seeks to avoid through intervention. Given the high correlation between foreign assets and domestic credit, adopting such an interpretation to identify the model (by reversing the causal ordering) affects the results reported below.

III. MODEL RESULTS

The model was used to address two broad questions. First, how do policymakers respond to shocks to the economy, as indicated by the behavior of foreign assets and domestic credit? Second, what are the main sources of variation in these policy variables? Of particular interest is whether domestic credit fluctuations reflect disturbances in foreign assets, which would indicate that sterilization is an important element in domestic credit policy. Also of interest is whether foreign asset fluctuations reflect changes in domestic credit, as this would suggest that policymakers intervene in foreign exchange markets to offset the effects of domestic monetary policy.

To address the first question, the dynamic responses to selected one-standard-deviation shocks are illustrated in Figures 1 to 3. To address the second question, statistical tests were first performed to determine which variables help predict foreign assets and domestic credit in the respective regression equations. The results of the tests (null hypothesis that the block of lagged coefficients is zero) are reported in Table 2. In addition, the contribution of each variable to the variance of the forecast error of foreign assets and domestic credit also was examined. The results of these decompositions are reported in Tables 3 and 4.

Dynamic Responses to Shocks

In order to assess policymakers' responses to shocks in Korea and Taiwan as well as the implications for the money supply, we examine the responses to shocks of foreign assets and domestic credit, and the net effect on reserve money.[6] As this study is largely concerned with conditions in foreign exchange markets, only the dynamic responses over a 60-month horizon to shocks to the exchange rate, foreign assets, and domestic credit are illustrated (in Figures 1, 2, and 3, respectively). The underlying series are in logs, so the dynamic responses can be interpreted as log deviations from the baseline path. The shaded areas define a confidence band that excludes the upper and lower 1 percent fractiles.

Responses to an exchange rate shock. The point estimates in Figure 1 indicate that a shock to the Korean exchange rate (depreciation) is associated with a decline in foreign assets and an offsetting increase in domestic credit. In contrast, in Taiwan, an exchange rate depreciation appears to be associated with an *increase* in net foreign assets and an offsetting reduction in domestic credit. The decline in Korean foreign assets indicates that Korean monetary authorities intervene to offset changes in the exchange rate, that is, they "lean against the wind," while in Taiwan intervention apparently "leans with the wind" in the months that follow the shock to the exchange rate.[7] In both economies, the offsetting movement in domestic credit indicates that intervention is largely sterilized. These policy actions are reversed gradually, after a period of about four

6. Since domestic credit is defined as the difference between the log reserve money and log foreign assets, the response of log reserve money can be computed by adding the respective responses of foreign assets and domestic credit

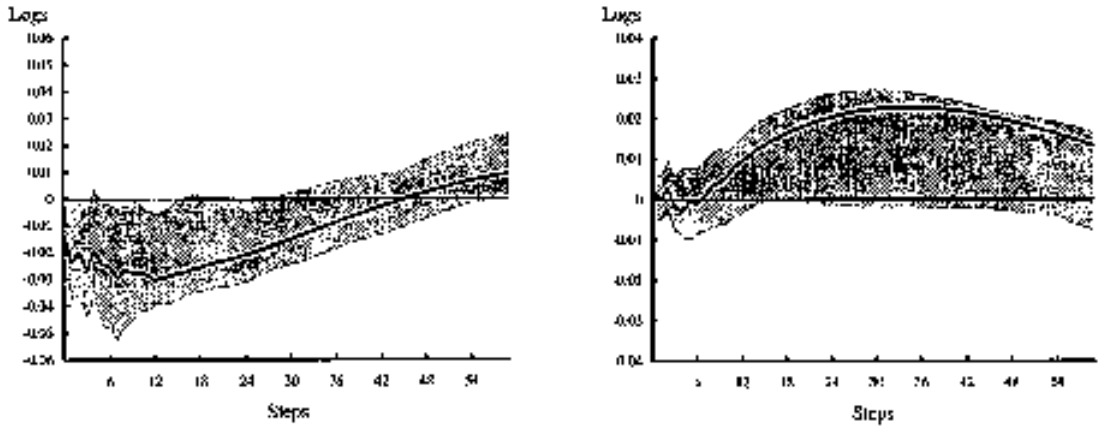
7. In interpreting this result, the reader may bear in mind that responses to shocks to the exchange rate do not fully describe intervention policy in response to disturbances in foreign currency markets. As discussed below, there are also responses to shocks to foreign assets.

