University of California, Santa Cruz
Department of Economics
Working Paper #294, May 1994
JEL: F36

Financial and Capital Account Liberalization in the Pacific Basin: Korea and Taiwan during the 1980's

Menzie D. Chinn
Department of Economics

University of California
Santa Cruz, CA 95064

William F. Maloney
Department of Economics

University of Illinois
Urbana, IL 61801

May 9, 1994

Abstract: This paper presents an alternative method of testing for financial capital mobility in the absence of forward exchange markets. A model of domestic interest rate determination during liberalization is applied to Korean and Taiwanese data. A variety of diagnostic and recursive tests are used to isolate structural breaks in the data. It is shown that Korean interest rates behave as if determined domestically until late 1988, while Taiwanese rates exhibit this behavior until early 1989.

Acknowledgments: We thank Clifford Tan for useful discussions, Yunqi Li and Eduardo Ribeiro for research assistance. We also gratefully acknowledge financial support from UCSC divisional research grants (Chinn) and the University of Illinois Research Board (Maloney).

1. INTRODUCTION

There is by now a great deal of evidence pointing to increasing capital mobility around the Pacific Rim. The most common measure of this integration is the extent to which covered interest parity (CIP) holds: In the absence of regulatory barriers to arbitrage, similar assets should yield similar returns across countries when adjusted for the risk of currency depreciation embodied in the forward discount. Hence the reduction of the covered interest differential has often been used as a test of capital account liberalization.[1] Yet, for a majority of countries that are liberalizing, or contemplating liberalization, forward markets are either extremely thin or non-existent, rendering interest parity tests irrelevant and making it difficult to judge the economic impact of capital account and financial sector liberalization with any degree of certainty.[2]

This constraint has been particularly frustrating in the cases of Taiwan and Korea, two countries which despite substantial (albeit intermittent) efforts toward freeing capital flows, show little evidence of increasing integration in the world capital markets. For instance, Kim (1993) finds no evidence of structural breaks in Feldstein and Horioka style savings investment correlations during the 1980's. Chinn and Frankel (1994b), using interest rates unadjusted for expected depreciation, find mixed evidence of increased comovement between domestic and US interest rates over the 1982-1992 period, but no significant evidence of increasing integration according to an uncovered interest parity condition. Perhaps the most ambitious and empirically sophisticated assessments, conducted

---

[1] See (for Pacific Basin countries) Frankel (1984) and Eken (1984) for Japan, and Chinn and Frankel (1994a). Essentially this approach equates the capital account opening with the elimination of what Aliber (1973) termed "political risk".

[2] This group includes not only Korea and Taiwan but also some second tier Asian NICs such as Indonesia and Thailand.

by Reisen and Yèches (1993), Jwa (1994) and Dooley and Mathieson (1994), employs a now popular technique introduced by Edwards and Khan (1985). This technique involves a regression of money balances on a (counterfactual) closed economy interest rate and a foreign interest rate, and the interpretation of the weight on the foreign interest rate as a measure of openness.[3] Corroborating the results of previous studies, Reisen and Yèches conclude that "Official liberalization measures undertaken in Korea and Taiwan during the 1980's 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" (p.304).

This paper examines essentially the same period as previous studies for Korea and Taiwan but employs a technique that extracts information from the behavior of the coefficients on the domestic determinants of interest rates; as a capital account opens, it is expected that these coefficients should decrease in importance. To specify the channels though which foreign capital flows influence domestic returns and the coefficients on these domestic determinants, we work in the context of a portfolio balance model developed in Maloney (1993) and based on earlier work by Kouri and Porter (1974). This approach seems more attractive than the previous ones for two reasons. First, the model suggests that the coefficient of openness approach employed by previous researchers does not account for some potentially important issues of simultaneity, and hence casts some doubt on their conclusion that there has been no opening. Second, the modelling approach appears to work well. Using the implied semi-reduced form specification on Japanese data, Maloney was able to identify the same structural break points as those indicated by the disappearance of the covered interest

[3] If the foreign coefficient enters in significantly, and the local rate provides little additional information, then the country is considered "open".

differential. Thus, on both theoretical and empirical grounds this technique appears to offer a reliable way to test for structural breaks when forward rates are absent.

Our results indicate that both Korea and Taiwan experienced structural breaks in their interest rate determination equations in the late 1980's. We therefore offer a more optimistic view of the consequences of their liberalization efforts. In Korea, recursive tests show the foreign rate of return clearly gaining a heightened importance in late 1988 and domestic factors losing a commensurate amount of influence, suggesting a greater openness to world capital markets. The break for Taiwan in early 1989 is more difficult to interpret due to the inability to correlate it with any particular liberalization measures and dramatic changes in central bank policy occurring at that time. However, overall the evidence points to a greater degree of openness after the break.

The paper is organized as follows. In section 2, the theoretical model is outlined, while in section 3,

the data and econometric methodology are described. Section 4 reports the empirical results. Section 5 concludes.

2. MODELING A LIBERALIZING CAPITAL ACCOUNT

2.1. Previous Literature

The general approach of measuring of openness by examining the relative influence of foreign and domestic interest rates was pioneered by Edwards and Khan (1985) and Edwards (1986). Their model takes the interest rates that would prevail under the two polar cases represented by a closed economy interest rate determination model (R') and the interest parity condition (R^*) and then weights

them using a "coefficient of openness,"φ.

$$R = \varphi R^{*} + (1-\varphi)R^{/} \qquad \textbf{(1)}$$

A semi-reduced form equation can be derived for the domestic interest rate in terms of income, the real money supply, and the foreign return which, when estimated, permits φ to be recovered. Building on this basic framework, Haque and Montiel (1990) derived coefficients of openness by estimating equations for money demand equations rather than for the domestic interest rate.

