Capital flows and exchange rates: recent Korean and Taiwanese experiences and challenges

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Abstract

We first study the characteristics of the crisis and its impacts on Taiwanese and Korean economies. We have examined 22 macroeconomic fundamentals, such as inflation rates, government budget, trade balance, external debt, money supply, and ratios of average monthly imports and cumulative inward portfolio investment to international reserves, and compared with an extensive data set of the two countries. The comparisons point out that the macro fundamentals of both countries are basically the same, except the international finance sector. After defining currency crisis and banking crisis, the causes of crises are identified as the nominal exchange rates and the short-term external debt to international reserves ratios. In view of this, we use cointegration and causality tests to examine the relationship between these two time series. We have found a unidirectional causality from the short-term debt ratio to the exchange rate for Korea, but no causality between the two for Taiwan. The paper ends with some discussions on the lessons and challenges from the experiences of the two countries.

Keywords: Asian Financial crisis; Short-term debts; Taiwan; Korea

1. Introduction

It is well known that Korea and Taiwan are the only two non-city-state countries, other than Japan, which have achieved and maintained rapid modern economic growth since the end of WWII. As such, most studies often lump them together as both countries achieved impressive growth through rapid industrialization and accelerated exports, like two wheels of a cart. Thus they are generally treated as twins, if not identical, in the world capitalistic development.

In recent years, however, their differences in the development process are also come to light. Taiwan relied more on domestic savings and direct foreign investment, along with emphasis on the contribution of small-and-medium size enterprises. Korea depended on foreign borrowing, incurring large external debt, with major role played by large conglomerates or chaebols in industrialization and trade. What are the impacts of Asian financial crisis on these differences?

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After the Asian financial crisis broke out in Thailand in the mid-1997, it spread quickly to the neighboring countries. The impacts of the crisis and the responses in these two countries are quite different. Taiwan seems to fare much better than most of the neighboring countries while Korea was severely affected. In 1998, the growth rate of current GDP in US dollars of Korea dipped to –32.6% (–8.5% in 1997), and that of Taiwan was –7.8% (4.76% in 1997), which is better than that of Japan, as Japan fell to –9.6% (–8.4% in 1997). This is shown by the columns of Figure 1, indicating quite different responses of the twins. The economy of these three countries recovered very quickly in the following year. In 1999, the above growth rate of Korea increased to whopping 29%, that of Taiwan, to 10%, and of Japan, to 19%. It appears that both Taiwan and Korea, and for that matter, the Southeast Asian countries, are already on the way to full recovery, although some lingering problems still exist among them. What are the reasons for such large differences?

Due to its possible global contagion, extensive literature already exists on Asian financial crisis, including crisis in Korea. However, few papers deal with Taiwan, as Taiwanese data are generally not available from the international organizations, and much less on the comparisons of different responses of Taiwan and Korea. The purpose of this paper is to examine economic characteristics and macroeconomic policy responses of the twins. We first discuss the causes and contagion of recent financial crisis. We then study the characteristics of the crisis and the distinct impacts on Taiwanese and Korean economies. We submit that, since Korea was one of the four countries, along with Thailand, Indonesia, and Malaysia, which were severely affected by the recent financial crises, and Taiwan was only slightly affected, comparisons of the two the twins using the time series analysis may contribute to the understanding of the cause and causality effects of the crisis.

Thus, after reviewing some explanations of the causes of the recent Asian financial crisis in Section 2, Section 3 examines 22 macroeconomic fundamentals. In the real sector, we have examined current GDP and current GDP per capita, their percentage growth rates, inflation rate, the lending rates of banks, government budget, fiscal surplus-GDP ratios, unemployment rates, money supply (M2) to GDP ratios. In the external and financial sectors, we examine the balance of trade, the current account balance, international reserves, ratios of the average monthly imports to international reserves, ratios of cumulative inward portfolio investment to international reserves, the total external debt, ratios of total external debt to international reserves, short-term external debt, ratios of short-term external debt to international reserves, exchange rates and their percentage changes, and the year-end stock indexes and their percentage changes.

The sources and impacts of financial crisis in Korea and Taiwan are explained in Section 4. The financial crisis is considered as the interaction between the currency crisis and the banking crisis. Section 5 examines the empirical findings of the linkage between the two crises, which are then reduced to the
causality relation between the nominal exchange rate series and the ratios of short-term external debt to international reserves series. Thus, in Sections 6 and 7, we examine first the stationarity of both time series data, and then their cointegration, and finally the causality relation by the error correction model for Korea and the standard Granger causality test for Taiwan. Once again, we find the differences between Taiwan and Korea. Section 8 ends the paper with comparing the Korean case with Taiwan, and discusses the lessons and challenges from the experience of the two countries and the prospects for the future.

2. Four explanations of the crisis

There are at least four explanations of the onset of Asian financial crisis:

(a) It is simply a phase of growth cycle. There was an economic downturn during 1983-85, which recovered and started over a decade of high growth. The pace of growth changed at the beginning of 1990, and a downturn was expected around 1994 (Ichimura, et al., 1998, 1). Thus, the crisis in the mid-1997 was not unexpected.

(b) Over-supply of labor intensive goods, such as footwear, textile products, and electronic products, and the rise of China as a large exporter, have reduced export earnings of East and Southeast Asian countries (IMF, 1997; Park, 1996). China’s 50% devaluation of yuan in early 1994 accelerated the trend. The rise of Mexican exports and enactment of NAFTA treaties also intensify competition in East and Southeast Asian.

(c) Basic weakness in Asian financial management and capitalism. Financial liberalization in Asian began in early 1990s. It was at best haphazard and incomplete. Increasing banking activity, growing short-term external debt, and its exposure to international capital market, along with the inadequate regulation and supervision, corruption, inefficiency, led to the increase in real estate speculation and non-performing loans (Krugman, 1998; Goldstein, 1998). The pegged exchange rates depleted the international reserves and aggravated the crisis.

(d) Self-fulfilling crisis and overreaction of the financial market. The macroeconomic fundamentals are, although not perfect, basically sound. However, once a liquidity crisis of a firm sets in, no creditor will make a loan if each creditor expects no other creditors will provide a new loan to repay the existing debt. Thus, when more and more foreign investors withdrew the loans, more and more domestic banks and firms will be driven into illiquidity and eventual insolvency (Radelet and Sachs, 1998). The panic then spread to the whole country and transmitted to other countries.

We submit that all four explanations reflect some aspects of the recent financial crisis and are consistent with our observations. Korea is one of the most affected countries in this financial crisis. What happened in Korea? We consider that the last two explanations seem more plausible.
3. Comparisons of Taiwanese and Korean economies in the 1990s

Several papers have discussed the macroeconomic background of financial crisis (Kaminsky and Reinhart, 2000; Alba, et al., 1999; Agenor, 2000). In this paper, we select some macroeconomic fundamentals to show similarity and difference among the economies of Taiwan, Korea, and Japan. For this purpose, instead of cluttering the paper with numbers, we use charts to visualize and dramatize the changes in some important macroeconomic variables over time from 1989 to 1999. To be consistent in data collection, most of the annual data of 1989-1999 in this section are taken from the latest issue of ICSEAD (2000), except those few noted otherwise.