FIGURE 1

RESPONSES TO A SHOCK IN EXCHANGE RATE

KOREA	TAIWAN

FOREIGN ASSETS



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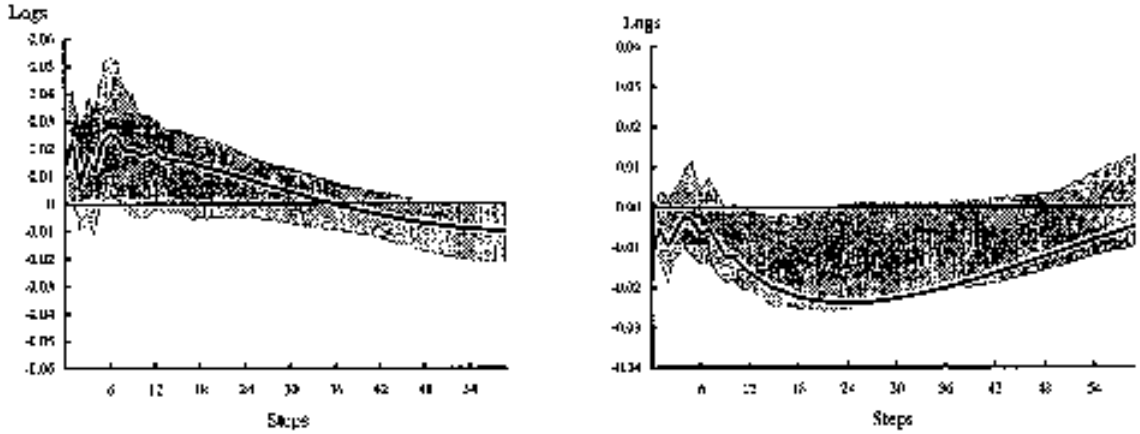

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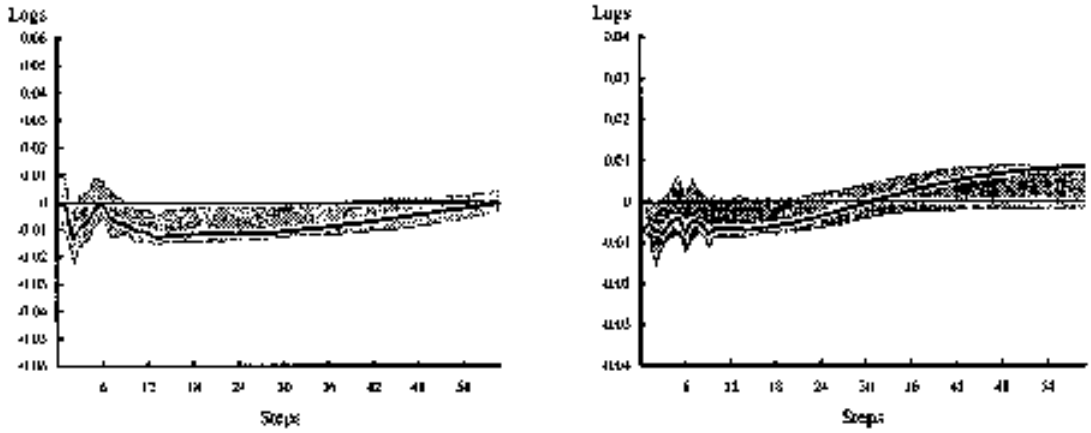
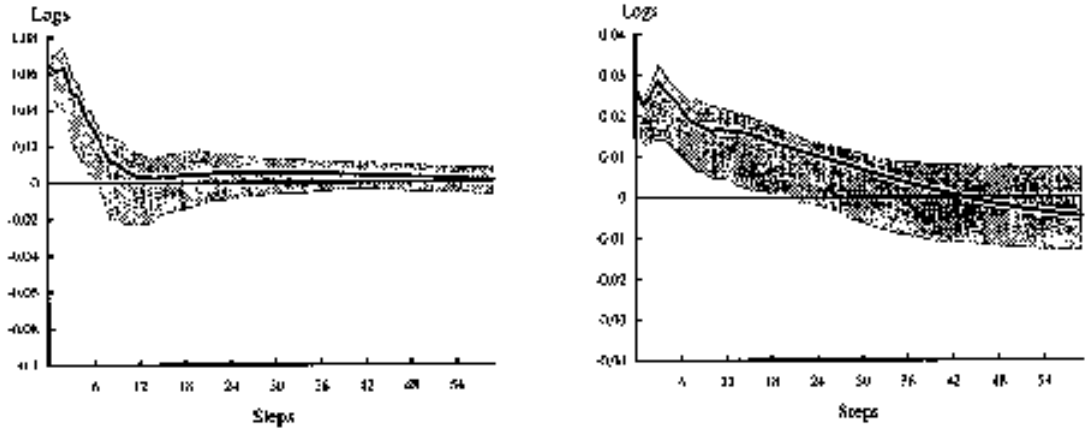


