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TIME-VARYING ESTIMATES
ON THE OPENNESS OF THE CAPITAL
ACCOUNT IN KOREA AND TAIWAN

by

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**Technical Paper No. 42,
"Time-Varying Estimates on the Openness of the Capital Account in Korea and
Taiwan",**

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PREFACE

The outstanding growth performance of Korea and Taiwan has been achieved with restricted financial systems. Capital controls have helped these two countries' authorities to target monetary aggregates successfully, and at the same time, the real exchange rate. Both countries, however, have recently been put under pressure to open up their financial markets and to convert to market-oriented foreign exchange systems. To what extent financial opening would imply the loss of monetary autonomy depends very much on how interest rate determination in Korea and Taiwan have evolved during the recent past.

Helmut Reisen and H el ene Y eches confirm Korea's and Taiwan's concern about loss of monetary autonomy in showing that interest rates in both countries have been largely determined by domestic monetary conditions. Their findings indicate a low and stagnant degree of financial openness for both countries over the 1980s. This study is part of Development Centre research on "Financial Policies for the Global Dissemination of Economic Growth" to which a grant by the government of Japan is gratefully acknowledged.

Louis Emmerij
President of the OECD Development Centre
August 1991

RÉSUMÉ

Quel est le degré d'ouverture des comptes de capital en Corée et à Taiwan ? Une tendance vers une plus grande ouverture financière s'est-elle manifestée au cours des années 80 ? Le but de ce document est de répondre à ces deux questions en procédant à l'estimation d'un modèle de détermination des taux d'intérêt, d'abord esquissé par Edwards et Khan, puis approfondi par Haque et Montiel. On utilise l'estimation d'un paramètre variant avec le temps et basée sur la technique du filtre de Kalman au lieu de l'estimation habituelle d'un paramètre constant. Les résultats indiquent un faible degré de mobilité des capitaux, à la fois pour la Corée et Taiwan et aucune tendance vers une plus grande ouverture financière (sauf récemment à Taiwan dans le marché inter-bancaire). Le démantèlement du système de contrôle des capitaux et des restrictions financières internes va donc provoquer une diminution sensible de l'autonomie monétaire dans ces deux pays.

SUMMARY

How open are the capital accounts in Korea and Taiwan? Has there been a trend towards more financial openness during the 1980s? This paper aims at answering both questions by estimating a model of interest determination first outlined by Edwards and Khan, in an extension suggested by Haque and Montiel. Use is made of a time-varying parameter estimation based on the Kalman filter technique, instead of the usual constant parameter estimation. The findings indicate a low degree of capital mobility for both Korea and Taiwan, and no trend towards more financial openness (except recently in Taiwan's interbank market). The dismantling of capital controls and of internal financial restrictions is thus likely to impose an important loss of monetary autonomy in both countries.

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I. INTRODUCTION*

Korea and Taiwan have been under pressure to open up their financial markets and to convert to market-oriented foreign exchange systems. In particular the US government is pursuing vigorously its efforts to remove foreign trade and investment barriers to US financial firms. While there has been some financial market liberalisation in both countries during the 1980s (OECD, 1990), the effective implementation of liberalisation measures has not always been in line with prior policy announcements. Both Korea and Taiwan have taken a hesitant approach to financial liberalisation and opening, and important controls are still in place. In particular, there are strict limits on both inflows and outflows of portfolio investment, banks have narrow foreign exchange exposure ceilings imposed on them, interest rates are often set at non-clearing levels, and the governments of both countries interfere heavily in the process of credit allocation.

It is often not well understood that Korea's and Taiwan's governments have several good reasons — going beyond short-sighted protectionism and vested interests — to take a cautious approach to financial opening. After all, these countries' outstanding growth performance has gone well with restricted financial systems. Industrial policy has been largely operated through selective credit programs (Korea) or the government-owned banking system (Taiwan); that policy has saddled domestic banks with a high level of non-performing loans which precludes their competitiveness with unfettered securities markets or foreign financial institution on a level playing field. The lesson from North and South America where financial deregulation has been accompanied by a wave of financial crises has told Korea's and Taiwan's governments that the removal of direct controls requires the establishment of appropriate and effective regulation and supervision of the banking system; time is needed to adopt international standards of capital adequacy, accounting and auditing, information provision, corporate law, and juridical procedures (Fry, 1990). Last but not least, the loss of monetary autonomy implied by financial opening worries Korea's and Taiwan's authorities; it is this concern which motivates our paper.

