



# Disorderly Adjustment to the Misalignment in the Korean Won

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# **Disorderly adjustments to exchange rate misalignments: the experience of Korea**

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This paper investigates the causes of the sharp exchange rate depreciation during the Korean crisis by estimating a single-equation model of real exchange rates. The econometric results suggest that the observed depreciation can be explained only partially by the adjustment to misalignments and that there was an excessive variation of the exchange rate unrelated to the fundamentals. Based on the findings, the author argues the case for a proactive exchange rate management which has an important implication for the choice of exchange rate regimes.

*Key words:* Autoregressive distributed lag model, Behavioural equilibrium exchange rate, Exchange rate misalignments, Exchange rate policy, Korean crisis.

*JEL classifications:* C22, C32, F31, F32.

## **1. Introduction**

The Asian crisis of 1997-1998 demonstrated how disorderly exits from the fixed exchange rates could result in economic disaster.<sup>1</sup> Against this background, a new conventional view on the exchange rate policy has emerged. The proponents of this so-called 'bipolar view' argue that emerging market economies, which are vulnerable to panic-driven capital flows, have to choose between the two extremes of floating rates and hard pegs (Eichengreen, 1999; Fischer, 2001; and Summers, 2000). The key implication of this view is that the national governments of those economies should refrain from actively managing their exchange rates and instead, let them be determined in the market or irrevocably fix them.

The objective of this paper is to argue the case for a proactive exchange rate management by examining the Korean crisis of 1997-1998. Korea experienced a sharp exchange rate depreciation following the sudden stops to capital inflows, which led to

deep economic recessions. It appears that the disorderly exchange rate adjustment had a severe contractionary effect on the domestic economy, transforming financial instability into a fully-fledged economic crisis.<sup>2</sup> However Korea's exchange rate rebounded steeply once the stability of the market was restored, suggesting that there may have been exchange rate overshooting in the middle of the turmoil.

In this paper, the causes of Korea's sharp exchange rate depreciation are investigated by estimating a single-equation model of real exchange rates. The paper demonstrates that the depreciation was in part necessitated by the adjustment to the misalignment generated under a relatively inflexible exchange rate system prior to the crisis; however, a large part of depreciation was due to the excessive variation of the exchange rate unrelated to the underlying fundamentals. Based on the findings, this author argues that a proactive exchange rate management is important to prevent serious misalignments and disorderly adjustments of exchange rates which could have a detrimental effect on economic activities.

## **2. Behavioural Equilibrium Exchange Rate Approach**

In this paper, the behavioural equilibrium exchange rate (BEER) approach to modelling the behaviour of real exchange rates is employed. The BEER approach posits that the real exchange rate varies according to the changes in the underlying fundamentals and it explicitly models the real exchange rate as a function of a relatively small set of fundamental variables.<sup>3</sup> The present analysis of Korean real exchange rates assumes that the long-run equilibrium exchange rate is a function of the following variables:

$$q = f(bs, nfa, tot) \quad (1)$$

where  $q$  denotes the internal real effective exchange rate defined as the relative price of non-traded to traded goods.  $bs$  denotes the Balassa-Samuelson effect and it is measured

by the labour productivity relative to that of the trading partners. A faster productivity growth in the traded goods sector is expected to be positively related to the real exchange rate.  $nfa$  denotes the ratio of net foreign assets to GDP and, as anticipated by a stock-flow consistent exchange rate model (such as the portfolio balance and Obstfeld-Rogoff (1995) models), is expected to be positively related to the real exchange rate.  $tot$  denotes the terms of trade and its improvement is expected to induce real exchange rate appreciation through the switching effect of a change in relative prices.<sup>4</sup> The definition of the variables entering Equation (1) is described in some detail in the data appendix.

In the application of the BEER approach to modelling the real exchange rate, it is common to include the real interest rate differential and the risk premium as a fundamental variable. The underlying assumption is that the short-run dynamics of exchange rates is determined by the risk-adjusted uncovered interest parity (UIP) condition where the expectation of exchange rate is given by the long-run equilibrium exchange rate defined by Equation (1). However, these variables are not included in the model of the present analysis for the following reasons.

