Do High Interest Rates Appreciate Exchange Rates During Crisis?: The Korean Evidence*

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ABSTRACT

This paper tries to answer the following basic question: Have the high interest rates had the desired effect of appreciating the nominal exchange rate in the Asian crisis countries? We use Korean high-frequency (weekly) data during the crisis and its aftermath to examine the relationship between the increase in interest rates and the behavior of exchange rates. We find that the lead-lag relation between the exchange rate and the interest rate clearly indicates that raising the interest rate has had the usual impact of appreciating the nominal exchange rate during the crisis period.

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"If we raise interest rates too high, we will destroy the Korean economy."

The IMF Director of the Asia-Pacific Department, Hubert Neiss, to IMF staff assembled to design the Korean bailout package, in Seoul Hilton, November 30, 1997.

"You are destroying our economy."

The Vice-Minister of the Ministry of Finance and Economy, Lee, to IMF staff assembled in his office in Kwachon, Korea during the Third Review of the IMF Standby, July 11, 1998.

I. Introduction.

For the countries most affected by the Asia crisis, Thailand, Indonesia, and Korea, economic events have been dramatic, and have defied expectations. Exchange rates that had enjoyed a sustained period of stability depreciated precipitously. Between June 1997 and July 1998, nominal exchange rates vis-a-vis the U.S. dollar in Thailand, Indonesia, and Korea depreciated by about 67 percent, 500 percent, and 88 percent, respectively.

In response to these massive depreciations and as a condition for its adjustment lending, the IMF has required the countries to adopt tight monetary policies, specifically, to raise their short-term interest rates. After the implementation of the IMF adjustment programs, the overnight call rates were raised from 15 percent to 22 percent in Thailand; from 10 percent to 47 percent in Indonesia; and from 15 percent to 32 percent in Korea.

This paper tries to answer the following basic question: Have the high interest rates had the desired effect of appreciating the nominal exchange rates in the crisis countries? It is well-known that in general, there is no stable empirical short-run relationship between exchange rates and interest rates (Frankel and Rose, 1995). Nominal exchange rates move as if they are a random walk (Meese and Rogoff, 1983). However, many policy-makers believe and anecdotal evidence suggests that historically high interest rates have succeeded in stabilizing nominal exchange rates in some crisis countries, especially in Latin America.[1]

During the recent Asian crisis, the relationship between exchange rates and interest

[1] See the case studies in Goldfajn and Baig (1998) and Furman and Stiglitz (1998).

rates has again been a topic of substantial controversy. The traditional view stresses that tight monetary policies are necessary to support the exchange rate: higher interest rates raises the return that an investor obtains from investing in the country, reduces capital flight, and discourages speculation. However, several prominent economists have argued a revisionist view that a rise in interest rates has a negative effect on the exchange rate Radelet and Sachs, 1998; Feldstein, 1998; Furman and Stiglitz, 1998).

The revisionist view is that under the unique conditions of a financial panic, tight monetary policies and high interest rates would result in capital outflows and exchange rate depreciation. That is, the high interest rates cause a financial implosion, and raise default probabilities, thus weakening the currency. Radelet and Sachs (1998, pg. 31) express this view strongly:

> ...It is entirely possible that in the unique conditions of the midst of a financial panic, raising interest rates could have the perverse effect of weakening the currency...Creditors understood that highly leveraged borrowers could quickly be pushed to 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 debt, and the important question was whether they would or not roll over their claims. High interest rates did not feed directly into these existing claims (which were generally floating interest rate notes based on a fixed premium over LIBOR). It is possible, however, that by undermining the profitability of their corporate customers, higher interest rates discouraged foreign investors from rolling over their loans.

While most of the work examining the relationship between tight monetary policies and exchange rates for the Asian crisis countries have been anecdotal, there have been recent papers that have empirically estimated the relationship. Goldfajn and Baig (1998), Kaminsky and Schmukler (1998), and Ghosh and Phillips (1998) use daily nominal interest rate and exchange rate data to attempt to calculate impulse response functions. Generally, because of the noise in daily data and possibly other specification issues, they are unable to find statistically significant coefficients in their vector autoregressive models (VAR). Goldfajn and Gupta (1998) and Furman and Stiglitz (1998) examine episodes of currency crises using cross-country data. The results are mixed. While Goldfajn and Gupta's find that high interest rates appreciate the nominal exchange rate, Furman and Stiglitz show that if the sample is restricted to low inflation countries–which includes East Asia– high interest rates lead to exchange rate depreciations.

In this paper, we use Korean high-frequency (weekly) data during the crisis and its aftermath to examine the relationship between an increase in interest rates and the behavior of exchange rates. We focus on Korea because of the availability of data, and because the increase in interest rates can be associated more clearly with a tightening of monetary policy.[2] We find that the lead-lag relation between the exchange rate and the interest rate clearly indicates that raising the interest rate has the traditional impact of appreciating the nominal exchange rate during the crisis period.

This paper is organized as follows. In Section II, we present two simple models that capture versions of the traditional and revisionist stories. We show that tight money can appreciate or depreciate the nominal exchange rate, depending on how the tight money affects the long-run real exchange rate. To date, most renditions of the revisionist story have lacked explicit analytical frameworks, and a model, however basic, is useful to fix ideas. The revisionist model shows that for reasonable parameter values, tight money can cause an economic implosion large enough to weaken the currency. Thus, from a theoretical perspective, the revisionist idea is certainly plausible. In Section III, we describe the data and examine some charts relating nominal interest rates with nominal exchange rates, default probabilities and corporate bankruptcies. In Section IV, our econometrics section, we deal with the identification problem inherent in interpreting exchange rate movements by attempting to isolate measures of exogenous shocks to monetary policy. Conclusions are in Section V.

II. Theoretical Considerations.

1. The Model.

We adapt the "workhorse" Dornbusch (1976) perfect foresight model, as modified by

[2]In Thailand and Indonesia short-term interest rates started to creep up before the IMF intervention. Thus, it is unclear whether the rates went up because of the tightening of policy or because of the crisis-induced disruption in short-term money markets.

Obstfeld and Rogoff (1996, pp. 609-621). Five equations comprise the model: of the domestic and foreign interest rates, i and i^*; real money demand, $m-p$; real exchange rate, q; aggregate demand, y; and the inflation rate, $p_{t+1}-p_t$. (All variables are in logs. Variables that are marked with $a *$ are for the foreign country; those that are marked with a bar are long-run steady-state values.)

(1) Uncovered interest parity:

$$i_{t+1} = i * + e_{t+1} - e_t. \tag{2.1}$$

(2) Money demand:

$$m_t - p_t = -\eta i_{t+1} + \phi y_t \tag{2.2}$$

(3) The real exchange rate:

$$q_t = e_t + p * - p_t \tag{2.3}$$

(4) Aggregate demand:

$$y_t = \bar{y} + \sigma(e_t + p * - p_t - \bar{q}) \tag{2.4}$$

(5) The Phillips-curve:

$$p_{t+1} - p_t = \psi(y_t - \bar{y}) + e_{t+1} - e_t \tag{2.5}$$

In addition, short-run prices are taken as fixed. That is, if the economy is shocked at time 0,

$$\Delta p_0 = 0. \tag{2.6}$$

Obstfeld and Rogoff (1996, p. 617) show that these equations yield (normalizing $p^* = i^* = \bar{y} = 0$) :

$$e_t = \frac{1}{(1+\eta)} \sum_{1+\eta}^{\infty} \left(\frac{\eta}{1+\eta}\right)^{s-t} m_s + \frac{(1-\phi\sigma)}{1+\psi\sigma\eta)}(q_t - \bar{q}), \tag{2.7}$$

where $\bar{q}$ is the long-run level of the real exchange rate, consistent with full employment.