Figures 1 to 10 compare economic conditions of Taiwan (in heavy solid lines or dark solid columns) and Korea (in heavy dotted lines and lightly filled columns), along with Japan (in light solid lines and empty columns), in 22 categories numbered in square brackets. Whenever possible, we have tried to compare the development patterns of these three countries, as they are closely related by international trade, and are historically had similar development patterns. Among the labels, J/10 in Figures 1, 2, 5, 6, and 8, or K/10 in Figure 9 implies that the Japanese or Korean data were reduced to one-tenth of the original value to fit into the diagrams. Thus, if a curve has been so indicated, the curve itself may only be used to compare the differences in the shape or fluctuations, the reader should be aware that the actual curve is ten times higher or larger than that plotted in the graph. To save space, we also created the secondary (right) Y-axis. All line charts use the left-hand side primary Y-axis, and all column charts use the right-hand side secondary Y-axis, the titles and labels of which are typed in italic. Each category of macroeconomic variables are numbered and enclosed in square brackets. They are explained briefly as follows.

A. The real sector

In Figures 1 and 2, the patterns of current GDP [1] and current GDP per capita (GDPpc) [3], all in U.S. dollars, for the three countries are very similar, all enjoying a robust economic growth until the peak year of both GDP and GDP per capita in 1995 for Japan, 1996 for Korea, and 1997 for Taiwan. They then turned downward and reached a local minimum simultaneously in 1998. In terms of the growth rates, %gGDP [2] and %gGDPpc [4], registered a negative value in 1998 for the first time for all three countries when the Thai baht plunged in the mid-1997. Korea’s growth rates were most severely affected, decreased more than 30% in 1998, although Korea’s GDP and GDP per capita growth rates were generally higher than those of Taiwan before 1995. It appeared that Korea was catching up with Taiwan in the 1990s.
The inflation rates in terms of consumer prices,\textsuperscript{4} \textsuperscript{[6]} in Figure 3, of Taiwan and Korea also had a similar pattern, both were decreasing up to 1997, but Korea’s inflation rate almost doubled from 4.7\% in 1997 to 8.2\% in 1998, while that of Taiwan continued to decrease from 2.98\% in 1996 to mere 0.9\% in 1997. Their lending rates of banks\textsuperscript{5} \textsuperscript{[7]} also tended to decrease until 1996. But Korea’s lending rates increased from 8.84\% in 1996 to 11.88\% in 1997 and whopping 15.28\% in 1998, while that of Taiwan increased only slightly from 7.53\% in 1996 to 7.65\% in 1997 and 7.87\% in 1998, the trend of which was similar to Japan. Note that for both inflation rates and lending rates, Korea’s rates are generally one to three percentage points higher than those of Taiwan, and Taiwan’s rates continue to decrease or maintain the same levels after the crisis. These probably indicate a better management of the Taiwanese monetary authority before and after the onset of the Asian financial crisis in the mid-1997. However, Figure 3 also shows that both Korea and Taiwan had fiscal deficits \textsuperscript{[5]} in 1991 and 1992, but Korea’s fiscal budgets turned positive after 1993, while those of Taiwan and Japan stayed negative. Korea had fiscal surplus to GDP ratios of about 0.4\% to 0.6\% during the four years just before the 1997 financial crisis, while Taiwan experienced 1.11\% to 3.95\% of deficit to GDP ratios and Japan, 1.6\% to 4.2\% deficit to GDP ratios. All three countries ran budget deficits in 1997.

Although we have not shown in the figures here, we have confirmed that, in terms of percentage of GDP, all three countries also had similar patterns in the private and government consumptions, fixed investment, and no drastic changes in these ratios before and after the 1997 crisis have been detected. The major difference is that Korea’s fixed investment to GDP ratios, which range from 35\% to 38.8\%, are much higher than those of Taiwan (20.7\% to 23.7\%), probably explaining Korea’s higher GDP growth rates in the pre-crisis period of the early 1990s. Despite higher growth rates, Figure 4 shows that the unemployment rates \textsuperscript{[9]} of Korea are generally 0.5\% to 1.0\% higher than those of Taiwan before 1995. They are, however, very low as compared with those in the developed countries, except in 1998 and 1999, showing the dire effect of the impacts of financial crisis. Through out the 1990s, Korea’s broad money
supply (M2) to GDP ratios [8] were much lower than those of Taiwan, and there were not much changes in the ratios for all three countries even after the 1997 crisis. Thus, in general, Korea’s real sector macroeconomic foundation appeared to be as good as, or even better than, those of Taiwan before the crisis.

B. The external and financial sectors

The major differences between Korea and Taiwan appear in the external and financial sectors. While the data show that merchandise imports and exports increased steadily during the 1990s for all three countries, the balance of trade, [11] in Figure 5, and the current account balance, [13] in Figure 6, of Taiwan and Japan have been consistently positive, while those of Korea have been almost always negative before 1997, except a mere US$ 1 billion current account surplus in 1993. Korea’s current account balance even fell to US$ –23 billion in 1996. Both balances of Korea increased quite dramatically from US$ -8 billion in 1997 to about US$ 40 billion in 1998, although both balances decreased to about US$ 24 billion in 1999. A reason given for the difference between Taiwan and Korea is the nature of outward foreign direct investment (OFDI). Taiwan’s OFDI is export-oriented, still using Taiwan’s machinery and intermediate goods exported to the host countries, while that of Korea is local-market oriented, resulting in misalignment of home and host countries’ production structures (Chen and Ku, 2000, 142).

The general trends of trade and current account deficits of Korea and surpluses of Taiwan and Japan are reflected in the much higher international reserves [16], in Figure 8, of Taiwan (US$ 73 billion to 90 billion) and Japan (US$ 84 billion to 272 billion) than those of Korea (US$ 14 billion to 52 billion) during the decade. Note that Korea’s international reserves fell from US$ 34 billion in 1996 to US$ 20 billion in 1997, but increased to US$ 52 billion in 1998.

The line charts of Figures 5 and 6 show the ratios of the average monthly imports to international reserves [10] and the ratios of cumulative inward portfolio investment to international reserves [12], all
are expressed as percentages. These are the indicators, along with the short-term external debt to international reserves ratios, [17] in Figure 8, closely related to the fluctuations in foreign exchange rates during the financial crisis. The ratio of average monthly imports to international reserves is generally considered that the lower the better for an economy. Since its inverse, the ratio of international reserves to average monthly imports indicates the ability of a country to pay for its imports in terms of months, it is generally considered that 6 months worth of reserves is a minimum safety amount. Hence, if the monthly imports to international reserves ratio is higher than 17% (1/6), that is, if the international reserves are not enough to pay for six months of imports, then the country is more vulnerable to financial crisis. The line chart [10] in Figure 5 shows that Korea has the highest and varied ratios among the three countries, ranging from 38% in 1989 to 73% in 1997. Japan’s ratios are modest, ranging from 48% in 1991 and decreased continuously to 16% in 1999, while that of Taiwan is the healthiest, ranging from mere 7.5% in 1989 to 14% in 1997.

The indicator [12] in Figure 6 is the ratio of cumulative inward portfolio investment to international reserves. This inward portfolio investment is highly speculative, it is the source of international hot money pursuing stock price changes. Here, the numerator is the cumulative sum of inward portfolio investment from 1980 and afterward. In fact, from 1991 to 1996, Korea’s cumulative inward portfolio investment increased from US$ 2.3 billion to 21.2 billion, and that of Taiwan increased from US$ 0.8 billion to 3.2 billion. During this period, the inward cumulative portfolio investment is higher than foreign direct investment in Korea, the former is twice to 18 times higher than the latter, but in Taiwan, it ranged 0.6 to 2.6 times higher. This was another sources of vulnerability of the Korean economy.

