Ohno, Kenichi; Shirono, Kazuko; Sisli, Elif

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Can High Interest Rates Stop Regional Currency Falls?: The Asian Experience in 1997-98

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Can High Interest Rates Stop Regional Currency Falls?

The Asian Experience in 1997-98

Kenichi Ohno,

Kazuko Shirono

and

Elif Sisli

ABOUT THE AUTHORS

Kenichi Ohno *is a Visiting Scholar at the Institute working in the fields of strengthening financial and exchange rate systems. He is also a Professor at the National Graduate Institute for Policy Studies and was formerly a staff economist at the International Monetary Fund.*

Kazuko Shirono *and* ***Elif Sisli*** *are, respectively, former and current Research Associates at the Institute.*

This paper is part of the Institute's research project on financial and exchange rate systems. Additional copies of the paper are available free from the Asian Development Bank Institute, 8th Floor, Kasumigaseki Building, 3-2-5 Kasumigaseki, Chiyoda-ku, Tokyo 100-6008, Japan. Attention: Publications.

PREFACE

The ADB Institute aims to explore the most appropriate development paradigms for Asia composed of well-balanced combinations of the roles of markets, institutions, and governments in the post-crisis period.

Under this broad research project on development paradigms, the ADB Institute Working Paper Series will contribute to disseminating works-in-progress as a building block of the project and will invite comments and questions.

I trust that this series will provoke constructive discussions among policymakers as well as researchers about where Asian economies should go from the latest crisis and current recovery.

Masaru Yoshitomi
Dean
ADB Institute

ABSTRACT

During the Asian crisis, some crisis-hit economies raised domestic interest rates persistently in an effort to appreciate their currencies. Although Asian currencies eventually stabilized, it is still debated whether high interest rates contributed to the restoration of stability. Correlation and causality analyses using daily data show that the relationship among interest rates, exchange rates and external financial variables changed significantly when the crisis started. During the height of the crisis, currencies in the region exhibited high synchronization and mutual causation, which had not been visible in the pre-crisis period. Japanese and U.S. financial variables also influenced the movements of the Thai baht and the Korean won. By contrast, domestic interest rates suddenly lost their impact on exchange rates as the crisis worsened. The Asian currency turmoil and subsequent return to stability was a regional phenomenon, in which interest rate policies of individual economies did not seem to have any significant impact on calming collective market psychology.

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Can High Interest Rates Stop Regional Currency Falls? The Asian Experience in 1997-98

Kenichi Ohno, Kazuko Shirono and Elif Sisli[?]

I. Introduction

As the Asian crisis unfolded in 1997 and continued well into 1998, many of the adversely affected countries? especially those with IMF-supported programs? initially raised interest rates significantly to prevent further precipitation of their currencies. This was partly a spontaneous policy response of the monetary authorities and partly a result of external pressure including IMF conditionality. The immediate impact of the high interest rate policy, however, was disappointing. Market confidence was not restored and, on some occasions, currency falls even accelerated. By the spring of 1998, though, calm began to return gradually to the majority of the crisis-hit currencies (with an important exception of the Indonesian rupiah). As most Asian currencies stabilized by late 1998, interest rates also declined (or were reduced) to levels even below those prevailing in the pre-crisis period.

In this sequence of events, did high interest rates contribute to the eventual recovery of the Asian currencies significantly, moderately, or not at all? Using daily financial data, this paper attempts to throw light on this empirical question. We propose to distinguish alternative views by noting the collective nature of the Asian crisis. In this crisis, a large number of currencies depreciated, but only some countries adopted *sustained* high interest-rate policies (see Section IV). Was currency stability correlated? with or without a lag? with high interest rates in individual countries or was it simultaneously achieved throughout the region? Depending on the answer, the IMF-supported programs implemented in Thailand, Korea and Indonesia may have to be significantly reassessed. The result also carries important implications for designing proper policy responses to similar crises in the future.

After presenting the contesting views in the next section, Section III reviews the existing empirical literature. Section IV looks at contemporaneous correlation and co-movement among Asian exchange rates and other financial variables, while Section V reports the results of Granger-causality tests. Section VI further explores the influence of external variables on currency movements in developing Asia. Section VII makes some conclusions.

II. Contesting Views

[?] We would like to thank Masaru Yoshitomi, Dean of ADB Institute, and participants of the seminar at Japan's Ministry of Finance (October 1999) and the ADBI workshop (November 1999) for useful comments. Views expressed here are those of the authors and do not reflect the views of any other individuals or institutions assisting our research.

In the Asian crisis, did currencies finally stabilize because of sustained high interest rates, or because unstable market dynamics came to an end irrespective of interest rates?