One objection to this approach is that it is does not make clear how the implicit averaging of closed and open economy interest rates arises from the behavior of individuals in the economy. Within a portfolio balance framework one can derive a semi-reduced form for interest rates that differs critically from that of the Edwards and Kahn tradition.

2.2. A Portfolio Balance Model[4]

In a simple open economy domestic agents can hold four assets in their portfolios: Money (M), Domestic Bonds (B) paying a return R, a foreign bond (F) paying R*, a nominal interest rate plus expectations of depreciation, and an asset, perhaps land (L), effectively indexed to inflation (π). Then money demand is a function of economic activity, home and foreign interest rates, expected inflation, and wealth. Expressing money demand in changes, monetary equilibrium requires that

$$\Delta M(Y, R, R^{*}, \pi^{e}, W) = \Delta DC + CA + KA \qquad \textbf{(2)}$$

where DC is domestic credit ,and CA and KA, the current and capital accounts respectively, reflect

[4] This is an abbreviated version of the discussion in Maloney (1993).

the reserve component of the money supply. It is assumed, for expositional purposes, that the money multiplier is unity. The capital account can be viewed as the change in foreign demand for domestic assets, represented by an analogous demand function (where * indicates the foreign country) minus the change in domestic demand for foreign assets:

$$KA = \Delta B^*(Y^*, R, R^*, \pi^{e*}, W^*) - \Delta F(Y, R, R^*, \pi^e, W) \quad \textbf{(3)}$$

Combining (2) and (3), expanding the asset demands around their arguments, and then invoking wealth constraint to solve for the change in the domestic interest rate (with the second order foreign arguments dropped) yields a semi-reduced form equation:

$$\Delta R = \beta_1 \Delta DC + \beta_2 CA + \beta_3 \Delta Y + \beta_4 \Delta \pi^e + \beta_5 \Delta W + \beta_6 \Delta R^* \quad \textbf{(4)}$$

where

$$\beta_1, \beta_2 = \frac{1}{\theta} \quad \beta_3 = \frac{L_y + B_y}{\theta} \quad \beta_4 = \frac{L_\pi + B_\pi}{\theta} \quad \beta_5 = \frac{L_w + B}{\theta}$$
$$\beta_6 = \frac{B(\lambda)_{R^*} + B(\lambda)^*_{R^*}}{\theta} \quad \theta = -[L_R + B(\lambda)_R + B(\lambda)^*_R] \quad \textbf{(5)}$$
$$B_{R*}, B^*_{R^*}, L_Y, B_Y, B_\pi < 0 \quad ; \quad B_R, B^*_R, L_\pi, L_W, B_W > 0$$

Here, λ represents the degree of openness of the capital account which is the key determinant of the magnitude of substitutability between domestic and foreign bonds as represented by the four domestic and foreign partial derivatives. These in turn determine the value of each coefficient in (4). In an entirely closed economy with $\lambda = 0$, there is no substitution between domestic and foreign assets so both B_{R^*} and B^*_R equal 0, making θ finite and $\beta_6 = 0$. This leaves an expression similar to a Fisher equation, where expectations of inflation affect the interest rate while the nominal return on foreign

assets and expectations of depreciation do not.

As λ rises and domestic and foreign bonds become more and more substitutable, B_R and $B^*_R \rightarrow \infty$ and B_{R^*} and $B^*_{R^*} \rightarrow -\infty$, forcing θ to infinity, all coefficients with finite numerators, $\beta_{1 \text{ to } 5}$, go to zero , and β_6 to unity. The intuition is straightforward. Any domestic factor that might increase the interest rate--a contraction of domestic credit, an increase in demand for transaction balances, or an increase in expectations of inflation--leads to an immediate capital inflow that forces the interest rate back to the world rate. The return to foreign bonds inclusive of expectations of depreciation completely determines movements in domestic interest rates, as in the standard uncovered interest parity condition.

Equation (4) differs from that estimated by Kahn and Edwards by excluding the endogenously determined capital account contribution to the money supply. This difference is critical. Inspection of equation (4) suggests that inclusion of ΔM instead of the sum of $CA + \Delta DC$ implicitly controls for capital inflows, when one actually wishes the capital inflows to be free to vary, and hence influence the domestic interest rate. In other words, changes in the money stock due to capital inflows are a critical channel of influence from the international to the domestic economy: A fall in the world rate leads to a capital inflow which expands the money stock and forces down domestic rates. Hence, it is probably not "openness" that φ is measuring, but perhaps the ease of reallocation of portfolios when asset stocks are fixed, i.e., when the capital account is closed. Moreover, theoretically there should be no structural break in the estimated relationship during liberalization unless this ease of reallocation is also affected. By contrast, testing for structural break in equation (4) can give us information on whether liberalization measures have in fact led to greater capital mobility.

3. DATA AND METHODOLOGY

3.1. Description of Data

The variables of relevance, as indicated by equation (4), include interest rates, domestic credit, the current account, income, expected inflation, wealth, and an expected foreign rate of return. Some of these variables -- expected inflation and the expected foreign rate of return -- are unobservable because they incorporate market expectations. For the former, we use either the ex post value as a rational expectations assumption would dictate, or lagged values (i.e., assuming adaptive expectations). The second unobservable, the expected foreign return, is composed of the foreign return, denominated in foreign currency units, and an expected change in relative currency values. We impose the assumption that expected changes in exchange rates are zero, so that the foreign rate of interest is used as a proxy for the relevant variable.[5]

Income and current account data are not available at the monthly frequency, so we use industrial production and the trade balance, respectively, as proxies. Since there are no adequate proxies for wealth, this variable is omitted from the analysis.