Huge inward portfolio investment may not be a threat in the case of crisis if a country has enough international reserves. Thus, we have to look at the ratio [12]. It is generally considered that the lower is the ratio the better. Over the years, Korea has much higher ratios through out the decade as compared with that of Taiwan. For Korea, it was only 13% in 1989, but increased rapidly and reached whopping 372% in 1997, and then decreased to 145% in 1998. This signals the danger of currency crisis in won in case of sudden flight of inward portfolio investment. For Taiwan, the ratios had maintained at a very low level. They were –0.32% in 1989, and increased slightly and steadily to mere 15% in 1996, well within the 100% threshold level.

Figures 7 and 8 show similar discrepancy between Taiwan and Korea in the international finance sector. The total external debt [14a] for both Taiwan and Korea have been increasing, very slowly for Taiwan, from US$ 17 billion in 1989 to only US$ 34 billion in 1997, an increase of 100%, but the increase was much more rapid for Korea, from US$ 42 billion in 1989 to US$ 143 billion in 1997, an increase of 240%. Apparently, Korea’s high rate of GDP growth [1] relied heavily on external debt. By
doing so, however, Korea also greatly increased its financial vulnerability, as shown by the total external debt to international reserves ratios [15]. Since Taiwanese international reserves [16] are much higher than those of Korea, Korea had much higher total debt to reserves ratios, 276% in 1989 to huge 704% in 1997, as compared with Taiwan’s ratios, which range from mere 23% in 1989 to 40% in 1997. Note that Korea’s short-term external debt [14b] was more than doubled from US$ 28 billion in 1993 to US$ 66 billion in 1996, which consisted about 50% of the total external debt of that year. As we will show below, since some economists regard the short-term external debt as the culprit of financial crisis, we also present the ratio of short-term external debt to international reserves [17] for Taiwan and Korea. Taiwan’s ratios range from only 20% in 1989 to 27% in 1997, while those of Korea range from 125% in 1989 to 347% in 1997, about six to twelve times larger than those of Taiwan.

In general, the ratio of total external debt to international reserves [15] shows a country’s solvency, and the ratio of the short-term external debt to international reserves [17] indicates the liquidity of the country at crisis. Both ratios for Korea are much higher than the critical point of 100%, at 390% and 160%, respectively, in 1996, and 704% and 347%, respectively, in 1997, while those for Taiwan are much lower than the critical point of 100%. Here lies the extremely vulnerability of the Korean economy to the international capital market fluctuations.

Figures 9 and 10 show the average levels and their percentage changes of the Korean won, the New Taiwan dollar, and the Japanese yen per U.S. dollar exchange rates [18] [19], and also the levels and percentage changes of the year-end stock indexes [20] [21]. Unlike Japan, whose yen continued to appreciate until 1995, Taiwan and Korea maintained more or less at the constant levels and percentage changes of exchange rates until 1996, moving somewhat around NT$ 26.5 per U.S. dollar for Taiwan and about 760 won per U.S. dollar for Korea. All three currencies started depreciating in 1996 (see the columns in Figure 9), and the depreciation of New Taiwan dollar and Korean won reached their peak in 1998, to NT$ 33.5 per U.S. dollar and 1,400 won per U.S. dollar, although both fell back slightly in 1999. Along with other indicators mentioned above, there were signs of quick recovery from the financial crisis in 1999.
The year-end stock price indexes, on the other hand, were rather erratic during the whole period. The indexes of Taiwan and Korea moved together before 1995 and deviated toward the opposite directions to each other, indicating quite different impacts of financial crisis on the two countries. The Taiwan index reached its high of 1.8 in 1997 and fell to 1.4 in 1998. The Korea index reached its low of 0.4 in 1997 and recovered slightly to 0.6 in the following year. Both indexes reached its ten-year high of 1.8 and 1.2, respectively, in 1999.

4. Short-term debt, exchange rates, and crisis in Korea

We have seen that the real sectors of the macroeconomic fundamentals of Korea and Taiwan basically have similar performance during the last decade. The major differences between these two countries lie on the external and financial sectors. Among the variables, we find that the greatest discrepancy is shown by the ratios of total external debt to international reserves, that is, series [15] in Figure 7. Since total external debt also includes the long-term external debt, which is bound by long-term contracts, the immediate cause of financial crisis may be attributable to the short-term external debt (Radelet and Sachs, 1998; Rodrik and Velasco, 1999). In fact, series [17] of the ratios of short-term external debt to international reserves in Figure 8 also yields a similar discrepancy as series [15] between the two countries. Since Taiwan barely faced the recent Asian financial crisis as compared with Korea, our finding points to the short-term external debt as the cause of the 1997 financial crisis in Korea, and possibly other Southeast Asian countries. This is consistent with the observation presented in Rodrik and Velasco (1999).

As Korea sought out to join the OECD in the early 1990s, it started financial reform in earnest. The prospects of prosperity that would come along with deregulation, reform, and openness attracted foreign capital to Korea in droves. This is reflected in the sweeping increase of total external debt [14a], especially short-term external debt [14b]. The waves of optimism and the government policy of controlling commercial banks to support government’s economic development plans fostered moral hazard of excessive lending and borrowing in the expectation that the central bank, the government, or an international organization will bail the banks or firms out when things go wrong. In fact, ironically, it has been often pointed out that this crony relation between the government and business was one of the
factors of Korea’s rapid growth. Under these circumstances, “the Korean banks kept lending to chaebols which the government preferred … Korean banks … developed few skills in credit analysis or risk management, … Reflecting the history of directed lending, banks generally did not insist on, or receive, full financial information from chaebols” (Shim, 2000, 154). On the other hand, with easy money, Korean firms expanded. “The debt-to-equity ratio of Korean cooperates was approximately 450 percent by the end of 1996, three times the comparable US ratio, and more than five times the comparable Taiwanese ratio.”

This is not the case of Taiwan. While the Taiwanese government also encouraged domestic savings and allocated capital to selected industrial sectors, capital was invested in the large public enterprises and a few large private firms. The private small-and-medium enterprises seldom received funds from the government or banks except export financing. This has resulted in low debt-equity ratios of the Taiwanese firms. Furthermore, the government didn’t adopt the policy of investment risk-sharing with the private enterprises, thus, the Taiwanese economy remained centered around small-and-medium enterprises, avoiding the problem of moral hazard which occurred in other East Asian countries.

In the case of Korea, the foreign banks (Japanese, European, or the U.S.) borrowed yen or dollar at low interest rates, relend the money at higher rates for short periods to Korean banks, which in turns relend the money to local firms for longer periods with higher interest rates (Uchitelle, 1998; Shim, 2000, 156). Before June 1997, Korean commercial banks are not required to maintain adequate liquidity ratios on the foreign currency assets. About 20% of the local foreign borrowings were also invested in the foreign securities in Thailand, Indonesia, Russia, and Latin America (Shim, ibid.). The mismatched foreign currency dominated borrowings and speculative investment in foreign countries added the vulnerability of the banking system and the possible contagion effect when financial crisis occurs. Using a simple two-period model, Rodrik and Velasco (1999) have concluded that the banking crisis (bank run) “can only occur when investors take on sufficiently large amounts of short-term debt.” They point out that the larger the stock of such debt, the larger the size of a crisis, and the larger the consequences in terms of liquidation and reduced output and consumption.

On the other hand, the currency crisis occurs when the monetary authority tries to maintain a fixed (or fixed within a band) foreign exchange rates (Fukushima and Takii, 1998, 11). Most developing countries pegged their exchange rates to one currency (U.S. dollar or French Franc) or a few currencies so to reduce the currency risk to attract inward foreign direct investment from developed countries. Korea was no exception. Since March 1990, Korea adopted the market average exchange rate system, but loosely pegged to the U.S. dollar. It was abandoned only when Korea moved to a complete floating system in November 1997 in the midst of financial crisis (EPA, 1998, 270).