Some consider initial high interest rates necessary? and even sufficient? for stopping a currency rout. According to this view, currency stability was brought about by high interest rates, albeit with a lag. As Stanley Fischer argues:

> When they approached the IMF, Thailand and South Korea had perilously low reserves, and the Indonesian rupiah was excessively depreciated. The first order of business was to restore confidence in the currencies. To achieve this, countries have to make their currencies more attractive, which requires increasing interest rates temporarily? even if higher interest costs complicate the situation of weak banks and corporations. Once confidence is restored, interest rates can return to more normal levels (Fischer 1998, pp.2-3).

The official view of the IMF is that the right balance was struck between domestic and external needs and that initial monetary tightening was not excessive:

> Monetary policy in the Asian crisis programs faced a difficult task of balancing two objectives. On the one side was the desire to avoid a depreciation-inflation spiral... On the other side were concerns that excessive monetary tightening could severely weaken economic activity... The programs sought to balance these two concerns (IMF 1999, p.55).

> In Indonesia, monetary policy was emphatically not too tight... A more difficult question is whether the Thai and Korean programs' successful stabilization caused monetary conditions to become too tight, contributing excessively to the contraction in economic activity. By [interest rate, monetary and credit] measures, monetary tightening in these countries was not extreme (in degree or duration) in relation to other crises elsewhere (IMF 1999, p.56).

Many critics remain skeptical, however, about the wisdom of raising interest rates persistently in regional currency crises. The question is not a general one of whether a country can defend its currency against speculative attacks by raising interest rates. As we all know, intervention and high interest rates are the two common tools to fend off speculators (for example, recall Hong Kong, China in October 1997). In particular, it is essential to distinguish the high interest rate policy adopted by the three hardest-hit Asian countries (after depreciation began) from a common currency defense that may use high interest rates (before the exchange parity is breached). Moderately high interest rates were sustained for several months in the former option. In the latter, however,

interest rates would be typically raised to extremely high levels (say, a few hundred percent) for a very short time (say, a day or less) ? and the success or failure of this defense would be known immediately. In this paper we are only concerned with this first type of high interest-rate policy.

Our specific question is as follows: *once a crisis begins and regional currencies start to fall rapidly and simultaneously*, can an individual country stop the currency fall by significantly raising domestic interest rates? Joseph Stiglitz argues that, on the contrary, it would aggravate the situation (for similar views see Ito 1999, Radelet and Sachs 1998b, 1999, Wade 1998ab, and World Bank 1998):

> [Advocates of contractionary policies] often argue that contraction (or at least the high interest rates and expenditure cuts that lead to it) is necessary for the restoration of confidence. Though this is more a matter for a market psychologist than for an economist? and there is little empirical evidence to support that hypothesis? I remain convinced that it is very hard to restore confidence in an economy. • that is going into a deeper recession or depression; worse still, since there is strong evidence that economic weakness gives rise to political and social instability, these instabilities reinforce the weakening of confidence in the economy (Stiglitz 1999, pp.8-9).

Moreover, in the case of the Asian crisis countries, balance sheets of corporations and financial institutions were particularly vulnerable to currency *and* interest rate shocks, for the following reasons. First, Asian firms were heavily dependent on bank finance. Highly-leveraged firms faced payment difficulties as interest rates were substantially raised while lending banks faced associated default risks. Second, as asset bubbles burst, long-term loans to property and manufacturing projects became harder to recover while banks' liabilities were mostly composed of short-term deposits and borrowings ('maturity mismatch'). Third, much of the borrowings by Asian enterprises were denominated in (uncovered) foreign currency, causing huge losses when the home currency depreciated ('currency mismatch'). Therefore, as the crisis erupted, defaults, capital erosion, demand contraction and paralysis of the financial system started immediately (Yoshitomi and Ohno 1999).

The Asian crisis was a capital-account crisis caused by a huge inflow of foreign private capital followed by a sudden and massive reversal which overwhelmed underlying current-account changes. These capital movements were highly sensitive to shifting market sentiments. In such a crisis, external currency crisis and internal banking crisis tended to reinforce each other (twin financial crises). Because of the peculiar financial weaknesses of the Asian economies discussed above, the high interest rate policy that was intended to attract private capital or prevent capital outflows may have, in fact, amplified the vicious circle among illiquidity, rising defaults and credit contraction.

At the height of the Asian crisis, Radelet and Sachs (1998a) wrote:

> [D]espite sharply higher interest rates, currencies have not

> appreciated, so the supposed benefits of this policy are in question ... Creditors understood that highly leveraged borrowers (whether Indonesian conglomerates, Korean chaebols, or banks in all countries) could quickly be pushed into insolvency as a result of several months of high interest rates. Moreover, many kinds of interest-sensitive market participants, such as bond traders, are simply not active in Asia's limited financial markets. The key participants were the existing holders of short-term debts, and the important question was whether they would or would not roll over their claims. Higher interest rates did not feed directly into these existing claims... It is possible, however, that by undermining the profitability of their corporate customers, higher interest rates discouraged foreign creditors from rolling over their loans (Radelet and Sachs, 1998a, pp.29-30).

