

# The effects of financial globalization on the Korean financial markets and monetary policy

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## I. Financial globalization trends in Korea

Due to financial system liberalization and capital flows since the 1990s, Korea has progressed rapidly toward financial globalization, and there has been a large increase in foreign direct investment and other types of capital flows.

Foreign stock investment, which comprises a large proportion of capital flows, has grown significantly. In 1992, when foreigners were allowed to invest in the Korean stock market for the first time, the share of foreign stock holdings in total stock market capitalization was only 4.9%. Subsequently the proportion increased gradually until July 1998, when the Korean stock market was completely opened to foreign investors.<sup>2</sup> After its complete opening, the proportion increased rapidly to reach 40% at the end of October 2003 (Table 1).

Table 1  
Ratio of foreign holdings of domestic stocks and bonds  
%

	1992	1994	1996	1997	1998	1999	2000	2001	2002	2003.10
Stocks <sup>1</sup>	4.90	10.19	12.97	14.59	18.61	21.92	30.08	36.62	36.02	40.12
Bonds <sup>2</sup> (including foreign banks' domestic branches)	-	0.04 (0.15)	0.05 (0.43)	0.09 (2.06)	0.30 (1.49)	0.32 (1.47)	0.16 (1.03)	0.09 (1.00)	0.11 (1.55)	0.25 (1.45)

<sup>1</sup> Ratio of foreign stock holdings to total stock market value. <sup>2</sup> Ratio of foreign bond holdings to total value of listed bonds; figures inside parentheses represent the ratios of foreigners' bond holdings, including those of branches of foreign banks using their borrowings from their head offices, in the total amount of listed bonds outstanding. (The figures for the bond holdings of foreign bank branches also include holdings of unlisted bonds, but these were on a trifling scale.)

Source: *Foreign Investment Trends*, Financial Supervisory Service.

Meanwhile, the ratio of foreign holdings of listed bonds to the total market value of listed bonds was only 0.25% at the end of October 2003, in spite of the complete opening of the domestic bond market to foreign investors, which took place in July 1998. Even though the share of foreigners' bond holdings (including those of branches of foreign banks investing with funds borrowed from their head offices)<sup>3</sup> in total bond holdings showed a general rise, reaching a level of 1.45% of the total as at the end of

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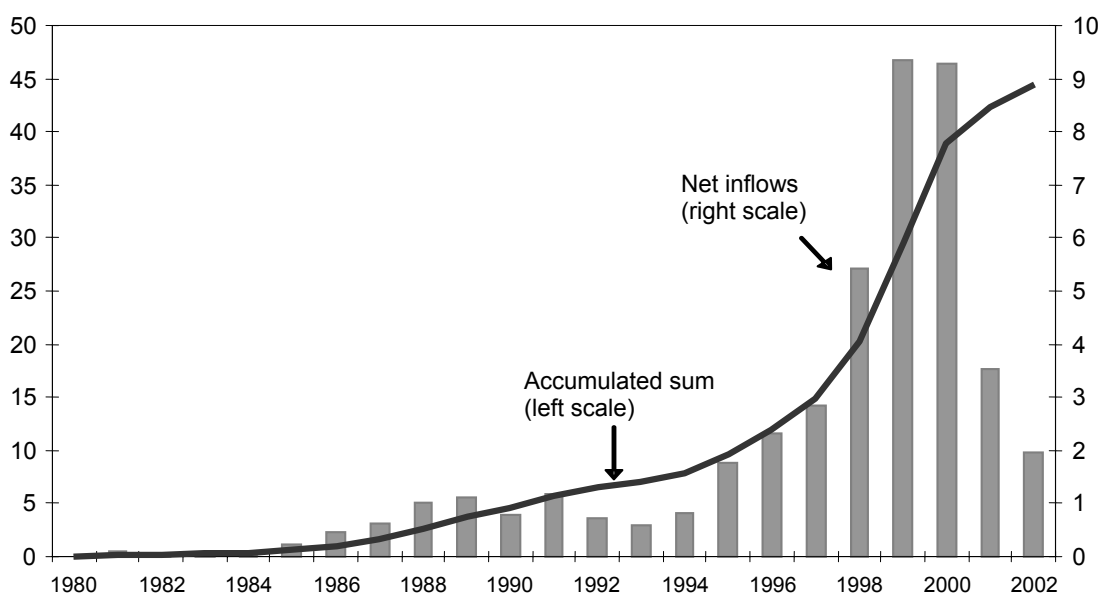
<sup>2</sup> Foreigners were allowed to invest in the Korea stock market for the first time in January 1992, subject to a ceiling of 10% on each issue and 3% on each investor. The ceilings were raised gradually in eight stages, and in May 1998 they were abolished completely.

