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«Exchange Rate Policies in Korea : has Exchange Rate Volatility Increased After the Crisis ?»

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**Exchange Rate Policies in Korea:
Has Exchange Rate Volatility Increased
After the Crisis?***

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I. Introduction

The type of exchange rate regime in emerging economies has been at the center of economic debate since the Asian crisis. The choice of exchange rate regime has been regarded as critical for emerging economies to achieve sustainable economic growth, and also has important implications for the world economy. In principle, the most appropriate regime for any given economy may differ, depending on the particular economic circumstances, such as the degree of integration into the world economy. Since economic circumstances vary over time, the most appropriate regime for any given country may also change over time.¹

Following the collapse of the Thai baht's peg on July 2, 1997, the exchange rate movements of East Asian countries – in particular, Thailand, Malaysia, Indonesia, the Philippines, and Korea – headed in parallel directions during late 1997 and early 1998. Common external shocks, strong trade linkages, and similar patterns of capital movements in the region caused the exchange rates of those currencies to move in a similar direction. Behind this backdrop, the regime shift from managed, or pseudo fixed, to a free floating exchange rate system brought about these parallel movements of currencies in the region.

The purpose of this paper is to delve into the question of whether a free floating exchange rate regime is a viable option for Korea. The recent experiences in Korea will provide not a definitive, but an insightful answer to this question. This paper divides the sample period into three sub-periods: pre-crisis, crisis, and post-crisis. And then, we analyze the causal relationships among both levels and volatilities of three financial variables: exchange rates, interest rates, and stock prices. The empirical results will provide clues for understanding how the Korean financial markets have evolved after the crisis.

The rest of this paper is organized as follows. The next section will review the stylized facts related to the movements of the three financial variables. Section III will conduct empirical analyses to find out the relationships among these three variables. Finally, based upon the empirical results, we will discuss the policy implications and the relevance of the exchange rate regime in Korea.

II. Stylized Facts on Exchange Rates and Related Financial Variables

In this section, we will describe the stylized facts on exchange rates movements and their relationship with related financial variables such as interest rates and stock prices. In order to find out whether regime changes induce structural breaks in the behaviors among three variables (exchange rates, interest rates, and stock prices), we divide the overall period into pre-crisis, crisis, and post-crisis.

The market average exchange rate (MAR) system was adopted in March 1990. Since then, the won-dollar exchange rates have been in principle determined by market forces.

¹ In terms of the exchange rate system, the share of fixed exchange rates has fallen from about 60 percent in 1989 to about 45 percent in 1999, while the share of floating currencies has risen from about 12 percent to 25 percent during the same period. According to JP Morgan (1999), the theme most likely to dominate foreign exchange markets in the years ahead is the continued trend towards a polarized exchange rate system in the global economy – fewer fixers and even fewer peggers and an increasing number of floaters.

However, frequent interventions by the Bank of Korea were also common phenomena under this managed floating regime. The actual change in the exchange rate regime took place in December 1997, when the Korean government abolished the previous managed floating regime. However, in October 1997, there were episodes of speculative attacks on the Hong Kong dollar as well as the Hong Kong stock market crash, and the spread of forward contracts rose rapidly in the offshore non-deliverable forward (NDF) markets. Taking these developments into account, we presume that the crisis period started from October 1997. Finally, we suppose that the post-crisis started from September 1998, because the first-round of financial restructuring was completed at that time and the domestic spot rates and the offshore NDF three-month forward rates have moved more tightly since that time. Accordingly, the three sub-periods are defined as follows:

- Pre-crisis period : March 2, 1990 – September 30, 1997
- Crisis period : October 1, 1997 – September 30, 1998
- Post-crisis period : October 1, 1998 – September 30, 1999

2.1 Pre-Crisis Period: March 1990 – September 1997

During the pre-crisis period, Korea maintained the MAR system which could be classified as a managed floating exchange rate system. Under this system, the Bank of Korea occasionally intervened in the foreign exchange market, although the modes and frequency of intervention changed, as did the objectives guiding the intervention. Active intervention resulted in changes in foreign reserves, whatever sterilization or non-sterilization took place. However, indirect intervention, through changes in monetary policies, did not result in changes in foreign reserves.

This managed floating system having the above features, generally speaking, has pros and cons. The benefits and costs of this system can be characterized as ones somewhere between those of pure floating and fixed exchange rate regimes. As in a free floating regime, this managed floating system shoulders the bulk of the adjustments to external and domestic shocks through changes in the nominal exchange rate. However, higher level of foreign reserves may be needed as a self-defensive countermeasure against the abrupt capital outflows or sharp exchange rate depreciation. Occasional intervention also dampens excessive fluctuations in exchange rates, although a consensus view is that the effects of intervention are typically short-lived and may destabilize the market. While the fixed exchange rate system gains credibility, one of its major shortcomings is that the lack of transparency of central bank behavior may introduce too much uncertainty to the market.

Unlike the experiences in most industrial countries having freely floating exchange rates, direct intervention in the foreign exchange market could be effective in the case of those developing countries which adopted managed floating systems. Various studies on the effectiveness of intervention in Korea during the managed floating system also confirmed that sterilized intervention had at least a short-run effect. As the capital market opened more widely and the central bank firmly targeted M2 growth rates, however, intervention policies became increasingly less effective.² In the early 1990s,

² See Rhee and Song (1999) for further elaboration on the effectiveness of intervention policies in Korea.

current account deficits caused mild depreciations of the Korean won. Interest rates also continued to decline until the end of 1993, and stock prices continued to rise until the end of 1995.

Despite continued extensive capital controls, liberalization measures during the pre-crisis period led to increasingly larger net capital inflows. In addition, an investment-led boom between 1994 and 1996 generated a strong demand for low cost capital. This steep increase in net capital inflows put appreciation pressures on the Korean won. To offset these pressures, the government relied on restrained sterilization, and managed to curb the abrupt appreciation of the won and resultant increase in the current account deficit. During early 1994 to mid 1995, exchange rates mildly appreciated and interest rates rose while stock prices continued to rise. Furthermore, Standard and Poor's upgrading of Korea's sovereign credit rating in May 1995 attracted further foreign portfolio investment.³ However, the current account balance sharply deteriorated from mid 1995, resulting in the depreciation of the Korean won by offsetting the downward pressures of the capital account surplus. The combination of foreign capital inflows and expansionary monetary policies caused the interest rates to fall. However, stock prices started to fall in early 1995. The Korean economy experienced large negative terms of trade shock in the second quarter of 1996, which created a significant depreciation pressure on the Korean won. As a result, the current account deficit in 1996 reached a historical high - USD 23.7 billion.

<Figure 1> Exchange Rates and Interest Rates (3-year Corporate Bond Rate):
January 1992 – September 1997

The large interest rate differential between home and abroad, coupled with the bright prospects of the economy, have made Korea one of the most attractive markets among the emerging economies to foreign investors, and capital account liberalization has triggered massive capital inflows. However, most foreign portfolio investment took place in the stock market, since the bond market was completely closed until 1994 and heavily regulated until the end of 1997. The cumulative net inflow of portfolio investment during 1992-1996 was USD 16.3 billion. As of the end of 1996, the share of foreign ownership in the Korean stock market has risen to 10.5 percent of the market value.

Although a lion's share of foreign capital inflow also rushed in through bank loans, mainly due to interest differentials between domestic and foreign capital markets, capital inflows through portfolio investment funds significantly affected exchange rate fluctuations. Furthermore, as foreign investors became increasingly important market players in the Korean stock market, the Korean stock price index (KOSPI) was also influenced by foreigners' equity investment flows to a substantial extent. Therefore, it might be expected that there existed a negative correlation between stock prices and won-dollar exchange rates. Nevertheless, albeit continuous inflows of foreign investors' equity investment during 1992-1994, no noticeable relationship between these two variables could be captured. Since the KOSPI hit its highest level (1,138.75) on November 8, 1994, it had already started its slid even before the crisis broke out.

³ Moody's upgraded Korea's sovereign credit rating from A2 to A1 in April 1990, and maintained the rating until August 1997.

<Table 1> Trend of Foreign Portfolio Investments (Net Inflows)
(In Million US Dollar)

	1992	1993	1994	1995	1996	1997	1998
Stocks	2034.5	5696.5	1960.3	2203.8	4373	777.4	3988.1
Bonds	0	0	30.3	17.2	15.9	197.5	227.6

Source: Bank of Korea

<Figure 2> Exchange Rates and Stock Prices (KOSPI): January 1992 – September 1997

In conclusion, large interest rate differentials and the overhauling of the previous heavy regulations on capital movements were major contributing factors in triggering massive capital inflows. Although these massive capital inflows, including foreign stock purchases, offset the depreciation pressure induced by the current account deficit, the Korean won dropped to 753 won per dollar on July 7, 1995,⁴ and continued to depreciate gradually until the crisis set in. Since all the regional currencies, except China's *renminbi* and the Hong Kong dollar, lost value after the crisis, many economists and policy makers argued that these regional currencies were overvalued on the eve of the crisis. Although the lack of an operational definition of overvaluation is still troubling,⁵ the price-based real effective exchange rates in Korea had been around the equilibrium level until 1994, but was slightly overvalued on the eve of the 1997 currency crisis according to our calculations shown in Table 2.⁶

<Table 2> Trend of Real Effective Exchange Rates

1990.1	1991.1	1992.1	1993.1	1994.1	1995.1	1996.	1997.1	1997.4
111.39	104.62	100.26	100	97.86	92.02	90.51	93.66	96.06
1997.7	1997.10	1998.1	1998.4	1998.7	1998.10	1999.1	1999.4	1999.7
95.50	99.56	119.58	109.64	113.21	107.26	105.55	103.89	105.17

Note: the real effective exchange rates are calculated based on trade-weight, consumer prices index, and January 1993 as the basis year.

2.2 Crisis Period: October 1997 – September 1998

The currency crisis led to a dramatic depreciation of the nominal exchange rates. The sudden collapse of investors' confidence and concomitant capital outflows, and/or sharp decline of the rollover ratio of short-term external borrowings, caused the nominal exchange rates to overshoot during the crisis. Inflation, albeit higher than before the crisis, had been below expectations; consequently, real exchange rates depreciated by about 20 percent. Most observers agree that exchange rates fell below the levels required to achieve adequate current account adjustment. There are two mechanisms

⁴ The won-dollar exchange rate bottomed out at the level of 695.5 on March 5, 1995 as a result of continued current account surpluses in the late 1980s.

⁵ On the definition of overvaluation, see Chinn (1998), Milesi-Ferretti and Razin (1996), and Williamson (1994).

⁶ Radelet and Sachs (1998) reported that the real effective exchange rate appreciated by about 12 percent in Korea between 1990 and early 1997. Chinn (1998), interestingly, reported that the Korean won was undervalued even before its recent discrete drop in value.

through which the real exchange rate can be corrected in case it is undervalued: through nominal currency appreciation or through higher inflation. As in Goldfajn and Gupta (1999), we can say that a successful reversal occurs primarily through nominal appreciations rather than through higher inflation.

Due to large increases in nominal interest rates under the IMF program, Korea stands out as having maintained real interest rates at a significantly higher level than before the crisis for an uninterrupted period of several months.⁷ Therefore, it has experienced sharp slowdowns in money and credit growth during the adjustment process thus far.⁸ Realizing the hardships faced by the real economic sector, however, the IMF took a more flexible stance toward the high interest rate policy in the 5th Letter of Intent (February 7, 1998). Accordingly, the government ought to be pushing forward with its plan to lower interest rates as it gains momentum in stabilizing the foreign exchange market.⁹ The Korean government brought down the short-term interest rates from a 30 percent level in January 1998 to a 15 percent level in June 1998, as the won-dollar exchange rate demonstrated considerable stability staying between 1,300 and 1,400 since March 1998. As an ensuing effect, the call rate initially fell to a 27 percent level in early 1998, and further fell to 15 percent by late June of 1998. Furthermore, corporate bond yields with a 3-year maturity fell to 14 percent on July 4, 1998.¹⁰ Nonetheless, only the core businesses of the largest *chaebol* could enjoy the benefits of these interest rate reductions. The rest of the large, medium, and small-sized businesses were yet unable to secure loans, although they were willing to pay interest rates of more than 20 percent because they were suffering from a credit crunch. As shown in Figure 3, interest rates and exchange rates moved in the similar directions during the crisis period.