Firstly, the UIP condition may not hold due to the existence of capital controls in Korea. Under perfect capital mobility, fixed exchange rates and monetary policy autonomy are not compatible — a proposition known as ‘impossible trinity’. However, the Korean government had heavily regulated the cross-border capital flows at least until the mid-1990s, thereby maintaining some degree of autonomy both in exchange rate and interest rate policies.<sup>5</sup> Under such circumstances, exchange rates and interest rates do not necessarily satisfy the arbitrage rule underlying the UIP condition.

Secondly, even if the UIP condition holds, the empirical measurement of a risk premium will not be straightforward. A risk premium can vary according to a change in the investors’ risk appetite and their valuation of political and default risk. The quantitative measurement of such investors’ psychological factors and subjective

perceptions are particularly challenging because they are not directly observable. However, these factors seem to have played an important role in triggering the massive capital outflows during the Korean crisis. Given the importance of a risk premium that captures the investors' attitude to risks, the omission of a relevant proxy variable could cause a serious bias in the estimated coefficient of interest rates in the model.

For these reasons, the UIP condition is not explicitly incorporated in the model of the present analysis and instead, the short-run dynamics of exchange rates are described by the estimated error correction model (ECM) associated with the long-run relationship between the real exchange rate and the fundamental variables. It is assumed that the long-run equilibrium exchange rate derived from the long-run relationship will serve as an anchor for the real exchange rate in the sense that the misalignment (i.e., the deviation from the long-run equilibrium exchange rate) will be corrected either through a change in nominal exchange rates or the underlying fundamentals, by either market forces or policy interventions over time. Such an assumption is likely to hold for a small open economy such as Korea where the delay in correcting severe misalignments could be the source of economic instability or even a crisis.

### **3. Econometric Methodology and Results**

In order to test the existence of long-run relationship and estimate the associated ECM, the autoregressive distributed lag (ADRL) method is employed as developed by Pesaran and Shin (1999) and Pesaran et.al. (2001). The ARDL method is chosen because it can be applied to the estimation of long-run relationship irrespective of whether the underlying regressors are integrated in the order of zero ( $I(0)$ ) or one ( $I(1)$ ). Accordingly, it can circumvent the pre-testing problem associated with a standard cointegration analysis which requires the classification of the variables into  $I(0)$  and  $I(1)$ . In addition, the error terms in the ARDL model are allowed to follow the autoregressive conditional heteroscedastic (ARCH) process so that its conditional variance can change over time.

The sample period is 1970 quarter 1 to 2004 quarter 4.

The ARDL method involves two stages. At the first stage, the existence of long-run relation between the variables is tested by computing F-statistic for testing the significance of the lagged levels of the variables in the error correction form of the underlying ARDL model. Table 1 reports the F-statistic for the joint significance of the lagged level variables. As can be seen from the table, the null of no long-run relation between the variables can be rejected at the 95-percent level when the real exchange rate ( $q$ ) is treated as the dependent variable. By contrast, the null of no relationship between the variables cannot be rejected at the 95-percent level when either the Balassa-Samuelson effect ( $bs$ ), the net foreign assets ( $nfa$ ), or the terms of trade ( $tot$ ) are treated as a dependent variable. These results suggest that  $bs$ ,  $nfa$ , and  $tot$  can be interpreted as the long-run forcing variables for the explanation of  $\Delta q$ .