<sup>3</sup> There is evidence that foreign bank branches tended to invest in domestic bonds when the difference between domestic and foreign market interest rates increased during the first half of 2002. At that time, the difference between these rates increased substantially (from 1.63% (September 2001) to 2.92% (December 2001) and then to 2.97% (June 2002)). And foreign bank branches' borrowing from their head offices soared (from USD 9.9 billion (December 2001) to USD 15.1 billion (June 2002)). Foreign bank branches' investment in domestic government bonds also showed a marked increase (from USD 7.6 billion (December 2001) to USD 12.9 billion (June 2002)).

October 2003, this remained remarkably low as compared to foreigners' share of total stock market capitalization.

As seen in Graph 1, foreign direct investment in Korea increased steadily from the mid 1990s. It rose greatly during the three consecutive years from 1998 to 2000 thanks to corporate restructuring and the reform of the foreign investment system.<sup>4</sup> Since 2001, however, the net inflow of foreign direct investment has decreased substantially, reflecting the global trend of a contraction of foreign direct investment due to the business downturn in developed countries.<sup>5</sup>

Graph 1  
**Trends in foreign direct investment**  
In billions of US dollars



Source: BOP, The Bank of Korea.

From the beginning of the 1990s until the time of the foreign exchange crisis that began in November 1997, foreign entry into the Korean financial sector largely involved the opening of domestic branches

<sup>4</sup> Main reform measures included the abolition of the mandatory open purchase system in February 1998, which increased the possibility of M&As, the opening of various types of businesses to foreigners in April 1998, and the enactment of the Foreign Investment Promotion Act in November 1998.

<sup>5</sup> Meanwhile, overseas direct investment (ODI) by domestic residents also increased steadily from the mid-1990s, due to the capital market liberalization and the sharp increases in domestic labor costs and land prices. Since 2001, however, the net outflow of ODI has decreased substantially, reflecting the global trend of a contraction of direct investment.

**Trends in overseas direct investment**

In billions of US dollars

	1980-90	1991-95	1996	1997	1998	1999	2000	2001	2002	2003.1-3q
Net outflows	0.46 <sup>1</sup>	2.00 <sup>1</sup>	4.67	4.45	4.74	4.20	5.00	2.42	2.67	2.41
Accumulated sum	5.03 <sup>2</sup>	15.04 <sup>2</sup>	19.70	24.15	28.89	33.09	38.09	40.51	43.19	45.60

<sup>1</sup> Average amounts of net outflows in the periods concerned. <sup>2</sup> Accumulated sums at the ends of the periods concerned.

of foreign banks. Foreign entry picked up in 1995-97 in response to the easing of regulations on foreign financial market entry (1994 and 1995). However this dropped off greatly after the foreign exchange crisis. Reflecting this, the equity capital of foreign bank branches, which had grown rapidly for three years straight from 1995 through 1997, declined slightly in 1998 and has still not returned to its year-end 1997 level.