In the past, capital controls have helped Seoul and Taipei to target monetary aggregates successfully and, at the same time, the real exchange rate. Low to moderate inflation rates have laid out a fertile macroeconomic background to growth, competitive and stable exchange rates have allowed both countries to crowd in world demand for domestic tradable production. With increasing openness of the capital account, however, the effectiveness of monetary policy depends critically on the degree to which the exchange rate is left flexible. A country such as Korea whose companies are structured to exploit scale economies on the world market based on low profit margins cannot easily afford to ignore the exchange rate, however. Real appreciation induced by capital inflows tends to bite quickly into low margins while the

* We would like to thank Jean-Claude Berthélemy, Frank Browne and Isabelle Joumard for comments, and Andrés Solimano for providing us with a computer program on the Kalman filter technique. The usual disclaimer applies.

benefits of industrial upgrading are slow to come. Sterilised intervention by the central banks¹ to counterbalance private capital flows and to manage the exchange rate will only be effective when the substitutability between foreign and domestic assets is sufficiently imperfect to replace the dismantled capital controls. In other words, only the existence of an exchange risk premium which explains deviations from uncovered interest parity (Frankel, 1989) can be exploited by managed floating to reconcile monetary and exchange rate targets in spite of financial openness. Moreover, during the process of financial opening the world's pent-up demand for Korean and Taiwanese assets may easily exceed the sterilisation capacity in both countries.

The degree to which the above concerns about loss of monetary autonomy are warranted depends very much on how interest rate determination in Korea and Taiwan have evolved during the recent past. If existing capital controls have been sufficiently effective, interest rates should have been largely determined by domestic monetary conditions, not by world interest rates. In this case, the removal of existing controls and restrictions would indeed reduce the effectiveness of monetary policy unless exchange rates were purely floating. However, the effectiveness of capital controls is widely questioned. If capital controls have not prevented international interest arbitrage in Korea and Taiwan, the official dismantling of these controls would not imply important modifications for macroeconomic policy.

This paper will assess how the openness of the capital account and curb (unregulated) market interest determination have evolved during the 1980s in Korea and Taiwan. We will use a model first outlined by Edwards and Khan (1985) and an extension recently suggested by Haque and Montiel (1990) to estimate the degree of openness of the capital account (Section II). We will make use of time-varying parameter estimation based on the Kalman filter technique, instead of the usual constant parameter estimation, to obtain information about how openness has evolved during the period 1980-1990 (Section III). Our findings indicate a low degree of capital mobility for both countries. The index of financial openness has been somewhat higher in Korea than in Taiwan, but has displayed more instability and even a tendency to decline during the second half of the 1980s. The dismantling of capital controls and internal restrictions is thus likely to imply an important loss of monetary autonomy in both countries.

II. INTEREST RATES IN SEMI-OPEN ECONOMIES

Financial semi-openness can be defined as lying between two extremes. The one extreme is the completely open economy with no impediments to capital flows. In such an economy, there should be full arbitrage between domestic and foreign interest rates, both being market-determined. Arbitrage under full openness should lead to convergence of risk-adjusted nominal rates of return on financial assets denominated in different currencies or issued in different countries. For a small open economy it would imply that domestic interest rates are solely determined by foreign interest rates, after taking into account exchange rate expectations (or the forward premium). The other extreme is the economy which is completely closed to the world. If they are market-determined, interest rates in the closed economy are thought to result from domestic money market disequilibrium with excess money demand raising domestic interest rates.

Most developing countries are neither wholly closed in financial terms, nor wholly open. Edwards and Khan (1985) have proposed a model of interest determination for semi-open economies in which both domestic and world influences play a role. Haque and Montiel (1990) have recently extended that model. The approach assumes the domestic (nominal) market-clearing interest rate (i) to be the weighted average of the uncovered interest parity rate (i^*) and the domestic market-clearing interest rate that would be observed if the private capital account were completely closed (i')

$$i = \psi i^* + (1-\psi) i' ; \quad 0 \leq \psi \leq 1 \quad (1)$$

The parameter ψ serves as an index of financial openness. Running from zero to one, the parameter rises when a country strengthens its integration with world financial markets. With $\psi = 0$, external factors play no role in the determination of the domestic interest rate — this is only possible with the private capital account effectively closed. If $\psi = 1$, the domestic market-clearing interest rate is equal to its uncovered parity value, and capital mobility is assumed to be perfect².