In 1996, Korean exports declined and trade deficit grew due to the decrease in demand
for semiconductors and the appreciation of the won against yen, which was induced by the appreciation of the U.S. dollar against yen (ibid., 119; Fukushima and Takii, 1998, 146). The decrease in demand for steel in China and the increasing competition in Asian markets forced Hanbo Steel, the flagship of the 14th largest chaebol in terms of total assets in 1996, with US$ 6 billion in debt, declared bankruptcy in January 1997 (Fukushima and Takii, 1998, 142). The bankruptcy of Sammi Steel (Sammi Chaebol, ranked 26th) followed in March. Then the Kia Motors (Kia Chaebol, ranked 7th), the third largest Korean automaker, with US$ 10.6 billion in debt, followed on July 15 (ibid., 143). The government reacted by letting some chaebols to go under, but defended the won at the end of 1997 (Radelet and Sachs, 1998, 1999). This action resulted in the sharp depletion of international reserves, and marked increase in the ratio of the short-term external debt to international reserves in 1997. This then triggered a chain reaction.

The foreign creditors, who were already alarmed at the Thailand’s financial crisis in July 1997, refused to roll over the short-term debt. They started pulling capital from Korea, and as the borrowers cannot pay back to lenders fast enough, the won devaluated further. On July 5, 1997, the won plummeted to 905.60 per U.S. dollar, the lowest in decade (Fukushima and Takii, 1998, 148). The news of depletion of international reserves sent the won further down to 2,000 won per U.S. dollar by the end of 1997 (EPA, 1998, 119). The turmoil in the exchange rate market continued well into 1998. The average annual exchange rate shot up almost 50%, from 951 won in 1997 to 1,400 won per U.S. dollar in 1998, as shown in series [18] and [19]. At the same time, the assets value plummeted. The year-end stock price index decreased 26% in 1996 and 42% in 1997, as shown by series [20] and [21]. The government’s defense of the won was ineffective, the pegged exchange rate system gave way to the complete floating system on December 16, 1997, and the Korean won continued to depreciate.

5. On currency and banking crises

We have seen from the analysis in Section 3 that the differences in macroeconomic performance between Korea and Taiwan can be found in the external and financial sectors. The fluctuations of Korean exchange rates (won/US$) and the short-term external debt to international reserves ratios (hereafter, the short-term debt ratios) seem to be closely related. Section 4 explains the process of their interaction. We have also shown that, while the financial crisis in Korea and the Southeast Asian countries appears to be triggered suddenly by the financial crisis in Thailand in July 1997, the signs of the crisis already revealed in 1996, and the root of Korean crisis may be traced back to the early 1990s when the government started preparing to join the OECD. We may say that a long-run undercurrent of crisis has been snowballing for a long time, and it erupted as a financial crisis only in July 1997. This may also be the case in Thailand and other Southeast Asian countries.
In the literature, banking crises are difficult to identify empirically. They are “a combination of events, such as forced closure, merger, or government takeover of financial institutions, run of banks, ... failure to roll over interbank deposits, … the share nonperforming loans in banks’ portfolios, large fluctuations in real estate and stock prices, …”, etc. (IMF, 1998, 76). In this paper, we follow Radelet and Sachs (1998) and Rodrik and Velasco (1999) to consider the short-term debt ratios as the major source of financial crisis. On the other hand, in the literature, currency crisis is either “identified simply as a substantial nominal currency devaluation” or by an index of foreign exchange market pressure (IMF, 1998, 76). In this paper, we consider nominal currency devaluation as the source of financial crisis.

Based on the various definitions, IMF (1998, 77) has identified, between 1975 and 1997, 158 episodes of currency crisis and 54 banking crisis. “For emerging market countries, the frequency of currency crises shows no marked trend, while banking crises are clustered in the early 1980s and the 1990s” (ibid., 77-78). This is “possibly related to the financial sector liberalization” during this period (ibid., 77). As IMF and other scholars have observed,

Given that the two types of crises may have common origins, or that one type of crisis may induce the other, it is not surprising that countries appear to have banking and currency crises at around the same time. In these instances, banking crises preceded currency crises more often than the other way round. … banking crises led currency crises by one year on 13 occasions, and by two years on 10 other occasions. The crises were contemporaneous in 12 instances. Currency crises preceded banking crises by one year only seven times and by two years another four times. This evidence, while suggestive, should be interpreted with caution in view of the difficulties in dating the beginning of banking crisis (ibid., 78).

In view of the interest in the linkage between the currency crisis and the banking crisis, we would like to go a step further and examine econometrically the causality between the two crises. This way, we may also avoid the ambiguity problem in dating, namely, timing the beginning and ending of the crises (Park, 2000). So far as we are aware of, the time series analysis of the causality between the two crises has not been done in the literature, as most of the analyses have been based on the cross-section data.

6. The causality test –the case of Korea

We now would like to use recently developed econometric techniques to examine the relationship and the causality between the nominal exchange rates and the short-term debt ratios using annual data from 1979 to 1998 given in ICSEAD (1999, 2000).
A. The unit-root test

It is well known that many macroeconomic time series are non-stationary. Therefore, before examining the cointegration and the causality between the variables, we employ the Augmented Dickey-Fuller (ADF) unit-root test (Dickey and Fuller, 1979, 1981) to examine the stationarity of Korea’s nominal exchange rate\(^2\) (hereafter, exchange rate) and the short-term debt ratio. The general equation for the ADF test is,

\[
\Delta x_t = a_0 + a_2 t + a_1 x_{t-1} + \sum_{i=1}^{k} \beta_i \Delta x_{t-i} + \epsilon_t
\]  

(1)

where \(x_t\) (level series) is the natural logarithm of Korea’s exchange rate series (or, \(x_t\) is the short-term debt ratio series), and \(\Delta x_t\) is the first-difference series of \(x_t\). The variable \(t\) is the time trend. The variable \(x_{t-1}\) is the one-period lag of \(x_t\) for the unit-root test, and \(\Delta x_{t-i}\) is the \(i^{th}\) lag of the dependent variable. The optimal lag length \(k\) is chosen by minimum Akaike information criterion (AIC) (Enders, 1995; Maddala and Kim, 1998).

Part 1 of Table 1 presents the ADF unit-root test results on the level series. For a unit-root test, the null hypothesis is \(H_0: a_1 = 0\) (unit-root), against the alternative hypothesis \(H_1: a_1 < 0\). For Korea’s exchange rate series and the short-term debt ratio series, the test equation (1) includes a constant and a statistically significant trend. Both calculated test-statistics are greater than their critical values at the 10% significance level. Therefore, we cannot reject \(H_0\). Since both level series are not stationary, we proceed to test their first-difference series. The test results are presented in Part 2 of Table 1. In both cases, the calculated test-statistics are less than their critical values at 1% significance level, so we can reject \(H_0\). Hence, both of the first-difference series of Korea’s exchange rate and the short-term debt ratio are I(0), and their level series are I(1).