Similarly, Yoshitomi and Ohno (1999) warn of further loss of confidence caused by contractionary monetary policy:

> [G]iven such inherent credit contraction and domestic demand decline caused by the twin financial crises, the situation was made much worse by the conventional policies adopted by the governments (often nudged by the IMF and international creditors) ... If external loss of confidence is intricately linked with domestic bad debt and financial disintermediation (as in the case of Asia's crisis countries), high interest rates which hurt the balance sheets further are more likely to keep potential investors away (Yoshitomi and Ohno 1999, pp.17-18).

To further contrast the two opposing views, let us consider a developing economy with not-so-efficient domestic financial markets.[1] Due to perceived risks of default, policy shifts, terms-of-trade shocks, and other uncertainties associated with such an economy, risk-adjusted uncovered interest parity (UIP),

(1) $i - i^* = x + \rho$

where i and i* are domestic and foreign interest rates, x is the (average) expected change in the exchange rate and ? is risk premium (averaged over market participants), is unlikely to hold exactly.[2] We thus assume that capital mobility is *imperfect* so that violation of UIP (inclusive of *average* risk premium) leads to

[1] The following equations are for expositional purposes only; they are not developed into a model or empirically estimated in this paper. Uncovered interest parity is also used by Dekle, Hsiao and Wang (1999) to contrast the two views although their model is more fully developed (and less general).

[2] According to Min (1998), barriers to capital movement include capital and exchange controls, differential tax treatment for asset returns across countries, possibility of future controls and regulations, and other country-specific transaction costs such as differences in language and business practices.

only finite capital movement rather than infinite, in proportion to the size of violation.

(2) $KA_p = ?_0 + ?_1[i ? i^* ? x ? ?], \quad ?_1 > 0$

where KA_p is the private capital account and $?_1$ represents the sensitivity of KA_p to the risk-adjusted interest differential. If we further assume that the home currency tends to appreciate or depreciate depending on the sign of KA_p, equation (2) can also be used to gauge the pressure on the foreign-exchange market.

High interest-rate policy can be construed as raising i in this equation to increase KA_p, exerting an appreciating pressure on the home currency. This strategy assumes, however, the exogeneity of x and ?. If these variables behave differently during crises compared to normal times, because of the nature of the crisis or policies adopted to deal with the crisis, the relationship between domestic interest rates and capital flows (and exchange rate movements) becomes ambiguous. There are four possibilities.

First, volatility in x and ? may sharply increase during a crisis when uncertainty and diversity of opinion among traders is extremely high. During such times, a large part of exchange rate fluctuations will come from x and ? which can easily swamp the impact of i ? i*. Using a GARCH model, Min (1998) demonstrates that conditional heteroscedasticity of deviations from UIP jumped significantly during the recent crisis period in Asia. Such large deviations, which he interprets as 'time-varying systemic risk', cannot be explained by policy-induced changes in domestic interest rates.

Second, it is also conceivable that higher i may send an inadvertent signal to the market that the government is desperate and/or forced to adopt self-destructive policies (by misconception or through international pressure), which further erodes confidence. This is particularly true in a highly leveraged economy with double balance-sheet mismatches, as discussed above. In such a case, high interest rates are a harbinger of more defaults and bad debt to come, with continued difficulties in both real and financial sectors.[3]

Third, in a regional currency crisis, movements of x (and also possibly ?) may be highly correlated across countries if speculators do not distinguish between individual countries in the crisis-hit region. In other words, currency markets are dominated by herding and contagion. Then policies adopted by one particular country may not be able to calm collective market psychology.

Fourth, high interest rates may fail to affect the behavior of such

[3] Some argue that Asia's crisis countries with depreciating currencies should have raised interest rates more sharply (to hundreds of percentage points) but briefly in order to overcome the lost confidence as embodied in very high-risk premium, ?. According to them, this would have restored confidence sooner. But the validity of such a strategy remains seriously in doubt, and at least it is not empirically proven. In an economy with a serious balance sheet problem, raising i to an extreme level may drive ? even higher, further destabilizing expectations and worsening recession and credit contraction. We would like to thank the participants of the ADBI workshop for an interesting discussion on this point.

capital, depending on the type of capital that withdraws from a crisis country. If the currency attack is staged by speculators who must borrow in local currency to take a position, extremely high short-term interest rates may deter them. But if capital reversal is mainly due to foreign lenders wanting to repatriate their loans or local investors engaged in capital flight, short-term local interest rates are less relevant to their calculation[4] (see also Sachs and Radelet (1998) quoted above). The exact nature of capital reversal at different phases of the Asian crisis in each country is not well known.