The hypothetical closed economy interest rate i' is derived in two steps, starting with the demand for money

$$\ln (M^D/P) = \alpha_0 + \alpha_1 i + \alpha_2 \ln (y) + \alpha_3 \ln (M/P)_{-1} ; \quad (2)$$

$$\alpha_1 < 0; \quad \alpha_2, \alpha_3 > 0$$

where y is real output, P is the domestic price level and M^D is the demand for money.

Assuming equilibrium in the money market [$\ln (M^D/P) = \ln (M^S/P) = \ln (M/P)$], an expression for the observed domestic interest rate is obtained

$$i = - (\alpha_0/\alpha_1) - (\alpha_2/\alpha_1) \ln (y) - (\alpha_3/\alpha_1) \ln (M/P)_{-1} + (1/\alpha_1) \ln (M/P) \quad (3)$$

The money supply which would correspond to the hypothetical situation with a closed private capital account is:

$$M' = M - KA_p \quad (4)$$

the actual money supply less the portion of reserve flows accounted for by private capital movements (KA_p). The hypothetical interest rate i' is the value of i which satisfies the money-market equilibrium condition

$$\ln (M'/P) = \ln (M^D/P) \quad (5)$$

or, using equation (2):

$$i' = - (\alpha_0/\alpha_1) - (\alpha_2/\alpha_1) \ln (y) - (\alpha_3/\alpha_1) \ln (M/P)_{-1} + (1/\alpha_1) \ln (M'/P). \quad (6)$$

Replacing this hypothetical closed economy interest rate in equation (1) we obtain:

$$i - i' = \psi (i^* - i') \quad (7)$$

Equation (7) can be estimated directly to determine the key parameter ψ as an index of financial openness. Direct estimation of equation (7), however, requires the observation of domestic market-clearing interest rates. In most developing countries, including Korea and Taiwan, organised securities markets are shallow or absent, and interest paid on bank assets is subject to legal controls (such as ceilings, "window guidance", etc.). Therefore, the only domestic market-clearing interest rate is commonly found on the unorganised curb market. Estimates along the Edwards/Khan approach based on curb market rates may pose two problems. First, published curb market rate data are rarely available. To circumvent this problem, Haque and Montiel (1990) have recently extended the Edwards/Khan approach, assuming that the unobserved true domestic interest rate is an argument of the money demand function given in equation (2). The second problem arises when data on curb market rates are available — as is the case in Korea and Taiwan — so that estimates of the index of financial openness can be based on direct tests of interest arbitrage. Curb market risks and other institutional characteristics drive a substantial wedge

between domestic market-clearing interest rates and uncovered interest parity. This mark-up of curb market over foreign interest rates reflects differences in the quality of underlying assets and not lack of financial openness.

Figure 1 shows two series for each country: the solid curve denotes the difference between nominal curb market rates in Korea and Taiwan, and the three-month LIBOR interest rate on the US dollar; the broken curve is the quarterly percentage change of the won/dollar rate, respectively the Taiwan dollar/US dollar rate. The spreads between curb market rates and the US dollar LIBOR rate have remained significant and persistent during the 1980s. Note in particular that the spread persisted during the second half of the 1980s when both the Korean won and the Taiwan dollar appreciated against the US dollar. To account for different asset quality, we introduce a constant into equation (7), so that:

$$i - i' = \alpha + \psi (i^* - i') \quad (8)$$

The deviation of the observed curb market rate from the hypothetical closed economy interest rate is proportional to the divergence of uncovered interest parity from the closed economy interest rate, corrected for a constant mark-up which captures different asset qualities.

FIGURE 1
INTEREST DIFFERENTIALS AND EXCHANGE RATE CHANGES

III. TIME-VARYING ESTIMATES: METHODOLOGY AND RESULTS

Usually, estimates of the index of financial openness ψ have been presented as a constant for a given period. Since the aim of this paper is to reveal how effective financial integration in Korea and Taiwan has changed during the 1980s, we recognise here that ψ is a variable coefficient with its value changing in response to various measures of financial liberalisation (or repression). The time-varying parameter estimation is done using the Kalman filter. Explanations of this statistical technique are available in, and its application in this paper are based on, McNelis and Neftçi (1982), Gourieroux and Monfort (1983), and Browne and McNelis (1990).

The domestic interest rate element of our estimates of financial openness have been based on curb market rates in both countries. There are two fundamental reasons for this decision: (1) the degree of market determination of reported interest rates, and (2) the persistent importance of the curb market for domestic fund intermediation. In Korea, interest rates other than those yielded on the curb market cannot be qualified as "market-clearing": government bonds are sold at yields below market rates to captive buyers; deposit money banks are still subject to quantitative ceilings on lending and loan rates; and Korean authorities still tend to intervene when they judge that market-determined interest rates are going too high. In Taiwan, the largely government-owned banking system has not yet become an important source of investment financing, and the corporate bond market is virtually nonexistent. According to flow-of-funds accounts for private business enterprises, the ratio of curb market to total bank borrowing was 48 per cent in 1986 (Fry, 1990).