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Place Table 1 here

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B. The cointegration test

Although Korea’s exchange rate and the short-term debt ratio are both I(1) series, it is quite possible that they can be cointegrated, and there exists a long-run equilibrium relationship between the two series. There are several testing procedures available for cointegration test, each method has its own merits and weakness (Enders, 1995). Since we have a bivariate case and our sample has only 20 observations, it is appropriate to use Engle and Granger’s two-step cointegration test to estimate the cointegrating equations from both directions and then test the stationarity of both residual series (Engle and Granger, 1987, 1991; Enders, 1995; Maddala and Kim, 1998).
For this purpose, we generate the residual series from the estimated cointegrating equation (step 1) and then use the ADF unit-root test to examine the stationarity of the residual series (step 2). The ADF test equation for a unit-root in the residual series is,

\[
\Delta e_t = \alpha e_{t-1} + \sum_{i=1}^{k} \beta_i \Delta e_{t-i} + \nu_t
\]

(2)

where \( \Delta e_t \) is the first-difference series of residuals \( e_t \), and \( \Delta e_{t-i} \) is the \( i \)th lag of \( \Delta e_t \). The value of optimal lag length \( k \) is selected by minimum AIC method. \( \nu_t \) is the random error term. Since the residual series is calculated from a cointegrating equation, we do not need to include an intercept or time trend in equation (2).

Table 2 presents the results of the two-step cointegration test for Korea. When we use the exchange rate as the dependent variable in cointegrating regression, the estimated cointegrating equation is:

\[ x_t = 6.119 + 0.035t + 0.071y_t \]

(3)

where \( x_t \) is the logarithmic series of exchange rate, \( y_t \) is the short-term debt ratio, and variable \( t \) is the time trend. From (3), we generate the residual series \( e_t \), and then applied the ADF unit-root test on \( e_t \) series using the test equation (2).

On the other hand, when we use the short-term debt ratio as the dependent variable, the estimated cointegrating equation is:

\[ y_t = -27.445 - 0.290t + 4.970x_t \]

(4)

We then generate the residual series \( u_t \) from (4) and perform the ADF unit-root test using equation (2), where \( e_t \) is replaced by the \( u_t \) series. In both cases, the test-statistics are less than the critical values at the 10% significance level. Hence, we can reject \( H_0 : \alpha = 0 \) in both cases and \( e_t \) and \( u_t \) series are stationary.

This implies that Korea’s exchange rate series and the short-term debt ratio series are cointegrated and there exists a long-run equilibrium relationship between these two series. We have shown that Korean exchange rate series and the short-term debt ratio series are cointegrated and there exists a long-run equilibrium relationship between these two series.

C. The ECM causality test

We have shown above that Korea’s exchange rate and the short-term debt ratio are individually I(1) series, and they are cointegrated with order one. Hence, the error correction model (ECM) is
appropriate to use in testing their causality relationship (Engle and Granger, 1987). The test involves the estimation of following two equations:

\[
\Delta x_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta x_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta y_{t-j} + \eta e_{t-1} + \mu_t \tag{5}
\]

\[
\Delta y_t = \delta + \sum_{i=1}^{p} \lambda_i \Delta x_{t-i} + \sum_{j=1}^{q} \theta_j \Delta y_{t-j} + \phi u_{t-1} + \nu_t \tag{6}
\]

where \(\Delta x_t\) and \(\Delta y_t\) are the first-difference series of Korea’s exchange rate and the short-term debt ratio. They are individually I(0) stationary series. The optimal lag lengths for \(m, n, p,\) and \(q\) of the lagged variables \(\Delta x_{t-i}\) and \(\Delta y_{t-j}\) are selected by the minimum AIC method. The \(e_{t-1}\) is the lagged residual series from the cointegrating equation (3) and \(u_{t-1}\) is the lagged residual series from the cointegrating equation (4). \(\mu_t\) and \(\nu_t\) are the random error terms in the ECM. The causal relationship in equation (5) is seen from the joint significance of the coefficients \(\gamma_j\)’s of \(\Delta y_{t-j}\)’s. The causal relationship in equation (6) is seen from the joint significance of the coefficients \(\lambda_i\)’s of \(\Delta x_{t-i}\)’s (Granger, 1969; Hsiao, 1987). The significance of the negative coefficients \(\eta\) and \(\phi\) represents the long-run adjustment process and the convergence of the two series.

Place Table 3 here

The left-hand side of Table 3 presents the ECM regression results (note that the variable resid(-1) is \(e_{t-1}\) in equation (5) and resid(-1) is \(u_{t-1}\) in equation (6)). The right-hand side of the table presents Wald’s coefficient test, the results of causality direction, and the long-run adjustment process of the series. For equation (5), the optimal lag lengths are \(m = 2\) and \(n = 1\). The Wald’s test for \(H_0: \gamma_1 = 0\) shows that the F-statistic is 1.844, which has p-value = 0.19. This means that the test is significant at the 20% level. Although this significance level is slightly higher than the usual practice of the 10% or 15% level, nevertheless, it did imply that there is a causality relationship running from Korea’s short-term debt ratio to the exchange rate. In addition, the coefficient \(\eta\) is -0.527, which is significant at the 15% level. This implies that there exists a significant long-run adjustment process between the two variables.

On the other hand, for equation (6), the optimal lag lengths are \(p = 1\) and \(q = 1\). The Wald’s test for \(H_0: \lambda_1 = 0\) shows that the F-statistic is 0.055, which is very small and has a large p-value at 0.82. This means that the test is not significant even at the 20% level. This implies that there is no feed back causality from Korea’s exchange rate to its short-term debt ratio. In addition, the coefficient \(\phi\) is -0.836, which is significant at the 5% level. This means that there exists a significant long-run adjustment process between the two variables, which is consistent with the results from equation (5).
In sum, at the 20% significance level (a rather weak case), our results from ECM causality test indicate a unidirectional causality from Korea’s short-term debt ratio to the exchange rate. Furthermore, the test results also show that there exists a long-run adjustment process between the two variables.

7. The causality test – the case of Taiwan

For comparisons, we would like to use the same econometric techniques in the case of Korea above to examine the causality relation between Taiwan’s nominal exchange rate (NT$/US$) and the short-term debt ratio using the annual data from 1979 to 1998. The data are taken from the same sources in the ICSEAD (1999, 2000).

A. The unit-root test

In the case of Taiwan, for the ADF unit-root test equation (1), the variable $x_t$ (level series) is the natural logarithm of Taiwan’s exchange rate series (or, $x_t$ is the short-term debt ratio series), and the other variables have the same definition. Part 1 of Table 4 presents the test results of the level series. Since both test-statistics are greater than their critical values at the 10% significance level, Taiwan’s exchange rate series and the short-term debt ratio series are not stationary.

| Place Table 4 here |

Part 2 of Table 4 shows the test results of the first-difference series. Since both calculated test-statistics are less than their critical values at the 1% significance level, the first-difference series of Taiwan’s exchange rate and the short-term debt ratio are stationary, $I(0)$, and their level series are $I(1)$.