In sum, we have two contending hypotheses:[5]

Hypothesis 1: when the domestic currency falls in a collective speculative-attack, raising domestic interest rates by individual countries is effective in reversing the exchange rate movement since the increased interest gap outweighs any induced shifts in exchange-rate expectations or risk premium; and

Hypothesis 2: in such an attack, engineered interest differentials cannot stop currency depreciations because they are outweighed by increased volatility in exchange rate expectations or risk premium (which are often regional), or because they even accelerate such volatility.

III. Existing Empirical Literature

Despite the heated debate on the effectiveness of high interest rates in (collective) currency depreciation surveyed above (for a fuller review see Furman and Stiglitz, 1998), empirical evidence on the issue has so far been limited, often with mixed or inconclusive results. Overall, however, the existing literature seems more consistent with Hypothesis 2.

Dekle, Hsiao and Wang (1999) estimate vector auto-regressions (VARs) using weekly data from Korea, Malaysia and Thailand during the recent crisis period and detect lagged effects from domestic interest rates to exchange rates. Despite the authors' claim to have supported the traditional view (Hypothesis 1), most of the crucial coefficients are statistically insignificant, especially for Korea and Thailand. Goldfajn and Gupta (1999) examine the effect of tight monetary policy in currency crises using monthly data from 80 countries covering the period of 1980-98. They find that high real-interest rates correct undervaluation through nominal appreciation (rather than through high inflation), which supports Hypothesis 1. When the authors distinguish twin financial crises (currency crisis with banking crisis) from other crises, however, they find that the probability of currency appreciation conditional on tight monetary policy is much lower. This suggests that the

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[4] We would like to thank Kenji Aramaki and Kunio Saito, among other participants of the ADBI workshop, for pointing out this fact.

[5] Dekle, Hsiao and Wang (1999) call these hypotheses the 'traditional' and 'revisionist' views respectively. However, the question is not whether high interest rates can defend the currency in general, but whether it is effective even for reversing a collective and continuing currency crisis such as the Asian one (see above). Precisely speaking, there does not seem to be any "traditional" view in this unprecedented context.

traditional high interest-rate defense might not work in an economy facing twin financial crises, as in recent Asia.

Among works more supportive of Hypothesis 2, Furman and Stiglitz (1998) analyze nine countries[6] with episodes of temporarily high interest rates. Their results show that in low-inflation countries (the crisis-hit Asian countries are included in their sample), each additional day of high interest rates leads to a further depreciation of roughly 0.3 percent. Gould and Kamin (1999) conduct Granger-causality analysis with weekly data from Indonesia, Korea, Malaysia, Philippines, Thailand and Mexico. They find that during a financial crisis, exchange rates are significantly affected by credit spreads (premium on dollar assets issued by the country, measuring default risk) and stock prices (proxy for investors' confidence), but are not impacted in any of the countries examined by changes in interest rates.

Other works give highly ambiguous results. Using monthly data from the Asian crisis period, Goldfajn and Baig (1998) report a positive correlation between the real interest rate and real appreciation for Hong Kong, China; Indonesia, Malaysia and the Philippines, but negative correlation for Korea and Thailand. Their VAR analysis, using daily data, shows that the impact of an interest rate shock on the exchange rate is insignificant in five crisis- affected countries (i.e. excluding Hong Kong, China) with the possible exception of the Philippines. Similarly, Kaminsky and Schmukler (1998) investigate lagged correlations and conclude that the use of high interest rates to defend the exchange-rate parity might not always yield the desired result.

Some studies do not directly address the question of the effectiveness of high interest-rate policy but provide supplementary evidence. Kaminsky and Reinhart (1999a) examine 80 crisis episodes and empirically identify three channels of contagion: (i) bank channel (international banks may withdraw funds from the developing world simultaneously); (ii) liquidity channel (mutual funds can face liquidity constraints in cross-market hedging); and (iii) trade links (through bilateral trade and competition in a common third-market). If contagion is an inherent feature of a regional currency crisis, monetary policy in just one country may not be able to stop it.

Kaminsky and Reinhart (1999b) and Baig and Goldfajn (1999) detect substantial interdependence among the Asian exchange rates after the outbreak of the recent crisis. For example, the latter's VAR analysis shows that depreciation of the baht was immediately followed by falls of the currencies of Malaysia, Indonesia and the Philippines. Baig and Goldfajn (1999) are also the only existing study that explicitly controls for external financial variables. Their regression results for the Asian crisis period indicate that the yen/dollar exchange rate affected the currency movements in Thailand, Malaysia, Korea and the Philippines while the U.S. stock index was significant in Thailand and Malaysia.[7]

It is useful to point out several shortcomings of the existing empirical studies reviewed here. First, simple correlation analysis is not very informative as it fails to reveal any causation. Second, employing monthly or weekly data (when daily data are available)

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[6] Argentina, Brazil, Czech Republic, Ecuador, Indonesia, Korea, Mexico, Philippines, and Slovakia.