The low degree of international tradability in informal curb market assets, however, gives rise to an important problem of data interpretation. Time-varying estimates on linkages with foreign interest rates may thus reflect time-varying factors specific to the curb market (such as degrees of financial dualism) rather than changes in financial openness. To handle this interpretation problem, we will supplement our estimates based on curb markets with estimates based on the official money market in Korea and on the market for interbank call loans in Taiwan. The assets traded on these markets are generally qualified by the highest degree of international tradability; it is not easy to judge *a priori*, however, to what extent interest rates on these markets are free of government intervention in the case of Korea and Taiwan.

To obtain preliminary information with constant parameters, we first performed an Ordinary Least Squares (OLS) estimation of the money demand function given in equation (2). Using quarterly data for the period for which curb market rates were available — 1980:1 to 1990:1 in the case of Korea, and 1981:1 to 1990:1 in the case of Taiwan — the estimates produced the following results³:

Korea:

$$\ln (M^D/P)_t = 0.715 - 0.005 i_t + 0.447 \ln (y)_t + 0.436 \ln (M/P)_{t-1}$$

(0.766) (-1.916) (3.231) (3.300)

$$\bar{R}^2 = 0.896, \quad h = 1.298$$

Taiwan:

$$\ln (M^D/P)_t = -1.183 - 0.019 i_t + 0.486 \ln (y)_t + 0.654 \ln (M/P)_{t-1}$$

(-0.591) (-4.016) (2.027) (6.423)

$$\bar{R}^2 = 0.991, \quad h = -0.023$$

In both equations, i_t stands for the domestic curb market interest rate. Curb market rates which were quoted on a per month basis have first been annualized and subsequently been based on quarterly averages. $(Y)_t$ is the local currency GDP (Korea), and GNP (Taiwan) at constant 1985 prices. $(M)_{t-1}$ is the lagged money stock defined as M_1 denominated in national currency. In both countries, the interest, income and lagged money parameters are correctly signed and significant (t-values in brackets). The corrected regression coefficient \bar{R}^2 shows a good fit, and Durbin's h statistic to test for first order autocorrelation in the presence of a lagged dependent variable shows absence of autocorrelation.

The estimates of the money demand function described above allowed us to estimate the hypothetical closed economy interest rate i' . Equation (3) was first estimated employing the non-linear least squares method. Then, we inserted the coefficients estimated in equation (3) into equation (6) and calculated the closed economy interest rate i' by replacing the observed money supply by the hypothetical closed economy money supply for each current period t . The money supply which would correspond to the hypothetical situation with a closed private capital account was defined as M_1 less foreign direct investment, portfolio investment, other short-term capital and errors and omissions. These various steps prepared the ground for the estimation of equation (8).

In the estimation of equation (8), the definition of i^* , the uncovered interest parity rate, posed the usual conceptual problem. In view of the continuing strong impact of the US dollar for both countries, the three-months LIBOR interest rate of the dollar was used to reflect world interest rates. Expected devaluation was proxied by the actual rate of devaluation of the respective currency with respect to the US dollar at the end of the corresponding period. This simplifying assumption, consistent with the perfect foresight variant of the rational expectations view, can be justified by the

nature of the exchange regime prevailing in both Korea and Taiwan during the 1980s (basket peg followed by managed float).

Since our aim is to analyse the stability of ψ during the process of financial opening, it is important that equation (8) satisfies tests for autocorrelation, heteroscedasticity and normality of residuals based on the assumption of constant parameters before we can apply the Kalman filter. To this end, equation (8) was first estimated using OLS techniques, incorporating the error term $\Sigma_t (0, \delta^2)$. The test revealed homoscedasticity and normally distributed residuals, but autocorrelation in the error term in the case of Korea. For Korea, then, serial correlation was eliminated by using the Cochrane-Orcutt procedure. The results obtained by the autoregressive process of order one (AR1) for Korea, and by OLS for Taiwan⁴, were:

$$\text{— Korea} \quad (i-i)_t = 10.498 + 0.594 (i^*-i)_t \\ (6.452) \quad (7.945)$$