The data are drawn from a variety of sources. The foreign rate of return is measured by a 3 month EuroYen CD rate, from Data Resources, Inc.. The Korean explanatory variables (domestic credit, the trade balance, industrial production and consumer price inflation) are drawn from the IMF's International Financial Statistics database. The corresponding Taiwanese variables are drawn mainly from the Monthly Bulletin of the Republic of China. Details are provided in Appendix 1.

The key variable in this approach is the domestic interest rate. The theory indicates that we

[5] This is equivalent to assuming that the nominal exchange rate follows a random walk. A similar assumption was made in Faruqee (1992).

wish to use the most market determined rate. The candidate time series for Korean interest rates are illustrated in Figure 1. The 3 month investment and company bill rate (KO1) is highly regulated, and shows little variation. Although the Monetary Stabilization Bill (MSB) rate (KO2) is typically used as a market determined rate, we use the corporate bond rate (KO3) since this series is available for a longer time period and is freer of government intervention.[6]

The Taiwanese case is complicated since its banking sector has been highly regulated over most of its history and a large proportion of total credit is issued in the unofficial curb market. We considered two series, the curb market and the 90 day banker's acceptance rate (ICTI and ITI), which are plotted in Figure 2. The curb market rate is often used as a proxy for the free market rate (as in Reisen and Yèches, 1993). However, the curb rate represents the interest rate on marginal demand not satisfied by the formal regulated market, and incorporates a (time-varying) risk premium due to the unsecured nature of the debt. Since we do not wish to model the risk premium on informal loans, we focus on results using the 90 day banker's acceptance rate.

3.2. Preliminary Data Analysis

Notice that because of the linearity in equation (4), one could integrate up to obtain a relationship between the level of the interest rate, and the levels of the right hand side variables. This specification would be appropriate if all the series were trend stationary, or alternatively, if they were all cointegrated. We therefore conduct a preliminary analysis of both the Korean and Taiwanese data, using the standard tests for unit roots and co-integration. The results, reported in Appendix 2,

[6] The latter two rates tend to move together. The corporate bond series was provided by Bong Sung Oum.

indicate that most series fail to reject the null hypothesis of a unit root, using an Augmented Dickey-Fuller test, with constant and trend. The sole exceptions are the cumulative trade balances for both Taiwan and Korea, which reject at low levels of marginal significance.

Proceeding under the presumption that all the series contain unit roots, we now test for cointegration, i.e., the possibility that the series contain common stochastic trends. The Engle-Granger test for cointegration fails to reject the null hypothesis of no cointegration in both cases. In fact, the ADF statistics are nowhere near even the 10% critical values. Hence, we estimate the model in a first differences rather than an error correction specification.

3.3. Econometric Methodology

Finding the "correct" model is not essential so long as the explanatory variables explain a substantial fraction of the total variance and are orthogonal to the error term. While in theory there are feedback equations relating the right-hand-side variables to the domestic interest rate, it is doubtful that the effects are instantaneous (or within-the-month), so for the most part, the right-hand-side variables can be taken as predetermined. The one possible exception is the change in domestic credit, which the central bank presumably can quickly change in response to changes in the interest rate. In principle one could jointly estimate a central bank reaction function with equation (4). Since such functions are notoriously unstable (McNees, 1992), we undertake a less ambitious approach, and test to see whether the right-hand side variables can be taken as exogenous or at least predetermined. Hence a series of Wu-Hausman (exogeneity) tests are conducted for the domestic credit variable, which appears most likely to be endogenous.

Several graphical and statistical tests are employed to test the stability of the model over the

sample period.

1. The graph of one-step-ahead Chow tests asks if parameter constancy can be rejected given a one-step forecast with progressively longer base sample period. This, as with the following two tests, scales the Chow tests to yield the horizontal critical value line at unity.

2. Recursive parameter estimates update using the information from each additional observation and allow testing for individual parameter stability.

3. The Standard Chow test generated by fitting the model to both sub-periods independently and comparing the Residual Sum of Squares of the constrained and unconstrained sub-periods.

4. EMPIRICAL RESULTS

4.1. Results for Korea

Table 1 presents a stable specification of the determinants of the Korean interest rate for the 1983:02-1988:08 period. Both domestic credit and the industrial production variables enter strongly and with the correct signs. The trade balance enters significantly but of vacillating sign suggesting perhaps the crudeness of the proxy. The multiple lags nonetheless contribute to the overall explanatory power and to reducing serial correlation. The ex post, rational expectations proxy for inflationary expectations entered significantly, although the contemporaneous rate entered more so, and of larger value. Hence results using the backward looking proxy are presented.[7] The foreign rate of return is also included. It appears insignificant and of the incorrect sign. This result would be

[7] The apparent superiority of the backward looking proxy could be due to the large amount of measurement error associated with using an ex post measure, especially when realized one month inflation rates.

expected if the local financial market is well insulated from the world market by capital controls.[8] The specification appears to pass the diagnostics for serial correlation, heteroskedasticity, ARCH, normality, and omitted variables (the Ramsey RESET test).

Results for the same specification for the entire sample (1983:02 to 1991:11) are given in the second column. All of the domestic variables drop in both economic and statistical significance; only two lags of industrial production entering significantly. In contrast, the EuroYen rate now becomes a more important determinant of local interest rates and statistically significant at the 10% level.