B. The cointegration test

Table 5 presents the Engle-Granger’s cointegration test results. When we use Taiwan’s exchange rate ($x_t$) as the dependent variable, the estimated cointegrating equation is:

$$x_t = 3.619 - 0.032t + 0.180y_t$$

(7)

where $y_t$ is the level series of Taiwan’s short-term debt ratio. When we use Taiwan’s short-term debt ratio as the dependent variable, the estimated cointegrating equation is:

$$y_t = 0.194 + 0.008x_t.$$  

(8)

The ADF unit-root tests on the residual series $e_t$ from equation (7) and $u_t$ from equation (8) above yield the test-statistics that are greater than their critical values at the 10% significance level. Hence, $e_t$ and $u_t$ series are not stationary. Hence, Taiwan’s exchange rate series and the short-term debt ratio series are not cointegrated. This finding is different from the case of Korea.
C. The standard Granger causality test

Although the level series of Taiwan’s exchange rate and the short-term debt ratio are not stationary and not cointegrated, their first-difference series are stationary. We can use them in the short-run dynamic model of the standard Granger causality test (SGCT) to examine their causality relationship. The SGCT model involves the estimation of the following two equations:

\[
\Delta x_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta x_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta y_{t-j} + \mu_t \tag{9}
\]

\[
\Delta y_t = \delta + \sum_{i=1}^{p} \lambda_i \Delta x_{t-i} + \sum_{j=1}^{q} \theta_j \Delta y_{t-j} + \nu_t \tag{10}
\]

where \(\Delta x_t\) and \(\Delta y_t\) are the first-difference series of Taiwan’s exchange rate and the short-term debt ratio, respectively, and the other variables have the same definition as in equations (5) and (6).

Table 6 presents the causality test results for Taiwan. For equation (9), the optimal lag lengths are \(m = 1\) and \(n = 1\). The Wald’s test for \(H_0: \gamma_1 = 0\) shows that the F-statistic is small at 0.234, which has a large p-value at 0.64. Therefore, we cannot reject the null hypothesis even at the 20% significance level. This implies that Taiwan’s short-term debt ratio does not cause the exchange rate. On the other hand, for equation (10), the optimal lag lengths are \(p = 1\) and \(q = 3\). The Wald’s test for \(H_0: \lambda_1 = 0\) shows that the F-statistic is very small at 0.067, which has a large p-value at 0.80. Hence, like in equation (9), we cannot reject the null hypothesis even at the 20% significance level. This implies that Taiwan’s exchange rate does not cause the short-term debt ratio.

In sum, the test results from the SGCT indicate that there is no causality relationship between Taiwan’s nominal exchange rate and the short-term debt ratio. This finding is different from the case of Korea. Again, our study has demonstrated that the short-term external debt to the international reserves ratio has very different impact on Korea’s and Taiwan’s exchange rates.

8. Conclusion: lessons and challenges

We have shown that macroeconomic fundamentals of the Korean economy were at least as good as those of Taiwan before the onset of the Asian financial crisis. Yet, Taiwan has fared better than most
of the Asian countries, but Korea was severely affected. Our figures show that the major difference between the two countries appears to be the external and financial sectors. Korea has extremely high ratio of total external debt, in particular, the ratio of short-term external debt, to international reserves, along with the high ratio of cumulative inward portfolio investment to international reserves. It is conceivable that a nation that has too much indebtedness heightens the vulnerability of the speculative attack of foreign capital. When this occurs, all the four factors that cause the crisis, as we have explained in Section 2, will set in motion, resulting in currency and banking crises.

The wave of financial crisis reached Taiwan by the end of July 1997, resulting in currency devaluation and stock price decline until the end of the year. However, Taiwan consistently had large trade and current account surpluses, see [11] and [13] in Figures 5 and 6, abundant international reserves, see [16] in Figure 8, and above all, very low short-term external debt, see [14b] in Figure 7. On the other hand, unlike Korea, as early as 1989, Taiwan already moved from the market average exchange rate system to completely flexible exchange rate regime (EPA, 1998, 270). Thus, avoiding the extreme vulnerability to both banking and currency crises. Furthermore, amply available internal capital funds, the large current account surpluses, the large share of government-held banks (55% by the end of 1996), the fear of capital flows from China, etc., did not motivate the Taiwanese to seek external borrowing actively. The slower pace of Taiwan’s financial liberalization and internationalization also did not attract massive international indirect foreign investment inflows either (Fukushima and Takii, 1998, 138; EPA, 1999, 177-180). Ironically, while its slower pace of financial liberalization saved Taiwan, the planned acceleration of liberalization in the post-crisis era may pose a great challenge and renew instability in the future.

Our causality test results show that the ratio of short-term external debt to international reserves and the nominal exchange rate have a quite different causality relationship between Taiwan and Korea. The two series for Taiwan are not cointegrated, and there is no causality relation between the two series. However, the two series for Korea are cointegrated, showing the existence of a long-run equilibrium relationship between the two series. Furthermore, the causality test results for Korea shows that the ratio of short-term external debt to international reserves causes unidirectional exchange rate fluctuations, but not vise versa. Considering the different impacts of the financial crisis on Taiwan and Korea, these findings are consistent with our expectation.

They are consistent with the fact that national currency depreciation and stock market fluctuations are the results of self-fulfilling herd behavior of highly speculative international short-term debt. The unidirectional causality result is also consistent with the recent cross-sectional study of Kaminsky and Reinhart (2000, 478) that “a banking crisis increases the probability of that a country will fall prey to a currency crisis.” The unidirectional causality may also rise from the fact that the banking crisis due to
sudden reversal of capital flow has more severe and protracted effects on economy than currency crisis (Calvo and Reinhart, 1999). The prolonged attempt of the government to defend the national currency and to bail out the failed firms might aggravate the crisis (Radelet and Sachs, 1998). The Taiwanese government intervened in the foreign exchange market heavily only a very short period from July to October 1997, preserving the precious international reserves, and keeping the already low short-term debt-to-reserves ratio reasonably low.

In Korea, after a considerable debate, the government finally in December 3, 1997, accepted the rescue aid of US$ 57 billion from international organizations, including IMF, World Bank, etc., under stringent conditions of economic reform (Fukushima and Takii, 1998, 141-142; Shim, 2000, 159-160). The conditions, which are challenges to the Korean government, include orderly reductions of the current account deficit, build-up international reserves and containment of inflationary pressures, improvement of financial sector transparency, market-oriented practice and supervision, and risk management, reduction of reliance on short-term debt, and allowance of foreign investment in Korean financial institutions, and establishment of foreign financial subsidies to promote competition (Shim, ibid.).

As the financial reform and restructuring programs of chaebols proceeded rapidly and smoothly under the newly elected government, the economy started recovering during the first quarter of 1999. Reduction in domestic demand and imports (EPA, 1999, 158) prompted the unprecedented surpluses in trade balance and current account balance in 1998 (Figures 5 and 6), and spurted GDP growth in 1999 (Figures 1 and 2). The economy has continued recovering and the recovery seems real and lasting (EPA, 2000, 151-161).

What is the economic future of these two countries? Recent prediction by the Asian Development Bank (2000, 242-243) is that the growth rate of real GDP (and real GDP per capita) for Korea is 7.5% and 6.0% (6.4% and 5.0%) in 2000 and 2001, respectively. That for Taiwan is 6.3% and 6.2% (5.1% and 5.4%) in 2000 and 2001, respectively. The estimated figures are higher than most of the Asian countries, including China. The continuous growth of the Korean and Taiwanese economies in the near future may be expected.

It is likely that the 1997 financial crisis will induce vigorous restructuring of the Korean financial system and rationalization of its economy, and Korea and other Asian countries will come out as stronger competitors of Taiwan. While Taiwan has fared better in the recent crisis, the need for restructuring and rationalization of its economy have also been revealed in this crisis, as its economy has also slowed down in recent years. If Taiwan does not complete its own economic reform resolutely, its future exports competitiveness may suffer irrevocably. The final impact of the Asian financial crisis is yet to be seen. A great challenge to these two countries, as well as other Asian countries, is to complete the restructuring of financial and corporate sectors (Kawai, 2000), to improve regional integration and cooperation taking
lessons from the euro zone (Letiche, 2000). These are basic steps to make the economic recovery lasting, and revive the “East Asian economic miracle” in the new millennium and the new international economic order (Dutta, 2000).