$$\text{RHO1} = 0.554 \quad \bar{R}^2 = 0.807, \quad h = -0.258 \\ (7.888)$$

$$\text{— Taiwan:} \quad (i-i)_t = 6.687 + 0.353 (i^*-i)_t \\ (9.970) \quad (10.202)$$

$$\bar{R}^2 = 0.747, \quad \text{DW} = 1.523$$

The regression results will be interpreted and put into perspective in Section IV. It will suffice here to note that the parameter ψ satisfies the theoretical *a priori* bounds (0,1) and that they are highly significant. Durbin's h statistics are consistent with the absence of serial correlation in the residuals. The corrected regression coefficient \bar{R}^2 indicates that the model fits the data fairly well. Note also the high and significant value of the constant which proxies the mark-up to capture different asset qualities.

The main interest of this paper is to identify how the parameter ψ has changed over the 1980s in response to major financial policy developments. The Kalman filter requires some *a priori* specification of the movement of ψ_t over time. We assumed the following motion process

$$\psi_t = A\psi_{t-1} + v_t; \tag{9}$$

with the null hypothesis of parameter constancy, i.e. assuming an identity matrix $A = 1$.

Without repeating the Kalman technique employed here to arrive at time-varying estimates of ψ in any great detail, we nevertheless want to stress some points peculiar to the procedure used in this paper [for further explanation, see McNelis and Neftçi (1982)].

- For the AR1 estimation of Korea, all observed variables were transformed with the filter $F(L) = 1 - \rho L$. Under the null hypothesis of time-invariant parameters which is done at the starting point of the application of the Kalman procedure, the use of a fixed ρ is defensible even if it could be objected that ρ should vary along with the other parameters of the equation (9). Under the assumption of an invariant ρ , the Cochrane-Orcutt procedure yields a consistent estimate of ρ which in turn is used to produce a consistent estimate of parameter ψ in equation (9). Therefore, the results obtained by the AR1 estimations are the starting point for the Kalman filter iterative process.
- The Kalman filter technique is quite sensitive to the specifications of equation (9). For the specification of the variance-covariance matrix of the transition equation (9) estimate, we have to assume different values beforehand in order to represent various degrees of uncertainty in equation (9). We multiplied the variance-covariance matrix by $\sigma = 0.001$ and $\sigma = 0.0001$; both values result in estimates for ψ which do not violate the theoretical *a priori* assumptions for ψ .

After these checks, we applied the Kalman iterative procedure. Student's test was used to determine if the variation of the estimated values of ψ obtained by the Kalman filter was significant. In order to assess the variability of ψ , we plotted the Kalman filter estimates (Figures 2 and 3) with OLS (Taiwan) and AR1 (Korea) constant estimates and the 95 per cent confidence intervals obtained. Under the null hypothesis of a constant parameter, the Kalman filter estimates show significant differences from the constant coefficient, and thus significant variability over the observation period if the estimate falls outside the 95 per cent confidence interval.

Figures 2 and 3 chart the time-varying parameter for the index of financial openness in Korea and Taiwan. In both countries, and throughout the complete observation period, the parameter estimates satisfy the theoretical interval between zero and one. For Korea, the Kalman filter estimates show "significant" differences from the constant AR1 estimate under both σ specifications. The estimates display a wide variability in the index of financial openness, between 0.40 and 0.65 for $\sigma = 0.0001$ and between 0.20 and 0.75 for $\sigma = 0.001$. By contrast, the hypothesis of parameter constancy cannot be rejected for Taiwan, neither in the $\sigma = 0.0001$ nor in the $\sigma = 0.001$ which specify different degrees of uncertainty for the estimation of ψ in equation (9). Note also that the constant AR1 estimate tends to overestimate the degree of financial openness in Korea for most of the observation period (except during 1984-85).

FIGURE 2

FIGURE 3

To facilitate the interpretation of the curb market based results, we finally report estimates based on money markets. For Korea, estimates have been based on money market rates for which data have been published from 1984:1 on. For Taiwan, we used interbank call loan rates for which data have been available throughout the observation period 1980:1 to 1990:1. Again, the degree of market determination and the importance of these money markets for domestic fund intermediation guided our selection among markets.