Inspection of the actual and fitted series, the recursive estimates for the coefficients, as well as both Chow break tests and Chow 1-step-ahead forecast error tests, confirm that a dramatic break occurred sometime between 1988:08 and 1988:11 (see Figures 3 and 4). These conclusions are reinforced by the results from the recursive coefficient estimates shown in figures 7-12 which further indicate that the break was due to an increase in capital mobility: The coefficients on inflation, industrial production, the current account, domestic credit and the seasonal dummies all become insignificant and move toward zero, while the EuroYen coefficient shows a clear movement toward both greater economic and statistical significance.[9] Although in all cases (except inflation) lagged values were used thereby excluding the possibility of feedback from the dependent variable, the Wu-Hausman tests (Wu, 1973) suggest some possible lack of exogeneity of the first lag of domestic

[8] The regressions were also run without the foreign interest rate included but showed little change from those presented.

[9] Although the series presented are the most dramatic, they are in all cases representative of movements in the unreported recursive series as well.

credit.[10] This might explain the lack of clear direction in the movement of this variable's coefficient, although the same basic pattern is repeated in the higher order lags of domestic credit which, arguably, must be predetermined.

Finally, column 3 presents results for a reasonable post-break specification, where the EuroYen rate enters significantly. The coefficient suggests that over 60% of any innovation in the foreign rate is passed through to domestic rates. Industrial production again enters strongly, (although with different lags) as does one seasonal dummy, implying that the capital account is still not perfectly open. The coefficient on domestic credit approaches significance but in overall magnitude and significance it is far less important than in the pre-break specification suggesting some loss of control by monetary authorities.

Overall, the results very strongly indicate a break in how interest rates were determined after 1988:08. While this outcome could be caused by any number of domestic financial reforms, the fact that the recursive estimates for all domestic factors and dummies moved toward zero argues persuasively that a significant element of the break was due to a greater openness to the world market.

4.2. Results for Taiwan

Since a market determined rate is necessary to impute changes in coefficients to capital market liberalization, the analysis begins in 1986 when the central bank freed interest rates to be determined more by market forces. The story that emerges is one of a capital account that remained

[10] The instrumental variables for the tests are the first lags of industrial production, inflation, EuroYen rate, the contemporaneous inflation rate, the fourth lag of domestic credit formation, and seasonal dummies.

relatively closed until at least 1989 or early 1990. Column 1 in Table 2 presents a reasonable specification for the period 1986:01 to 1989:03 that passes all the diagnostic tests. The foreign interest rate is again insignificant as would be expected if domestic capital markets were still insulated from outside influences. Industrial production enters very strongly and of the correct sign. The ex post inflation rate proved insignificant although the second period lag is significant at the 10% level and of the correct sign. The trade balance is significant though of conflicting signs. Together with seven seasonal dummy variables, the domestic factors appear to explain almost 70% of the variation in the interbank rate.

Once the sample is expanded to include 1986:01 to 1991:11, all the domestic and seasonal dummy coefficients decline in statistical significance while the EuroYen coefficient becomes statistically significant, and of correct sign. The graphs of actual and fitted values and the 1-step-ahead forecasts in figures 5 and 6 corroborate the very strong results of the Chow tests indicating that there was a dramatic structural break around 1989:04. As in the Korean case, the recursive parameter estimates presented in figures 13 though 17 suggest that part of this break was due to the opening up of the capital account: The foreign rate clearly jumps in significance and magnitude while inflation, the trade balance, industrial production and six of the seven seasonal dummies move toward zero.[11]

In the third column, a reasonable post-break specification is presented. While only three domestic variables show up with any statistical significance (industrial production lagged one period and two seasonal dummies), the EuroYen rate coefficient, while of a plausible value, also fails to

[11] Since domestic credit is not included in the specification, endogeneity would not appear to be a problem. A Wu-Hausman test fails to reject the null of any of the right-hand-side variables being correlated with the error term.

show up as statistically significant.[12] Since it appears statistically significant for the full sample specification, this outcome appears mysterious and casts some doubt on the interpretation of the break as representing increased integration with world capital markets.

4.3. Interpretation

It would be ideal to match the estimated structural breaks with coinciding policy reforms. Since studies of the Korea and Taiwanese liberalizations have been conducted by in some detail by Frankel (1991), Lindner (1992) [for Korea], Moreno (1993) and Jwa (1994) among others [for both], this paper will not attempt to offer more detail than they have provided. However, what emerges from a brief overview of the two countries' experiences is a pattern of uneven and tentative reforms, that have been implemented and sometimes reversed as macroeconomic conditions dictate.

Korea: Throughout the 1980's, Korea imposed restrictions on foreign holdings of many types of financial instruments in an attempt to maintain domestic control over monetary policy. These restrictions were eased only in the face of massive current account surpluses over the 1986-89 period which induced rapid monetary growth. The response included moderation of the restrictions on financial institutions and individuals foreign borrowing and lending which are detailed in Moreno (1993).