<Figure 3> Exchange Rates and Interest Rates: October 1997 – September 1999

As mentioned above, stock prices had already declined during the pre-crisis period. This indicated one of the earliest signs of trouble, although policy makers were inclined to believe that declining stock prices were mainly due to cyclical factors rather than structural problems. During 1996, stock prices (in domestic currency terms) fell by more than 20 percent in Korea. Several of the largest *chaebol* posted losses in 1996 and 6 of the top 30 went bankrupt in 1997 before the crisis broke out. The crisis aggravated

⁷ Pursuant to the agreement with the IMF, the Korean government lifted the ceiling on the interest rate from 25 percent to 40 percent on December 22, 1997, and eventually abolished the ceiling on December 29, 1997.

⁸ The growth rate of the monetary base at the end of December 1997 was negative 12.5 percent, which exceeded the target level of negative 9.5 percent set by the IMF program.

⁹ On January 28, 1998, the Korean government and 13 representatives of the foreign commercial banks reached an agreement on the maturity extension of short-term external debts. Following the due procedures, the contracts were signed on March 31, whereby 96.5 percent of Korean commercial banks' short-term debts, amounting to USD 22.65 billion, were converted to long-term maturity of one to three years. This effectively provided breathing room for Korean commercial banks to improve their foreign currency position. After completing the maturity extensions, the Korean government issued USD 4 billion of global bonds for the first time. They were issued within 6 months after the financial crisis broke out. The first global bond issuance was successful given the unfavorable market condition such as the sovereign credit rating being below investment grade. These two events, along with the liquidity assistance from the international financial institutions such as IMF, IBRD, and ADB, contributed to the stability of the currency and financial markets in Korea.

¹⁰ This figure is comparatively high when the pre-crisis level of 12 percent is taken into consideration.

the situation and severely undermined investors' confidence in the stock market. As a result, the stock price index fell to 376.31 by the end of December 1997.

Having hit the bottom, the KOSPI quickly recovered at the beginning of 1998, with the aid of foreigners' stock purchases. However, after peaking at 574.35 on March 2, 1998, the KOSPI once again began to slide downwards. Following the sudden weakening of the Japanese yen, the KOSPI plunged below 300 on June 16.¹¹ Again, foreign investors left the Korean market, and more bankruptcies were predicted while corporate and financial restructuring was in process. During the crisis period, the foreign portfolio investors had played an increasingly important role in determining stock prices.

A related issue of interest is whether the trading patterns of foreign portfolio investors were destabilizing the Korean stock market during the pre-crisis and crisis periods. Choe, Kho, and Stulz (1998) find evidence of positive feedback trading (e.g., rushing to buy when the market is booming and rushing to sell when the market is slumping) and herding by foreign portfolio investors. But no evidence of destabilizing effects of foreign investors' trading on the Korean stock market during the pre-crisis period and last three months of 1997 were found. Kim and Wei (1999a) improved and updated information on trade data on the Korean Stock Exchange. They find strong evidence of positive feedback trading and herding by foreign investors before, during, and after the crisis, but fail to explain whether foreign investors were largely accountable for destabilizing the market.¹²

By updating the data period and taking domestic investors into account, Park and Park (1999) support the earlier findings. Furthermore, several additional findings are also obtained from more micro-based analysis. As shown in Figure 4, foreign investors actively increased their holdings of Korean stocks even during the crisis period (December 1997 – April 1998), although they left the market during September 1997 – November 1997. In contrast, most domestic institutional and individual investors reduced their shareholdings after the crisis broke out. Interestingly, domestic individual investors' responses to the market change were quite passive and perhaps irrational. When foreign investors and most of the domestic institutional investors left the market right after the crisis touched off, individual investors stayed on and increased their stock holdings. Similarly, when foreign investors and domestic investment trust companies returned to the market after market stability was restored, individual investors reduced their stock holdings and only gradually returned to the market. In this regard, Park and Park (1999) conclude that domestic investors, especially individual investors, were the major source of the increased volatility.

<Figure 4> Net Foreign Equity Purchase and Stock Prices (KOSPI)

Stock prices and exchange rates also moved in a predictable direction during the early

¹¹ The KOSPI bottomed out at 280 on June 6, 1998.

¹² Kim and Wei (1999b) compare the trading behavior in Korea by offshore funds with that of their onshore counterparts registered in the United States and the United Kingdom. There are a number of interesting findings. First, there is indeed evidence suggesting that the offshore funds trade more intensively than their onshore counterparts. Second, however, there is no evidence that the offshore funds engage in positive feedback trading. In contrast, there is strong evidence that the funds from the U.S. and U.K. do so. Third, while offshore funds herd, they do so significantly less than the offshore funds from the U.S. or U.K.

crisis period (October 1997 – December 1997). As the crisis set in, exchange rates sharply depreciated and stock prices plunged. However, the stock prices fell again in February 1998 and remained stagnant until the end of September while the won-dollar exchange rate stabilized (appreciated) remarkably. In conclusion, foreign portfolio investment did not contribute to the stability of foreign exchange rates in Korea during the latter period of the crisis.

<Figure 5> Exchange Rates and Stock Prices (KOSPI): October 1997 – September 1999

2.3 Post-Crisis Period: October 1998 – September 1999

One of the most commonly voiced objections to the floating exchange rate regime is that exchange rates will be excessively volatile. During the crisis period, exchange rates and asset prices were highly volatile. Starting in September 1998, however, the Korean won began to exhibit an impressive degree of stability. As was the case in the Mexican experience during 1996-97, we may ask ourselves the question of whether this stability was consistent with the freely floating regime. A particularly interesting aspect of the Mexican case is that the relative lack of volatility of the peso/dollar rate during this period was not caused by direct central bank intervention in the foreign exchange market. According to Edwards and Savastano (1998), however, during this period the central bank adopted a feedback rule for monetary policy that took into consideration the short-run behavior of the nominal exchange rate.¹³

During the post-crisis period, starting from October 1998, we clearly observe simultaneous interactions between interest rates and exchange rates. Both interest rates and won-dollar exchange rates continued to fall. Furthermore, since most foreign portfolio investment took place in the stock market rather than the bond market, the continued inflow of foreign portfolio investment funds not only boosted the stock prices, but also contributed to the stability of exchange rates.

One of the most impressive developments during the post-crisis period is the continued increase of Korea's usable foreign reserves. The usable foreign reserves increased from less than USD 3.9 billion in December 1997 to USD 48.5 billion in December 1998 and to USD 66.2 billion in October 1999. Such a level of foreign reserves would serve as an effective buffer against any potential external shock. However, the accumulation of the foreign reserves also contributed to easing of appreciation pressures induced by the current account surplus and the continued capital inflow through foreign direct and portfolio investment funds.

The Korean government recently announced that it would issue up to five trillion won (USD 4.22 billion) of won-denominated government bonds by the end of 1999 so as to keep the local currency from rising too quickly against the U.S. dollar. The government originally planned to issue bonds worth five trillion won in August 1999, but shelved the plan as the pressure on the won dissipated after the Daewoo crisis erupted in July. To balance the supply of and demand for dollars, the government is also taking other measures, such as encouraging local banks to purchase dollars to provision for their foreign currency-denominated non-performing loans resulting from the Daewoo crisis.

¹³ More specifically, using weekly data they were able to identify a reaction function that showed that the monetary authorities tightened liquidity (base money) below its preestablished target when the peso lost value vis-à-vis the dollar, and eased liquidity when the peso appreciated.

III. Empirical Analysis

In this section, we investigate empirical relations among three financial variables - exchange rates, stock prices, and interest rates - to see if there has been any active foreign exchange market intervention after the crisis. That is to say, to infer from the empirical results if there has been any change in policy directions toward the foreign exchange market since the free floating regime was adopted as a market discipline. Because the intervention data is, unfortunately, not available to the public in Korea, we cannot identify how the operations of the government's intervention has changed after the crisis. Thus, in order to determine if exchange rate fluctuations under the free floating regime have still remained under the reign of government authority, as it had been under the managed floating scheme, we only have to resort to empirical findings.

There are numerous economic rationales to connect those three financial variables. For example, according to the hypothesis of interest parity, expected changes in the nominal exchange rate should be positively related to the difference in the nominal interest rates across countries. However, the empirical evidence for this hypothesis is mixed and inconclusive. (See Dornbush (1976), Bilson (1979)) Also, there are some papers which find support for the conclusion that interest rates are an important factor for determining equity returns. (See Breen, Glosten, and Jagannathan (1989)) Here, we do not test those unsettled theoretical and empirical issues regarding the relationship, such as interest parity or joint dynamics of the equity and bond markets. Rather, our interest is in finding out if price variables in the foreign exchange, stock, and bond markets are likely to have different empirical relations before and after the crisis in terms of level and volatility.

Since bond markets in Korea are not well developed in the sense of not having deep and liquid secondary markets of benchmark yields, we pay close attention to the relationship between stock prices and exchange rates before and after the crisis. Our testing hypothesis is that there should be close empirical relationships in either level or volatility between the KOSPI index and exchange rates if there has been no foreign exchange market intervention. This intuition stems from two facts. First, the KOSPI index moves closely with foreign investors' net purchase as shown in Figure 4. Even though the daily stock trading volume by foreign investors is less than 10 percent in value, they are major driving sources for the movements of the level and volatility of the index. Second, it is reasonable to think that capital inflows, mainly due to foreign portfolio investment, are also playing a major role in the foreign exchange market since the daily average turnover of the foreign exchange market is only 2~3 billion USD.

These intuitions provide the following mixture model that describes the relationship between the stock price index and the exchange rate (Tauchen and Pitts (1983)):

$$P_{1t} = \mu_{1t} + \sigma_1 \sqrt{I_t} u_{1t}$$

$$P_{2t} = \mu_{2t} + \sigma_2 \sqrt{I_t} u_{2t}$$

where P_{1t} , P_{2t} denote the stock price index and exchange rate respectively, u_{1t} , u_{2t} are independent $N(0,1)$ variables, μ_{1t} , μ_{2t} are predictable parts, and I_t represents the random number of news commonly arriving at both markets. It can be easily seen that both markets are driven in either level or volatility by common variables of news arrival process such as foreign investors' net purchase of stock. If the government still actively intervened after adopting a free floating exchange rate system, it is very difficult to find any empirical relation between the two variables.

There are many ways to analyze inter-relationships among the three financial variables. One simple, but useful empirical methodology to uncover and compare inter-relationships among the three variables is Granger causality tests and variance decomposition that are byproducts of Vector Auto Regression (VAR) estimation. Granger Causality tests provide information about causal or explanatory relations between two variables. The forecast error variance decomposition tells us the proportion of the movement in a sequence due to its own shocks versus shocks to the other variables and, therefore, a sequence can be exogenous or endogenous. When we perform our empirical analysis, we undertake a separate analysis of the crisis period since the free floating period covers an abnormal situation which was extremely volatile in the latter part of 1997.

3.1 Data

We used as samples 2,242 daily data on three financial variables, which cover the period of March 2, 1990 to September 30, 1999. The crisis and post-crisis period have almost the same sample size (240 and 241 respectively), while the pre-crisis period, covering the duration of the managed floating regime, has a much larger sample (1,761). The won-dollar exchange rates as the daily closed values, interest rates as three-year corporate bond yields, and stock prices as the daily closed values of the KOSPI were used. The levels and differences of the three variables are depicted in Figure 6, 7, 8.