2. Monetary Tightening — the Traditional View.

Suppose that the economy starts at a long-run ("steady-state") level of $\bar{m}$, and $\bar{e} = \bar{m} + \bar{q}$. At time 0, an unanticipated permanent decrease in the money to $\bar{m}'$ occurs. It can be shown that the nominal exchange rate at time 0 will be (Obstfeld and Rogoff, 1996, p. 617):

$$e_0 = \bar{m} + \bar{q} + \frac{(1 + \psi\sigma\eta)}{(\phi\sigma + \psi\sigma\eta)}(\bar{m}' - \bar{m}) < \bar{e} \tag{2.8}$$

That is, a fall in the supply of money will appreciate the nominal exchange rate. Given (2.4) and (2.6), falls. Then given (2.2) and (2.6), will rise if $\delta\phi < 1$. In short, in the traditional view, monetary tightening will appreciate the nominal exchange rate and raise nominal interest rates.

3. Monetary Tightening — the Revisionist View.

Assume now that instead of being constant, the long-run real exchange rate, $\bar{q}'$, depends negatively on the change in the nominal money supplies at time 0:

$$\bar{q}' = \bar{q} - \Theta(m_0' - m_0) \tag{2.9}$$

Equation (2.9) captures the revisionist notion that tighter monetary policies during times of economic crisis raises bankruptcies, corporate defaults, and generally damages the long-run performance of the economy, if is positive.[3] Thus, a more depreciated real exchange rate is needed to achieve full employment.

[3] There is a macroeconomics literature starting from Bernanke (1983) that has argued that because markets for financial claims are incomplete, intermediation between some classes of borrowers and lenders requires nontrivial market-making and information-gathering sources. Tight money can reduce the effectiveness of the financial sector as a whole in performing these services, and thus case a credit-crunch. In fact, Bernanke (1983) has argued that such a credit-crunch helped convert the U.S. downturn of 1929-130 into a protracted depression.

Some commentators (Furman and Stiglitz, 1998) have pointed out that during the recent Asian crisis, these depression-like phenomena have been replicated by the tight monetary policies. High interest rates compromised the net worth of many Asian firms, and the bankruptcies of these firms had adverse effects on the net worth of the firms' creditors, especially that of domestic financial institutions. In turn, as these financial institutions went bankrupt, and banks cut lending, credit became highly constrained. A credit crunch set in, exacerbating the economic downturn.

We assume that the long-run (irreversible) damage to the economy from tight money occurs entirely in the short-run, at time 0, when prices are sticky. Clearly, as prices adjust, real money supply is constant. Thus, we assume that the behavior of money from time 0 onwards does not affect the long-run real exchange rate.

Since by assumption, nominal money supplies from time 1 to infinity (m_1 to m_∞) do not affect $\bar{q}'$, we can assume that the money supply changes are permanent and rewrite (2.9) as:

$$\bar{q}' = \bar{q} - \theta(\bar{m}' - \bar{m}) \tag{2.10}$$

Equation (8) now becomes:

$$e_0 = \bar{m} + \bar{q} - \theta(\bar{m}' - \bar{m}) + \frac{(1 + \phi\sigma\eta)}{(\psi\sigma + \psi\sigma\eta)}(\bar{m}' - \bar{m}) \tag{2.11}$$

For a monetary tightening to depreciate the nominal exchange rate, $e_0 > \bar{e}$,

$$\theta > \frac{(1 + \psi\sigma\eta)}{(\phi\sigma + \psi\sigma\eta)}. \tag{2.12}$$

By inspection of (2.2) and (2.4), it can be seen that even with the modification (2.10), the fall in y_0 and the rise in i_1 are of the same magnitudes as in the traditional case above.

Equations (2.11) and (2.12) capture the revisionist notion that if the negative impact of the nominal money tightening on the long-run real economy is high enough, then the money tightening can perversely cause the nominal exchange rate to depreciate.

Given plausible parameter values, what must θ be for (2.12) to be satisfied? Tseng and Corker (1991) estimate that for Korea, $\eta = 0.01, \phi = 1.0, \psi = 5$ and $\sigma = 1.0$. Given these parameter values, a value of θ greater than unity will satisfy (11) and cause the nominal exchange rate to depreciate.

Is a value of 1 for θ plausible? From (2.2), it can be shown that for nominal interest rates to increase by 17 percentage points (as in December 1997 in Korea), nominal money would need to fall by about 10 percent.[4] Then from (2.9), given $\theta = 1$, the long-run real

[4]Assuming a projected 10 percent decline in y_t.

exchange rate must depreciate by 10 percent. A fall in $\bar{q}$ of this magnitude certainly seems plausible.

4. More General Money Supply Processes.

During the recent Asian crisis, the tightening of monetary policies were only temporary. For example, in Korea, after rising sharply in December, interest rates were steadily brought down starting in January 1998 and by August 1998, rates were even lower than in October 1997, before the crisis.

The revisionist case can be justified under more general money supply processes, including one in which money supply sharply contracts, and then gradually loosens—as in Korea. Assume as above that there is long-term damage to the economy when money is tightened sharply. This damage is not reversed when money supply is subsequently relaxed. Assume that after contracting at time 0, the money supply process returns to its old path. Since the model is linear in m_s (equation 7), the nominal exchange rates under the traditional (e_0) and revisionist (e_0^R) cases differ only by - $\theta(m_0' - m_0)$ (given (9)). Thus, e_0^R will always be more depreciated than e_0. In fact, for a large enough θ, a fall in m_0 can cause e_0^R and e_0 to move in opposite directions; e_0^R can depreciate.

III. The Data and Charts.

For Korea, we have obtained daily data on both forward and spot exchange rates; various interest rates; and corporate bankruptcies from September 1997 to August 1998. We have also obtained daily data on interest rates for the United States. The data on spot exchange rates and interest rates are from the Bloomberg terminal. The data on forward exchange rates, and corporate bankruptcies are from the Bank of Korea.[5] Because of the difficulty that earlier researchers have had in uncovering relationships between exchange rates and interest rates with daily data, we perform our analysis at the weekly frequency, by using observations for each Wednesday.

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[5]Forward rates are non-deliverable and are quoted in Singapore.

For the Bank of Korea, the main monetary instrument is the overnight call rate. Chart 1 depicts the relationship between the overnight call rate and the differential between the Korean 3- month CD rate and the U.S. 3-month Treasury bond rate.[6] The call rate and interest rate differentials move closely together. After the announcement of the Stand-by agreement with the IMF on the week of December 8, the call rate was increased from about 12 percent to 24 percent. An agreement was reached between the Korean authorities and the IMF that the call rate will be increased and will be kept high as long as the exchange rate remained at a depreciated level.[7] In the following week, however, the won depreciated further, and the call rate was raised again during the week of December 22 to over 32 percent. Over the following months, as the won appreciated, the call rate was gradually lowered, and by early August, was even below pre-crisis levels.