Table 2  
Trends in equity capital of foreign bank branches

In billions of Korean won, %

	1992	1993	1994	1995	1996	1997	1998	1999	2000
Capital	546	589	623	1,027	1,392	1,593	1,583	1,515	1,555
(rates of increase)	(33.47)	(7.88)	(5.77)	(64.81)	(35.60)	(14.42)	(-0.63)	(-4.31)	(2.66)

Source: *Monetary Bulletin*, The Bank of Korea.

Meanwhile, in the aftermath of the foreign exchange crisis, there has been a substantial increase in foreign equity participation in domestic financial institutions through greenfield investment and the purchase of failed financial institutions during Korea's financial restructuring. As a consequence, the share of foreign holdings in the equity capital of all listed domestic banks has increased sharply since the crisis (Table 3), from 16.4% at the end of 1997 to 50.2% as of the end of June 2003.

Table 3  
Foreign ownership in major domestic banks

Banks (Asset ratio) <sup>1</sup>	At the end of 1997		At the end of June 2003	
	Foreign ownership	Major shareholder and its share	Foreign ownership	Major shareholder and its share
Kookmin Bank <sup>2</sup> (30.0)	Kookmin: 25.1 HCB: 41.2	Bank of New York 8.4 Bank of New York 24.4	68.4	Bank of New York 9.4 Goldman Sachs 5.1 ING Bank N.V., Amsterdam 3.9
Korea First Bank (4.6)	0.1	-	48.6	NewBridge Capital 48.6*
Shinhan Bank (10.2)	21.7	-	46.2 <sup>3</sup>	Citi Bank 4.6 BNP Paribas 4.0
Korea Exchange Bank (8.5)	2.7	-	77.4 <sup>4</sup>	Loan Star 51.0* Commerzbank 14.8
Hana Bank (9.1)	21.3	-	26.2	Allianz AG 8.2
Hanmi Bank (6.0)	32.8	Bank of America 18.6*	71.5	KAI(JP Morgan Carlyle) 15.7
<b>Listed banks total</b>	<b>16.4</b>		<b>50.2</b>	

Note: The symbol \* means that the foreign shareholders referred to directly participate in management with their management rights.

<sup>1</sup> Figures in parentheses are the ratios of the assets of the banks concerned to all commercial banks at the end of 2002.

<sup>2</sup> Kookmin Bank and Housing & Commercial Bank (HCB) merged in November 2001. <sup>3</sup> This figure refers to foreign ownership of Shinhan Financial Group - the holding company of Shinhan Bank. <sup>4</sup> This figure is based on data as of the end of October 2003.

Source: Korea Investors Service Inc Database.

Table 4  
**Foreign ownership in major domestic  
non-bank financial institutions**

%

Securities companies			Insurance companies		
	End of Mar 1997	End of Mar 2003		End of Mar 1997	End of Mar 2003
			<b>Life insurance companies</b>		
Samsung Securities (15.51)	5.10	23.61	Samsung Life Insur (39.21)	0	0.28
			Korea Life Insur (19.35)	0	17.00
LG Investment & Securities (11.16)	11.30	6.76	TongYang Life Insur (2.42)	0	16.57
			Dongbu Life Insur (0.63)	50.00	0
Hyundai Securities (10.00)	0	8.10	Allianz Life Insur <sup>1</sup> (4.59)	0	100.00*
			Met Life Insur <sup>2</sup> (0.91)	51.00	100.00*
Daewoo Securities (9.01)	10.90	7.77	New York Life Insur <sup>3</sup> (0.10)	51.00*	100.00*
			<b>Property &amp; liability insurance companies</b>		
Daishin Securities (6.52)	2.80	26.46	Samsung Fire & Marine Insur (29.89)	20.30	51.62
Shin Young Securities (1.16)	16.0	28.02	Hyundai Marine & Fire Insur (14.07)	0	29.23
			Dongbu Insur (13.26)	16.80	6.45
Bridge Securities (0.76)	1.50	48.11*	LG Insur (12.77)	19.60	4.89
			Oriental Fire & Marine Insur (7.65)	14.30	13.33
Seoul Securities (1.09)	1.30	45.41	First Fire & Marine Insur (4.30)	0	0.47
<b>Listed securities companies total</b>	<b>5.24<sup>4</sup></b>	<b>15.30</b>	<b>Listed insurance companies total</b>	<b>15.65<sup>4</sup></b>	<b>40.28</b>