<Figure 6-8>

Basic statistics on the three variables are reported in Table 7. None of the three variables show any large deviation from a normal distribution in terms of skewness.¹⁴ Surprisingly, however, most of the kurtosis shows thin tails when compared to a normal distribution, which has not been the case in previous empirical findings of advanced countries. The standard deviation of stock prices during the crisis period has the lowest number since the stock prices plunged sharply during the early stages of the crisis and remained at low levels for quite a while. In contrast, the won-dollar exchange rates show a degree of high volatility during the crisis by having roughly four times a higher value of standard deviation than those during the pre-crisis and post-crisis periods. Interestingly, however, standard deviations between the pre-crisis and post-crisis periods do not show any difference. This might imply that the foreign exchange market, under the free floating regime, performed unexpectedly well in terms of volatility once the

¹⁴ The standard normal distribution has a value of 0 and 3 in skewness and kurtosis respectively.

foreign exchange market stabilized. With respect to interest rates, three-year corporate bond yields during the post-crisis period display remarkably low levels and volatility compared with those of the pre-crisis and crisis periods.

<Table 7> Basic Statistics on Exchange Rates, Stock Prices, and Interest Rates

	Mean	Max	Min	Standard Deviation	Skewness	Kurtosis
<Exchange Rate>						
Whole Period	839.97	1962.50	695.90	225.47	1.78	2.31
Period 1	786.40	914.95	695.90	46.56	0.51	0.35
Period 2	1360.07	1962.50	912.55	224.26	-0.31	-0.07
Period 3	1215.86	1389.00	1149.00	50.18	1.51	1.61
<3 Year Corporate Bond Yields>						
Whole Period	14.04	31.00	7.15	3.29	0.50	0.43
Period 1	14.40	19.87	10.40	2.58	0.63	-1.00
Period 2	16.72	31.00	11.70	3.98	0.75	0.33
Period 3	8.82	11.40	7.15	0.95	0.39	-0.90
<KOSPI>						
Whole Period	723.97	1138.75	280.00	180.48	-0.26	-0.33
Period 1	770.35	1138.75	459.07	140.13	0.30	-0.72
Period 2	421.67	644.92	280	100.09	0.33	-1.20
Period 3	686.13	1027.93	305.22	203.88	-0.02	-1.25

Note: Period 1 is between 1990. 3. 2<1997. 9. 30, Period 2 is between 1997. 10. 1<1998. 9. 30, Period 3 is between 1998. 10. 1<1999. 9. 30.

3.2 Empirical Results

3.2.1 Granger Causality

During the pre-crisis period, interest rates and stock prices had strong feedback relations, which implies that both variables had mutually explanatory power with some lags. Because bond markets remained practically closed to foreign investors during this period, the level of interest rates indicates the extent of the abundance of liquidity in the domestic financial markets. Lower interest rates are expected to make liquidity more abundant, and thus cause higher stock prices. On the other hand, higher stock prices, which might be induced by foreign purchase of stocks, imply that foreign capital inflows put downward pressures on the interest rates.

Regarding the causal relations between interest rates and exchange rates, only unidirectional causality is found: interest rates responded to exchange rate movements, but exchange rates movements were not explained by interest rates. Our reflection is that the exchange rate itself was an important policy target during the pre-crisis period. Finally, no causal relationship was found between stock prices and exchange rates during this period. Exchange rates were quite stable, while stock prices fluctuated quite sharply.

<Table 8> Granger Causality Test: Period 1 (Level)

Null Hypothesis	Lags
-----------------	------

	1	2	3	5	10
Exchange rate -/-> KOSPI	2.82*	1.46	2.47*	1.84	1.58
KOSPI -/-> Exchange rate	0.70	0.60	0.44	0.76	0.97
Interest rate -/-> KOSPI	0.10	4.45*	3.19**	2.98**	1.59
KOSPI -/-> Interest rate	0.03	6.05**	4.17**	5.05**	2.83**
Interest rate -/-> Exchange rate	0.83	0.53	0.75	0.89	1.27
Exchange rate -/-> Interest rate	8.02*	4.61**	4.84**	3.31**	1.91**

Note: 1) *, ** denote significance at 10%, 5% respectively

2) The null hypothesis (A -/-> B) refers that A does not Granger cause B

During the crisis period, interest rates and stock prices had feedback effects upon each other. Interest rates strongly Granger cause exchange rates, while exchange rates Granger cause interest rates with lags. Exchange rates also strongly Granger cause stock prices, but stock prices do not explain the movements of exchange rates. Interestingly, however, we cannot find any significant Granger causality among the three variables during the post-crisis period.

<Table 9> Granger Causality Test: Period 2 (Level)

Null Hypothesis	Lags				
	1	2	3	5	10
Exchange rate -/-> KOSPI	7.11**	9.22**	7.19**	4.47**	2.34**
KOSPI -/-> Exchange rate	1.15	0.46	1.82	2.28**	0.64
Interest rate -/-> KOSPI	1.70	1.73	4.63**	3.13**	2.06**
KOSPI -/-> Interest rate	0.49	0.98	4.63**	2.68**	1.69*
Interest rate -/-> Exchange rate	24.88**	12.84**	9.52**	6.17**	2.99**
Exchange rate -/-> Interest rate	0.42	0.32	6.16**	4.73**	4.97**

Note: 1) *, ** denote significance at 10%, 5% respectively

2) The null hypothesis (A -/-> B) refers that A does not Granger cause B

<Table 10> Granger Causality Test: Period 3 (Level)

Null Hypothesis	Lags				
	1	2	3	5	10
Exchange rate -/-> KOSPI	1.84	0.82	0.59	0.74	0.81
KOSPI -/-> Exchange rate	0.02	1.41	1.00	0.61	0.55
Interest rate -/-> KOSPI	0.09	0.11	0.08	0.30	0.73
KOSPI -/-> Interest rate	0.89*	2.06	2.23*	1.78	1.77*
Interest rate -/-> Exchange rate	3.57	2.14	1.52	1.55	1.18
Exchange rate -/-> Interest rate	0.94	0.57	1.72	1.17	1.10

Note: 1) *, ** denote significance at 10%, 5% respectively

2) The null hypothesis (A -/-> B) refers that A does not Granger cause B

Now, let us examine the Granger causality of the volatilities of the three financial variables. We define the volatility of a variable y as $\frac{1}{2}|y_{t+1} - y_t|$.¹⁵ During the pre-crisis period, the volatility of stock prices Granger causes the volatility of exchange rates. And the volatility of exchange rates also strongly Granger causes the volatility of interest rates. However, other significant causal relations are not found. During the crisis period, the volatilities of exchange rates and interest rates respectively Granger caused the volatility of stock prices. The volatilities of exchange rates and interest rates have strong feedback effects. During the post-crisis period, however, no Granger causality is found among the volatilities of the three variables.

<Table 11> Granger Causality Test: Period 1 (Volatility)

Null Hypothesis	Lags				
	1	2	3	5	10
Exchange rate -/-> KOSPI	1.02	0.74	3.43**	2.10*	1.80*
KOSPI -/-> Exchange rate	0.50	3.37**	3.19**	2.42**	1.89**
Interest rate -/-> KOSPI	0.36	1.07	1.03	0.95	0.73
KOSPI -/-> Interest rate	3.73*	2.10	1.75	1.78	2.08**
Interest rate -/-> Exchange rate	2.06	0.72	0.54	0.48	1.39
Exchange rate -/-> Interest rate	6.77**	4.59**	3.09**	2.38**	2.01**

¹⁵ This definition is borrowed from Frenkel and Mussa (1980).

<Table 12> Granger Causality Test: Period 2 (Volatility)

Null Hypothesis	Lags				
	1	2	3	5	10
Exchange rate -/-> KOSPI	14.37**	9.97**	5.72**	3.51**	2.10**
KOSPI -/-> Exchange rate	2.38	1.06	0.53	0.64	1.26
Interest rate -/-> KOSPI	11.76**	5.41**	4.58**	2.77**	1.50
KOSPI -/-> Interest rate	1.14	1.22	0.99	1.41	1.90**
Interest rate -/-> Exchange rate	16.88**	11.39**	5.71**	3.76**	2.01**
Exchange rate -/-> Interest rate	8.95**	18.56**	11.52**	4.81**	4.28**

<Table 13> Granger Causality Test: Period 3 (Volatility)

Null Hypothesis	Lags				
	1	2	3	5	10
Exchange rate -/-> KOSPI	0.46	0.73	0.56	1.11	1.86*
KOSPI -/-> Exchange rate	1.73	0.77	1.18	0.85	1.79*
Interest rate -/-> KOSPI	0	0.78	0.74	0.84	1.25
KOSPI -/-> Interest rate	0.21	0.13	0.10	0.62	0.45
Interest rate -/-> Exchange rate	0.72	0.41	0.39	1.57	1.51
Exchange rate -/-> Interest rate	0.09	0.14	0.11	0.37	0.91

3.2.2 Variance Decomposition

We examine how much forecast error variance, in each financial variable, is explained by its own and other lagged variables. Understanding the properties of the forecast errors is exceedingly helpful in uncovering inter-relationships among the variables in the system. Tables 14-16 reports the forecast error variance decomposition of each variable during the three different periods. Stock price shocks explain most of their own variation during the pre-crisis period. However, exchange rate shocks during the crisis period explain about 23 percent of the stock price variations at the peak. The peak contribution is found at 3 days after the shocks. Interest rate shocks also have contributed more to the stock price variations during the crisis period at longer lags after the shocks. Shocks in exchange rates and interest rates, during the post-crisis period, explain much less of the variation of the stock prices than those during the crisis period.

Shocks in the foreign exchange market explain most of the variation in the exchange rates except for the case of the crisis period. During the crisis period, interest rate shocks explain about 24 percent of the exchange rate variations at the peak. The peak contribution is found at 10 days after the shocks. With respect to the interest rate variations, its own shocks have a relatively smaller contribution to its variations than the other two variables. During the crisis period, exchange rate shocks explain about 37 percent at the peak. The peak contribution is found at 10 days after the shocks. During the post-crisis period, the contribution becomes much less, but still not negligible (about 15 percent at the peak).

We also apply the variance decomposition techniques to the volatility measures of the

three financial variables. The empirical results are reported in Table 17-19. Except for the crisis period, variations in stock price volatility are explained by its own shocks. With respect to variations in exchange rate volatility, shocks in the stock and bond markets have almost negligible contributions over the whole sample period. During the post-crisis period, shocks in the foreign exchange market explain about 11 percent of variations of the interest rate volatility.

In summary, during the crisis period, shocks in other related markets have some contribution in explaining the variations of each financial variable – in terms of both level and volatility. Shocks in other markets have relatively larger contribution to the variations of each financial variable during the post-crisis period than during the pre-crisis period. Nevertheless, the size of the contributions is not impressive, implying that the change in exchange rate regime from managed floating to free floating does not lead to any close relationship among the three variables. This result is a bit surprising since the Korean economy is building a full-blown financial market after the crisis and, therefore, there should exist co-movement between either volatilities or levels of stock prices and exchange rates. Our further reflection will be pursued in the next section.