Many measures were implemented in the months around the break period of late 1988, though none of them obviously explains the break. In March, the limit on foreign exchange holdings for investment in foreign securities by authorized Korean securities firms was tripled to US$ 30 million

[12] A variety of specifications were tries but in no case did the t-statistic on the EuroYen rate exceed 1.10.

and Korean residents were granted automatic approval for overseas investment up to US$ 1 million. In November, this ceiling was raised to $US 2 million and the limit on export of Korean currency notes was raised from 5,000 won to 2 million won. Also, in that month, Korea formally accepted the obligations of Article VIII, Sections 2-4 of the IMF's Articles of agreement. This move required Korea to eliminate its remaining restriction on payments and transfers for current account transactions (Lindner, 1992: 5). In January of 1989, there were further restrictions imposed on unregistered inflows of foreign exchange which were undone in December. No new significant reforms of the external sector appear until January of 1990, long after the period of break.[13] There were also some reforms of the domestic financial system in December 1988, when lending rates, deposit rates and money market instruments were liberalized.[14] Hence, the problem seems not to be a dearth of candidate explanations, but rather a surfeit.

Taiwan: Like Korea, Taiwan traditionally restricted capital outflows, but was prompted by massive accumulation of foreign reserves to undertake some liberalizing measures. Again, it is difficult to isolate a particular measure that would explain the observed break around April of 1989.

In July, 1987, the ceiling on non-bank purchases of foreign exchange was raised dramatically although regulation of bank holdings (the conduit through which traditionally most transactions occurred) remained heavily regulated with sporadic openings and closing [See Chang (1989) and Shirley W. Y. Kuo, (1989)]. The Central bank lifted a freeze on bank holdings of foreign liabilities on October 1, 1987 and following a dramatic inflow of $3 billion in one day, reimposed a freeze at

[13] At this time, the ceiling on foreign investment subject to automatic approval is raised to US$100 million from the US$3 million level; however, this was far after the estimated break.

[14] The actual impact of these measures is somewhat in doubt, according to Frankel (1991) and Jwa (1994: 138), although Tseng and Corker (1991: 39) term them "significant".

$16.2 billion the following day. This ceiling was eventually raised to 30% of the average daily balance in July 1989 for a 45 day period, two months after the observed break.

In June 1988, foreign banks were permitted to join the local interbank remittance system. In July, current account transactions were completely liberalized and requirements to surrender export proceeds, advanced import deposits and restrictions on payments for invisible were lifted. Individuals or enterprises were permitted to purchase and remit outward up to $US 5 million annually. A ceiling for inward remittances was set at US$50,000 annually and would be raised to US$ 200,000 in July 1989 and then to US$500,000 in September and finally to US$ 1 million in November of that year. In August, a foreign interbank call loan market was established.

Though the exact timing of the break could be a few months on either side of April 1989, none of the reform measures seem to have occurred around that period leaving the exact cause still unidentifiable. In fact, a closer inspection of the data (see Figure 2) reveals that the break point coincides with initiation of a tight monetary policy aimed at bursting the stock market bubble (FEER, 1990: 232). This gives rise to at least two possible interpretations of the break. First, the extraordinary measures taken by the central bank, and not included in the regression, would have decreased the influence of formerly important factors and thus showed up as a structural break at the same time that a perhaps unrelated upward movement in the EuroYen rate makes that variable seem, temporarily, to gain in explanatory power. The break thus, does not indictate increased integration. Alternatively, the financial markets are more integrated but the statistical relation is obscured by the central bank's actions. While the domestic interest rate enters a new phase of high volatility, the EuroYen rate continues to move with much less volatility (See Figure 18). Thus short run comovements (which are detected by regressing the first difference of the Taiwanese rate on the first

difference of the EuroYen rate) are not apparent but long run comovements should still appear. A bivariate cointegration test indicates that the two rates in levels are borderline cointegrated during the post-break period.[15] This finding, combined with the failure to find cointegration over the entire period lends additional support for the second explanation, and for the contention that there was an increased degree of financial openness in the post break period.

5. CONCLUSIONS

This paper has applied a simple econometric model in order to evaluate whether the restrictions on capital flows in Korea and Taiwan have been significantly loosened over the 1980's. Our results show that there were structural breaks in the respective interest rate equations and movements of individual parameter estimates suggest that these breaks were due to increased capital mobility. In contrast to the results obtained by Reisen and Yèches (1993) and Jwa (1994), we find that the effect of the changes persists until the end of 1991. We do have difficulty in matching these statistical shifts to specific reforms of either a regulatory or policy nature. In Korea, we find several measures taken that could be responsible and believe that, in fact, capital markets are now more integrated than they were prior to November 1988. In Taiwan, we speculate that although measures to liberalize were taken, the dramatic break we detect is more related to an increased volatility induced by the central bank than any particular liberalization measures taken at that date. However,

[15] The Engle-Granger statistic (for a regression with constant, no trend, and one lag of the first differences) is 3.13, while the 10% critical value is 3.19.

increased long run cointegration of the domestic and foreign interest rates after the break suggests that there was, nonetheless, closer integration with world financial markets.

References

Aliber, Robert Z., 1973, "The Interest Rate Parity Theorem: A Reinterpretation," Journal of Political Economy, Nov.-Dec., 81 (6), pp. 1451-59.

Chang, Chi-cheng, 1989, "Financial Liberalization in the Republic of China," Economic Review, The International Commercial Bank of China, Taipei, May-June, pp. 1-6.

Chinn, Menzie David and Jeffrey A. Frankel, 1994a, "Capital Barriers in the Pacific Basin: 1982-1992," Journal of Economic Integration, March, 9(1), pp. 62-79.

_____ and _____, 1994b, "Financial Links around the Pacific Rim: 1982-1992," in R. Glick and M. Hutchison, (eds.) Exchange Rate Policy and Interdependence: Perspectives from the Pacific Basin (Cambridge: Cambridge University Press).

Dickey, David A. and Wayne A. Fuller, 1979, "Distribution of the Estimators for Autoregressive Time Series With a Unit Root," Journal of the American Statistical Association 74, pp. 1057-1072.