Note: Figures in parentheses show the market share of the relevant company as of the end of March 2003. In the case of securities companies they show the ratio of the relevant securities company's deposits in customers' accounts to total customer account deposits in securities companies; in the case of insurance companies the share of the relevant companies' insurance premiums in total insurance companies' insurance premiums. The symbol \* means that the foreign shareholders referred to directly participate in management with their management rights.

<sup>1</sup> In July 1999, Allianz AG took over the First Life Insurance Company. <sup>2</sup> In March 1998, Kolon-MetLife Insurance was wholly acquired by MetLife International Holdings, Inc. <sup>3</sup> In March 1999, the equity capital of Kohab New York Life Insurance was wholly acquired by New York Life Insurance. <sup>4</sup> Figures are based on data as of the end of December 1997.

Source: Korea Investors Service Inc Database.

In the case of the securities business, foreign entry took the form of the opening of branches from 1991, when the first such branch was established, until the outbreak of the foreign exchange crisis. After the crisis erupted, however, a number of measures were put in place to open up all major aspects of the securities business in May 1998, including the authorization of the establishment of securities companies through greenfield investment and the abolition of the (50%) ceiling on the ratio of foreign investment in existing domestic securities companies. This has led to a sharp increase in the stakes held by foreign-based investment banks and investment funds in domestic securities companies. Reflecting this, at the end of March 2003, foreign equity participation in major domestic securities companies was, with a very few exceptions, generally very much higher than the levels at the end of March 1997 (Table 4). The share of foreign holdings in total equity capital of listed domestic securities companies has increased substantially, from 5.24% at the end of 1997 to 15.3% as of the end of March 2003.

Foreign entry into the domestic life insurance industry mainly took the form of opening of branches and setting up of joint ventures, because domestic life insurance companies' shares are not listed. There was also a remarkable wave of acquisitions of troubled domestic life insurance companies following the foreign exchange crisis.<sup>6</sup> Consequently, at the end of March 2003, foreign participation in the capital of all the major domestic life insurance companies with the exception of Samsung Life Insurance was much larger than in the pre-crisis period.

Meanwhile, in the non-life insurance sector, foreign entry involved equity participation, rather than the opening of branches. Foreign equity participation in Samsung Fire Insurance and Hyundai Marine Insurance increased substantially. As these companies had high market shares, the result was higher foreign equity participation in casualty life insurance companies as a whole. In line with this, the share of foreign holdings in total equity capital of listed domestic insurance companies substantially increased from nearly 16% at the end of 1997 to around 40% at the end of March 2003.

## **II. Effects of financial globalization on domestic financial markets and monetary policy**

### **1. Effects of expansion of international capital movements on the domestic financial markets**

It is generally recognized that the expansion of international capital movements influences the financial market as a whole by increasing its efficiency and transparency, the volatility of asset prices and the linkages between domestic and foreign price variables.

Turning first to the question of domestic financial market efficiency, the expansion of capital movements accompanying financial liberalization most likely reduces information asymmetry through the improvement of disclosure<sup>7</sup> as countries seek to conform with international standards. The increased sensitivity of equity prices and exchange rates to market conditions also plays a role. As international capital movements expand, the information efficiency of financial markets can be augmented through the rapid incorporation of market information into price variables such as equity prices and exchange rates. In addition, it is thought that more capital movements raise the efficiency of financial resource allocation. This is because foreign investors largely focus on the economic value of companies, tending to favor sound firms with good future growth prospects. The spillover of foreign banks' advanced techniques also has the effect of improving credit screening in the domestic financial industry as a whole.