Given that the call rate and interest rate differentials move closely together and that interest parity conditions relate exchange rates to interest rate differentials, we conduct our econometric analysis using interest rate differential data. Chart 2 depicts the relationship between interest rate differentials and the spot and forward won/dollar rates. Both the spot and forward exchange rates started to depreciate during the week of October 20 and the rates of depreciation accelerated during the week of November 17. The won reached its low point during the week of December 1, and while it briefly appreciated, reached another low point during the week of December 22. It was only in late February 1998, when the won started to steadily appreciate. The volatility of exchange rates was also high between late November and late February (Chart 3).[8]

The revisionist view on the impact of high interest rates on exchange rates hinges on how interest rates impact bankruptcies and therefore default probabilities. Chart 4

[6]Since the Korean government has guaranteed the liabilities of Korean banks, the CDs are essentially sovereign debt. Since the mid-1990s, foreigners were able to hold these CDs.
[7]An understanding was reached between both parties that a won/dollar exchange rate above 1500 was too weak (depreciated). The understanding was that as long as the won remained below 1500, the call rate could gradually be brought down.
[8]Weekly volatilities are calculated as the standard deviation of the daily spot exchange rates.

shows the relationship between higher interest rates and bankruptcies.[9] Chart 5 depicts the relationship between interest differentials and default premia, defined as the interest differential minus the forward premium.[10] The default premia (S) started to rise during the week of November 3, peaking during the week of December 3, as interest rates peaked. Thereafter, the default premia declined, following the downward trend in interest rates. Default premia can also be calculated as the difference between the interest rates of U.S. bonds and dollar denominated Korean bonds. Chart 6 depicts the behavior in the long-term bond default premium (L), calculated as the difference between the U.S. 10-year treasury bill and the 10-year Korea Export-Import Bank (KExim) dollar denominated offshore bond.[11] The default premia on KExim bonds started to rise during the week of October 20, and peaked during the week of December 22, but subsiding thereafter.

The positive relationship, however, between the interest differential, and the default premia shown above does not prove the revisionist position. For example, default premia can rise due to heightened risk that is reflected in higher exchange rate volatilities. The authorities may be responding to these risks by raising interest rates, and thus the correlation between default premia and interest rates could be spurious.

4. Empirical Results

Because of the controversy surrounding the role of tight monetary policies and high interest rates in stabilizing the exchange rate, in this section, we hope to shed light on this dispute by examining some Korean high frequency financial market data during the crisis. We examine the Korean weekly spot exchange rate, the Korean and U.S. interest

[9] Corporate bankruptcies in the Seoul area.

[10] For countries with open capital markets and liquid foreign exchange markets, given covered interest parity, banks simply calculate the forward premium from the difference in interest rates. However, given the existence of various capital restrictions and the possibility of default in Korea, covered interest parity may not exactly hold, and the won/dollar forward premia that is quoted in Singapore is market determined.

[11] The KExim is a government-owned bank, and therefore its liabilities are sovereign.

rate differential, the Korean and U.S. inflation rate differential, and the Korean corporate bankruptcy rate from September 1997 to August 1998. Given that the right model for the Asian crisis is unknown, structural estimation can lead to biased estimates. Therefore, instead of estimating model-based parameters, we take the approach of letting the data speak for themselves.

The advantage of our vector autoregressive time series approach is that it is an unrestricted reduced form specification, and thus avoids the possibility of misleading inference due to incorrect model specification. The disadvantage of a time series specification is that it is usually involves a large number of parameters.[12] This makes the selection of an appropriate time series specification difficult, because the distribution theory on which tests are based is asymptotic. For many of the hypothesis tested, the degrees of freedom of the test statistics are of the same magnitude as the degrees of freedom left in the data after fitting the model.

To partially alleviate the problems associated with estimating a profligately specified time series model, we shall combine the notion of Granger (1969) causality and cointegration (Engle and Granger (1987)) to reduce the number of parameters estimated and get around the issue of nonstandard test statistics with the presence of integrated variables. In addition, we also consider the inter-relationships between our time series model and some simple structural models (such as Purchasing-power Parity) by placing the restrictions implied by the structural models on the corresponding time series model. Our goal is to obtain robust inferences of the relationship between the exchange rate and the interest rate differential.

We take the following steps to fit the time series models:

First, because estimates based on stationary and nonstationary data have very dif-

[12]For an unrestricted vector autoregressive model involving four variables with the order of lag equal to 5, we will have to estimate 80 coefficients and 10 variance-covariances. The shortages of degrees of freedom and multicollinearity can yield a large number of statistically insignificant coefficient estimates. This empirical phenomenon makes the interpretation of the test difficult.

ferent limiting distributions (e.g. Anderson (1971), Johanson (1988, 91), Phillips (1986, 87, 91, 98)), we test for the presence of unit roots in the logarithmic transformation of the spot exchange rate, s_t, interest rate differential, i_t, inflation rate differential, p_t, and corporate bankruptcy rate b_t. We use both the Akaike (1973) and the Schwarz (1978) criteria to choose the optimal order of lags to conduct the ADF test (Dickey and Fuller (1979)). Table 1 gives the ADF test statistics for the level and the first difference of the logarithmic transformation of exchange rate, s_{t1} interest rate differential i_t, inflation-rate differential p_t, and bankruptcy rate b_t. These results indicate that we should treat all these variables as integrated of order 1, I(1), process.

Second, because the results of hypotheses testing are very sensitive to the order of the autoregressive process (e.g. Hsiao (1979a, 82a,b)), we use the Akaike (1973) criterion to determine the order of the vector autoregressive process. Since we have only a limited number of observations, a priori we specify the highest order of lag to be five. The Akaike criterion selects the optimal order of lag to be 3.

Third, we test for the rank of cointegration using Johanson likelihood ratio test. The likelihood ratio test statistic of rank 0 against rank 1 based on maximum eigenvalue of the stochastic matrix is 26.07. The 95% critical value is 28.27. The likelihood ratio test statistic based on the trace of the stochastic matrix is 55.53. The 95% critical value is 53.48. The test statistic between rank 1 and 2 is 29.46. The 95% critical value is 34.87. From these results, it appears that either these four variables are not cointegrated or are cointegrated with rank 1.

Fourth, under the assumption that the cointegrating rank is 1, we apply the Johanson (1988) maximum likelihood method to estimate to the following model

$$\Delta \underset{\sim}{w}_t = \Pi_1 \Delta \underset{\sim}{w}_{t-1} + \Pi_2 \Delta \underset{\sim}{w}_{t-2} + \underset{\sim}{\alpha} \underset{\sim}{\beta}' \underset{\sim}{w}_{t-1} + \underset{\sim}{\eta}_t, \tag{4.1}$$

where $w_t = (s_t, i_t, p_t, b_t), \Delta = (1 - L)$ and L denotes the lag operator, $\underset{\sim}{\alpha}$ and $\underset{\sim}{\beta}$ are 4×1 vectors denoting the short run response coefficient from the deviation of the long-run equilibrium and long-run equilibrium relation, respectively. The estimates are reported in Table 2.

Fifth, because the estimated long-run relation takes the form

$$s_t = 4.9098 - 0.43718 i_t + 6.3586 p_t - 0.47924 b_t \tag{4.2}$$

which is hard to give a meaningful economic interpretation, we impose the long-run purchasing power parity relation by specifying $\underset{\sim}{\beta}' = (1, 0, -1, 0)$ and re-estimate model (4.1). The results are presented in Table 3.

Sixth, under the assumption that there is no cointegrating relation among these four variables, we take the first difference to transform the data into stationarity. We then use Hsiao's (1979a,b) method to select a parsimonious vector autoregressive specification that allows each variable to enter into each equation with different order of lags. The seemingly unrelated regression estimates of the final specification are reported in Table 4.

Seventh, we split up the sample period into two. The first period consists of observations from 1 to 41. The second period consists of the last seven observations. We use the first period data to reestimate models 1, 2, and 3, then use the estimated coefficients and first period data to generate predicted values for the last seven observations.

Table 5 presents the prediction root mean square error of the changes and levels of spot exchange rate, interest rate differential, inflation rate differential, and bankruptcy rate. It is interesting to note that apart from the changes in the bankruptcy rate, the time series model imposing the long-run purchasing power parity restriction (model 2) actually predicts better than the unrestricted time series model with our estimated cointegration relation (model 1). The model without cointegration (model 3) predicts worse than model 2, but better than model 1 with regard to changes in the spot exchange rate, interest rate differential, inflation rate differential, and the levels of the inflation rate differential and the bankruptcy rate, but worse in predicting the levels of the spot rate, interest rate differential, and the changes in the bankruptcy rate. Thus using the prediction error as a criterion, the results strongly point in favor of the time series model with the imposition of the a priori long-run purchasing power parity relation, over the unrestricted time series model with the cointegration relation, or the model without cointegration.