Acknowledgments

This paper was presented at the AEA/ACAES Session at the 2001 ASSA Annual Meeting at New Orleans, LA. We are grateful to Professors Richard Hooley, Hugh Patrick, and Stephen Reynolds for helpful comments and suggestions. We are also indebted to Professors Steven R. Beckman, Charles Engel, Ronald W. Jones, Henryk Kierzkowski, Robert McNown, Ron P. Smith, and Myles Wallace for helpful comments, and to Professors Peter C.Y. Chow, Jin-Lung Henry Lin, Keith Maskus, Eric D. Ramstetter, Don Roper, Hiroshi Setooka, Dr. Tatsufumi Yamagata, Messrs. Pao-Jui Chen, Jirawat Panpiemras, and Changsuh Park for help in data collection. All errors of omission and commission are ours.

Notes

1 The impacts on the growth rates of real GDP in national currency were much less dramatic. For Korea, in terms of 1995 won, the percentage changes from 1997 to 1999 were 5.01%, -5.84%, and 8.50%, respectively. For Taiwan, in terms of 1991 NT dollars, they were 6.77%, 4.65%, and 5.50%, respectively. For Japan, in terms of 1990 yen, they were 1.59%, -2.50%, and 1%, respectively. (ICSEAD, 2000, 60)
2 Elsewhere we have shown that the real GDP per capita growth rates of these three countries in the postwar period (1951-1992) were highest among the 56 countries listed in Maddison (1995, Appendix D): Taiwan, 6.03%; Korea, 5.90%; Japan, 5.57% (Hsiao and Hsiao, 2000b, Table 1).
3 In the prewar period (1911-1940), Korea’s real GDP per capita and its growth rate were consistently higher than those of Taiwan. After the war (1951-1992), they have been consistently lower. See Figure 2 and Table 1 in Hsiao and Hsiao (2000b).
4 Taiwan’s price changes are calculated from consumer price indices in TSDB, 2000, 186. The Korea’s price changes are calculated from “all cities consumer price indexes,” Bank of Korea, 1999, 200.
5 Korea’s lending rates are from IMF, 1999, also in ICSEAD, 2000. Taiwan’s lending rates are secured loans bank interest rates from TSDB, 2000, 164. Also in ICSEAD, 2000.
6 Calculated as exports (#20) minus imports (#34) in Table 2 of each country in ICSEAD, 2000.
7 The original data were given as the ratio of international reserves to one-twelfth of the absolute value of the sum of the debits of goods, services, and income in balance of payment. See the data sources and notes for each country in ICSEAD, 2000, Tables 5.2, 6.2, #55. We take its inverse and then multiply by 100.
8 Calculated as the inverse of the ratio of international reserves to the cumulative sum of inward portfolio investment from 1980 forward. See the data sources and notes for each country in ICSEAD, 2000.
9 The original data were given as the ratio of international reserves to the cumulative inward portfolio investment, which is calculated as the cumulative sum of inward portfolio investment from 1981 forward (ICSEAD, Tables 5.2 and 6.2, #56 and footnote). We take its inverse and then multiply by 100.
10 It had been the general trend in East and Southeast Asia that during the early 1990s, capital flooded into the area and the share of foreign portfolio investment (FPI) was higher than that of foreign direct investment (FDI), except China, which did not de-regulate foreign portfolio investment. (EPA, 1998, 55). In comparing Korea and Taiwan, Chen and Ku (2000, 127) suggested that Korean chaebols crowded out FDI, and so foreign capital could only invest in security markets.
11 The indexes are taken as follows: For Taiwan, 1991=1; for Korea, 1995 = 1; and for Japan, 1990 = 1 (ICSEAD, 2000, no. 43 of Table 1 of each country)
12 Korea joined the prestigious OECD in 1996.
The herd behavior is not the monopoly of financial crisis. For an overview of pull and push of capital flow and exchange rates, see Glick, ed. (1998). Kaminsky and Reinhart (2000, 480) find that “In the 1980’s and 1990’s most liberalization episodes have been associated with financial crises of varying severity. ... the twin crises may have common origins in the deregulation of the financial system ....”

The problem of moral hazard was prevalent in East Asian countries before the 1997 crisis, and it was one of the reasons that attracted massive foreign capital in the area during the 1990s. Other reasons are deregulation of capital inflows, relatively high rates of interest, etc. (EPA, 1998, 83).

EPA, 1998, 145. More generally, a long-run view is that “the system that produced the Asian crisis of 1997-98 also produced the impressive economic performance of the previous two decades” (Crockett, 2000).

Shim (2000, 146) quoted from another source. However, according to EPA (1998, 82), the external capital ratios (external capital/(internal and external capital)) of Korea in 1995-96 were 74%-76%, for Taiwan were about 55%, for Japan and the United States were 61%-66%, for Malaysia and Indonesia were 44%-58%. While Korea’s ratio was high, it did not seem particularly alarming.

EPA, 1998, 85-86. This may be seen from the fact that the ruling government has been an émigré regime (Gold, 1986) which has no root in the local business. For Taiwan’s small-and-medium enterprises, see Hsiao and Hsiao, 1996, 1999.

In this system, the won per US dollar rate was “allowed to float in the interbank market within a daily range around the weighted average of the previous day’s interbank rates for spot transactions” (Shim, 2000, 146). The allowed range of variation was ±1.5% up to December 1995, and expanded to ±10% in November 1997.

1997 was also the year of presidential election in Korea. The uncertainty of election outcome reduced propensity to invest (EPA, 2000, 146), which, coupled with the decrease in exports, turned the 1997 GDP growth rate to near negative 10%, see [2] in Figure 1. Thus, the effect of Asian financial crisis is manifested only in 1998, during which the nominal GDP growth rate decreased more than 30%.

In addition to London based Economist, as early as in the early 1996, IMF and Institute of Developing Economies in Tokyo had warned the vulnerability of the Thai economy (Abe, 1998, 3). Abe (1998) conducted a field work in Thailand in September 1997, and pointed out that the change in the fix exchange rate system to the managed floating exchange rate system in July 2, 1997 signaled the changes from an export-led growth to a bad-loans-ridden economy, and triggered the Thai financial crisis. He delineates Thailand’s ten underlying problems which “are rather inherent, structural and long-term.” (ibid., 5, 41). Also see Appendix: Thailand, A stylized chronology in Corbett and Vines (1999).

Since foreign lenders and speculators’ behavior is generally based on the anticipation of the daily changes in nominal exchange rate, we adopted this as our variable. Real exchange rates are useful in explaining the changes in trade performance and current account balance over the years.

See Engle and Yoo (1987), Table 3. We use the available critical value for sample size = 50.

However, Chen and Ku (2000, 127) suggest “the timing and sequencing of capital account liberalization in Taiwan was quite similar to that in Korea.” According to a short chronology of financial liberalization in EPA (1998, 57), Korea seems ran faster. It is also not clear when the local banks were allowed to borrow money from foreign financial institutes. Indonesia did it in March 1989.

Fukushima and Takii, 1998, 138; EPA, 1999, 177-180. For a discussion of economic and political liberalization from historical perspectives, see Hsiao and Hsiao (2000a). For Taiwan’s globalization process, see Hsiao and Hsiao (2001). Incidentally, China didn’t deregulate its capital market and strongly favored foreign direct investment. This is the major reason that China also weathered the financial crisis relatively well (EPA, 1998, 57).