Dooley, Michael P. and Donald J. Mathieson, 1994, "Exchange Rate Policy, Financial Structure, and the Transition from Credit to Monetary Instruments," in R. Glick and M. Hutchison, (eds.) Exchange Rate Policy and Interdependence: Perspectives from the Pacific Basin (Cambridge: Cambridge University Press).

Edwards, Sebastian, 1986, "Monetarism in Chile, 1973-1983: Some Economic Puzzles," Economic Development and Cultural Change,April, pp. 534-548.

Edwards, Sebastian, and Mohsin S. Khan, 1985, "Interest Rate Determination in Developing Countries: A Conceptual Framework." IMF Staff Papers, Sept., pp.377-403.

Eken, Sena, 1984, "Integration of Domestic and International Financial Markets: The Japanese Experience." IMF Staff Papers, Sept., pp.499-548.

Engle, Robert F. and C.W.J. Granger, 1987, "Co-integration and Error Correction: Representation, Estimation, and Testing." Econometrica, March, pp. 252-276.

Far East Economic Review, 1990, Asia Yearbook 1990.

Faruqee, Hamid, 1992, "Dynamic Capital Mobility in Pacific Basin Developing Countries: Estimation and Policy Implications," IMF Staff Papers, 39(3), Sept., pp. 706-717.

Frankel, Jeffrey, 1984, The Yen/Dollar Agreement: Liberalizing Japanese Capital Markets, (Washington, D.C.: Institute for International Economics).

Frankel, Jeffrey, 1991, "Liberalization of Korea's Foreign Exchange Markets, and the Role of U.S. Trade Relations," mimeo (Berkeley: University of California).

Haque, Nadeem U., and Peter Montiel, 1990, Capital Mobility in Developing Countries -- Some Empirical Tests," IMF Working Paper #117, December.

Jwa, Sung Hee, 1994, "Capital Mobility in Korea since the Early 1980s: Comparison with Japan and Taiwan," in Taketoshi Ito and Anne Kruger (eds.) Macroeconomic Linkage: Savings, Exchange Rates, and Capital Flows NBER-East Asia Seminar on Economics Volume 3 (Chicago: Univ. of Chicago Press for NBER),pp 123-165..

Kim, Sun Bae, 1993, "Do Capital Controls Affect the Response of Investment to Savings? Evidence from the Pacific Basin, Economic Review, Federal Reserve Bank of San Francisco, No.1, pp. 23-39.

Kouri, Pentti J.K. and Michael G. Porter, 1974, "International Capital Flows and Portfolio Equilibrium," Journal of Political Economy, May-June, pp. 443-467.

Kuo, Chich-Heng, 1991, International Capital Mobility and the Developing World: The Case of Taiwan (New York: Praeger).

Kuo, Shirley W. Y., 1989, "Liberalization of the financial Market in Taiwan in the 1980's," Economic Review, The International Commercial Bank of China, Taipei, June-August, pp. 1-20.

Lindner, Deborah, 1992, "Foreign Exchange Policy, Monetary Policy, and Capital Market Liberalization in Korea," International Finance Discussion Papers #435.

McNees, Stephen, 1992, "A Forward-Looking Monetary Policy Reaction Function: Continuity and Change," New England Economic Review, Nov./Dec., pp. 3-13.

Maloney, William F., 1993, "Testing Capital Account Liberalization without Forward Rates: Japan and Chile in the 1970's," Mimeo (Dept. of Economics, Univ. of Illinois at Urbana-Champaign).

Moreno, Ramon, 1993, "Exchange Rate Policy and Insulation from external Shocks: The Experience of Taiwan and Korea-1970-1990," Working Paper 93-05, Center for Pacific Basin Monetary and Economic Studies, Federal Reserve of San Francisco.

Reisen, Helmut and Hélèn Yèches, 1993, "Time-varying Estimates on the Openness of the Capital Account in Korea and Taiwan." Journal of Development Economics 41, pp. 285-305.

Tseng, Wanda and Robert Corker, 1991, Financial Liberalization, Money Demand, and Monetary Policy in Asian Countries, Occasional Paper 84 (IMF: Washington, DC).

Wu, D.-M., 1973, "Alternative Tests of Independence between Stochastic Regressors and Disturbances," Econometrica 41, pp. 733-50.

Table 1
Korea: Average Corporate Bond Rate

Coefficient	1983:02-88:08	1983:02-91:08	1988:09-91:08
const.	0.140	0.111	0.077
	(1.75)	(1.38)	(0.86)
EuroYen	-0.031	0.236	0.632
	(0.33)	(1.63)	(2.05)
industrial production			0.036
			(2.38)
industrial production (-1)			0.046
			(3.07)
industrial production (-2)	0.038	0.022	0.036
	(2.11)	(1.49)	(2.55)
industrial production (-3)	0.036	0.009	
		(1.69)	(0.60)
industrial production (-4)	0.065	-0.001	
	(3.15)	(0.11)	
current account	0.036	-0.007	
	(2.91)	(0.41)	
current account (-1)	-0.028	-0.027	
	(1.97)	(1.41)	
current account (-2)	-0.017	-0.017	
	(1.24)	(0.77)	
current account (-3)	-0.027	0.018	
	(2.09)	(0.93)	
current account (-4)	0.032	0.022	
	(2.50)	(1.19)	
domestic credit (-1)	-30.07	-4.093	
	(4.74)	(0.75)	
domestic credit (-2)	-5.176	-1.554	
	(0.84)	(0.75)	
domestic credit (-3)	-15.92	-9.143	-8.337
	(2.61)	(1.41)	(1.49)
inflation	0.230	0.054	
	(3.99)	(0.90)	
s1	-0.516	-0.171	
	(3.65)	(.86)	
s2	-0.300	-0.123	