Comparing the results in Tables 2, 3 and 4 we note that the relation between the exchange rate and interest rate differential is surprisingly robust. The exchange rate equation under the assumption of no cointegrating relation is

$$\begin{aligned}\Delta s_t = \underset{(-0.68)}{0.00598} - \underset{(-0.34)}{0.0471\Delta s_{t-1}} + \underset{(4.34)}{0.5598\Delta s_{t-2}} \\ - \underset{(-2.27)}{0.286\Delta i_{t-1}} + \underset{(2.54)}{6.4286\Delta p_{t-1}} + \hat{\eta}_t;\end{aligned} \tag{4.3}$$

with the long-run purchasing power parity imposed is

$$\begin{aligned}\Delta s_t = \underset{(-0.047)}{-0.0075\Delta s_{t-1}} + \underset{(3.50)}{0.50\Delta s_{t-2}} - \underset{(-2.34)}{0.3346\Delta i_{t-1}} + \underset{(0.61)}{0.0864\Delta i_{t-2}} + \underset{(2.35)}{4.4248\Delta p_{t-1}} \\ - \underset{(-0.10)}{0.2117\Delta p_{t-2}} + \underset{(1.85)}{0.0442\Delta b_{t-1}} + \underset{(0.79)}{0.0193\Delta b_{t-2}} - \underset{(0.34)}{0.00042 v_{t-1}}\end{aligned}$$

and with the estimated cointegrating relation is

$$\begin{aligned}\Delta s_t = \underset{(0.55)}{0.101\Delta s_{t-1}} + \underset{(3.74)}{0.540\Delta s_{t-2}} - \underset{(-1.63)}{0.251\Delta i_{t-1}} + \underset{(0.90)}{0.130\Delta i_{t-2}} \\ + \underset{(1.82)}{3.5465\Delta p_{t-1}} + \underset{(0.45)}{0.924\Delta p_{t-2}} + \underset{(0.11)}{0.00498\Delta b_{t-1}} - \underset{(-0.16)}{0.00513\Delta b_{t-2}} + \underset{(1.19)}{0.616\hat{v}_{t-1}},\end{aligned} \tag{4.5}$$

where the t-statistics are in parenthesis and $v_t = s_t - p_t$, $\hat{v}_t = -2.37 s_t - 1.04 i_t + 15.1 p_t + 1.14 b_t + 11.6$.

The rise in the interest rate differential has the traditional impact of appreciating the nominal exchange rate. We have not found evidence supporting the revisionist view that a rise in the interest rate differential has a negative effect on the exchange rate. Figure 1 plots the impulse response functions of one standard error shock to the interest rate differential on the exchange rate. Again, the three different time series models have remarkably similar effects. However, the chain of events of the interest differential shock under these three specifications are different. In (4.3), a shock to the interest rate differential creates a shock to the exchange rate. However, because the exchange rate follows a random walk,the effects of the shock never dies out. On the other hand, equations (4.4) and (4.5) imply that the impact of the interest differential shock also depends on its impact on the inflation rate and the bankruptcy rate through the long-run relations $s_t = p_t$ or $s_t = 4.91 - 0.437i_t + 6.357p_t - 0.479b_t$.

The bankruptcy rate also appears to respond positively to the nominal exchange rate. However, we are not able to find any direct link between the bankruptcy rate and the interest rate differential in the short-run. This is perhaps due to short-time period used, or perhaps because the interest rate is reacting to the exchange rate depreciation and the impact of rising interest rate has already been picked up by the exchange rate depreciation. These results are consistent with the traditional view that high bankruptcies are caused not by high interest rate, but by depreciated exchange rates which raises debt burdens in dollar terms.

V. Conclusions

In this paper we have presented two views on the impact of tight monetary policies on nominal exchange rates during times of economic crisis. The empirical results are supportive of the traditional view. Monetary tightening and the rise in interest rates appear to have succeeded in appreciating the Korean won. Given the limited number of observations and noise in the data, the time series specifications can be fragile. However, we found that the relationship between the exchange rate and the interest rate differential is surprisingly robust to different specifications. As Leamer and Leonard (1983) remarked: "Researchers (are) given the task of identifying interesting families of alternative models and (are) expected to summarize the range of inferences which are implied by each of the families. When a range of inference is small enough to be useful and when the corresponding family of models is broad enough to be believable, we may conclude that these data yield useful information. When the range of inferences is too wide to be useful, and when the corresponding family of models is so narrow that it cannot credibly be reduced, then we must conclude that inferences from these data are too fragile to be useful".

Thus, we conclude that the Korean experience supports the traditional view that raising the interest rate does appreciate the nominal exchange rate. Furthermore, we find that the corporate bankruptcy rate responds more to the exchange rate depreciation than to the interest rate increase. In short, we have not found evidence supporting the revisionist view that high interest rates result in rising corporate bankruptcies, capital outflows, and hence, depreciating exchange rates.