[Table 1 around here]

The second stage of the ARDL method is to estimate the coefficients of ECM. First, the ARDL model with the ARCH error is estimated by the maximum likelihood estimation. Using the maximum lag of four for the selection of the lag order in the ARDL model, the Schwarts Bayesian criterion (SBC) selects the ARDL (1,0,0,0) with the ARCH (1) error.<sup>6</sup> Corresponding to the selected ARDL model, the following ECM is obtained. The standard errors are reported in the brackets, most of which are significant at 95-percent level.

$$\begin{aligned} \Delta q_t = & 0.86304 - 0.18973(q_{t-1} - 4.54878 - 0.143978rpro_{t-1} - 0.34634nfa_{t-1} - 0.773046tot_{t-1}) \\ & (0.14861) \quad (0.03144) \quad (0.22679) \quad (0.07315) \quad (0.10941) \quad (0.22755) \\ & + 0.027317\Delta rpro_t + 0.065711\Delta nfa_t + 0.14667\Delta tot_t + u_t \\ & (0.01392) \quad (0.01804) \quad (0.03966) \\ h^2 = & 0.0007609 + 0.56777u_{t-1} \end{aligned} \quad (2)$$

(0.000146)      (0.19272)

Then, the long-run equilibrium exchange rate can be expressed as follows:

$$q_t = 4.54878 + 0.143978rpro_t + 0.34634nfa_t + 0.773046tot_t \quad (3)$$

The level of the fitted value (short-run fundamental value, hereafter) and the long-run equilibrium exchange rate, which are obtained by inserting the actual value of the fundamental variables into Equation (2) and (3), respectively, are plotted against the actual exchange rate over the post-Bretton-Woods period in Figure 1.

[Figure 1 around here]

#### 4. Misalignments

As can be seen from Figure 1, Korea's real effective exchange rate was substantially overvalued prior to the crisis of 1997-1998. The size of the misalignment was larger than the previous major ones which had been observed in the first half of the 1980s (overvaluation) and in the second half of the 1980s (undervaluation), respectively. What, then, caused Korea's exchange rates to deviate from the long-run equilibrium rates by such degrees? Were there any common factors behind these three cases of misalignments?

The first case of misalignment was the overvaluation of Korea's exchange rates during the period 1982-1983. The Korean won appreciated on an effective basis under the dollar peg as the US dollar strengthened against major currencies. At the same time, the long-run equilibrium rate depreciated primarily due to the deterioration in Korea's foreign asset position after the second oil shock. Consequently, the won became overvalued by more than 11 percent by the end of 1982.

In response to the widening of current account deficits, the Korean government adopted an adjustable multiple currency basket peg system and devalued the won-dollar rate in 1980.<sup>7</sup> Although the magnitude of the misalignment decreased substantially by

the end of 1984, the won became significantly overvalued again as the US dollar strengthened against major currencies in the first half of 1985. It was only after the Plaza Accord of 1985 which facilitated the depreciation of the US dollar against the German mark and the Japanese yen that the misalignment of the won almost disappeared.

The second case was the undervaluation of the won during the period 1986-1987. The won depreciated on an effective basis as the Japanese yen strengthened against the US dollar. At the same time, the long-run equilibrium rate appreciated due to the improvement of Korea's terms of trade and foreign asset position resulting from the favourable economic environment known as 'the three lows' (i.e., low oil prices, low world interest rates, and the low US dollar). As a result, the won became undervalued on average by about 12 percent in 1987.

When Korea's current account registered a sizable surplus (largely with the United States) in 1986, the Korean government came under strong international pressure to allow the won-dollar rates to appreciate (Nam and Kim, 1999). Following the rise in won-dollar rates, the real effective rate appreciated sharply and the misalignment almost disappeared at the beginning of 1990.

The third case was the overvaluation of the won before the crisis of 1997-1998. The Korean government adopted a new exchange rate system known as the Market Average rate (MAR) system in 1990. Under this system, the basic won-dollar rate was determined by market forces, though, only within the limits of daily fluctuation bands set around the weighted average interbank rates of the previous day. In order to maintain the won-dollar rates within the band, the Bank of Korea frequently intervened in the market. Moreover, the Bank exercised window guidance with the aim of preventing large fluctuations even within the band.