OLS estimation of money demand functions produced the following results:

Korea:

$$\ln (M^D/P)_t = \begin{matrix} 0.041 & + & 0.013 & i_t & + & 0.608 & \ln (y)_t & + & 0.307 & \ln (M/P)_{t-1} \\ (-0.035) & & (1.087) & & & (3.435) & & & (1.707) \end{matrix}$$

$$\bar{R}^2 = 0.742, \quad h = 0.206$$

Taiwan:

$$\ln (M^D/P)_t = \begin{matrix} -2.819 & - & 0.011 & i_t & + & 0.464 & \ln (y)_t & + & 0.763 & \ln (M/P)_{t-1} \\ (-1.494) & & (-3.883) & & & (1.905) & & & (7.462) \end{matrix}$$

$$\bar{R}^2 = 0.991, \quad h = 0.480$$

In Korea's money demand function, the interest rate coefficient is wrongly signed but insignificant. An alternative specification of the money demand function including expected inflation did not change the sign of the interest coefficient (which stayed insignificant). This suggests that the official money market rate is irrelevant as an opportunity cost to hold M_t , in contrast to the informal curb market rate. This result prevents us from pursuing any meaningful estimation of the index of financial openness based on the Korean money market.

The results for Taiwan's money demand function satisfy the theoretical *a priori* expectations. The interest, income, and lagged money parameters are correctly signed and significant; the corrected regression coefficient \bar{R}^2 shows a good fit and Durbin's h statistic shows the absence of autocorrelation. These results enabled us to move on to estimate the index of financial openness in equation (8) based on the interbank call loan rates. The whole estimation procedure was exactly as described above for estimates based on curb market rates. Since OLS estimation of equation (8) revealed autocorrelation in the error terms, serial correlation was eliminated by using the Cochrane-Orcutt procedure. The result obtained for the AR1 estimation was:

$$\text{--- Taiwan } (i_t - i_t') = \begin{matrix} -0.789 & + & 0.464 & (i_t^* - i_t') \\ (-1.46) & & (6.030) \end{matrix}$$

$$\text{RHO} = 0.534, \quad \bar{R}^2 = 0.741, \quad h = -0.258 \\ (2.974)$$

In comparison with the curb market-based estimates performed above, two observations on the money market-based estimates are noteworthy. First, the constant in the money market-based estimate is insignificant and close to zero while it was substantial and significant in the curb market-based estimate of equation (8). This confirms the importance of accounting for different asset quality when estimates on financial openness are based on curb market rates; by contrast, assets traded on Taiwan's interbank call loan market do not seem to display a lower asset quality than foreign (US) interbank traded assets. Secondly, we note that the constant estimate of Taiwan's financial openness is only slightly higher when estimates are based on the official interbank market (0.464) rather than on the informal curb market (0.353). Both values are significantly different from zero, but also significantly different from one, excluding for Taiwan both polar cases of full capital mobility and immobility.

The time-varying parameter for the index of financial openness based on Taiwan's interbank market (see Figure 4) reveals a further divergence with estimates based on the curb market (Figure 3). While the hypothesis of parameter constancy could not be rejected for Taiwan's curb market-based estimates, there is a clear trend towards increasing financial openness from early 1987 onwards when estimates are based on Taiwan's interbank market. By the end of 1989, the index of financial openness rises beyond the upper confidence bound and the index mounts to 0.70 for $\sigma = 0.001$, but it stays within the confidence bound for $\sigma = 0.0001$.

FIGURE 4

IV. INTERPRETATION

The interpretation of our results must be subject to two important caveats. First, our estimates along the Edwards/Khan and Haque/Montiel approach are based on curb market rates. We have allowed for a presumably low quality of assets underlying the curb market by correcting interest arbitrage relationships with a constant mark-up of curb market over foreign interest rates. The constant mark-up cannot capture factors specific to curb markets, however, which tend to prevent speedy arbitrage with foreign interest rates. Such factors include: the dualism between the formal and the informal sector which could explain the existence of the curb market even under full capital mobility; or informational imperfections which give rise to such problems as moral hazard and adverse selection. Wherever possible, empirical tests of interest arbitrage should be based on assets and liabilities whose degree of international tradability is higher than those subject to the curb market.

The second reason for caution is the widespread failure of uncovered interest parity to hold even for highly liberalised OECD economies (see Blundell-Wignall and Browne, 1991). A low estimate of the index of financial openness may thus reflect a high currency risk premium, irrational expectations in the foreign exchange market, or the peso problem, rather than low capital mobility. Since our results are based on curb market rates, however, it seems plausible to assume that exchange rate considerations are largely neglected due to the low tradability of curb market assets. The absence of free forward exchange markets and of market-clearing interest rates other than on the informal curb market currently precludes any more reliable estimates than the one performed here on the degree of financial openness in Korea and Taiwan.