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Chart 1

Call Rate and Interest Differentials

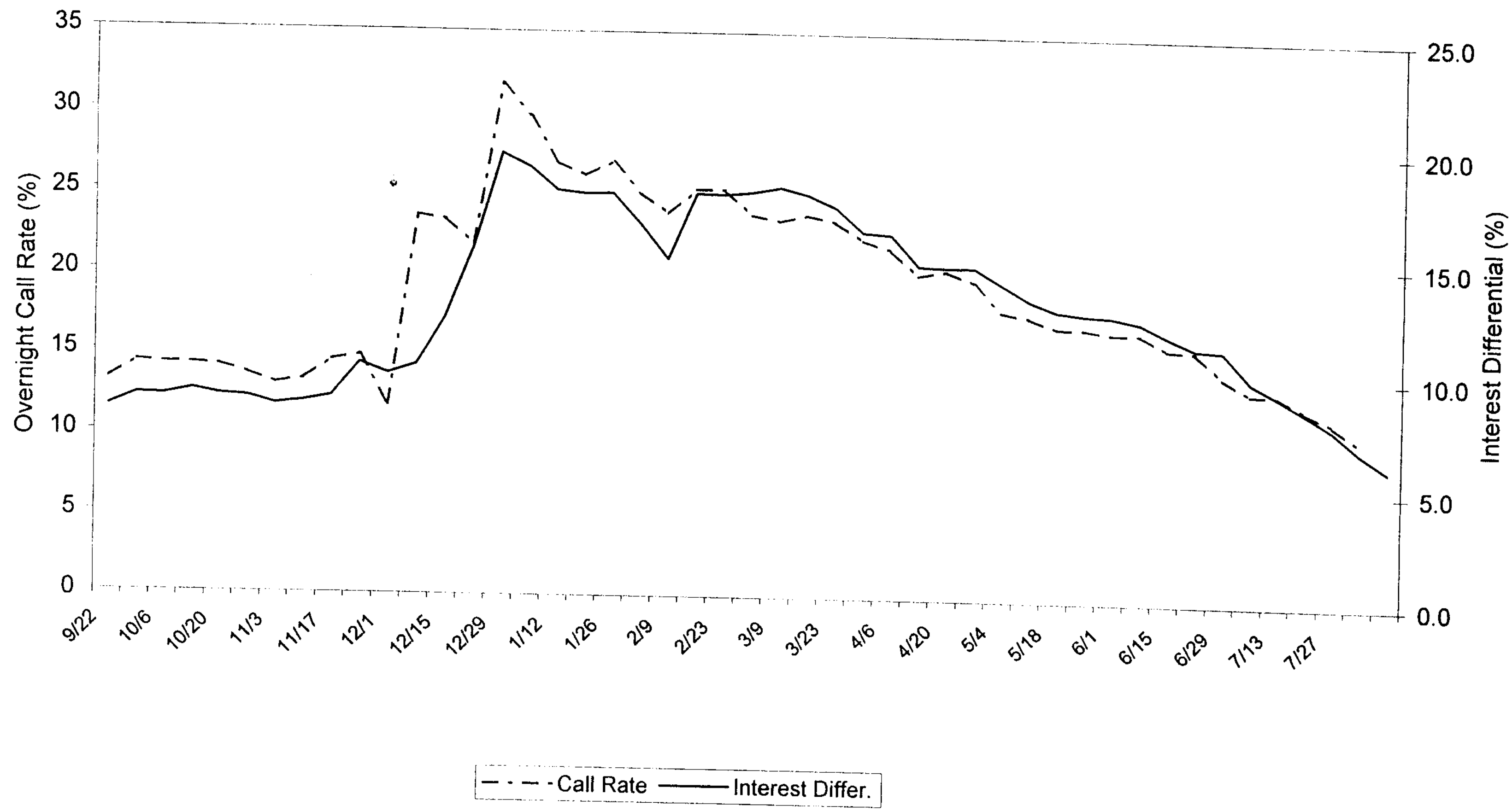


Chart 2

Exchange Rates and Interest Differential

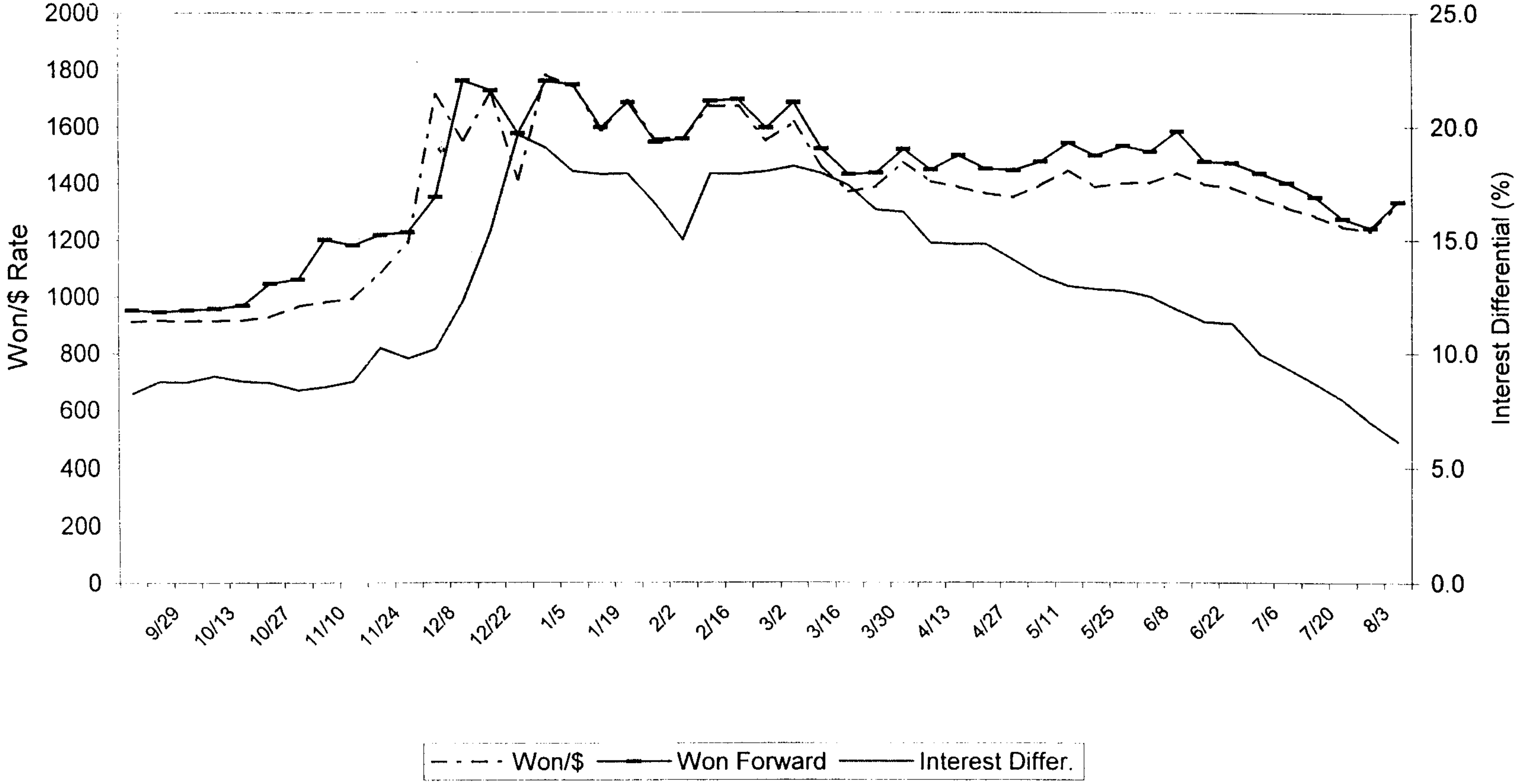


Chart 3

Volatility and Interest Differentials

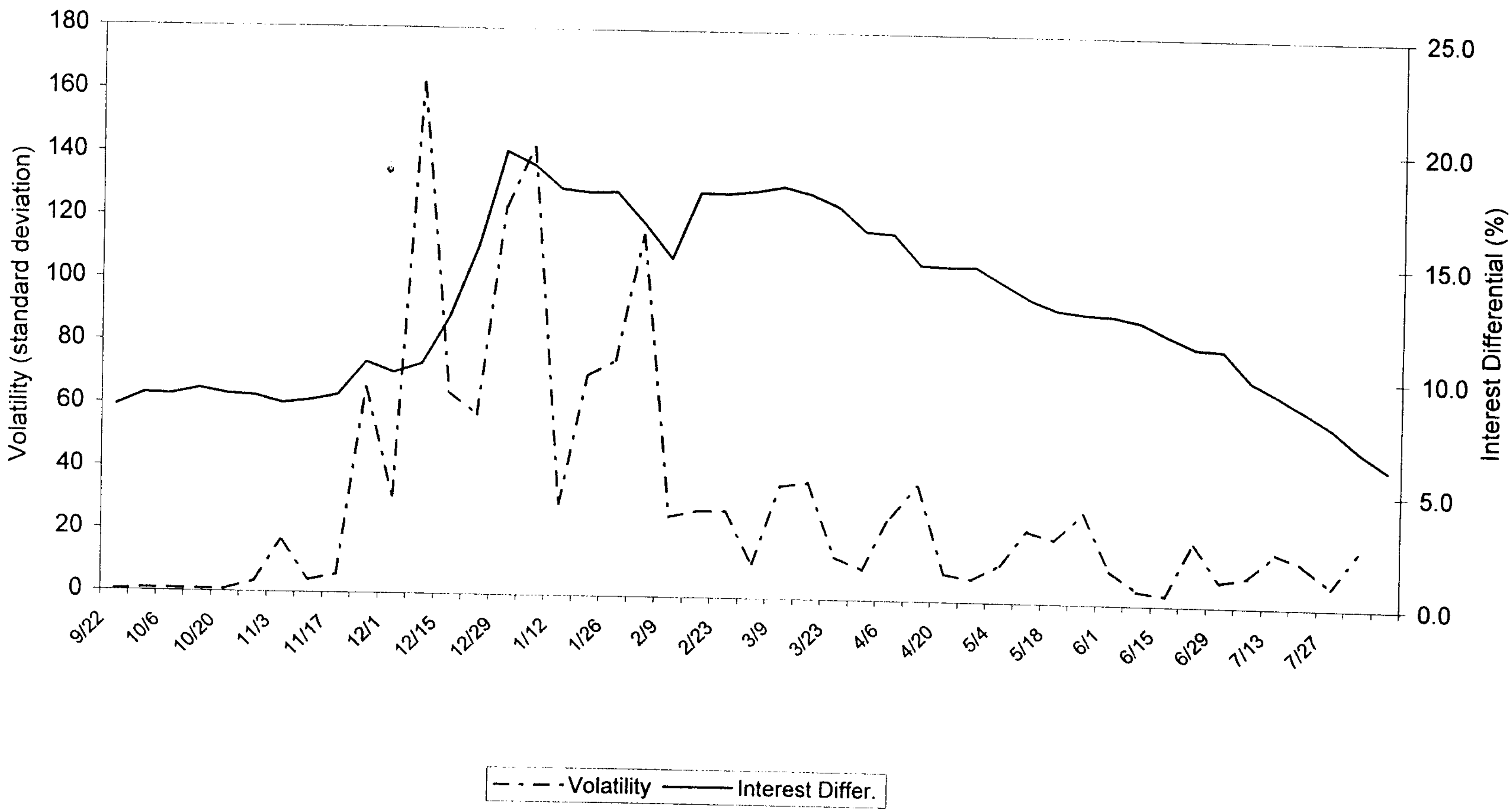
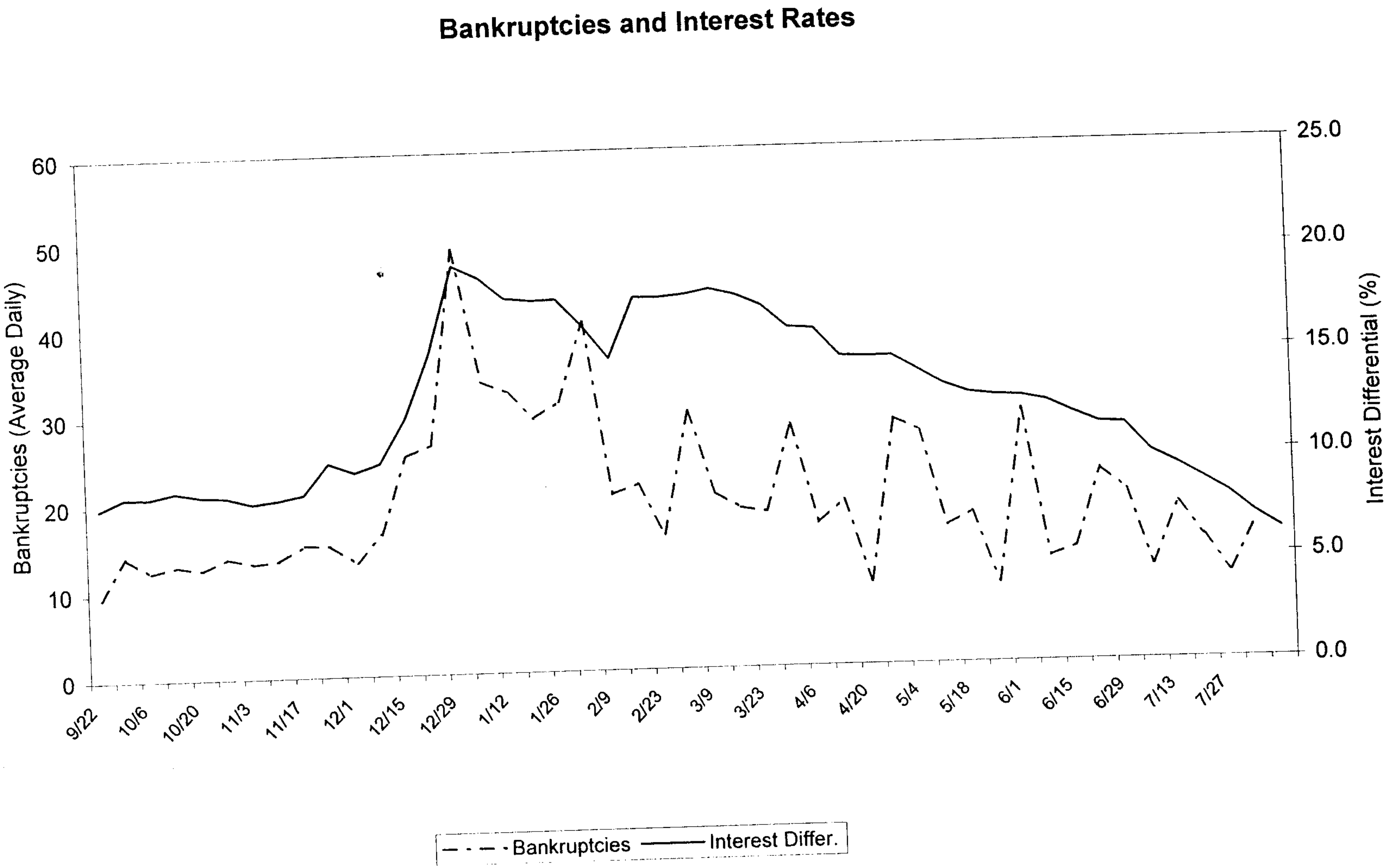


Chart 4



Bankruptcies and Interest Rates
Bankruptcies (Average Daily)
Interest Differential (%)
60
50
40
30
20
10
0
25.0
20.0
15.0
10.0
5.0
0.0
9/22
10/6
10/20
11/3
11/17
12/1
12/15
12/29
1/12
1/26
2/9
2/23
3/9
3/23
4/6
4/20
5/4
5/18
6/1
6/15
6/29
7/13
7/27
Bankruptcies
Interest Differ.

Chart 5

Interest Differential and Default Premia (S)