Under this MAR system, Korea's real effective rate was largely in line with the long-run equilibrium rate during the first half of the 1990s. This was, however,



primarily due to the absence of large shocks to the underlying fundamentals. Under such a favourable economic environment, the stable won-dollar rates helped to avoid serious misalignments in Korea's real effective rate.

The long-run equilibrium rate, however, started to depreciate substantially following the deterioration of Korea's terms of trade due to the cyclical decline in semiconductor prices from 1995. At the same time, the won rate appreciated on an effective basis as the US dollar strengthened against major currencies. Consequently, Korea's real effective exchange rate became overvalued on average by more than 25 percent during the four quarters preceding the crisis (1996 quarter 4 to 1997 quarter 3). The size of the misalignment this time was much larger than the previous ones observed during the 1980s.

The adjustment process to the misalignment was most disastrous in this last case. Korea was hit by a crisis and forced to abandon the MAR system in December 1997. Following that, the won-dollar rates depreciated dramatically and the real effective rate fell to a record-low level, which was about 20 percent below the long-run equilibrium rate in 1998 quarter 1. Such large scale of exchange rate overshooting had not been observed previously in the post Bretton-Woods period.

The main findings of the above analysis can be summarised as follows. Firstly, serious misalignments in Korea's exchange rates emerged repeatedly under the relatively inflexible exchange rate systems which failed to absorb external disturbances, such as terms of trade shocks. Although the ensuing adjustment proceeded in a relatively orderly fashion in the first case, it was either forced by international pressures or crisis-driven in other cases.

Secondly, misalignments emerged also due to the large variation of exchange rates among major currencies, particularly the US dollar and the Japanese yen. This was mainly because too much weight had been attached to the stability of won-dollar rates under Korea's exchange rate system despite its diversified foreign trade pattern.

Finally, the fact that the exchange rate was substantially overvalued before the crisis of 1997-1998 suggests that some part of the subsequent depreciation was unavoidable in order to correct the misalignment. It is, however, not clear from the preceding analysis to what extent the depreciation can be explained by the short-run dynamics of exchange rates induced by the response to the misalignment. This question is focused on in the next section.

## **5. Overshooting**

The collapse of the MAR system precipitated a rapid fall of Korea's exchange rates in December 1997. The exchange rate depreciated even further in 1998 quarter 1, causing not only the overshooting of the long-run equilibrium rate but also a large deviation from the short-run fundamental values (see Figure 1). However, it rebounded sharply in 1998 quarter 2, offsetting some of the preceding overshooting. Apparently, there was an excessive variation of exchange rates relative to the underlying fundamentals during the crisis period.

[Figure2 around here]

To illustrate this point more clearly, Figure 2 displays the size of deviations measured as percentages of the short-run fundamental values. As can be seen from it, there were temporary but large deviations of the actual rates from the short-run fundamental values between 1997 quarter 4 and 1998 quarter 2. The size of deviations was particularly large in 1998 quarter 1, which was about 5.3 times more in absolute terms than its standard deviation over the estimated period. Such a large scale of deviations implies that the short-run dynamics of exchange rates induced by the response to the misalignment can provide only a partial explanation for the observed sharp depreciation. What, then, caused the large temporary deviations from the fundamental values?

One possible explanation is the distorting effect of the behaviour of noise traders, i.e., a type of irrational traders who act not in response to fundamentals but rather to noise,

such as random price movements.<sup>8</sup> Typically, noise traders rely on some form of convention, such as chartist technique.<sup>9</sup> Even if the behaviour of a certain trader is guided by fundamentals in the long-run, he or she may act like a noise trader in the short run due to the lack of relevant information on fundamentals. Noise trading is likely to prevail and influence the process of exchange-rate determination when there is a sharp increase in economic uncertainty due to a major regime change in the economy.

The observed large deviations of Korea's exchange rates from the fundamental values can be interpreted in a similar fashion. The abrupt collapse of the MAR system in December 1997 must have created huge uncertainty regarding the prospects of the Korean economy and thus its exchange rates, turning market players into noise traders. Consequently, the process of exchange-rate determination was increasingly distorted by noise trading, generating an excessive variation in exchange rates relative to the underlying fundamentals. Indeed, there is a sharp rise in the estimated conditional variance of error terms in 1998 quarter 1 and quarter 2, suggesting that there was a dramatic increase of uncertainty in the foreign exchange market (see Figure 3).