Table 1

CONSTANT ESTIMATES OF FINANCIAL OPENNESS IN DYNAMIC ASIAN ECONOMIES

Country	ψ	t-value	Period
Indonesia	0.865	8.537	1969-87
Korea	0.594	7.945	1980-90
Malaysia	0.638	2.930	1969-87
Taiwan	0.353	10.202	1980-90
Thailand	0.590	6.300	1978-90

Source: Haque and Montiel (1990) for Indonesia and Malaysia; Robinson *et al.* (1991) for Thailand; see text for Korea and Taiwan.

Table 1 puts our constant estimates of parameter ψ into comparable Asian perspective. All results cited in Table 1 have been obtained with the Haque/Montiel specification of the Khan/Edwards approach. Perfect capital mobility cannot be ruled out for Indonesia and Malaysia, with the index of financial openness significantly different from 0, but only insignificantly different from 1. For Korea, Taiwan and Thailand, by contrast, both polar cases of perfect capital mobility and immobility can be ruled out. At least in these three countries, the government seems to have retained partial control over domestic interest rates and the money supply during the 1980s.

Our time-varying estimates based on curb market rates in Korea and Taiwan (shown in Figures 2 and 3) display no upward trend of financial opening during the 1980s. For Taiwan, there is no trend movement in the ψ parameter through the period. Korea, by contrast, shows a strong upward movement from 1981:1 to 1985:1, and then a return to the lower confidence bound (at 0.44) which stops in 1987:4, thereafter the trend is flat. These findings are, obviously, not consistent with a move to greater financial openness. As Figure 1 had visualised, the lack of curb market rates to react to US dollar movements against the Korean won and the Taiwan dollar may provide a key to the interpretation of our results.

To examine this issue further, we estimated a correlation matrix (not reported here) for the quarterly values of parameter ψ , the domestic curb market rate, the three-months LIBOR interest rate on the US dollar, and the nominal exchange rate (US dollar in domestic currency units). The correlation coefficient between parameter ψ and the won/dollar rate was positive and important (0.63 for $\sigma = 0.001$ specification), while the correlation between ψ and the Taiwan dollar/US dollar rate was small and negative (-0.13 for $\sigma = 0.001$). Since the won and the Taiwan dollar had moved quite in tandem against the US dollar, reflecting the rise of the US dollar up to 1985 and its subsequent decline, the different outcome for Korea and Taiwan is likely to be found in characteristics of their domestic financial systems rather than in developments on the foreign exchange market.

A recent description of Korea's financial sector is found in Park (forthcoming, 1991). The up and down of the index of financial openness estimated in our paper (Figure 2) is well reflected by Park's overview of Korea's financial sector: "despite numerous and often confusing reform measures, deregulation of the financial sector has been slow, uneven, and most of all limited in scope and degree" (p. 30). Specifically, the rise in Korea's index of financial openness from early 1981 to early 1985 corresponds well with the financial deregulation package on which the monetary authorities embarked in 1981 as part of the overall liberalisation of the economy. The deregulation led to privatisation of the existing nationwide commercial banks and to the creation of new banks and non-bank financial institutions. In the same year a commercial paper market free of government control was established. The creation of the commercial paper market and the encouragement of non-bank financial institutions seems to have introduced a higher degree of foreign determination on curb market rates during the first half of the 1980s.

The subsequent downturn in Korea's index of financial openness (during the years 1985 to 1987) corresponds to the period when the Korean won appreciated in

every quarter against the US dollar without inducing any narrowing in the respective interest differentials. While this result is probably due to the low international tradability of curb market assets, it is noteworthy that some official interest rates stayed fixed during the same period in Korea. Interest rates on bank deposits have been unchanged since the end of 1984, except on maturities of more than two years which were liberalised in 1988. The same observation holds for interest rates offered by nonbank financial intermediaries. According to many observers, this interest rate behaviour (in spite of reform) is largely explained by intra-bank collusion and pressure exerted by the government which gives up its attitude of benign neglect as soon as interest rates start to move towards unwanted levels.

In Taiwan, officially proclaimed interest rate deregulation during the 1980s has not had a significant impact on the nature of interest determination. Figure 3 shows that the index of financial openness remained low (OLS estimate = 0.353), and the hypothesis of parameter constancy could not be rejected for estimates based on curb market rates. Estimates based on interbank call loan rates (Figure 4) display a slightly different impression. Since 1988 or 1989 (according to the specification of σ) there is a clear trend towards higher financial openness, a move which seems to be linked to the liberalisation and internationalisation of Taiwan's securities market. In July 1989, the authorities revised the basic banking law which allows private acquisition of government-owned banks, the creation of privately held new banks, and setting deposit and lending rates in line with market conditions (OECD, 1990). Until then, nearly all domestic banks had been owned by the government; moreover, half of these had been established as specialised banks to service particular sectors with little competition from other financial institutions. This explains why the curb market has stayed an important source of finance for small-scale businesses which have enjoyed little access to institutional credit.