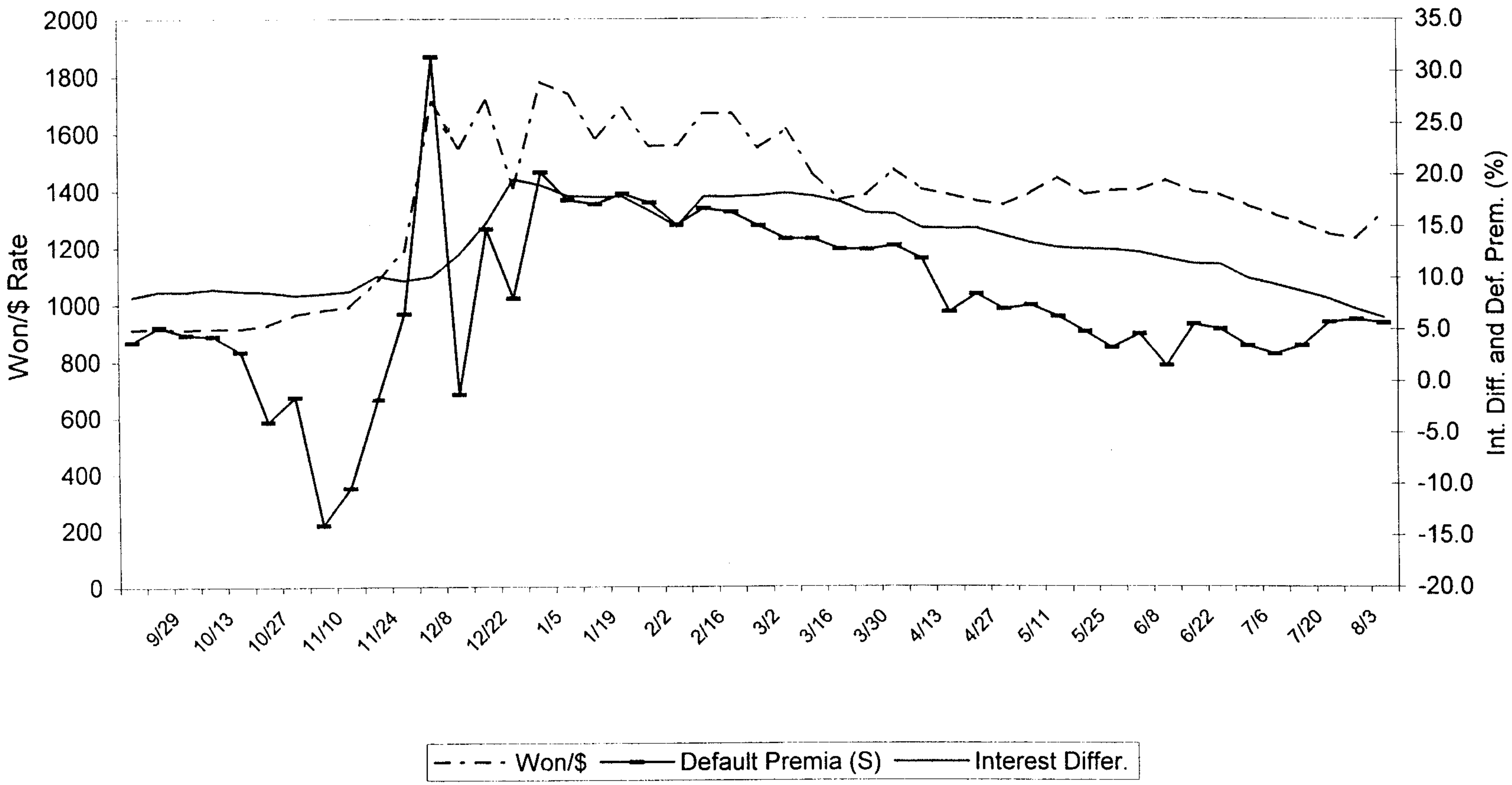
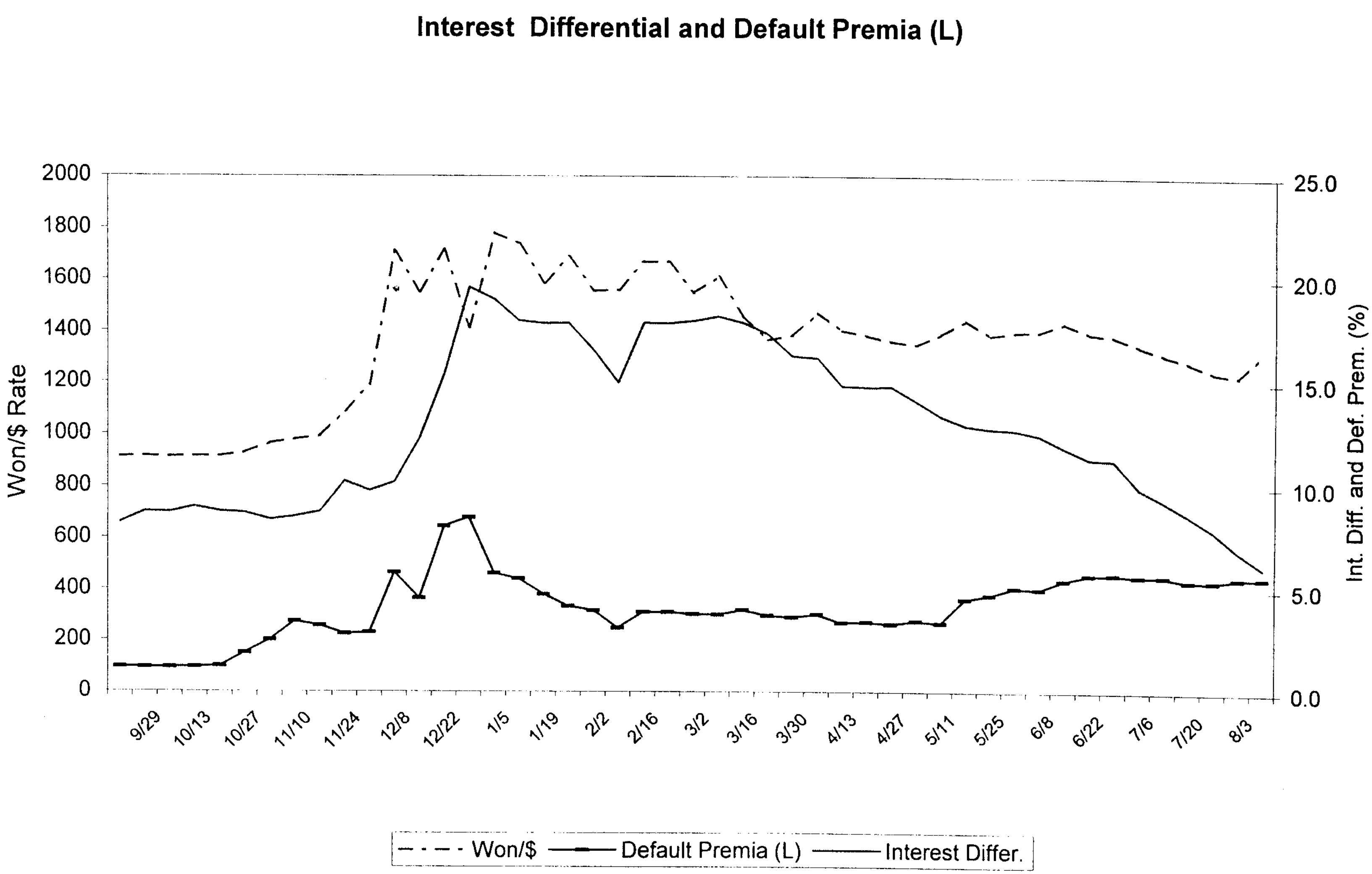


Chart 6



Interest Differential and Default Premia (L)
Won/$ Rate
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Int. Diff. and Def. Prem. (%)
25.0
20.0
15.0
10.0
5.0
0.0
9/29
10/13
10/27
11/10
11/24
12/8
12/22
1/5
1/19
2/2
2/16
3/2
3/16
3/30
4/13
4/27
5/11
5/25
6/8
6/22
7/6
7/20
8/3
Won/$
Default Premia (L)
Interest Differ.

Table 1 Unit Root Tests

Variables	AIC (P)	SBC (P)	95% Critical Values
S (Spot Exchange Rate)	-1.8262 (2)	-1.8262 (2)	
I (Interest Rate Differential)	-0.49663 (0)	-0.49663 (0)	-3.5189
P (Inflation Rate Differential)	-1.8881 (2)	-1.2970 (0)	
B (Korean Bankruptcy Rate)	-2.6721 (1)	-4.3862 (0)	
Δ S	-2.6649 (1)	-2.6649 (1)	
Δ I	-5.0740 (0)	-5.0740 (0)	-2.9339
Δ P	-2.0105 (4)	-2.5041 (0)	
Δ B	-6.6124 (1)	-10.6222 (0)	

AIC = Akaike Information Criterion
SBC = Schwarz Bayesian Criterion
P gives the order of lags selected by the AIC or SBC.