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<sup>6</sup> In March 1998, Kolon-MetLife Insurance was wholly acquired by MetLife International Holdings, Inc, in July 1999 the First Life Insurance Company by Allianz AG, and in March 1999 Kohab New York Life-Insurance by New York Life Insurance.

<sup>7</sup> In the case where information asymmetry prevails, the degree of information efficiency can be low as market information is only slowly incorporated into prices. For instance, if an item of information which is a factor increasing stock prices is disclosed only to some investors today and to other investors tomorrow, stock prices rise today as the first group of investors purchases stocks and they rise again tomorrow as the latter group of investors purchases. In this case, the information efficiency of the stock market is low as stock prices respond to the initial information slowly.

If information efficiency is high enough, stock price and exchange rate variables are known to show the characteristics of a random walk.<sup>8</sup> Jun-il Kim (2000) presented empirical evidence that domestic stock prices and the exchange rate did not show the characteristics of a random walk before the foreign exchange crisis but did so following the crisis in Korea. The rise in information efficiency in Korean markets is seen as being largely caused by the expanded inflows of foreign capital following the opening of the capital markets. Taking another perspective, Sang-in Hwang, In-bae Kim and In-seok Shin (2001) carried out an empirical survey of domestic banks. Their results show that the improved efficiency of financial markets and the enhanced operational efficiency of financial institutions were caused by heightened application of market principles in the domestic financial industry, improvements in the financial infrastructure and the upgrading of the quality of financial services. All of these factors were in large part a response to the increase in foreign banks' equity participation and the expanded market presence of foreign bank branches following capital market opening.

As to transparency, the expansion of international capital movements brings about heightened transparency of domestic financial markets as the domestic financial system is brought into conformity with international standards. Until the foreign exchange crisis in Korea, financial institutions' information disclosure lagged well behind international standards. However, in the aftermath of the foreign exchange crisis, the authorities sought to promote inflows of foreign capital in the process of financial restructuring. In this period, financial institutions' management transparency was greatly augmented due to the upgrading and systemization of information disclosure.<sup>9</sup>

Sang-in Hwang, In-bae Kim and In-seok Shin (2001) conducted a survey of domestic banks using a questionnaire to find out the effect of the expansion of international capital movements on the transparency of domestic financial institutions. A high proportion of responses indicated that transparency had been increased in reaction to foreign financial institutions' participation in the equity of domestic banks and the greater market penetration of branches of foreign banks.

Larger flows of foreign investment funds will generally increase price volatility because prices are more likely to be influenced by temporary disturbances, such as more speculative hot money flows. In order to examine the linkages between the expansion of capital movements and the volatility of financial market prices, we first compare the trends in the unexpected volatility<sup>10</sup> of stock prices (the conditional variance of the rate of change in stock prices) and the increase in the foreign stock investment ceiling. As can be seen in Graph 2, during the period in which foreign stock investment ceilings were being raised, the volatility of stock prices generally rose more than had been anticipated even after taking into account the effects of the heightened volatility of the stock prices resulting from the widening of their daily permissible fluctuation range.<sup>11</sup> This leads us to conclude that the expansion of international capital movements acted as a factor intensifying the volatility of stock price movements.

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<sup>8</sup> When information is rapidly incorporated into prices, the levels of stock prices and the exchange rate are decided reflecting all the information that may be acquired at the current time, and the levels of stock prices and the exchange rate at the next moment in time are decided on the basis of new information that becomes known at the next moment so that information at the current point in time does not help predict the change in price variables in the next moment. For this reason changes in these prices show the characteristics of a random walk.