	(2.44)	(0.62)	
s3	−0.521	−0.233	
	(4.63)	(1.26)	
s10			−1.036
			(3.86)
R^2 =	**.6183**	**.1504**	**.4953**
σ =	.2012	.4044	.4387
F-test:	F[16,50]	F[16,86]	F[6,29]
	5.06 [.00]	**0.95 [.52]**	**4.74 [.00]**
DW =	**1.84**	**1.72**	**2.01**
RSS =	2.024	14.066	5.581
	N= 67	N= 103	N= 36
AR 1-j:	j = 5	j = 6	j = 3
	F[5,45]	F[6,80]	F[3,26]
	1.37 [.25]	**2.32 [.04]**	**0.035 [.99]**
ARCH:	F[5,40]	F[6,74]	F[3,23]
	.25 [.9479]	**3.40 [.01]**	**0.035 [.99]**
J-B Normality:			
$\chi^2(2)$ =	**1.20**	**33.96**	**2.89**
Reset	**0.85 [.36]**	**9.29 [.00]**	**1.06 [.31]**

Tests of Parameter Constancy

Tests of parameter constancy estimated with the 1983:02–1988:08 sample over the period 1988:09 – 1991:08

Forecast $Chi^2(36)/36 = 20.366$

CHOW TEST(36, 50) = 8.26 [.0000]

Notes: P–values in brackets, t–statistics in parentheses. σ = standard error, DW= Durbin Watson, RSS= residual sum of squares, AR 1–j= LM test for residual auto–correlated from lags 1–j, ARCH= LM test for autoregressive conditional heteroskedasticity, J–B=Jarque–Bera test for normality, Reset=regression specification test for omitted variables.

Table 2
Taiwan: 90 Day Interbank Rate

Coefficient	1986:01-89:03	1986:01-91:11	1989:04-91:11
const.	0.448	0.484	-.00256
	(1.64)	(0.82)	(0.008)
EuroYen	0.347	1.082	0.916
	(0.91)	(1.89)	(0.89)
industrial production (-1)	0.049	-0.010	0.0433
	(4.40)	(0.60)	(2.19)
industrial production (-2)	0.060	-0.063	
	(3.65)	(2.53)	
industrial production (-3)	0.064	-0.030	
	(3.57)	(1.15)	
current account (-3)	-0.022	0.004	
	(2.80)	(0.33)	
current account (-4)	0.026	-0.020	
	(3.62)	(1.75)	
inflation (-1)	0.082	0.072	
	(0.99)	(0.67)	
inflation (-2)	0.131	-0.138	
	(1.62)	(1.06)	
s0	-1.274	1.145	
	(3.18)	(1.66)	
s1	-1.030	1.799	3.298
	(2.79)	(2.57)	(2.67)
s4	-1.190	1.023	
	(2.26)	(1.07)	
s5	-2.400	1.108	
	(3.44)	(0.95)	
s7	-1.931	-1.110	
	(5.83)	(1.69)	
s8	-0.967	-0.723	-2.343
	(2.61)	(1.09)	(2.32)
s9	-1.008	0.250	

	(2.80)	(0.393)	
R^2 =	**.6780**	**.4107**	**.3998**
σ =	.4272	1.1935	1.6313
F-test:	F[15,23]	F[15,55]	F[4,27]
	3.23 [.01]	**2.56 [.01]**	**4.49 [.01]**
DW =	**1.91**	**1.56**	**1.62**
RSS =	4.197	78.345	71.855
	N= 39	N= 71	N=32
AR 1-j:	j = 3	j = 5	j = 3
	F[3,20]	F[5,50]	F[3,23]
	0.73 [.55]	**1.66 [.16]**	**1.25 [.31]**
ARCH:	F[3,17]	F[5,45]	F[3,21]
	.44 [.72]	**0.35 [.88]**	**.36 [.78]**
J-B Normality:			
$\chi^2(2)$ =	**0.61**	**3.50**	**.37**
Reset	**1.41 [.25]**	**5.90 [.02]**	**.53 [.47]**

Tests of Parameter Constancy

Tests of parameter constancy estimated with the 1983:02-1988:08 sample over the period 1988:09 - 1991:08

Forecast $Chi^2(32)/32$ = 27.598

CHOW TEST(32, 23) = 12.699 [.0000]

Notes: P-values in brackets, t-statistics in parentheses. σ = standard error, DW= Durbin Watson, RSS= residual sum of squares, AR 1-j= LM test for residual auto-correlated from lags 1-j, ARCH= LM test for autoregressive conditional heteroskedasticity, J-B=Jarque-Bera test for normality, Reset=regression specification test for omitted variables.

Appendix 1
Description of Data

Eurodeposit Rate (IEJP)

For Japan

* Source: Bank of America up to 1986:09, as reported by DRIFACS.
Reuters' Information Service after 1986:09, as reported by DRIFACS.
* Series: Eurodeposit Rate
* Description: London close end-of-period 3 month Eurocurrency deposit rate; arithmetic average of bid and ask rates.