Recently, The Economist (November 11, 2000) and Business Week predicted debt problems in Taiwan in early next year. Standard & Poors recently downgrader Taiwan’s economic rating from “stable” to “negative,” Taipei Journal, December 22, 2000, 3. To our knowledge, none of the studies from Taiwan has been concerned about the possible instability due to accelerated financial reform. Unlike foreign reports, Taiwanese scholars generally consider that Taiwan got around the recent Asian financial crisis through “sound” monetary and fiscal policies. See papers in Policy Studies (1999).

Hu, et al., 1998; Yang, 1998. For surprisingly few other papers that deal with the financial crisis on Taiwan, see Chen and Ku (2000) and Wang (2000).
Table 1. ADF Unit-Root Test: Korean Exchange Rate and the Short-term Debt Ratio

**Part 1: Level Series**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Test-statistic</th>
<th>MacKinnon critical values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Exchange rate (c, t)</td>
<td>-0.140</td>
<td>-3.286</td>
</tr>
<tr>
<td>Short-term debt ratio (c, t)</td>
<td>-2.743</td>
<td>-3.296</td>
</tr>
</tbody>
</table>

**Part 2: First-difference Series**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Test-statistic</th>
<th>MacKinnon critical values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1% 10%</td>
</tr>
<tr>
<td>Exchange rate (c, t)</td>
<td>-8.077 ***</td>
<td>-5.115</td>
</tr>
<tr>
<td>Short-term debt ratio (c)</td>
<td>-2.805 *</td>
<td>-2.704</td>
</tr>
</tbody>
</table>

Notes:
1. The optimal lag length k is chosen at the minimum AIC from lag=1 to lags=7.
2. (c, t) denotes that the testing equation has included constant term (c) and significant time trend (t).
3. *** (*) denotes significant at the 1% (10%) level.

Table 2. Engle-Granger's Cointegration Test: Korean Exchange Rate and the Short-term Ratio

**Step 1: Cointegrating regression**

<table>
<thead>
<tr>
<th>Cointegrating equation</th>
<th>const.</th>
<th>t</th>
<th>dep. vari.</th>
<th>adj $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x = f(c, t, y)$</td>
<td>a0</td>
<td>a1</td>
<td>a2</td>
<td>0.578</td>
</tr>
<tr>
<td>$y = f(c, t, x)$</td>
<td>-27.445</td>
<td>-0.290</td>
<td>4.970</td>
<td>0.574</td>
</tr>
</tbody>
</table>

**Step 2: ADF unit-root test on residual series**

<table>
<thead>
<tr>
<th>Series</th>
<th>$\kappa$</th>
<th>Test-statistic</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>e</td>
<td>2</td>
<td>-3.031 *</td>
<td>-2.90</td>
</tr>
<tr>
<td>u</td>
<td>2</td>
<td>-3.168 *</td>
<td>-2.90</td>
</tr>
</tbody>
</table>

Notes:
1. The p-values are in the parentheses.
2. For step 1: $H_0$ is that the coefficient equals to zero in the standard t-test.
3. For step 2: * denotes rejection of $H_0$: a unit-root (no cointegration) at the 10% significance level.

Table 3. ECM Causality Test: Korean Exchange Rate and the Short-term Debt Ratio

**ECM Regression**

<table>
<thead>
<tr>
<th>Dep. var.</th>
<th>constant</th>
<th>$\Delta x(-1)$</th>
<th>$\Delta x(-2)$</th>
<th>$\Delta y(-1)$</th>
<th>resid(-1)</th>
<th>adj $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta x$</td>
<td>0.000</td>
<td>1.679</td>
<td>-0.442</td>
<td>-0.032</td>
<td>-0.527</td>
<td>0.599</td>
</tr>
<tr>
<td></td>
<td>(0.99)</td>
<td>(0.20)e</td>
<td>(0.20)e</td>
<td>(0.13)d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta y$</td>
<td>-0.053</td>
<td>0.993</td>
<td>---</td>
<td>0.125</td>
<td>-0.836</td>
<td>0.162</td>
</tr>
<tr>
<td></td>
<td>(0.87)</td>
<td>(0.82)</td>
<td>(0.74)</td>
<td>(0.04)b</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Wald's coefficient test**

<table>
<thead>
<tr>
<th>$\gamma_1$</th>
<th>1.844</th>
<th>1.844</th>
<th>D.R.--&gt;Ex.R.</th>
<th>D.R.--&gt;Ex.R.</th>
<th>(e)</th>
<th>(d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda_1$</td>
<td>0.055</td>
<td>0.031</td>
<td>Ex.R. does not</td>
<td>Ex.R.--&gt;D.R.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Causality**

1. The p-values are in the parentheses.
2. The a, b, c, d, and e denote that the test is significant at the 1%, 5%, 10%, 15%, and 20% level, respectively.
3. Ex.R. = Exchange Rate and D.R. = Short-term Debt Ratio.
Table 4. ADF Unit-Root Test: Taiwan’s Exchange Rate and the Short-term Debt Ratio

<table>
<thead>
<tr>
<th>Part 1: Level Series</th>
<th>MacKinnon critical values 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>k</td>
</tr>
<tr>
<td>Exchange rate (c)</td>
<td>1</td>
</tr>
<tr>
<td>Short-term debt ratio (c, t)</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part 2: First-difference Series</th>
<th>MacKinnon critical values 1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>k</td>
</tr>
<tr>
<td>Exchange rate (c, t)</td>
<td>3</td>
</tr>
<tr>
<td>Short-term debt ratio (c)</td>
<td>2</td>
</tr>
</tbody>
</table>

Notes: Same as notes 1, 2, and 3 in Table 1.

Table 5. Engle-Granger’s Cointegration Test: Taiwan’s Exchange Rate and the Short-term Debt Ratio

<table>
<thead>
<tr>
<th>Step 1: Cointegrating regression</th>
<th>Step 2: ADF unit-root test on residual series</th>
<th>Engle-Yoo critical values 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cointegrating equation</td>
<td>Test-statistic</td>
<td></td>
</tr>
<tr>
<td>x = f(c, t, y)</td>
<td>e</td>
<td>-1.817</td>
</tr>
<tr>
<td>y = f(c, x)n</td>
<td>u</td>
<td>-1.149</td>
</tr>
<tr>
<td>Notes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Same as note 1 in Table 2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Same as note 2 in Table 2 and n denotes that the equation has no significant time trend.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. For step 2: H_0 is that the residual series has a unit-root.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6. Granger’s Causality Test: Taiwan’s Exchange Rate and the Short-term Debt Ratio

<table>
<thead>
<tr>
<th>Regression</th>
<th>Wald’s coefficient test</th>
<th>Causality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dep. var.</td>
<td>constant</td>
<td>Δx(-1)</td>
</tr>
<tr>
<td>Δx</td>
<td>-0.015</td>
<td>0.427</td>
</tr>
<tr>
<td></td>
<td>(0.45)</td>
<td>(0.17)</td>
</tr>
<tr>
<td>Δy</td>
<td>0.006</td>
<td>-0.028</td>
</tr>
<tr>
<td></td>
<td>(0.41)</td>
<td>(0.80)</td>
</tr>
</tbody>
</table>

Notes: Same as notes 1, 2, and 3 in Table 3.
References


Engle, Robert F. and Clive W. J. Granger (1987). Co-integration and Error Correction: Representation,


A Comparative Analysis of Taiwan Experience. Working paper, Institute of Economics, Academia Sinica, Taipei, Taiwan.


Figure 9. Average Exchange Rates Per US$ and Percentage Changes

Figure 10. Year-end Stock Indexes and Percentage Changes