[Figure 3 around here]

To sum up, the sharp exchange rate depreciation during the Korean crisis can be explained only partially by the adjustment to the misalignment. A major amount of the depreciation was due to an excessive variation of the exchange rate unrelated to the fundamentals. The large size of deviations of the exchange rate from the fundamental values seems to have been related to the distorting effect of noise trading which increased in response to a rise in uncertainty after the collapse of the MAR system.

## **6. Conclusion**

This paper has investigated the causes of the sharp exchange rate depreciation during the Korean crisis of 1997-1998. The BEER approach to modelling the behaviour of real exchange rates has been employed and the long-run equilibrium exchange rate and the

associated ECM have been estimated by the ARDL method. The analysis has shown that Korea's real exchange rate was substantially overvalued prior to the crisis, suggesting that at least some part of the subsequent depreciation was unavoidable in order to correct the misalignment. It has also demonstrated that misalignments had frequently emerged under Korea's relatively inflexible exchange rate systems in the post Bretton-Woods period. However, the evidence has shown that there was not only the overshooting of exchange rates but also a large deviation from the short-run fundamental value at the height of the crisis, indicating that the observed sharp depreciation can not fully be explained by the adjustment to the misalignment. It seems that a large part of depreciation was due to an excessive variance of exchange rates generated by the distorting effect of noise trading in the midst of heightened uncertainty after the collapse of the MAR system.

The findings suggest the importance of proactive exchange rate management in emerging market economies in the following sense.

Firstly, serious misalignments have to be prevented by a timely adjustment of exchange rates. For most emerging market economies, severely misaligned exchange rates are not sustainable and could serve as a cause for abrupt and large changes in exchange rates. Misalignments in Korea's exchange rates repeatedly emerged under the relatively inflexible exchange rate systems. It is therefore important for an exchange rate system to have sufficient flexibility that allows for a timely adjustment of exchange rates in response to a change in fundamentals.

In this sense, hard pegs have serious disadvantages because the entire burden of adjustments falls on domestic prices under the irrevocably fixed exchange rate. An economy could be trapped in prolonged recessions when the real depreciation necessitated by external shocks takes place entirely through the downward adjustment of domestic prices, including wages.

Secondly, when an exchange rate adjustment becomes unavoidable due to either the

need to correct misalignments or a non-temporary reduction in capital inflows, priority has to be given to avoiding an excessive variation of exchange rates by an adequate exchange rate management. This is particularly important for emerging market economies because a sharp exchange rate variation could have a serious adverse effect on the economic activities due to their vulnerabilities, such as a greater exposure to foreign exchange risks in foreign trade, a high degree of pass-through, and extensive currency mismatches in the balance-sheets of banks and firms.

A floating exchange rate is inherently volatile because it tends to behave as an asset price in the sense that the present value depends on the future expectation. A mere shift of market expectations or a sharp increase in noise trading could be the cause of a sudden movement in exchange rates regardless of current fundamentals. It is therefore important for the government to make a credible commitment to an exchange rate target which will help to guide market participants in the midst of turmoil. From this perspective, an exchange-rate band regime has a clear advantage because the presence of an explicit band will serve as an anchor for market expectations. At the same time, a sufficiently wide band will enable a timely adjustment of exchange rates in response to misalignments.

However, it should be emphasised that the recent dramatic increase in the mobility of global capital flows has severely undermined the ability of emerging market economies to manage their exchange rates. A greater risk of sudden stops to capital inflows is likely to make capital flows to those economies more volatile and thus greatly increase the difficulty of maintaining the targeted exchange rate.