Interest Rate

Country	*Source*	*DRI Code*	*Description*	*Variable Name*
Japan	DRI	JAD03	3 month EuroYen rate	IEJP
Korea1	WFMr		3 month inv.&finance co.bill	IKO1
Korea2	WFMr		Monetary Stabilization Bonds (MSB) 5 year maturity.	IKO2
Korea3	alt		Avg. 1,3,5 yr.corp.bond avg. of daily	IKO3
Taiwan	WFMr		90 day bankers acceptances	ITI
Taiwan	FSM		Curb market rate	ICTI

Key:

DRI: DRIFACS
WFM: Morgan Guaranty, World Financial Markets, various issues.
WFMr: Morgan Guaranty database.
alt: personal communication from Bong Sung Oum.
FSM: Republic of China, Financial Statistics Monthly, various issues.

Industrial Production (IP##)

For Korea

* Source: IMF, International Financial Statistics
* Series: Manufacturing industrial production index.
* Description: Seasonally adjusted. IFS line 66..c.

For Taiwan.

* Source: Monthly Bulletin of Statistics of the Republic of China
* Series: Industrial production
* Description: No additional information available

Consumer Price Index (CPI##)

For Korea

* Source: IMF, International Financial Statistics
* Series: Consumer Price Index
* Description: CPI-All items, 1985=100, IFS line 64.

For Taiwan.

* Source: Federal Reserve Bank of San Francisco database, as provided by Ramon Moreno/Judy Wallen.
* Series: Consumer Price Index
* Description: CPI-All items, 1985=100.

Inflation Rate (INFL##)

* Series: Inflation rate
* Description: Monthly log-difference of the CPI
  INFL##1 inflation rate (log(CPI##) - log(CPI##(-1)))*1200

Domestic Credit (DC##)

For Korea

* Source: IMF, International Financial Statistics
* Series: Domestic credit
* Description: Domestic credit, seasonally unadjusted, line 32.

Cumulated Real Current Accounts

* Source: IFS
* Series: Cumulated real trade balance
* Description: In local currency
  Generated in steps:
    1. Calculate the trade balance (XM) by subtracting imports from exports (EX - M).
    2. Divide the trade balance by the CPI to obtain the real trade balance (XM##85).
    3. Cumulate with a 1982.09 base of 0 to obtain CMXM##85.

Appendix 2
Unit Root and Cointegration Tests

Table A1: ADF and Engle-Granger Tests

Korea: 1982.09-1991.11			Taiwan: 1986.01-1992.01		
Variable	ADF	k	Variable	ADF	k
IKO3	-1.529	4	ITI	-2.900	4
DCKO85	0.371	4	DCTI85	--	-
CMXMKO85	-3.887**	12	CMXMTI85	-3.189*	4
IPKO	-2.069	4	IPTI	-2.470	6
INFLKO1	-2.929	12	INFLTI1	-3.053	12
IEJP	-1.726	4	IEJP	-1.834	4
Korean: E-G stat.	-2.812	12	Taiwan: E-G stat.	-1.735	12

Notes: ADF is the augmented Dickey-Fuller (1979) τ_τ statistic (ADF w/constant and trend) for the indicated variable, or the cointegrating vector. k is the number of difference terms in the ADF regression. E-G stat. is the Engle-Granger (1987) test statistic for cointegration. *(**)[***] indicates significance at the 10%(5%)[1%] marginal significance level.

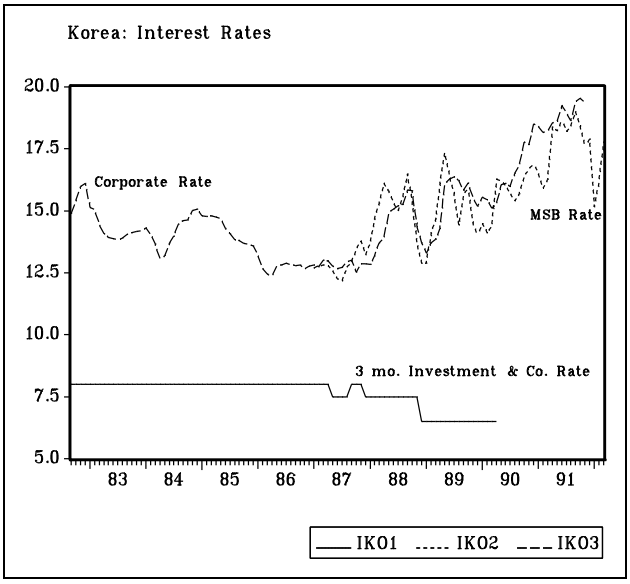

Figure 1

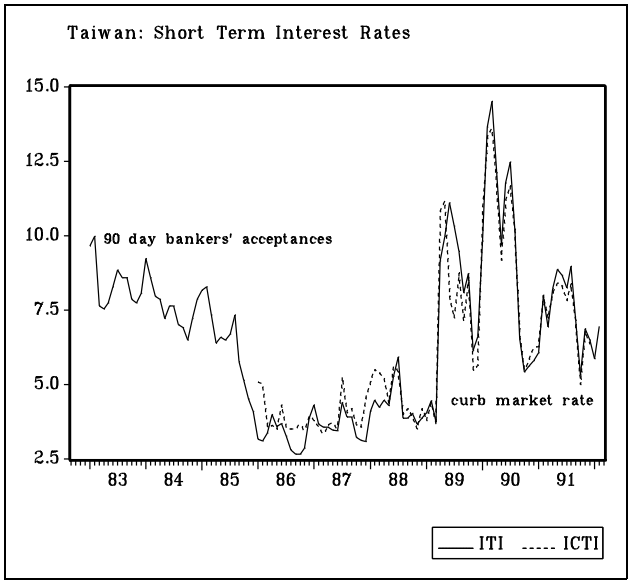

Figure 2