[7] These results concerning external financial variables are quite different from ours (see Section VI below). In particular, we found no significant influence of the yen/dollar rate on Asian currencies, using daily data as they also did and with similar and overlapping sample periods. This may be due to different additional variables included in the regression. Baig and Goldfajn include good and bad news dummies while exchange rates and interest rates of two Asian countries are included in our VARs.

does not seem appropriate from the viewpoint of capturing immediate effects and preserving degrees of freedom. Financial news travels and dissipates very fast.

Third, it is essential to distinguish different types of currency crises? isolated or collective, current-account crisis or capital-account crisis, whether or not accompanied by banking crisis, etc.? as the validity of high interest rate policy may differ depending on each circumstance. Pooling dissimilar crises in a sample may not yield any meaningful results. Fourth, it is desirable to control for variables outside the crisis region. As noted above, external influences are usually not incorporated with the exception of Baig and Goldfajn (1999).

With these in mind, the present study focuses exclusively on the special circumstance of the Asian crisis characterized by twin financial crises and collective and continued depreciation. Using daily data and VAR analysis (among other things), we investigate Granger-causality from interest rates to exchange rates while controlling for possible contagion among regional exchange rates and interest rates as well as through five external financial variables.

IV. Correlation and Synchronicity

We begin by simply observing the movements of nominal exchange rates and short-term interest rates.[8] Figure 1 plots daily exchange rates against the U.S. dollar with July 1, 1997 as the base. As is well known, Indonesia suffered the largest currency fall while Thailand, Korea, Malaysia and the Philippines also experienced severe depreciation. Currency movements were more moderate for Singapore and Taipei,China. The Chinese yuan and the Hong Kong dollar (not plotted) maintained their parities throughout the crisis.

While the timing and extent of the initial precipitation did not exactly coincide across currencies, we can see that the worst in the foreign exchange markets came around January 1998: all currencies hit bottom and rebounded thereafter (except the Indonesian rupiah). Some recovery occurred from January to May 1998, followed by a setback in May and June 1998. In the second half of 1998, most currencies either stabilized or showed an appreciating trend. The Malaysian ringgit was fixed at 3.8 to the dollar beginning in September 1998. By 1999, calm was firmly restored and all currencies remained stable (the Korean won appreciated in early 1999 while even the Indonesian rupiah stabilized, though at a low level). The important thing is that these general movements were common to all Asian crisis currencies. Furthermore, on close examination, short-term fluctuations were oftentimes also synchronous.

Figure 2 shows daily movements of interbank overnight interest rates. These are the short-term rates that monetary authorities often regulate and thus reveal policy intentions more directly. Indonesia, Thailand and Korea, the three most seriously hit countries with IMF-supported programs, kept interest rates high for substantial periods (see Table 1 for the chronology of interest rate policies of these countries). In Thailand interest rates tended to be high even

[8] Exchange-rate and interest-rate data are obtained from Data Stream. Stock-price data are from CEIC Data.

before July 2, 1997 when the floating began. By contrast, the Philippines, Malaysia, Singapore and Hong Kong, China raised their rates for very short periods only, while keeping them low at other times. Taipei,China did not experience any abnormally high interest rates.

The fact that Malaysia did not sustain high interest rates may conflict with the common perception that the country adopted such a policy during the crisis. After all, were not measures introduced in September 1998 (partial exchange control and a fixed exchange rate) supposed to terminate the macroeconomic austerity package including high interest rates? On close examination (not shown here), Malaysia's central bank rates (from one-day to three-month) and deposit rates (from one- to three-month) actually rose but only moderately? from around 7 percent in the pre-crisis period to 11 percent in 1998? then fell back to about 6 percent in September 1998. Base lending rates also rose from around 9 percent to a little over 12 percent, but money market rates, treasury bill rates and deposit rates hardly exceeded 10 percent (except very briefly). Thus Malaysia's 'high interest rate policy' was much milder than those in Thailand, Korea and Indonesia.[9]

Let us now ask: did regional co-movement of financial variables in developing Asia (NIEs4 and ASEAN4) intensify after the crisis began? To answer this question, we calculate relative variance of the first principal component. This is the share of total variance that can be explained by daily synchronous fluctuations. For every quarter, we calculate this ratio for exchange rates, stock prices and interest rates separately. The results for both levels and changes are shown in Figures 3, 4 and 5. The ratios excluding Hong Kong, China (which maintained its parity) are also calculated, but the results are almost identical when Hong Kong is included.