FIGURE 2

RESPONSES TO A SHOCK IN FOREIGN ASSETS

KOREA	TAIWAN

FOREIGN ASSETS



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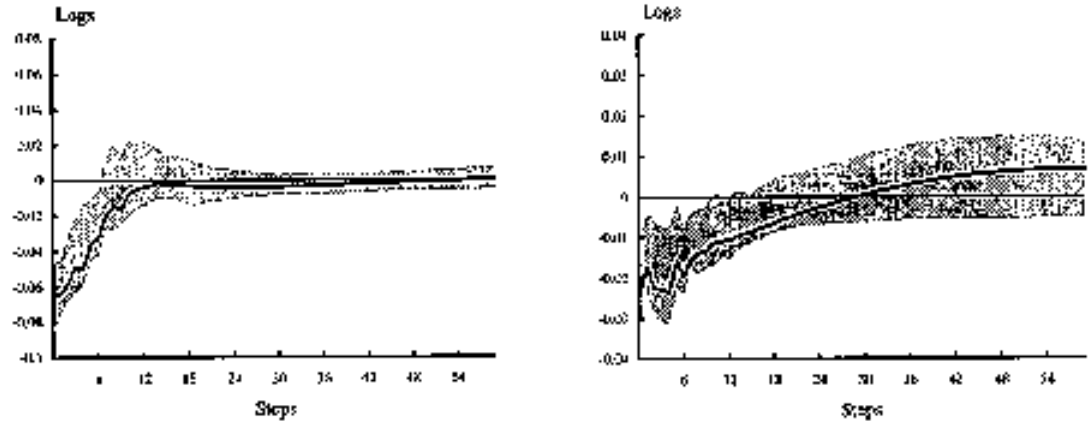

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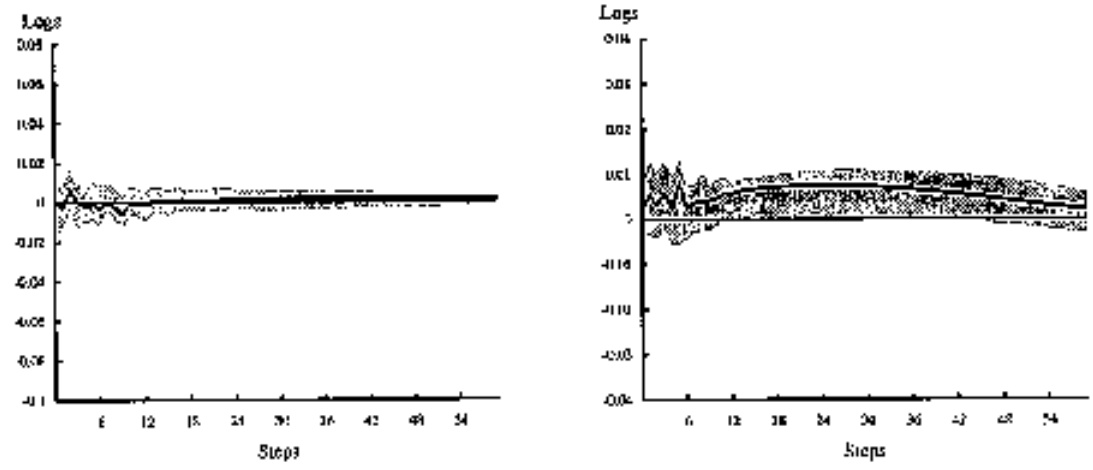
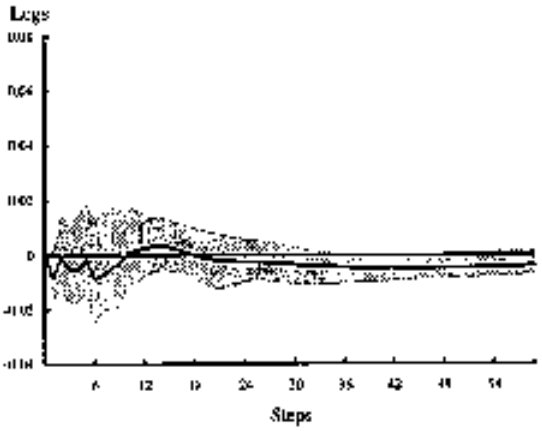