Table 2 Parameter Estimates of Model 1, with One Estimated Long-run Relation

	ΔS	ΔI	ΔP	ΔB
$\Delta S(-1)$	0.10100 (0.55455)	0.099065 (0.48780)	0.029160 (2.0476)	-1.9439 (-1.8687)
$\Delta S(-2)$	0.54026 (3.7391)	0.59879 (3.7166)	0.026589 (2.3535)	-0.39659 (-0.48057)
$\Delta I(-1)$	-0.25088 (-1.6257)	-0.063581 (-0.36950)	-0.0028158 (-0.23336)	-0.78358 (-0.88902)
$\Delta I(-2)$	0.12963 (0.90212)	-0.32097 (-2.0032)	0.017012 (1.5141)	-0.57249 (-0.69753)
$\Delta P(-1)$	3.5465 (1.8240)	4.0623 (1.8738)	0.066447 (0.47084)	10.8913 (0.98076)
$\Delta P(-2)$	0.92440 (0.45447)	-1.7923 (-0.79027)	0.16615 (1.0447)	25.4201 (2.1882)
$\Delta B(-1)$	0.0049843 (0.10556)	0.064777 (1.2304)	-0.0023211 (-0.62872)	0.33603 (1.2461)
$\Delta B(-2)$	-0.0051318 (-0.16451)	0.041174 (1.1837)	-0.6528E-3 (-0.26763)	0.25162 (1.4122)
V* (-1)	0.061562 (1.1853)	-0.047836 (-0.82600)	0.0074383 (1.8316)	-1.3923 (-4.6936)

*: Cointegrating Vector

$$V = -2.3731\ S - 1.0375\ I + 15.0899\ P + 1.1373\ B + 11.6$$

Table 3 Parameter Estimates of Model 2, Assuming Long-run Purchasing Power Parity

	Δ S	Δ R	Δ P	Δ B
Δ S (-1)	-0.0074633 (-0.046904)	0.19838 (1.1527)	0.014933 (1.1815)	0.60463 (0.52586)
Δ S (-2)	0.50042 (3.5033)	0.64976 (4.2056)	0.020283 (1.7876)	0.63156 (0.61187)
Δ I (-1)	-0.33460 (-2.3359)	0.10248 (0.66147)	-0.010981 (-0.96511)	0.94379 (0.91183)
Δ I (-2)	0.086411 (0.60817)	-0.29444 (-1.9160)	0.012315 (1.0912)	0.36033 (0.35097)
Δ P (-1)	4.4248 (2.3518)	3.7977 (1.8662)	0.14141 (0.94623)	-6.3199 (-0.46486)
Δ P (-2)	-0.21171 (-0.10375)	-1.7912 (-0.81160)	0.21088 (1.3011)	12.8233 (0.86969)
Δ B (-1)	0.044190 (1.8450)	0.029277 (1.1302)	0.0034184 (1.7968)	-0.75890 (-4.3850)
Δ B (-2)	0.019344 (0.78744)	0.025969 (0.97737)	0.0020202 (1.0353)	-0.27774 (-1.5646)
U* (-1)	-0.4265E-3 (0.34385)	-0.0016203 (-1.2078)	0.9401E-4 (0.95424)	-0.0027402 (-0.30574)

*: Imposed Purchasing Power Parity Condition: U = S – P

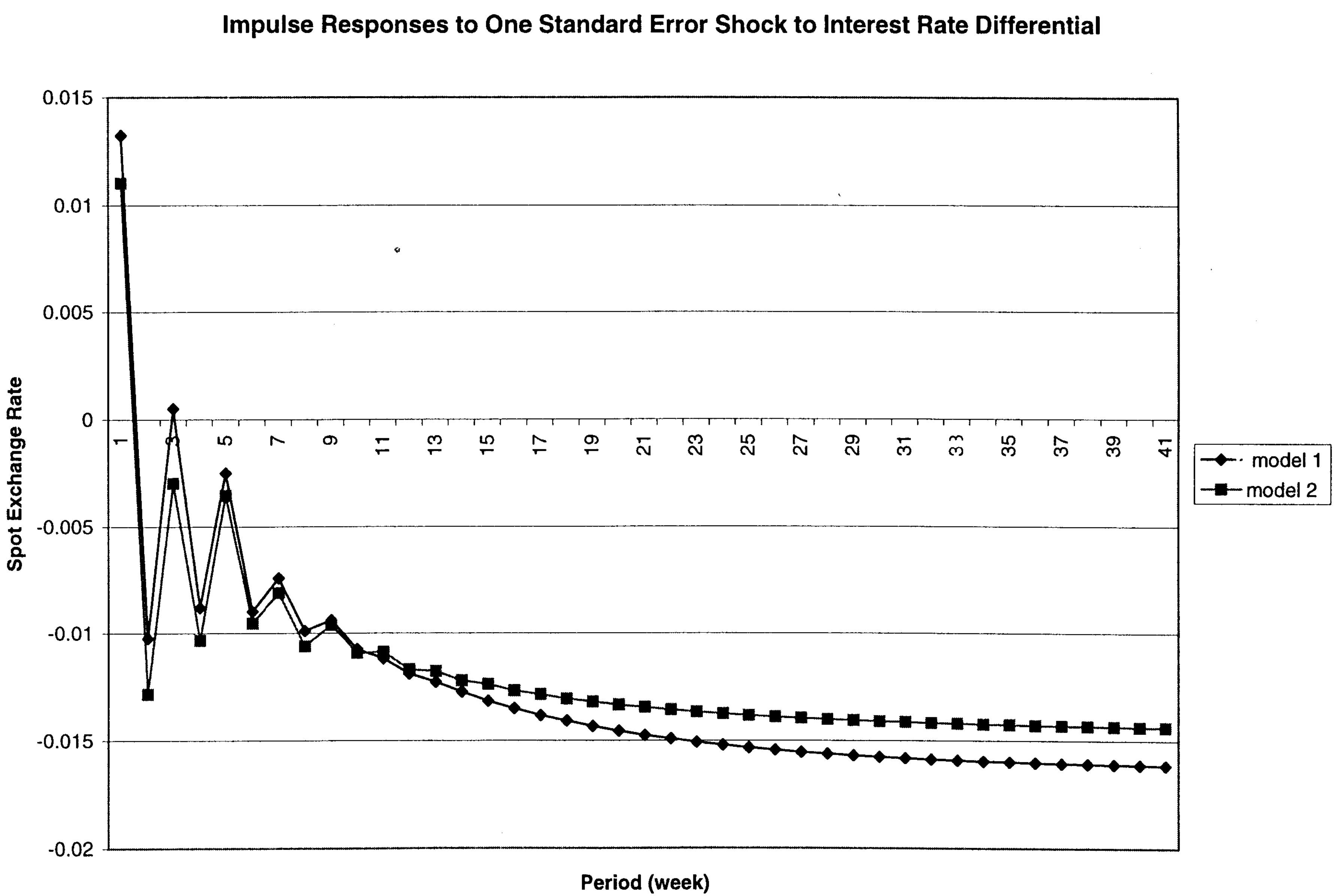
Table 4 Parameter Estimates of Model 3, Assuming No Cointegrating Relation

	ΔS	ΔI	ΔP	ΔB
Intercept	-0.00598039 (-0.68)	-0.011827 (-1.29)	0.00030641 (0.90)	-0.037891 (-0.67)
ΔS (-1)	-0.047141 (-0.34)	0.153907 (0.96)		0.487702 (0.49)
ΔS (-2)	0.559816 (4.34)	0.641913 (4.70)		1.763203 (2.03)
ΔS (-3)		0.311306 (1.96)		1.993429 (1.95)
ΔI (-1)	-0.286235 (-2.27)			
ΔI -2)				
ΔI (-3)				
ΔP (-1)	6.428625 (2.54)		0.801466 (8.47)	
ΔP (-2)				
ΔP (-3)				
ΔB (-1)				-0.831877 (-5.29)
ΔB (-2)				-0.551550 (-3.01)
ΔB (-3)				-0.301370 (-1.95)

Table 5 H-Period Ahead Root Mean Square Error Comparison

	Model 1	Model 2	Model 3
Δ S	0.032996	0.027577	0.029980
Δ I	0.051052	0.048289	0.048608
Δ P	0.0058651	0.0044566	0.00055145
Δ B	0.54950	0.44197	0.59747
S	0.067431	0.038322	0.098138
I	0.15316	0.14752	0.16349
P	0.023052	0.013003	0.00078863
B	0.40638	0.29109	0.38951

Figure 1


Impulse Responses to One Standard Error Shock to Interest Rate Differential
Spot Exchange Rate
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
Period (week)
model 1
model 2