Regional co-movement of exchange rates as well as that of stock prices after the Asian crisis erupted (1997:Q3) clearly intensified to as high as 0.9 for level and 0.5-0.6 for change, although the timing of the increase does not exactly coincide between level and change-variables. Synchronicity in the rate of change for both was highest in the first quarter of 1998, the period following the Korean turmoil when Indonesian instability continued and most currencies hit bottom. In contrast, the co-movement of short-term interest rates was generally much lower, and did not rise when the crisis broke out.

V. Testing Granger-Causality

To take delayed effects into account, we perform vector auto-regression (VAR)

[9] We would like to thank Susumu Atsuki for noting these interest rate developments in Malaysia. The question remains as to why Malaysia, with no significant interest-rate hikes, faced a severe banking crisis and mounting bad debt as in other Asian crisis countries (see also footnote 16 below). The large depreciation of the ringgit may have been sufficient to create the balance sheet problem, and external overborrowing prompted by financial opening may have greatly amplified the macroeconomic shock. Further research is needed in this area.

analysis following Toda and Yamamoto (1995) methodology. This method allows us to test Granger-causality regardless of the order of integration of each included variable (i.e., even if some of the variables are not stationary).

For each pairing of the seven Asian economies (ASEAN4 and NIEs4 except Hong Kong, China), we include (the levels of) dollar exchange rates and short-term interest rates of the two countries. The same daily data as in the previous section are used. The lag length for each equation is determined by the Akaike Information Criterion (AIC) (it ranges from one to six),[10] plus additional lags whose number is equal to the estimated maximum order of integration in each equation.[11] The Wald statistics calculated over the relevant group of coefficients (excluding added lags reflecting the integration order) is asymptotically distributed as chi-square (Toda and Yamamoto 1995).

The analysis is conducted over three periods: the pre-crisis period (January 1996-June 1997), the crisis-worsening period (July 1997-January 1998), and the crisis-recovery period (February-December 1998). The beginning of the second period? July 1997 when the baht started to float? is unambiguous. The distinction between the second and third period is somewhat arbitrary. We take January-February 1998, when most crisis currencies reached their lowest, as the turning point in collective market sentiment (see Figure 1). While the worst month for the Korean won was December 1997 and the Indonesian rupiah dipped again in June 1998, the choice of early 1998 as the beginning of Asian financial recovery appears reasonable.

Detected Granger-causality is summarized in Tables 2 and 3. Both results are obtained from the same 4-variable VARs, including interest rates and dollar exchange rates of two Asian economies. In Table 2, Granger-causality between all possible pairs of Asian exchange rates is presented. In Table 3, Granger-causality from the domestic interest rate to domestic exchange rate is shown when another country's similar variables are present. In either case, there are 21 pairwise VARs and 42 cells to examine. Dark cells indicate significance at the 5 percent level while gray cells indicate significance at the 10 percent level.

The results are striking. As Table 2 shows, Granger-causality among Asian currencies was virtually non-existent prior to the Asian crisis: none of the 42 possible bilateral influences were statistically significant at the 5 percent level, and only three at the 10 percent level (these are well within the specified margin of Type I error). In the crisis-worsening period, however, exchange rates in the region exerted much greater mutual influence. The number of cells significant at the 5 percent level jumped to eight and those at the 10 percent level to fourteen. The signs of the sum of coefficients (not reported in the tables) in significant cells are all positive except in just one case, implying that the affecting and the affected currencies were moving in the same direction. The

[10] Six trading days are considered to be sufficiently long for financial variables to influence each other. Weekends and holidays are simply omitted in our dataset.

[11] For all economies, Dickey-Fuller tests reveal that all dollar exchange rates are I(1) at the significance level of 5 percent. As for interest rates, they are all I(1) except those for the Philippines and Malaysia which are I(0), with the same level of significance.

strong causality detected from Indonesia to Korea is consistent with the fact that Korean banks had large exposure in Indonesia. The Filipino peso was a passive currency during this period, affected by other currencies but not affecting them.