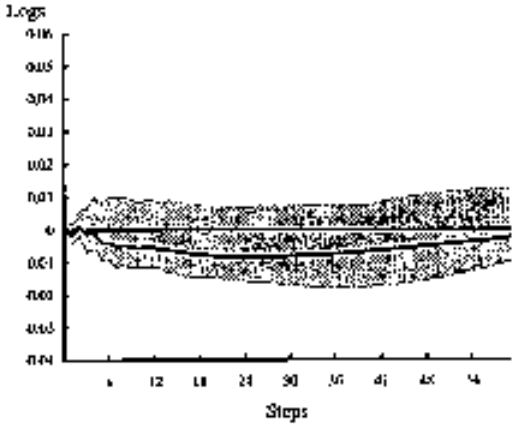
FIGURE 3

RESPONSES TO A SHOCK IN DOMESTIC CREDIT

KOREA	TAIWAN

FOREIGN ASSETS





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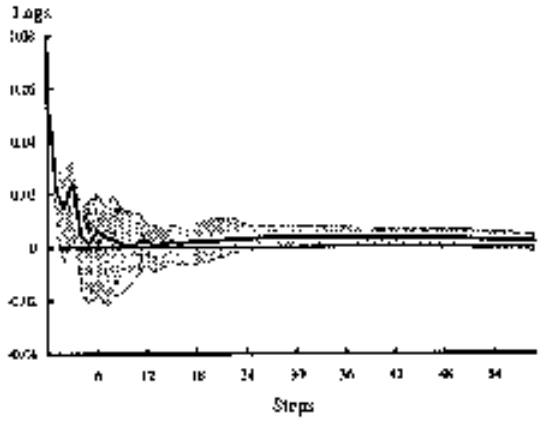

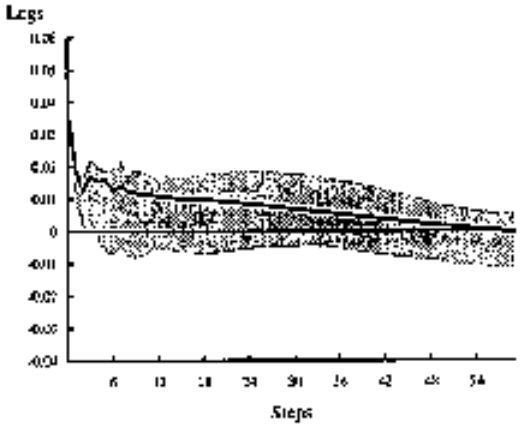

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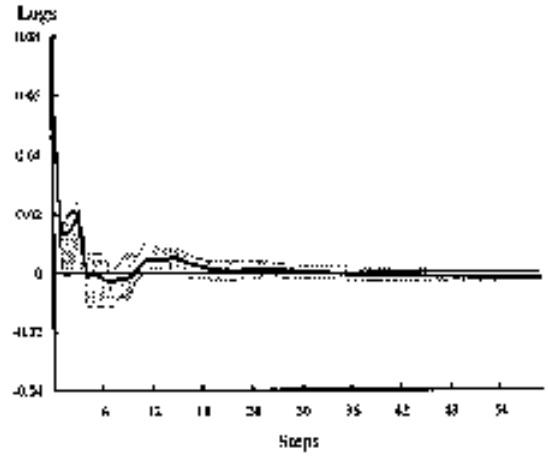