<Table 14> Forecast Error Variance Decomposition (KOSPI)

Lags	KOSPI			Exchange Rate			Interest Rate		
	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3
1	98.13	79.35	91.04	1.56	17.03	6.58	0.31	3.62	2.38
2	97.53	73.56	90.26	1.51	22.62	6.98	0.96	3.83	2.76
3	97.29	70.50	89.51	1.49	23.20	7.66	1.22	6.30	2.82
5	96.92	67.40	88.15	1.53	20.32	9.17	1.55	12.29	2.68
10	96.32	67.35	84.98	1.79	14.26	12.67	1.89	18.39	2.35

<Table 15> Forecast Error Variance Decomposition (Exchange Rates)

Lags	KOSPI			Exchange Rate			Interest Rate		
	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3
1	0	0	0	100.00	100.00	100.00	0	0	0
2	0.01	0.50	0.72	99.98	95.92	99.08	0.01	3.58	0.20
3	0.01	0.99	1.19	99.98	90.73	98.07	0.01	8.28	0.74
5	0.01	1.48	1.52	99.98	83.09	95.87	0.01	15.42	2.61
10	0	1.47	1.55	99.99	74.78	89.00	0.01	23.75	9.45

<Table 16> Forecast Error Variance Decomposition (Interest Rates)

Lags	KOSPI			Exchange Rate			Interest Rate		
	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3
1	0	0	0	4.33	23.23	13.21	95.67	76.77	86.79
2	0.23	0.24	0.33	5.17	25.86	15.14	94.60	73.90	84.52
3	0.27	0.29	0.72	5.35	27.77	15.23	94.38	71.95	84.05
5	0.34	0.21	1.29	5.26	31.38	14.10	94.40	68.40	84.61
10	0.47	0.28	2.25	4.58	36.91	11.35	94.95	62.81	86.41

<Table 17> Forecast Error Variance Decomposition of Volatility (KOSPI)

Lags	KOSPI			Exchange Rate			Interest Rate		
	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3
1	98.88	91.00	98.18	0	4.10	1.59	0.11	4.90	0.24
2	98.71	89.37	97.55	0.28	5.85	2.23	0.32	4.78	0.22
3	98.71	87.00	97.53	0.30	7.87	2.25	0.32	5.13	0.23
5	98.19	84.40	97.53	0.52	9.69	2.25	0.39	5.92	0.23
10	98.04	79.42	97.53	0.68	11.23	2.25	0.41	9.35	0.23

<Table 18> Forecast Error Variance Decomposition of Volatility (Exchange Rates)

Lags	KOSPI			Exchange Rate			Interest Rate		
	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3
1	0	0	0	100.00	100.00	100.00	0	0	0
2	0.28	0.28	0.41	99.72	98.66	99.40	0	1.06	0.19
3	0.30	0.85	0.78	99.70	97.03	99.00	0	2.12	0.22
5	0.52	1.06	0.88	99.43	96.28	98.90	0.05	2.66	0.23
10	0.68	1.11	0.88	99.10	92.68	98.89	0.22	6.21	0.23

<Table 19> Forecast Error Variance Decomposition of Volatility (Interest Rates)

Lags	KOSPI			Exchange Rate			Interest Rate		

	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3
1	0	0	0	1.94	20.12	11.07	98.06	79.88	88.93
2	0.30	0.05	0.03	2.29	20.39	10.97	97.41	79.56	89.00
3	0.31	0.17	0.76	2.56	26.33	10.91	97.13	73.51	88.32
5	0.33	1.65	0.88	2.75	31.63	10.91	96.92	66.72	88.21
10	0.41	1.98	0.88	3.57	37.47	10.91	96.01	60.55	88.21

3.3 High Frequency Data Analysis

From the above empirical analysis, we find that causal relations among the three financial variables are still weak during the post-crisis period, and furthermore, shocks in other financial markets do not have significant contribution to explaining the variations of each financial variable's forecast errors. Now, we will more closely examine the exchange rate behaviors during the post-crisis period by using high frequency data, so as to be able to determine whether the government has intervened in the foreign exchange market. Our hypothesis is that if the government has intervened in the foreign exchange market and the government has effectively offset any significant shock to the exchange rate, the intraday exchange rate data will not show any volatility clustering phenomenon, which is quite commonly found in most advanced foreign exchange markets.¹⁶

We use the intraday exchange rate data, the interval of which is two minutes. The sample period covers September 10-20, 1999. Thus, the number of observations in the sample is 1,188. During this sample period, the won-dollar exchange rates have fluctuated within 20 won, and the rate of change is within ± 5 won. These surprisingly stable exchange rate movements are based on the fact that any larger change in the won-dollar exchange rates disappears immediately (merely within a few minutes) as shown in Figure 9. Thus, exchange rate data in Korea's foreign exchange market does not exhibit volatility clustering, which is a typical phenomenon of the free floating exchange rate regime. In this regard, we are more inclined to say that the Korean government has intervened in the foreign exchange market so as to stabilize the exchange rate fluctuations.

<Figure 9> High-Frequency Data

IV. Policy Challenges: *Is the free floating exchange rate regime a viable option?*

The Korean government responded to the currency crisis by adopting a free floating exchange rate regime and by more actively pursuing capital account liberalization. As a natural consequence, we may expect that the foreign exchange market is more likely to be linked to other financial markets, such as stock and bond markets. However, the

¹⁶ The issue of intraday exchange rate volatility has been recently taken up by the micro structural analysis. For further references, see Anderson and Bollerslev (1997) and Anderson et al (1998), and Goodhart and O'hara (1996).

foreign exchange market has been relatively stable during the post-crisis period, while the stock market has been quite volatile. Since the bond market in Korea is not fully developed and credit risks of corporate bonds are still high, foreigners are rather reluctant to participate in the domestic bond market. One important indication, to support our presumption that the Korean government has intervened in the foreign exchange market, is the stability of exchange rates relative to that of stock prices.

Under the free floating exchange rate regime with free mobility of capital flows, why has the Korean government intervened in the foreign exchange market? We would like to focus on two reasons. One is related to the vulnerability of financial markets in Korea. In order to build a buffer to this vulnerability, the Korean government continued to accumulate foreign reserves even during the post-crisis period. While financial and corporate restructuring were still underway, events of Daewoo's bankruptcy and resultant ITC troubles increased the vulnerability in Korea's financial markets. To counter the financial vulnerabilities, the Korean government has undertaken various measures. Also recognizing the fact that the currency turmoil resulted in financial panic in Korea just two years ago, the Korean government is now endeavoring to strengthen the ex ante defensive measures.

A certain level of foreign reserves can be geared into a set of ex ante defensive measures. However, the recommended level of foreign reserves, which is equivalent to the value of three month imports, will not be adequate in times of free capital mobility. Taking short-term capital movements and possible reversals into account, it can be suggested that a minimum level of foreign reserves, which can finance short-term external liabilities plus capital outflows, should be maintained. Short-term external liabilities include 1) short-term external liabilities of domestic financial institutions and companies, 2) long-term external liabilities having maturities within one year, and 3) local financing through foreign financial institutions by subsidiaries of domestic companies. On the other hand, capital outflows are composed of foreign portfolio investment outflows and residents' capital flight. For the sake of simplicity, we assume that capital flights are negligible (not necessarily, even in the case of Korea). Table 20 exhibits a benchmark minimum level of foreign reserves as of the end of October 1999.

Short-term external liabilities amount to approximately USD 36 billion, while long-term external liabilities having maturities within one-year sum to about USD 13 billion. Short-term local financing also amounts to approximately USD 16 billion. Now, one delicate technicality concerns the estimated level of capital outflows from the stock of foreign portfolio investment. As of the end of September 1999, the market value of foreign portfolio investment stock amounts to USD 46.2 billion. For the sake of simplicity, we assume that approximately 20 percent of the total will leave the domestic financial markets, when the crisis set in. Thus, our estimated amount of capital outflows will be approximately USD 9 billion. Summing up these four components, we have USD 74 billion as a benchmark minimum level of foreign reserves.

<Table 20> A Benchmark Minimum Level of Foreign Reserves
(unit: USD billion)

Item	Amount
Short-term External Liabilities	36
Local Financing by Overseas Subsidiaries	16
Long-term External Liabilities having maturities within one year	13

Capital Outflows form Foreign Portfolio Investment Stock	9
Total	74

It is undoubtedly a controversial issue whether this minimum level of foreign reserves can be considered as a useful benchmark for the government's reserve policies. If Korea can meet external financing requirements without any serious difficulty at the time of a foreign liquidity shortage as most industrial countries do, a currency crisis can be resolved more easily through immediate adjustments of exchange rates. However, if we suppose that short-term external borrowings are not rolled over, since domestic financial institutions lose the confidence of foreign creditors, a currency crisis will then develop into a full-blown financial crisis. Adjustments of exchange rates through sharp depreciations will relieve the pressure of capital outflows. However, financial market vulnerability will not vanish within a short period of time.

The Korean government is keenly aware of the important lesson from the recent crisis that, in the age of global financial integration, the financial sector is increasingly as important as the real sector. Based upon this recognition, the Korean government will pursue financial sector restructuring on a continuous basis. However, it will take several years to develop healthy financial institutions and markets such as those in industrial countries. A more flexible exchange rate system will definitely reduce the required level of foreign reserves, only if Korea has much sounder financial systems.

Korea's foreign reserves are currently approaching our estimated minimum level. Once reached, the foreign reserves are expected to stay around this level unless any other events occur which destabilize the financial markets. If foreign reserves continue to accumulate, the government intentionally makes the currency cheap through foreign exchange intervention. However, this undervaluation of the currency will not be sustainable because anticipated appreciation will continuously bring about more foreign capital inflows. Many exporting companies in Korea still demand that the government not only maintains exchange rate stability, but also keeps the won-dollar exchange rate undervalued, even though the free floating exchange rate regime has been introduced. Export competitiveness and resultant current account surplus might be policy targets, but in most cases, might incur both external and internal imbalances. In this regard, the role of price mechanism under this free floating exchange rate regime should not be discredited.

The other important justification for the government's intervention in the foreign exchange market can be found in the vulnerable and underdeveloped infrastructure of the foreign exchange market. As the free floating exchange rate regime was introduced, the Korean government also endeavored to develop the infrastructure of the foreign exchange market through various means. First of all, policy makers pointed out the problem that market participants are limited in Korea's foreign exchange market. Table 21 exhibits indirect evidence of the relatively poor performance of Korea's foreign exchange market in comparison with other advanced and emerging economies.

In order to broaden the foreign exchange market, the government has lifted various regulations on the speculative trading. If the foreign exchange market operates freely from any intervention, volatility will increase and the necessity of hedging and speculative demand will increase. Volatility may be a necessary evil so as to induce more market participants. In this regard, it might be argued that the government should allow for some degree of volatility as a natural outcome of the free floating exchange

rate regime, since foreign exchange market intervention seems truly inconsistent with the government's plan for foreign exchange market development. Nevertheless, there are many other obstacles in developing a more liquid foreign exchange market. That is to say, the government's non-intervention exchange rate policies will not sufficiently increase the volume of daily turnovers in Korea's foreign exchange market.

<Table 21> Volume of Daily Turnover in Foreign Exchange Markets (1998)
(unit: USD billion)

	Daily Turnover (A)	Exports + Imports (B)	GDP (C)	(A/B) x100	(A/C) x100
United States	350.9	1,626.7	8,510.7	21.57	4.12
United Kingdom	637.3	589.1	1,388.1	108.18	45.91
Japan	148.6	668.4	3,798.2	22.23	3.91
Germany	94.3	1,014.7	2,361.8	9.29	3.99
Singapore	139.0	214.6	84.4	64.77	164.70
Hong Kong	78.6	358.5	166.0	21.92	47.35
Korea	3.5	225.6	320.7	1.55	1.09
Thailand	3.0	97.4	111.3	3.08	2.69
Indonesia	1.5	76.0	94.2	1.97	1.59
China	0.2	323.8	919.0	0.06	0.02
Mexico	8.6	248.3	415.0	3.46	2.07
Brazil	5.1	118.0	776.4	4.32	0.66

Source: International Monetary Fund (1999), *International Financial Statistics*, Bank for International Settlements (1998), *Central Bank Survey of Foreign Exchange and Derivatives Market Activity*.