Several policy measures can be taken to resolve such challenges. One possible solution would be to introduce some institutional arrangements which help to reduce excessive volatility in capital flows and exchange rates, examples of these being some form of restrictions or taxation on cross-border capital flows and foreign exchange transactions.<sup>10</sup> Another solution would be to improve access to supplemental

financing which would enhance the capacity of national governments to deal with market pressures. Establishing a regional exchange rate arrangement which involves effective financing facilities for member countries' exchange rate stability is one possibility.<sup>1 1</sup> With the enhanced ability to stabilise exchange rates, emerging market economies would better cope with panic-driven capital flow reversals, which could otherwise cause a severe economic crisis.

## Data Appendix

**Internal real exchange rate  $q$ :** Assuming that the law of one price holds for traded goods, this variable is defined as follows:

$$q = \log(neer) + \log(kcpi) - \log(fppi)$$

where *neer* denotes the trade-weighted average of the nominal exchange rate against the currency of the United states, Japan, and Germany (major trading partners, hereafter), *kcpi* denotes Korea's consumer price index and *fppi* denotes the trade-weighted average of the producer price index for the major trading partners.

**Balassa-Samuelson effect  $bs$ :** This variable is defined as Korea's labour productivity, which is measured by the log of seasonally adjusted industrial production index minus the log of manufacturing employment index, relative to the trade-weighted average of the equivalent for the major trading partners.

**Net foreign assets  $nfa$ :** This variable is defined as Korea's net foreign assets in the banking system (the sum of monetary authorities and deposit money banks), expressed as a ratio to nominal GDP.

**Terms of trade  $tot$ :** This variable is defined as the log of domestic export unit value minus the log of the import unit value relative to the trade-weighted average of the equivalent for the major trading partners.

[Source] IMF *International Financial Statistics* ; Datastream

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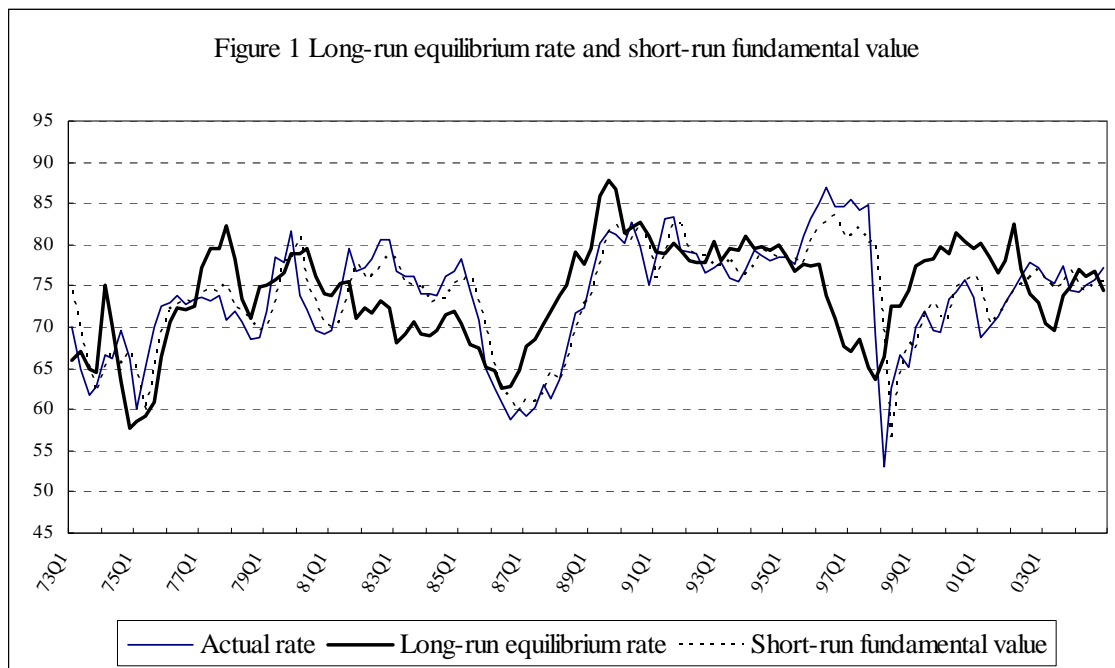