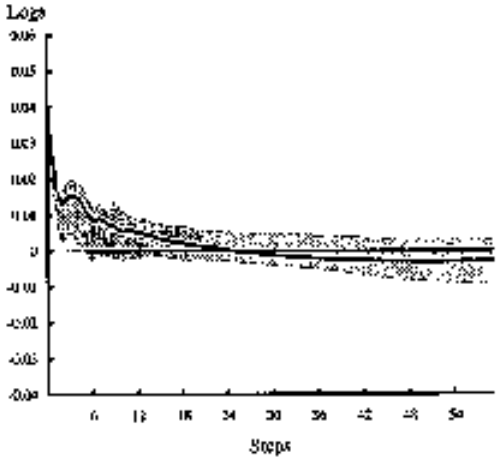


TABLE 2

TESTS OF PREDICTIVE ABILITY

	FA	*DC*
KOREA		
XR	1.3***	5.9*
CPI	23.2	0.0***
FA	0.0***	0.7***
DC	35.4	0.0***
TAIWAN		
XR	29.7	17.2
CPI	0.0***	0.8***
FA	0.0***	0.3***
DC	41.6	0.0***

Notes:
*** Significant at 1%
* Significant at 10%

TABLE 3

VARIANCE DECOMPOSITIONS FOR FOREIGN ASSETS

	Step	*XR*	*CPI*	*FA*	*DC*
KOREA					
	1	4	0	96	0
	24	40	9	50	1
	60	42	12	44	2
TAIWAN					
	1	1	1	98	0
	24	19	25	52	5
	60	48	22	25	6

TABLE 4

VARIANCE DECOMPOSITIONS FOR DOMESTIC CREDIT

	Step	*XR*	*CPI*	*FA*	*DC*
KOREA					
	1	2	0	53	45
	24	20	5	60	15
	60	22	9	54	15
TAIWAN					
	1	5	0	26	69
	24	34	17	24	25
	60	53	14	16	17

years. As shown in Figure 3, the net effect on reserve money is on balance negative in both economies.

While the apparent contrasting responses suggested by the point estimates are interesting, the confidence bands indicate that actual differences in policy responses may be less stark than those indicated by the point estimates. The hypothesis that the response of Korean foreign assets is zero can be rejected over some interval of the dynamic response, but this same hypothesis is generally not rejected in the case of the other responses in Figure 1.[8]

Responses to a shock to foreign assets. The point estimates in Figure 2 indicate that an unexpected increase in foreign assets in Korea is associated with an offsetting decline in domestic credit, evidence of a strong sterilization response. The responses to the shock are reversed relatively quickly, within about twelve months. On balance, the reserve money response fluctuates around zero. In contrast to the responses to exchange rate (and CPI) shocks, the responses of foreign assets and domestic credit to a foreign asset shock are estimated with sufficient precision so that, based on the confidence bands, the hypothesis that they are zero is easily rejected over some interval. However, the hypothesis that the response of reserve money is zero cannot be rejected, indicating that sterilization of shocks to foreign assets is complete in Korea.

In the case of Taiwan, an increase in foreign assets is also associated with an offsetting decline in domestic credit. However, the reversal in the gross responses is far more gradual than in Korea, taking 30 to 40 months. One possible explanation for the persistence of a shock to foreign assets is that restrictions on capital flows are more limited in Taiwan. For example, as noted earlier, in 1986–1987 Taiwan experienced large capital inflow surges that persisted for months, as speculators sought to capture gains from expected continued NT dollar appreciation. Such persistent surges have not been observed in Korea. In further contrast to Korea, in Taiwan the point estimates indicate that sterilization does not fully offset the shock to foreign assets. A foreign asset shock is followed by an increase in reserve money that dies out very gradually. While this result should be interpreted with caution due to wide