The basic transaction fees in the interbank market are surprisingly cheap: only KRW 4,000 per USD one million for spot, forward, and swap (beyond one month).¹⁷ The major factor restraining the market access of domestic banks into the interbank market is the inadequate provision of credit lines. As shown in Table 22, most interbank transactions occur in spot or swap.¹⁸ While foreign branches play a role as market makers, domestic banks as foreign exchange traders do not receive enough credit from those foreign branches because the credit ratings of most domestic banks are still below non-investment grade. This limited access of domestic banks to interbank forward or swap transactions has even aggravated foreign exchange trading in the customers markets. Since domestic banks have to square the foreign exchange positions through, such as, swaps, they have been reluctant to provide forward contracts to domestic companies. Most companies should provide some form of guarantee such as deposits or securities. This extremely limited accessibility to the currency hedging markets has obliged the government to intervene in the foreign exchange market to stabilize exchange rate fluctuations. As shown in Table 23, the volume of transactions in the third quarter of this year has increased almost twice as much as that in the same quarter of last year. This partly reflects the improvements in the creditworthiness of domestic companies.

¹⁷ Also, volume discounts are applied to the transactions exceeding USD 5 million.

¹⁸ According to the BIS survey (April 1998), interbank transactions are composed of spot (38.3%), forward (5.4%), and foreign exchange swap (56.3%).

<Table 22> Trend of Daily Interbank Foreign Exchange Turnovers

(unit: USD million)

	1998	1999.1	1999.3	1999.4	1999.5	1999.6	1999.7	1999.8
Spot	1,001.5	1,099.9	1,318.7	1,499.7	1,713.1	1,728.2	2,165.2	1,698.4
Forward	5.9	1.4	4.4	2.6	27.8	2.8	1.2	0.1
Swap	88.1	75.7	362.4	386.7	521.6	653.0	1,077.7	1,713.0
Total	1,095.5	1,176.9	1,685.5	1,889.0	2,262.5	2,383.9	3,244.2	3,411.5

Source: Bank of Korea

<Table 23> Trend of Foreign Exchange Transactions in the Customers Markets

(unit: USD million)

	1998. 3Q	1998. 4Q	1999. 1Q	1999. 2Q	1999. 3Q
FX purchase	44,642	51,648	52,811	69,246	80,035
FX sales	44,623	50,661	47,815	61,525	81,010
Total	89,265	102,309	100,626	130,771	161,045
Exports	30,481	34,723	30,259	35,835	35,232
Imports	21,462	24,624	25,569	28,731	29,775
Total	51,943	59,347	55,828	64,566	65,007
Foreign Portfolio Investment inflow	2,724	4,677	6,703	10,026	10,643
Foreign Portfolio Investment outflow	2,556	3,209	4,554	8,880	13,421
Total	5,280	7,886	11,257	18,906	24,064

Source: Bank of Korea

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<APPENDIX>
Evolution of the Exchange Rate Regime in Korea

Multiple currency basket peg system (March 1980 – February 1990)

The single currency peg (SCP) system had been in place for almost 16 years before the multiple currency basket peg (MCBP) system was introduced in March 1980. The US dollar peg system allowed for an extremely stable won-dollar exchange rate, which also encouraged trade with the United States, Korea's largest trading partner. However, this simple system neither correctly nor flexibly reflected the changes in interest and inflation rate differentials, the current account imbalance and the fluctuations of other currencies against the US dollar. The won tended to be overvalued relative to non-US currencies, and this situation was further exacerbated as Korea's trade and financial ties to Europe and East Asia grew in the latter part of the 1970's. This over dependence on the dollar led to continuous misalignment of the won's exchange rate. In order to address these imbalances, the won had to be devalued four times with the rate dropping from 255 won per US dollar in 1964 to 580 won in 1980. Thus, in 1980, the simple SCP system was replaced by the more complex and adept MCBP system.

Based upon a formula, which reflects changes in the special drawing rights (SDR) basket and the independent basket as well as the "policy factor," the new system adjusted the daily won-dollar exchange rate. The composition of the SDR basket, which was composed of a number of foreign currencies (originally 16 but eventually watered down to the US dollar, Deutsche mark, Japanese yen, British pound and the French franc), was determined by the IMF every 5 years. However, the composition of the independent basket was never disclosed. It is generally believed that it consisted of the currencies of Korea's major trading partners, namely the US, Japan, Germany and Canada. Even less is known about the last variable, the "policy factor." This factor ambitiously attempted to fill in the blanks and provide the inputs necessary to have the exchange rate reflect reality.¹⁹ Analysis of the exchange rate over the MCBP period suggests that the "policy factor" was the most influential part of the formula (see Kwack and Kim (1990) and Kwack (1989)).

During the second half of the 1980's, Korea's trade surplus with the US exploded. It rose to USD 8.6 billion by 1988 compared to only USD 763 million in 1982. At the same time this was taking place, the won actually began to depreciate against the US dollar.²⁰ The US government accused the Korean government of manipulating the "policy factor" variable to its advantage. To appease the US government and to also

¹⁹ According to Rhee and Song (1999), the policy factor might reflect the interest and inflation rate differentials between home and abroad, the future prospects of the current account balance, and the supply of and demand for US dollars in the domestic markets.

²⁰ In the first half of the 1980s, various liberalization measures were undertaken to induce capital inflows for the purpose of financing current account deficits. In particular, the Korean government encouraged domestic banks to borrow from abroad. However, in the latter half of the 1980s, the policy stance toward capital flows changed dramatically as the current account balance began to record a large surplus. In order to maintain export competitiveness by mitigating the appreciation pressure of the Korean won-dollar exchange rate, the government resorted to direct capital control. Commercial loans by domestic firms, with the exception of public enterprises, were prohibited. The overseas issuance of bonds and depository receipts by residents was also strictly regulated. In addition, banks were encouraged to reduce their exposure to external debt.

allow for a more market based determination of the exchange rate, since there was great confidence in the Korean economy, a variant of the managed floating rate system was adopted.²¹

Market average exchange rate system (March 1990 – December 1997)

The managed floating exchange rate regime, put into effect in 1990, was the market average exchange rate (MAR) system. Since the won-dollar exchange rate under this system was in principle determined by the market forces, the development of the interbank foreign exchange market was viewed as a key element of this new system. In order to encourage this, the Korean government relaxed the regulations on foreign exchange concentration. The BOK became merely one of many participants in the Seoul Foreign Exchange Market. It no longer determined and set the exchange rate as it had in the past. With the introduction of the MAR system and a partial liberalization of foreign exchange controls, the average daily turnover rose from a mere USD 0.2 billion in 1990 to USD 2 billion in 1995.

Under this system, the basic won-dollar rate was the market average rate of the previous day, determined by the weighted average of the market exchange rates, where the weights were the volumes of each transaction. The basic rate was announced in the morning of each trading day by the Fund Trading Center (FTC) of the Korea Financial Telecommunication and Clearing Institute. The exchange rates of the won with respect to other currencies were determined by the cross rates, as had been done in the past. These were calculated based upon the rates quoted in both the Tokyo and the New York foreign exchange markets. These were used as reference rates for the commercial banks and there were no restrictions on the spreads.

Although the won was open to market influences, the intra-day fluctuation of the won-dollar spot rate was restricted within a narrow band.²² This band was strictly adhered to and the “window guidance” of the BOK ensured that the banks refrained from quoting rates too close to the upper or lower limits of the band. In addition, unlike developed foreign exchange markets, the Seoul Foreign Exchange Market did not allow the entry of any foreign exchange brokerage firms. In fact, the Fund Trading Center conducted the lion’s share of the interbank transactions with only 3.2 percent being carried out by the over-the-counter (OTC) market in 1995. Thus, the BOK was able to closely monitor the foreign exchange market. This supervision may have helped to maintain the market’s stability but it may also have discouraged active price quotations by the banks as market makers.

During the period of the MAR system, the Foreign Exchange Management Law was revised. Under this revision, a significant step toward financial opening was taken in January 1992, when foreigners were allowed to purchase Korean stocks up to 3 percent of the outstanding shares of each company per individual, but no more than 10 percent of a company in total. Furthermore, the Korean government, in June 1993, announced a

²¹ In 1988, Korea formally accepted the obligations of Article VIII, Section 2-4 of the IMF’s Articles of Agreement. Since then, the capital market has steadily opened up. With limited but gradual capital account liberalization, the Korean government also found it increasingly more difficult to manage the MCBP system.

²² When the MAR system was first introduced, the daily trading band was ± 0.4 percent of the basic rate, but the government widened it four times by December 1995.

blueprint for the liberalization and opening of the financial sector which aimed at substantial progress in the deregulation of the financial markets. The plan envisaged further easing requirements for foreign exchange transactions, widening the daily won-dollar trading margins, expanding limits on foreign investments in the stock market, and permitting long-term commercial loans. Despite a series of deregulatory measures, however, the Korean government still maintained a conservative position and a considerable amount of capital control remained. The opening of the bond markets was given special attention.

Despite the extensive capital controls which remained, a capital account surplus continued after 1992 when foreign investment in individual Korean stocks was first allowed. While most capital outflows were liberalized, capital inflows, in the form of foreign portfolio investment in domestic securities and credits from abroad to non-banks, residents remained subject to various ceilings and certain other restrictions. The Korean government was concerned about a potential surge of capital inflows induced by large interest rate differentials. Table A1 shows current account balances and capital account indicators since 1992.

Further capital account liberalization became inevitable when Korea joined the OECD in 1996. However, the Korean government maintained many reservations to the code of liberalization of capital movements and current invisible operations. According to the membership negotiations, the government was reluctant to liberalize the capital account because of its concern about a dramatic increase in foreign capital inflows due to the interest rate differentials between home and abroad. The government had thus planned to delay liberalizing the capital account until the interest rates significantly converged.

<Table A1> Major International Transaction Indicators

(unit: US billion dollars)

	1992	1993	1994	1995	1996
Current Account Balance	-4.2	0.4	-4.5	-8.9	-23.7
Long-term Capital	7.2	8.9	5.9	7.8	11.9
Short-term Capital	1.1	2.0	3.2	5.6	5.4
Overall Balance	4.9	6.5	2.8	3.0	-5.7
Foreign Exchange Reserves	16.6	19.7	25.0	31.9	32.4
Exchange Rate (won-dollar)	788.4	808.1	788.7	774.7	844.2

Note: The year-end exchange rate is quoted.

Free floating exchange rate system (December 1997 – present)

The Asian crisis started on July 2, 1997 with Thailand's sudden decision to float the baht. On July 11, about a week later, the Philippines and Indonesia respectively widened the trading bands of their currencies (peso and ruphia) from 8 percent to 12 percent. On July 14, Malaysia abandoned the defense of the ringitt. Indonesia finally abolished its managed floating system on August 14. In the midst of this economic maelstrom, the Korean won also quickly depreciated, following a futile currency defense which cost Korea most of its foreign reserves. This forced Korea to seek financial assistance from the International Monetary Fund (IMF) on November 21, 1997. Korea widened its won trading band from 2.25 percent to 10 percent on November 19, and finally abolished its band and allowed the won to float on December 16. Since then, the IMF has only requested a restriction of the Bank of Korea's intervention in the foreign exchange

market, except in the event of dramatic exchange rate fluctuations.

According to a preliminary assessment of the IMF-supported programs in Indonesia, Korea and Thailand prepared by the IMF (1999), one key element of the programs in these countries was the decision to permit exchange rates to continue to float – part of the initial response of the authorities in all three countries to the pressures that had emerged – rather than readjusting the pegs to rates deemed to be defensible and consistent with medium-term fundamentals. The monetary authorities in these countries could then be free from targeting the exchange rate. However, another key element of the programs was the inclusion of tight monetary policy as performance criteria in the Letter of Intent. Such tight monetary policy, through increases in interest rates, was aimed at attracting sufficient capital to correct exchange rate overshooting in the early stage of the crisis and to build up the level of usable foreign reserves.²³

With the free floating exchange rate system in place, the Korean government also substantially accelerated its ongoing capital account liberalization plan. Under the IMF program, the Korean government agreed to undertake bold liberalization measures; in fact, the Korean government has taken much of the initiative behind this. Not only were all of the capital markets, including the short-term money markets, but the real estate market as well, which was once off-limits and considered non-negotiable, was completely opened to foreigners in the 6th Letter of Intent (May 2, 1998).