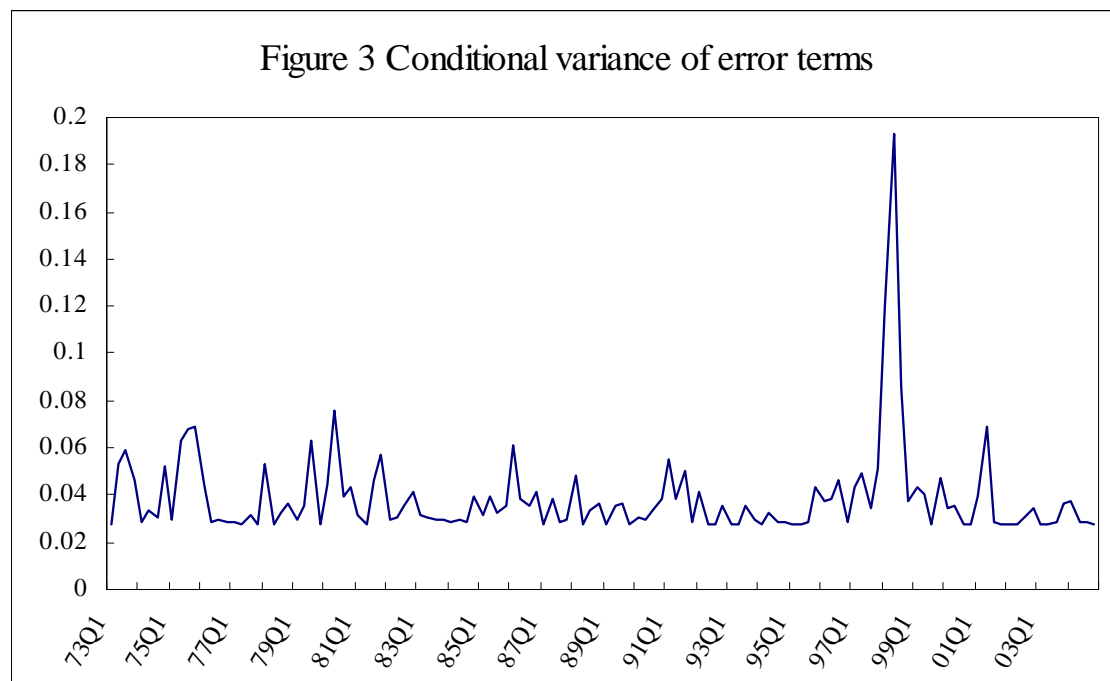
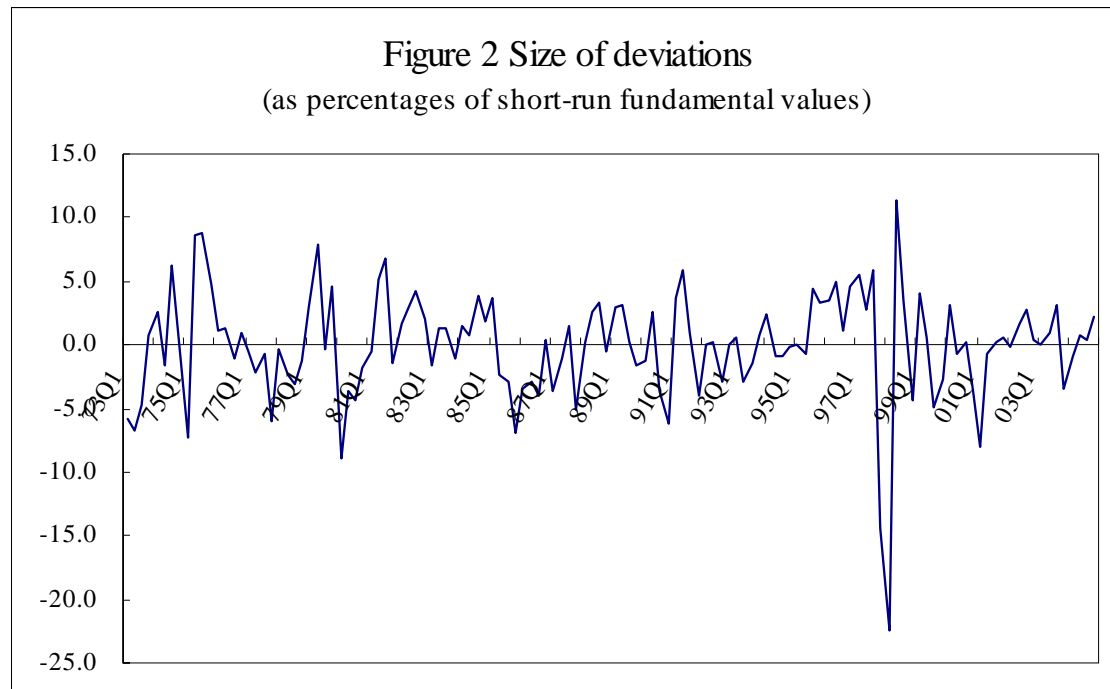
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Table 1 F-statistics for testing the existence of long-run relationship