8. Differences between the two economies are also apparent in the responses to a shock to the CPI (not shown). In Korea, such a shock is associated with a temporary increase in foreign assets and a contraction in domestic credit, while in Taiwan it is associated with a temporary (but persistent) decline in foreign assets and an increase in domestic credit. On balance, the monetary reserves response to a CPI shock in Korea is positive, while it appears to be negative in Taiwan. The confidence bands once again indicate that any inferences should be made with caution, as the null that the dynamic response is zero in many cases cannot be rejected.

confidence bands, it suggests that Korea may be able to achieve greater stability in the exchange rate with less net change in the money supply, possibly because of greater capital controls.[9] Indeed, in Figure 4, a one standard deviation shock to foreign assets in Korea results in an exchange rate change that is smaller than (according to the point estimate) or at least as large as (according to the confidence band) in Taiwan.

Responses to a shock to domestic credit. A shock to domestic credit in Korea is associated with an erratic response in foreign assets that is not significantly different from zero. The result is an increase in reserve money that is quickly eliminated. A similar pattern of responses is apparent in Taiwan. Thus, in sharp contrast to the tendency to dampen the monetary impact of shocks to foreign assets, shocks to domestic credit by and large are not offset by intervention in either Korea or Taiwan. This result may be viewed in the context of traditional models of balance of payments crises and abandonment of exchange rate pegs originally developed by Krugman (1979). In these models, domestic credit creation leads to a depletion in foreign assets that eventually leads to the abandonment of an exchange rate peg. Such an effect appears to be absent in both Korea and Taiwan, suggesting that monetary authorities in these two economies are prepared to accept fluctuations in the exchange rate and the money supply that may result from changes in domestic credit, even if they are not prepared to accept fluctuations in these variables that result from changes in shocks originating in the external sector. The effect also may indicate that shocks to domestic credit do not significantly affect the balance of payments for other reasons, such as imperfect capital mobility.

Predictive Ability and the Relative Importance of Shocks

While the preceding discussion gave an idea of the qualitative responses of foreign assets and domestic credit to economic shocks, it did not explicitly identify the main factors that drive these two variables. To shed light on this question, we first identify which variables help predict foreign asset and domestic credit behavior by testing exclusion restrictions. We also assess the contributions of different variables to the variance of the forecast errors of foreign assets and domestic credit.

The tests of exclusion restrictions are presented in Table 2. Both foreign assets and domestic credit are predicted by their own lags and by either the lagged exchange rate or the lagged CPI. One interesting result that emerges from the table is that in both Korea and Taiwan, lagged domestic credit does not help predict foreign asset behavior, while lagged foreign assets do help predict domestic credit.

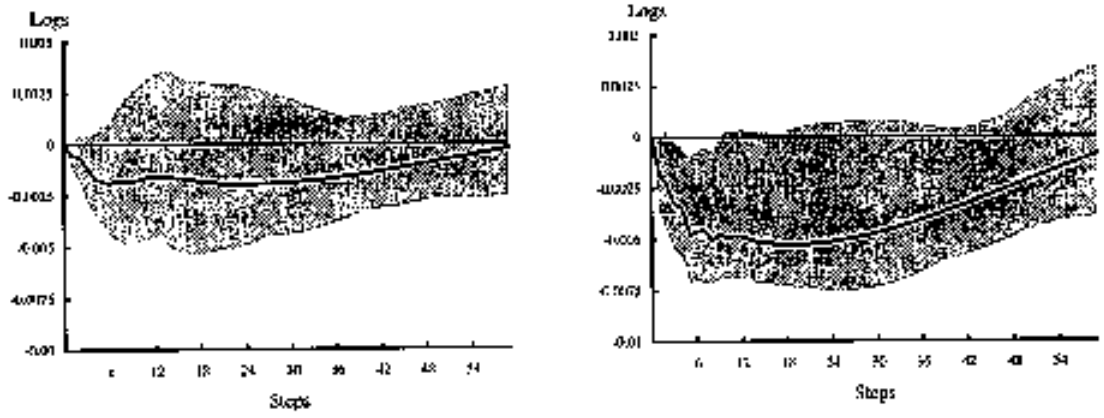
We can exploit the identifying restrictions of the model to estimate the contribution of innovations in each of the variables to the variance of the forecast error in foreign assets and domestic credit. The results are reported in Table 3.