The tendency for mutual causation did not weaken even after the worst of the crisis was over. In the crisis-recovery period, fifteen and sixteen cells were significant at the 5 and 10 percent levels, respectively. The sums of the relevant coefficients were all positive without exception. During this period, the rebounding Thai baht was the key indicator for currency market sentiment in Asia, as shown by the four dark cells in the Thai column. The dramatic rise in mutual causation after July 1997 and even into the recovery period strongly suggests that exchange-rate fluctuations were indeed regional.[12]

By contrast, as Table 3 evinces, Granger-causality from the interest rate to the exchange rate within the same country reveals the opposite tendency. Before the crisis, there were six significant cells at the 5 percent level and twelve at the 10 percent level. From the signs of estimated coefficients, it is revealed that the direction of causality was negative (except in one case), meaning that high interest rates induced appreciation as expected. But when the crisis occurred and continued to worsen, these effects suddenly evaporated. There was not even a single country where the domestic interest rate influenced its exchange rate movement! This is rather clear evidence that interest rate policies in individual countries became impotent during the crisis-worsening period. As the exchange rates collectively stabilized, however, we record four significant cells at the 5 percent level and seven cells at the 10 percent level. Moreover, the sign of causality was mixed, with positive signs outnumbering negative ones.[13]

These results are clearly in support of Hypothesis 2; namely, that in the particular circumstances of the 1997-98 Asian crisis, synchronous movements of Asian currencies dominated any engineered change in interest differentials. Stability in foreign exchange markets was restored independently from the interest rate policies of individual countries.[14]

VI. External Influences

Up to now, we have analyzed mutual causation among interest rates and exchange rates within developing Asia. There is strong evidence for a structural shift in their relationship after the inception of the Asian crisis. Regional currencies affected one another while

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[12] When the crisis-worsening and crisis-recovery periods are combined, the number of significant cells is eighteen at the 5 percent level and twenty-two at the 10 percent level.

[13] For robustness check, we replaced nominal interest rates by interest rate differentials vis-a-vis the United States or Japan, as alternative measures of tightness of monetary policy. The results look fairly much the same as in Tables 2 and 3. In addition, we examined the reverse causality from exchange rate to interest rate in the original VAR estimation. The number of significant cells is as follows (at 5 and 10 percent levels of significance, the latter in parentheses): pre-crisis period, 8 (9); crisis-worsening period, 0 (2); and crisis-recovery period 8 (13). This means that even the reverse causality was weak during the height of the crisis.

[14] There is a subtle point here. Our conclusion that interest rate hikes are ineffective in appreciating currencies once crisis begins may apply more generally, whether the currency crisis is isolated or regional and whether or not it is accompanied by domestic banking crisis. In view of the empirical literature surveyed in Section III above, this conjecture is not unreasonable. To show the exact conditions under which our conclusion is valid would however require more work.

domestic interest rates hardly influenced their movements, especially during the crisis-worsening period. Mutual causation among Asian currencies continued into the crisis-recovery period. Could there have been some common factor outside the region driving these exchange rates? This section explores that possibility.

For possible external influences, we have selected the following five financial variables: yen/dollar exchange rate, Japanese short-term interest rate, Japan's Nikkei 225 stock index, U.S. short-term interest rate, and S&P stock index. These are not only plausible candidates but also readily available on a daily basis. Although other variables? such as output, inflation, trade, policy announcements, political instability, etc.? may also impact exchange rates, we do not control for them since they are either unavailable in high frequencies or not easily quantifiable.

We follow basically the same procedure as in the previous section to test Granger-causality from external variables to Asian exchange rates. In turn, one of the external variables is added (with proper lags determined by the AIC) to the original VAR containing interest rates and exchange rates of a pair of countries. Wald statistics are used to determine statistical significance of relevant estimated coefficients.

In Table 4, we examine whether the results obtained in the previous section would be much affected by the addition of a control variable. For each period and for each additional external variable, the numbers of statistically significant cells at the 5 and 10 percent levels (the latter in parentheses) are reported. Panel (a) shows Granger-causality between pairs of Asian currencies and Panel (b) shows Granger-causality from the domestic interest rate to exchange rate. The first shaded row of each panel with no control variable corresponds to the original results in Tables 2 and 3, respectively. The results confirm the robustness of our findings in the previous section. That is, with or without an external variable, Asian currencies began to Granger-cause one another after the crisis broke out, and causation from the short-term interest rate to the exchange rate disappeared during the crisis-worsening period.

Next, Granger-causality from external control variables to Asian currencies is reported in Table 5. Structural shifts are again detected for different periods. Virtually none of the external variables influenced Asian currency markets before the crisis. Also, very few of such variables had a visible impact during the crisis-recovery period, with the possible exception of the Nikkei 225 index (where five and nine cells are significant at the 5 and 10 percent levels of significance, respectively). During the intervening crisis-worsening period, by contrast, the Japanese interest rate, Nikkei 225 index and U.S. interest rate were found to Granger-cause many Asian exchange rates. During this period, external influence cannot be ignored in explaining the movements of Asian currencies. Somewhat surprisingly, neither the yen/dollar exchange rate nor the U.S. stock prices were important determinants of Asian exchange rates during any period (also see footnote 7 above).