Under the initial IMF program, set out in early December 1997, the government raised the ceiling on the overall foreign ownership of stocks to 50 percent in 1997 from the previous ceiling of 26 percent. The individual ceiling was raised from 7 percent to 50 percent. These ceilings were lifted completely on May 25, 1998. All regulations on foreign purchases of debt securities were eliminated in December 1997. As of December 1997, all domestic enterprises, regardless of size, were allowed to borrow without limit from overseas as long as the maturity does not exceed one year. All the short-term money market instruments, such as commercial paper and trade bills, were also completely liberalized on May 25, 1998, and this made Korea's capital markets on a par with the level of openness of the advanced economies.

The liberalization of restrictions on capital movements was accompanied by a relaxation of rules governing the use of foreign exchange. The Korean government established a simple and transparent framework to replace the cumbersome laws and regulations that had governed such transactions. The new Foreign Exchange Transactions Law replaced the old Foreign Exchange Management Law, and took effect in April 1999. In particular, it replaced the positive list system with a negative list, which allows all capital account transactions except for those expressly forbidden by law. While foreign exchange dealings in the past had to be based on *bona fide* real demand, speculative forward transactions were permitted. This far-reaching liberalization was important in bringing Korea closer into line with the market-oriented principles adopted in more advanced foreign exchange markets.

The new system is to be implemented in two stages, April 1999 and the end of 2000,

²³ Exchange market pressure (EMP), the sum of exchange rate depreciation and reserve outflows, summarizes the flow excess supply of money in a managed exchange rate system. Tanner (1999) pointed out that Korea gained international reserves during 1998 and that EMP was negative, even as the Korean won depreciated under the free floating system. Contrary to the work by Sachs and Radelet (1998) and Furman and Stiglitz (1998), this finding, as he asserted, supported the conventional wisdom that contractionary monetary policy contributed to the stability of the exchange rate market in a broader sense.

in order to allow sufficient time to improve prudential, regulatory and accounting standards before full liberalization. The first stage of the new system eliminated the one-year limit on commercial loans while liberalizing various short-term capital transactions by corporations and financial institutions (see Table A2). Moreover, foreign exchange dealing was opened to all financial institutions.²⁴

The government also implemented appropriate measures that could counter excessive instability in the foreign exchange market caused by further liberalization measures. As of January 1999, the supervisory authority on domestic financial institutions' soundness in foreign assets and liabilities was transferred to the Financial Supervisory Commission, making it solely responsible for the nation's financial supervisory function. The required foreign currency liquidity ratio of more than 70 percent for foreign exchange banks has been applied to all overseas subsidiaries and offshore accounts of domestic financial institutions since July 1998.

By establishing a comprehensive computer network system that can oversee all foreign exchange transactions, including currencies, stocks, and futures markets, the government is now undertaking a close monitoring. With this monitoring system in place, the government also established an international financial center to operate an "early warning system" to foresee a possible currency crisis and to take the appropriate counter measures. To limit the risk of a systemic crisis, the liberalization of short-term capital transactions has been allowed only for "financially-sound enterprises." With the abolition of bona fide principles in forward contracts, the government decided to maintain a restriction on non-residents' borrowing of the Korean won to a certain limit. The new law also establishes a safeguard measure to be used in case of an emergency.

²⁴ Financial institutions satisfying the government-set requirements, such as possessing the necessary computer systems, will be allowed to conduct foreign exchange dealing businesses.

<Table A2> The First Stage of Foreign Exchange Liberalization (April 1999)

Area	Liberalization Measures
Current Account Transactions	- Abolition of restrictions on companies current account transactions with foreigners
Transition from a Positive list to a Negative list system	<ul style="list-style-type: none"> - Abolition of restrictions on the use of loans borrowed by the foreign subsidiary of a domestic company - Companies are allowed to borrow overseas at maturities of less than one year and issue overseas securities - Deposit by non-residents with maturities of more than one year and their investment in trust funds are allowed - Removal of restrictions on foreign direct investment abroad by companies and financial institutions (including the unrestricted establishment of overseas branches) - Companies' and financial institutions' investment in foreign real estate is permitted - Investment in overseas securities by domestic institutional investors is allowed - Domestic issuance of securities by foreigners is allowed - Domestic foreign exchange banks is permitted - Abolition of the real demand principle
Foreign Exchange Dealing	<ul style="list-style-type: none"> - All types of domestic or foreign financial institutions can deal in foreign currencies - Establishment of money exchange booths is allowed

Source: Ministry of Finance and Economy, Korea

<Table A3> Measures to Prevent a Currency Crisis

Area	Measures
Establishment of a Monitoring system	<ul style="list-style-type: none"> - Creation of a computer system to monitor speculative transactions in the foreign exchange, stock, bond and futures markets - Establishment of an "International Financial Center" to provide an early warning system against a currency crisis
Precautionary Measures	<ul style="list-style-type: none"> - Restrictions on short-term overseas borrowings by financially unsound companies - Restrictions on foreigners' borrowing of more than 100 million won at a maturity of less than one year - Requirement that securities with less than one year maturity issued domestically by foreigners be approved by MOFE
Emergency Measures	<ul style="list-style-type: none"> - Partial or complete freeze on foreign exchange transactions - Concentration of foreign currencies in the central bank - Capital transaction authorization system - A variable deposit requirement on capital inflows

Source: Ministry of Finance and Economy, Korea

In tandem with the first stage of foreign exchange liberalization, another two important institutional changes are worthy of note. First, the commercial foreign

exchange broker system was introduced, in January 1999, by allowing private organizations to establish brokerage firms. Also, the Fund Trading Center, the public foreign exchange broker which enjoyed a monopoly position in interbank trading, became a commercial company. Currently, two commercial foreign exchange brokers are competing in interbank transactions. However, as trading volumes grow in the Seoul Foreign Exchange Market, more brokers are expected to enter the brokerage market. Second, currency futures and options were introduced in the Pusan Futures Market in April 1999 so that companies and financial institutions exposed to foreign exchange risks could effectively use these hedging instruments.²⁵ Due to the fact that only large companies with good credit ratings could gain access to forward foreign exchange contracts, most small and medium-sized companies could not find relevant risk-hedging instruments in the foreign exchange market before the currency futures were introduced.

Recent performance in the Korean futures markets is reported in Table A4. Although this currency futures market was originally expected to function as a hedging market for small and medium-sized exporting companies, the share of individual traders is only 10.4 percent. The discouraging performance of the futures markets is mainly due to two factors. First, small and medium-sized companies do not have relevant in-house human resources to participate in the currency futures market. Although they recognize the need for covering the exposures to the exchange rate risks, market participation also incurs additional and sometimes unbearable costs. Second, spot exchange rate fluctuations have become moderate despite many uncertainties in the financial markets. This relative stability in the foreign exchange market during the post-crisis period significantly reduced the incentives to invest in futures contracts.

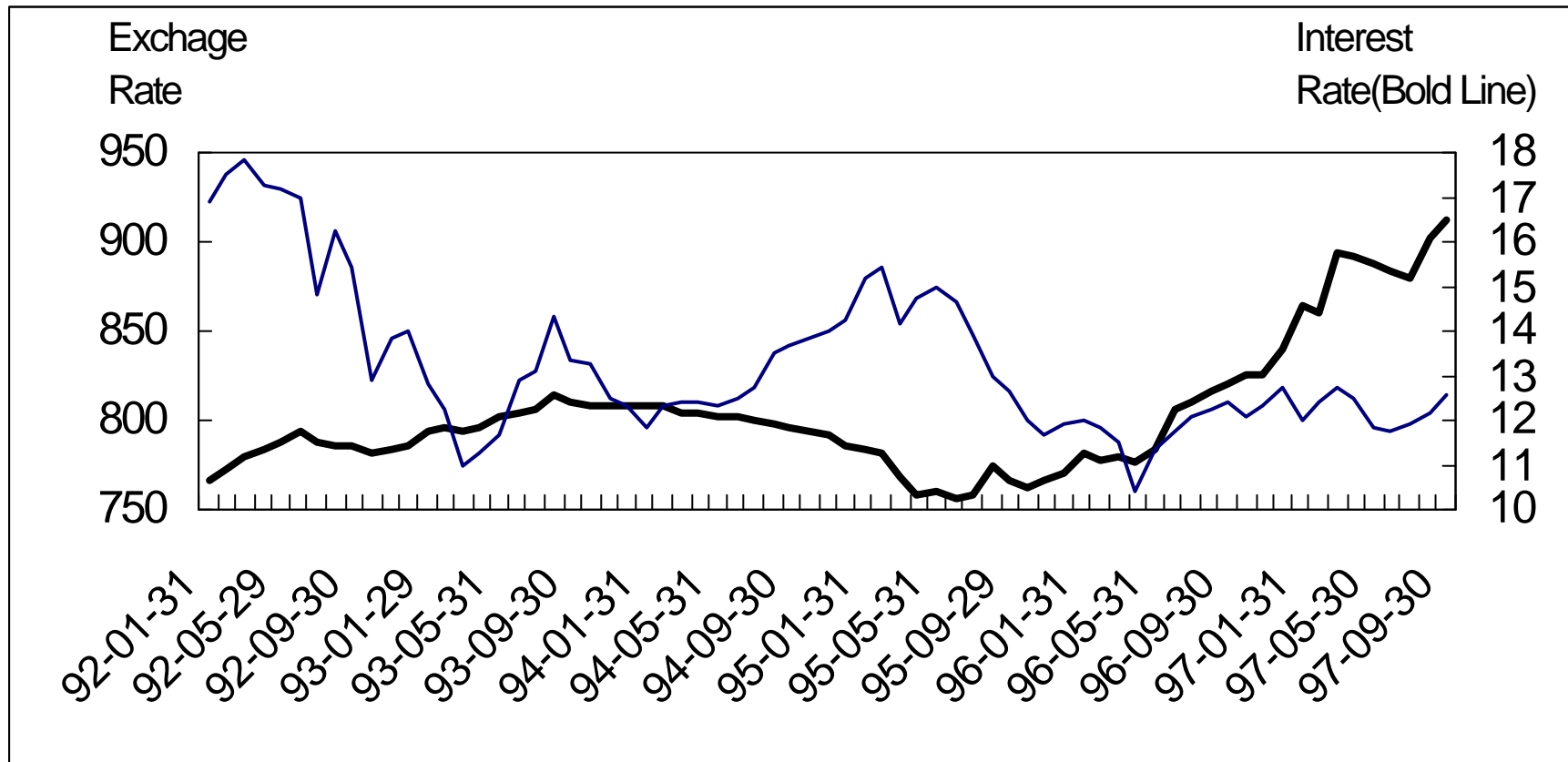
²⁵ Currency hedging products have usually emerged as countries have moved from managed floating regimes to more fully floating ones. Currency futures, since they are traded on organized exchanges, give benefits from concentrating order flows and providing a transparent venue for price discovery, while over-the-counter forward contracts rely on bilateral negotiations at often unpublished prices. However, despite the growing demand for such products, currency futures contracts are still in the early stages of development. See Jochum and Kodres (1998) for more elaboration on the introduction of futures on emerging market currencies.