Table 3 reveals that, in the very short run, the variance in foreign assets in both Korea and Taiwan cannot be explained by other variables. After 24 months the exchange rate accounts for about half of the variance in foreign assets in Korea, with innovations in foreign assets accounting for most of the rest. In the case of Taiwan, shocks to foreign assets account for most of the variance up to 24

FIGURE 4

EXCHANGE RATE RESPONSES TO A SHOCK IN FOREIGN ASSETS

KOREA TAIWAN



months; at 60 months shocks to the exchange rate and the CPI also play a role.

Table 3 also reveals that at a 24-month horizon, foreign assets account for about half of the variance in domestic credit in Korea and nearly a fourth of the variance in Taiwan. Innovations in the exchange rate also play a role, particularly in Taiwan, where they account for about half of the variance in domestic credit at a 60-month horizon.

Thus, the variance in foreign assets appears not to reflect innovations in domestic credit, reinforcing the impression conveyed by the dynamic responses, namely, that the extent to which monetary authorities intervene in foreign exchange markets to offset changes in domestic credit is small. In contrast, the variance in domestic credit appears to reflect innovations in foreign assets as well as in the exchange rate. The influence of foreign assets in domestic credit may reflect sterilization policies, while the influence of the exchange rate may indicate that policymakers rely not only on intervention, but also on domestic credit creation, to stabilize the exchange rate.

IV. CONCLUSIONS

This paper has developed an empirical model to analyze the monetary implications of intervention and sterilization policies in Korea and Taiwan. At least two interesting results emerge from the empirical analysis.

First, sterilization is an important element of the response to shocks to foreign assets in both economies. Shocks to foreign assets were largely offset by shocks to domestic credit, and were therefore generally associated with little net change in reserve money, particularly in the case of Taiwan. In line with this, a significant proportion of the variation in domestic credit reflects innovations in foreign assets.

It is interesting that the converse was not true. In general, shocks to domestic credit were not associated with fully offsetting movements in foreign assets, indicating that in contrast to the traditional description of unsustainable exchange rate pegs (Krugman 1979) domestic credit creation does not lead to asset depletion in this empirical model of Korea and Taiwan. Neither is domestic credit contraction associated with unsustainable asset accumulation in this model (Grilli 1986). In particular, it appears that monetary authorities in these two economies are prepared to accept fluctuations in the exchange rate and the money supply that may result from changes in domestic credit, while they are not so prepared to accept fluctuations in these variables that result from changes in foreign assets.

Second, there are some differences in the responses of Korea and Taiwan that indicate that Korea may be more insulated from foreign asset shocks. This is consistent with institutional practices that suggest that Korea may have had more restrictive capital controls over the sample period. Shocks to foreign assets are quickly reversed in Korea, while they appear to be much more persistent in Taiwan. This may reflect more persistent foreign exchange market speculation in Taiwan made possible by less restrictive capital controls. In addition, Korea has tended to sterilize shocks to foreign assets more fully than has Taiwan, achieving a smaller exchange rate change with a far smaller change in the money supply.

The preceding conclusions are sensitive to the identifying assumptions used in this model, specifically the assumption that foreign assets are contemporaneously exogenous to domestic credit. However, this assumption does not appear to be unreasonable, since episodes with large swings in the balance of payments and in foreign assets appear to have been associated with certain identifiable international events, such as the dollar depreciation of 1985–1987.

A number of additional questions warrant further research. It would be of interest to investigate further the apparent asymmetry in policymakers' responses. Policymakers appear to be concerned with offsetting the monetary and exchange rate effects of balance of payments shocks, but less concerned with offsetting domestic credit shocks. It would also be interesting to examine to what extent foreign asset behavior and domestic monetary conditions are influenced by a more disaggregated set of external shocks, such as the value of the U.S. trade-weighted dollar against the currencies of major industrial countries or U.S. interest rates. This can be done by expanding the VAR model explicitly to take account of these variables.

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