Official liberalisation measures undertaken in Korea and Taiwan during the 1980s have thus largely failed to strengthen interest links with the rest of the world. The capital account of both countries seems still quite closed, with the possible exception of Taiwan's interbank market in very recent years. Therefore, the authorities in both Korea and Taiwan have continued to enjoy considerable scope for an independent short-term monetary policy. This conclusion, however, must not hold even for the near future, given recent reform measures in Taiwan and announced reform in Korea. The authorities' concern about a possible loss of monetary autonomy is confirmed by our results.

APPENDIX

DATA DEFINITIONS AND SOURCES

Korean data were first converted in billions of won. For the estimation of the money demand function, income was proxied by the quarterly GDP at constant prices (IFS line 99bp) and when quarterly data were unavailable GDP has been weighted by a production index (IFS line 66c). Money stock at the end of the period was proxied by M1 (IFS line 34). The hypothetical closed economy money demand M' was defined as M1 less direct investment (IFS line 77bad), portfolio investment (IFS line 77bbd), other capital, nie (IFS line 77gd) and net errors and omissions (IFS line 77ed) not accounted for by the resident official sector. Real money stocks M1 and M' were calculated by dividing nominal stocks by the consumer price index at end of period (IFS line 64). For the uncovered interest parity rate, the LIBOR on three month US dollar deposits was used, corrected for the subsequent change in the exchange rates (local currency units per US\$) at the end of period (IFS line ae). Curb market rate were received from the Korea Development Institute (courtesy Sang-Woo Nam), in percentage per month and have then be annualized. Money market rates are from IFS, line 60b.

For Taiwan all data are converted in millions of NT dollars. For the estimation of the money demand function, income was proxied by the quarterly GDP at constant prices from Directorate-General of Budget, Accounting and Statistics, The Republic of China, *Monthly Statistics of The Republic of China*. The same source was taken for data on M1 and the consumer price index. The hypothetical closed economy money demand M' was calculated as for Korea, from the source publication of the Central Bank of China, *Balance of Payments - Taiwan District The Republic of China*. For the uncovered interest parity rate, the LIBOR was obtained from IFS (line 111601dd) and the exchange rate from *Monthly Statistics of the Republic of China*. Curb market rates and interbank call loan rates were obtained from the Bank of China, *Financial Statistics Monthly, Taiwan District, The Republic of China*.

NOTES

1. Apart from the issue of effectiveness, sterilised intervention is likely to pose problems for smooth implementation in countries where securities markets are thin and monetary instruments are limited.
2. Note that most empirical studies reject uncovered interest parity, even for industrialised countries (Frankel, 1989). While covered interest parity has been largely found valid, the rejection of uncovered interest parity allows two different interpretations: either foreign exchange speculators are bad forecasters, and the rational expectations hypothesis does not hold; or, alternatively, the finding is evidence in favour of the existence of an exchange risk premium which explains the difference between the forward discount and expected depreciation. Thus, a low index of financial openness may reflect nothing but an important exchange risk premium. Notwithstanding this conceptual deficiency of the Edwards/Khan approach, the lack of forward exchange markets in most developing countries precludes its estimation based on covered interest parity.
3. The inclusion of an inflation variable (as another opportunity cost item to hold money) did not add much information about money demand functions in Korea and Taiwan. Expected inflation proved more relevant than current inflation. Being an unobserved variable, we assumed expected inflation to equal the actual next-period inflation. For Korea, expected inflation proved to be a significant determinant of money demand. However, the inclusion of the inflation variable introduced autocorrelation into Korea's money demand function. Moreover, estimates of the index of financial openness based on parameters of the extended money demand function were similar to those reported below. In the case of Taiwan, the coefficient for expected inflation was not significantly different from zero.
4. For the sake of comparability of results, we also performed an AR1 estimate for Taiwan which did not significantly change the index of financial openness (4). The result was $(i-i')_t = 5.933 + 0.313 (i-i')_t$

(6.581)
(6.842)

$$\text{RHO1} = \frac{0.326}{(1.870)} \quad \bar{R}^2 = 0.747, \quad h = -0.452$$

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