Dependent Variable	Lagged levels of variables	F-statistics	Critical value bounds (95-percent level)	
			I(0)	I(1)
$\Delta q$	$q \ bs \ nfa \ tot$	6.078		
$\Delta bs$	$q \ bs \ nfa \ tot$	2.319	2.649	3.805
$\Delta nfa$	$q \ bs \ nfa \ tot$	3.774		
$\Delta tot$	$q \ bs \ nfa \ tot$	2.232		

Source: Pesaran et. al. (2001)





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\* Ministry of Finance, Japan. The views expressed are those of the author and do not necessarily reflect the position of the ministry. The author is grateful to Jerry Coackley, Laurence Harris, Machiko Nissanke, Graham Smith, and two anonymous referees for their very useful comments on the earlier version of the paper.

<sup>1</sup> For the discussion of the nature of the Asian crisis, see Arestis and Glickman (2002), Chang (1998), Eatwell and Taylor (2000), Radelet and Sachs (1998), and Wade (1998).

<sup>2</sup> In the context of the Asian crisis, a number of commentators argue that the sharp exchange rate depreciation had a severe contractionary effect on the domestic economy through its adverse impact on bank balance sheets which involved extensive currency mismatches. See Eichengreen (1999), Goldstein (2002), and Kenen (2001).

<sup>3</sup> For the concept and application of BEER approach, see Clark and MacDonald (1999) and MacDonald (2000).

<sup>4</sup> See MacDonald (1997) and Montiel (1999) for the discussion of the determinants of the long-run equilibrium exchange rate.

<sup>5</sup> Chang, Park, and Yoo (1998) review the process of financial liberalisation in Korea.

<sup>6</sup> Alternatively, GARCH (1,1) and GARCH-in-mean models were estimated. However, none of the coefficients of the additional terms were statistically significant.

<sup>7</sup> See Rhee and Song (1999) for further details of Korea's exchange rate policy during the post Bretton-Woods period.

<sup>8</sup> Jeanne and Rose (2002) develop a model of noise traders where the presence of noise traders is the source of excessive exchange rate variations.

<sup>9</sup> Keynes (1936) used the metaphor of "beauty contest" to describe the precarious nature of speculation where the convention is a key component. For the empirical evidence of a wide use of chartist technique in the modern foreign exchange market, see Allen and Taylor (1990).

<sup>10</sup> Grabel (2003) discusses the policy options for crisis prevention including the transaction tax on foreign exchange and the Chilean capital-inflow tax. Nissanke (2005) argues the case for a two-tier Tobin tax as an instrument to enhance the manageability of exchange rates.

<sup>11</sup> Wade (1998) argues the case for regional financing facilities.