Finally, Table 6 shows the results in more detail for the three external variables that were significant during the crisis-worsening period. The Japanese interest rate mainly influenced currency movements in Thailand and Korea (the sign of causality was negative for Thailand and positive for Korea. Here, negative causality means that a rise in the Japanese interest rate appreciates the Asian currency). The Nikkei 225 performance also had a significant impact on the Korean won in all reported cells (i.e., it was significant regardless of which other country was included in the bilateral VAR. Its impact was negative; that is, when Japanese stock prices fell, the Korean won depreciated).[15] As for Thailand, causality from the

[15] The influence of Japanese interest rates and stock prices on the Korean won is consistent with the fact that Korea borrowed heavily from Japanese banks. The balance sheets of these

U.S. interest rate to the baht was also significant in all bilateral combinations (a rise in the dollar interest rate depreciated the baht). These findings suggest that the influence of external variables was concentrated on two countries, namely Thailand and Korea, as the crisis deepened. Aside from Indonesia, these were the two hardest-hit countries in the Asian crisis.

Japanese banks could be impaired by adverse movements of these variables: higher Japanese interest rates or lower Japanese stock prices hurt Japanese banks, which in turn hurt Korea and depreciated the won.

VII. Conclusion

Using daily exchange rates, short-term interest rates and other financial data, we have demonstrated the ineffectiveness of high interest rate policy during the height of the Asian crisis. When the crisis started, the relationship among these variables shifted greatly. Currencies in the crisis-hit region exhibited strong co-movement and mutual causation. The Thai baht and the Korean won were additionally influenced by Japanese and U.S. interest rates and the Nikkei stock index. On the other hand, domestic interest rates suddenly lost their impact on exchange rates, albeit temporarily.

The three hardest-hit countries with IMF programs sustained tight monetary policies in order to stabilize their exchange rates at the cost of domestic recession. If the supposed benefit of currency stability did not in fact exist, however, this strategy may have only brought additional, unnecessary pain to the national economy.[16] In light of our results, policy responses to regional currency depreciation accompanied by domestic banking crises (i.e., twin financial crises) should be reconsidered. In particular, internationally coordinated measures seem necessary to calm upset foreign investors who do not distinguish among individual countries in the crisis region.

[16] This point requires additional proof. Our paper has focussed on the (lack of) causality from interest rates to exchange rates during the Asian crisis. Whether high interest rate policy in turn caused domestic recession and/or credit crunch needs separate analysis which is beyond the scope of the present paper.

Appendix: The Bagehot Rule

Walter Bagehot (1826-1877), British economist and renowned editor of the Economist, is often invoked to make a certain point regarding financial-crisis response: for example, by Fischer (1999) to propose an international lender of last resort. It may be worthwhile to briefly review what Bagehot actually said.

Bagehot's most famous book, Lombard Street, recommends the monetary authority raise interest rates against an external gold drain and lend unlimitedly against an internal one under a well-functioning international gold standard:

> [F]oreign payments are sometimes very large, and often very sudden. The 'cotton drain,' as it is called? the drain to the East to pay for Indian cotton during the American Civil War? took many millions from this country for a series of years. A bad harvest must take millions in a single year. In order to find such great sums, the Bank of England requires the steady use of an effectual instrument. That instrument is the elevation of the rate of interest (Bagehot 1873, p.22).
>
> Whatever persons? one bank or many banks? in any country hold the banking reserve of that country, ought at the very beginning of an unfavorable foreign exchange at once to raise the rate of interest, so as to prevent their reserve from being diminished further, and so as to replenish it by imports of bullion (Bagehot 1873, p.23).
>
> A domestic drain is very different. Such a drain arises from a disturbance of credit within the country, and the difficulty of dealing with it is the greater, because it is often caused, or at least often enhanced, by a foreign drain. ... The two maladies? an external drain and an internal? often attack the money market at once. What then ought to be done? In opposition to what might be at first sight supposed, the best way for the bank or banks who have the custody of the bank reserve to deal with a drain arising from internal discredit, is to lend freely (Bagehot 1873, p.23).

Bagehot's advice was to raise interest rates against an external gold drain and lend freely against an internal one (or when both occur at the same time). However, it is well to remember his counsel was for a world very different from ours. Among other things, the Bagehot rule was intended to cope with a situation under irrevocably fixed exchange rates where confidence in the parity was rarely questioned except in extreme cases such as war or revolution. Crisis consisted of reserve losses, but not self-fulfilling and contagious currency attacks followed by great depreciations, in economies with an acute balance sheet problem. Moreover, this rule was proposed for the United Kingdom, the country at the hub of the world economy with deep and efficient financial markets: unlike

the Asian developing economies which are located in the peripheries and have only recently joined the global financial markets.

Although the Bagehot rule seems to support expansionary monetary policy in twin financial crises, clearly we cannot invoke it to directly answer the question we raised in this paper. We must be careful in applying this famous rule in the present context, which is a very different one.

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