<Table A4> Recent Performance of Pusan Futures Market: Daily Average Contracts

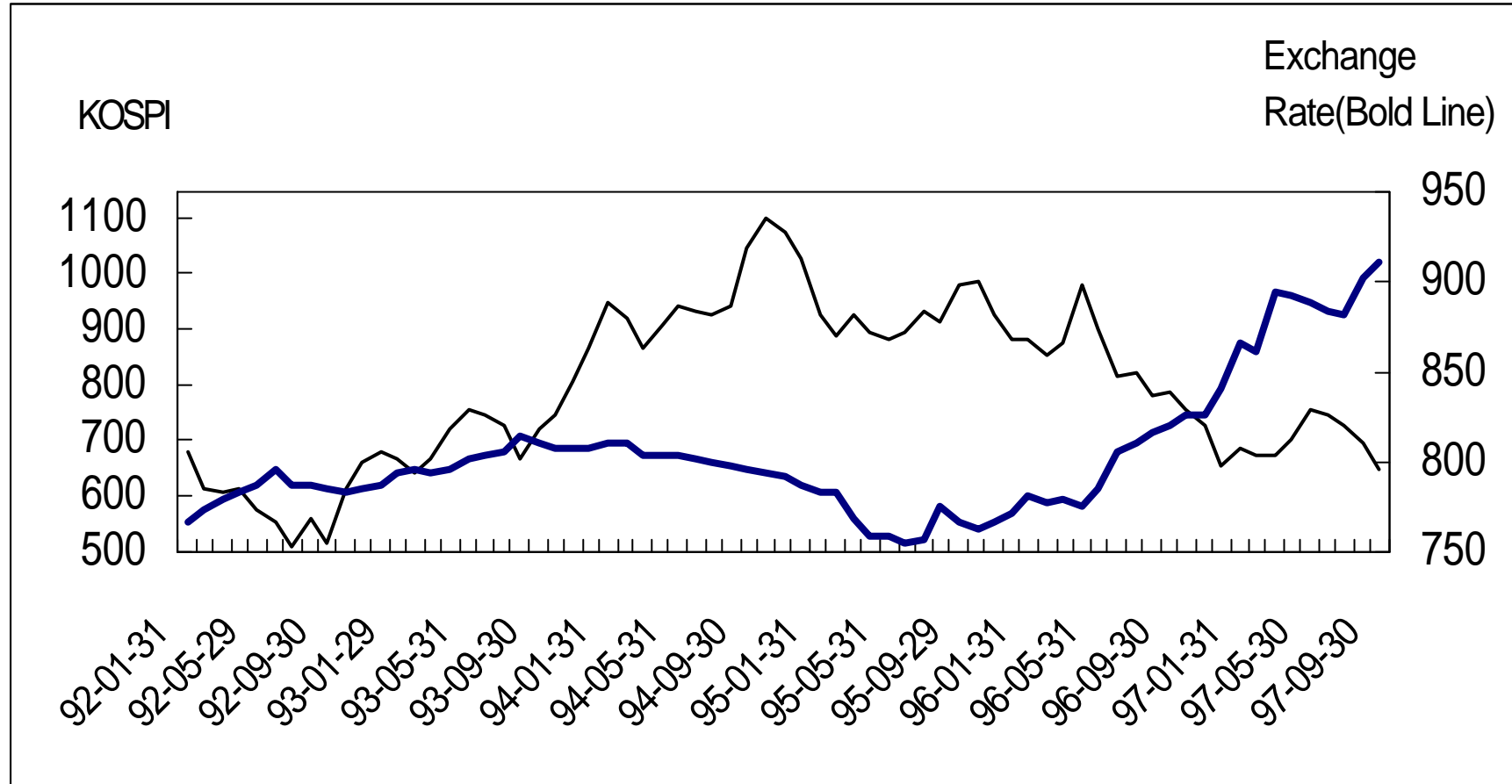
	CD Futures	Sovereig n Bond Futures	Dollar Futures	Dollar Call Options	Dollar Put Options	Gold Futures	Total
April	278	-	240	66	59	73	716
May	643	-	372	26	26	28	1,096
June	635	-	687	205	145	23	1,694
July	4,097	-	1,622	433	328	107	6,587
August	3,328	-	1,321	207	232	66	5,153
September	5,084	678	1,942	139	112	197	7,541
October	2,304	5,584	1,592	16	41	96	9,632
Average	2,581	5,039	1,196	176	150	84	4,896
Cumulative	330,373	90,699	153,056	22,522	19,261	10,772	626,683

<Figure 1> Exchange Rates and Interest Rates (3-year Corporate Bond Rate): January 1992 – September 1997

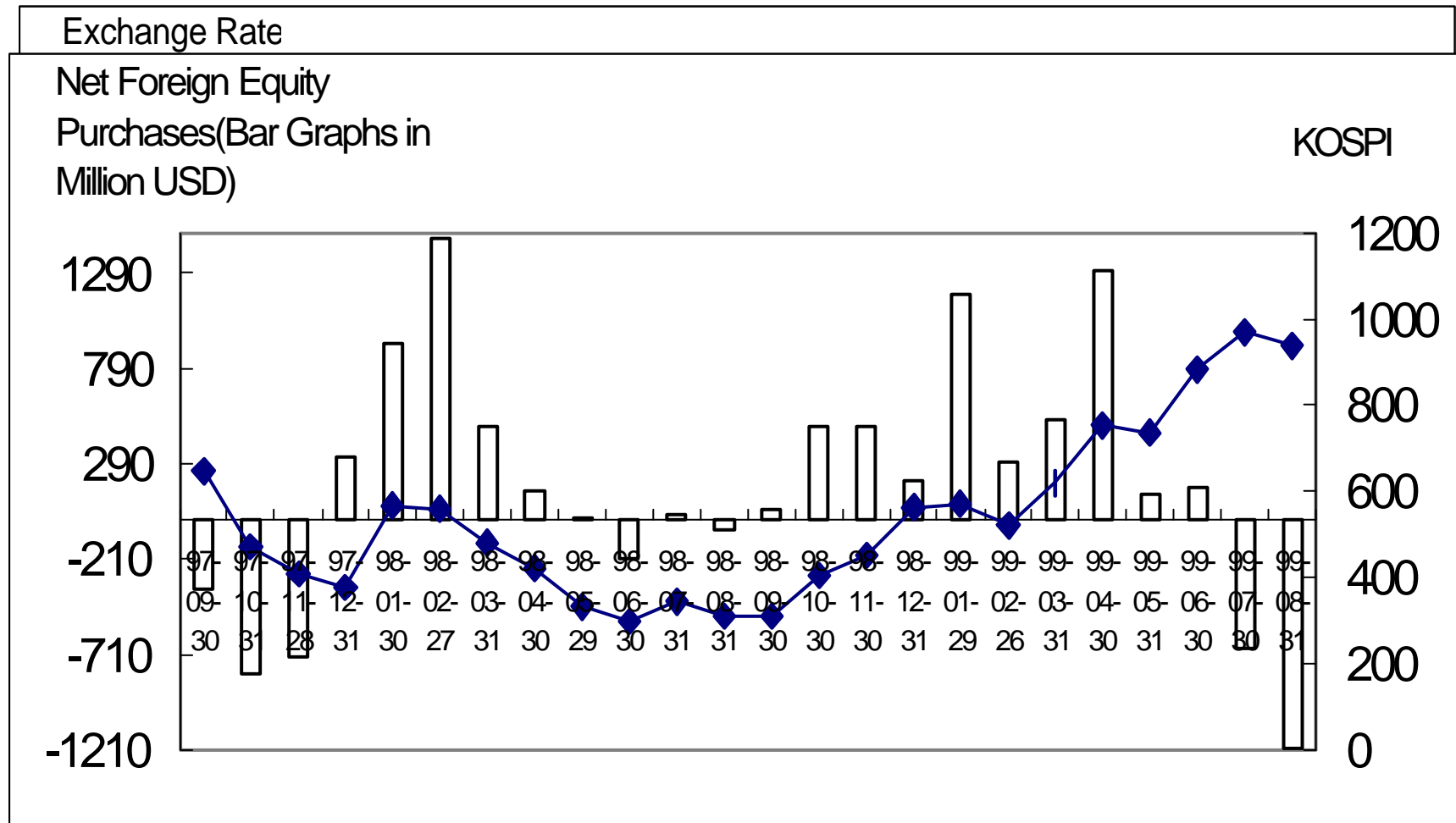
<Figure 2> Exchange Rates and Stock Prices (KOSPI):



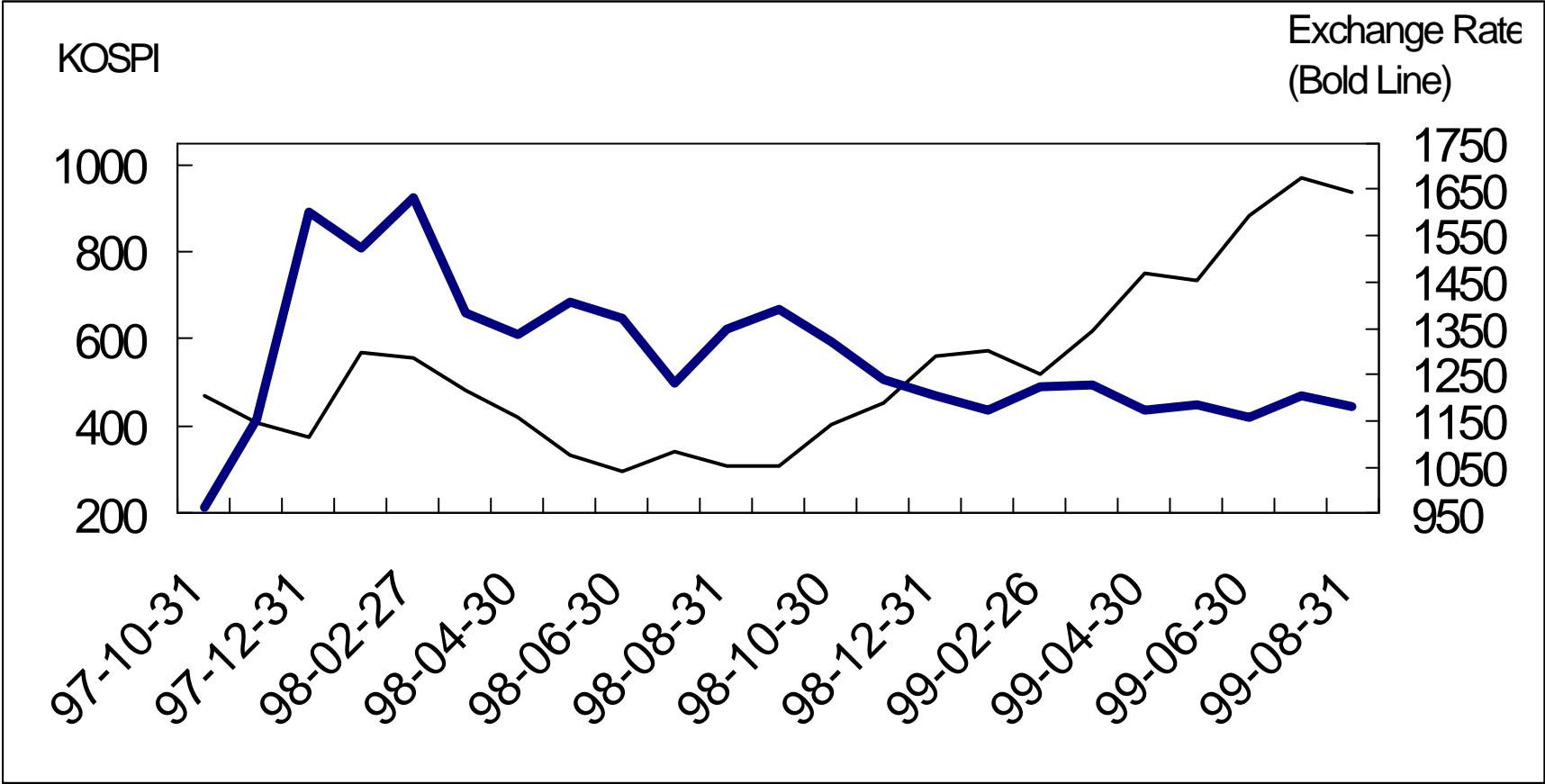
January 1992 – September 1997



<Figure 3> Exchange Rates and Interest Rates(3-year Corporate Bond Rate): October 1997 - September 1999
<Figure 4> Net Foreign Equity Purchase and Stock Prices (KOSPI)

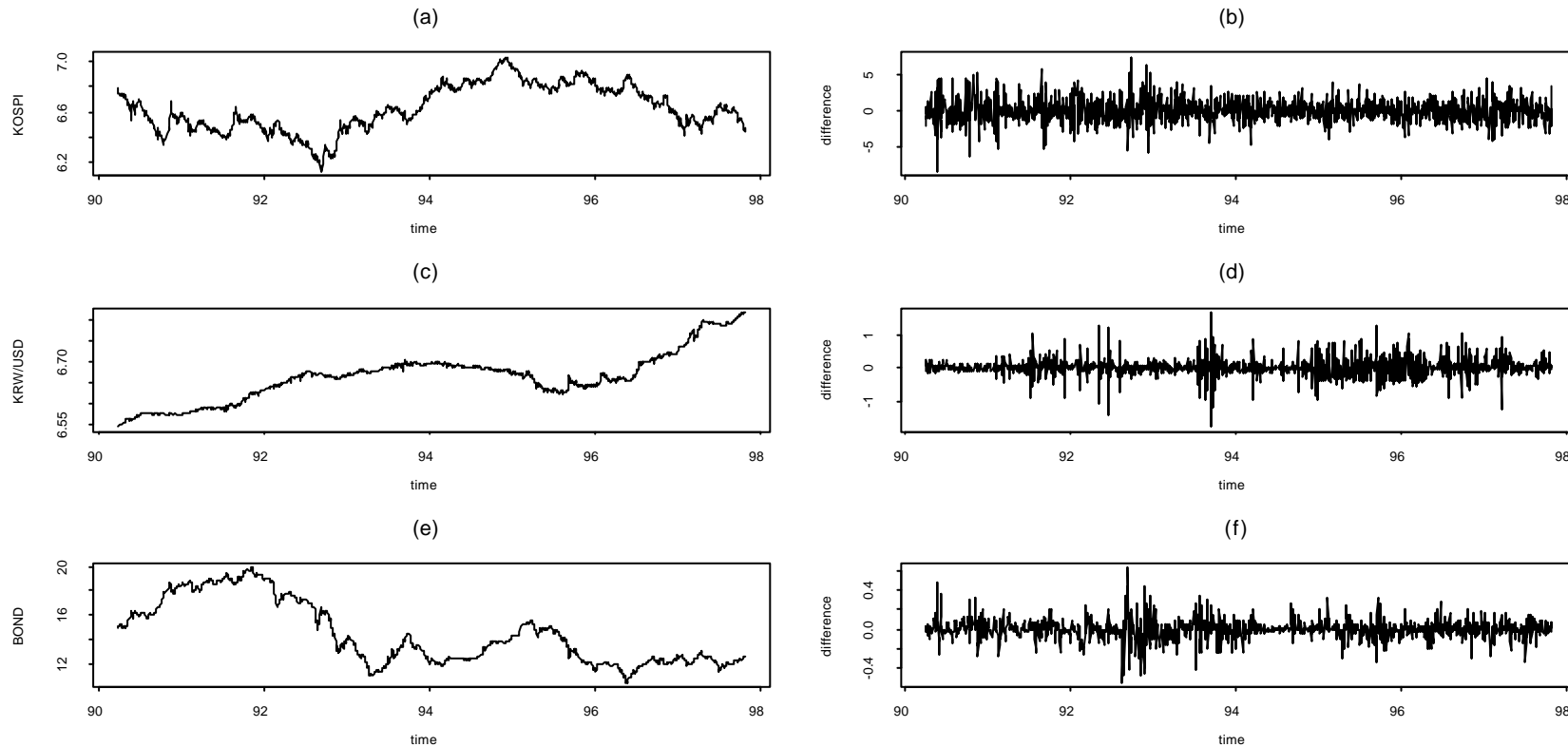


**<Figure 5> Exchange Rates and Stock Prices (KOSPI):
October 1997 - September 1999**



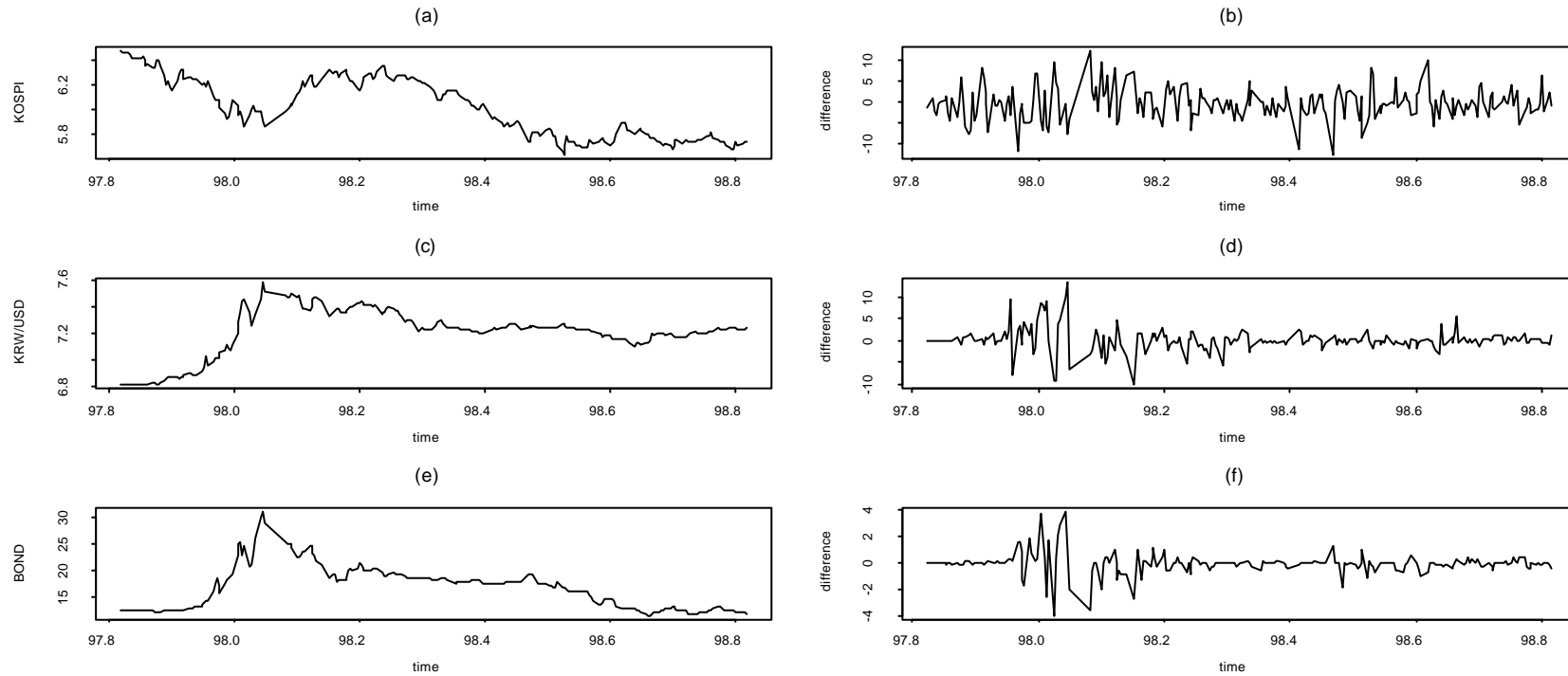
<Figure 6> KOSPI, Exchange Rate, Interest Rate During Period 1 (March 1990 – September 1997)

Note: (a) KOSPI (level), (b) KOSPI (first difference), (c) Exchange Rate (level), (d) Exchange Rate (first difference) (e) 3 year corporate bond yields (level), (f) 3 year corporate bond yield (first difference)



<Figure 7> KOSPI, Exchange Rate, Interest Rate During Period 2

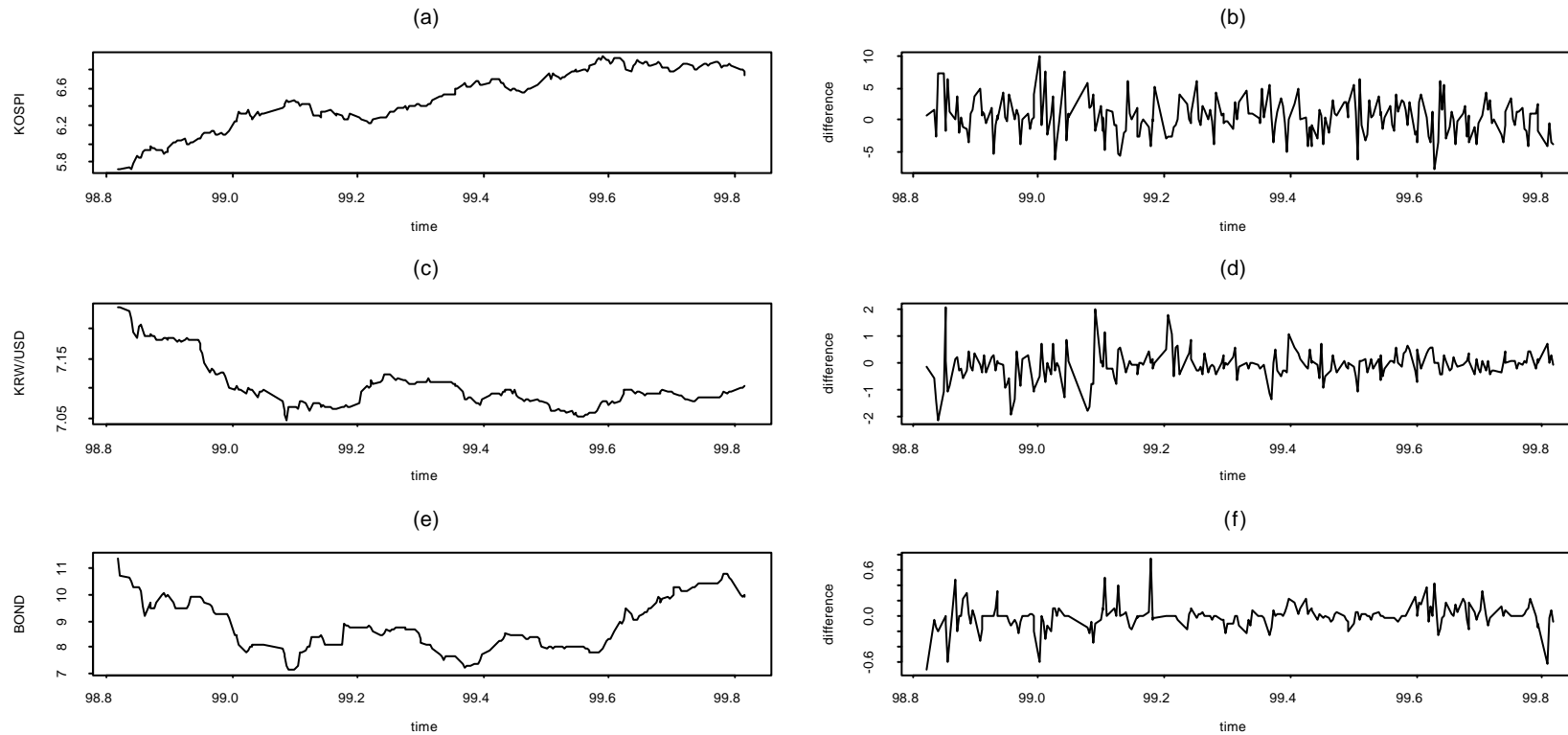
(October 1997 – September 1998)



Note: (a) KOSPI (level), (b) KOSPI (first difference), (c) Exchange Rate (level), (d) Exchange Rate (first difference) (e) 3 year corporate bond yields (level), (f) 3 year corporate bond yield (first difference)

<Figure 8> KOSPI, Exchange Rate, Interest Rate During Period 3 (October 1998 – September 1999)

Note: (a) KOSPI (level), (b) KOSPI (first difference), (c) Exchange Rate (level), (d) Exchange Rate (first difference) (e) 3 year corporate bond yields (level), (f) 3 year corporate bond yield (first difference)



<Figure 9> High-Frequency Data