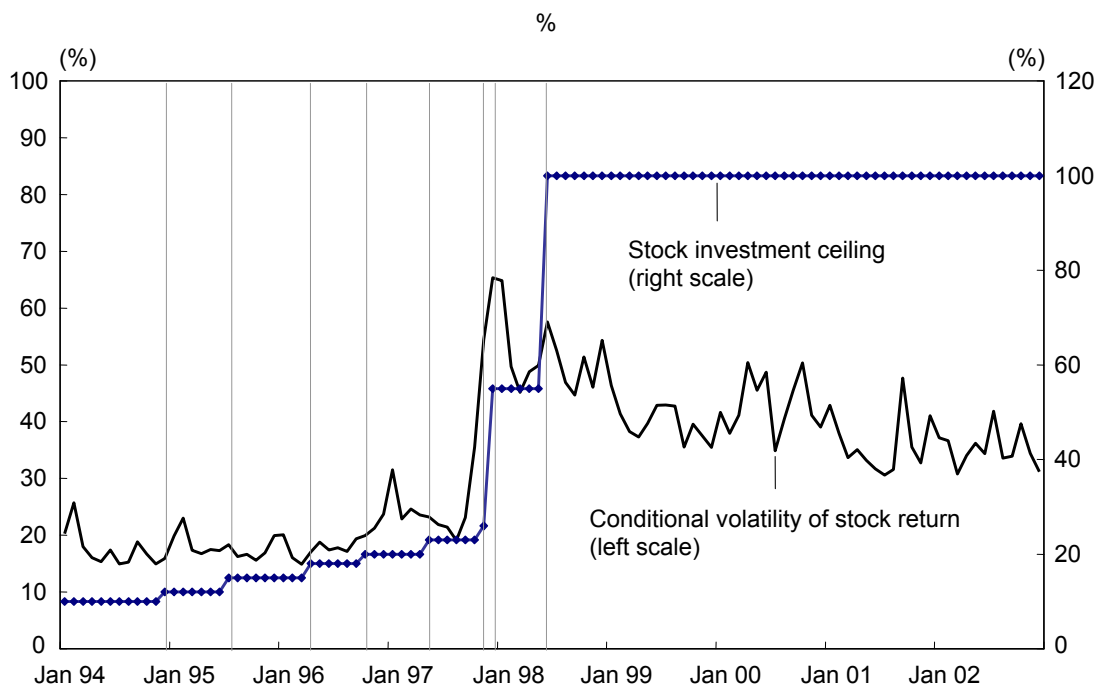
<sup>9</sup> In the case of banks, a further nine items were added or supplemented on top of the existing 55 items for disclosure related to management performance and financial status in order to bring periodic disclosure up to par with international standards and the level of advanced countries. These additional nine items include the scale of non-performing loans, credit assessment grades, loans to subsidiaries, the status of off-balance sheet transactions including large losses related to financial derivatives, and foreign currency liquidity ratios. In addition, the sanctions against insincere or misleading disclosure were strengthened so that disciplinary steps may now be imposed under the related legislation where full and proper disclosure or re-disclosure is demanded in the event of disclosure not being made in good faith; for example, if important matters are omitted or the materials disclosed are compiled in a misrepresenting manner. In addition the credibility of management disclosure is being heightened by the imposition of the requirement that financial statements be externally audited with closing financial statements receiving a full audit and half yearly interim financial statements being subject to review.

<sup>10</sup> The unexpected volatility of stock prices was calculated using a GARCH (Generalized Auto-Regressive Conditional Heteroskedasticity) model. In the GARCH (1,1) model, the conditional variance equation is affected by the one-period ahead conditional variance ( $\sigma_{t-1}^2$ ) and information about volatility observed in the previous period ( $\varepsilon_{t-1}^2$ ).

<sup>11</sup> From 1994 until just before the crisis (October 1997) the average conditional volatility stood at 19.45, but for the period from just after the foreign exchange crisis until the end of the year 2002, it registered 41.72, meaning that the volatility of stock prices expanded almost 2.17-fold following the crisis.

We then compared the trends in exchange rate volatility in Korea and the increase in the foreign stock investment ceiling. In contrast to the pre-crisis period, the volatility of the exchange rate increased more than had been expected when the ceilings on foreigners' stock purchases were greatly raised following the foreign exchange crisis, even taking account of the increase in exchange rate volatility resulting from the widening of its daily permissible fluctuation range (refer to Graph 3).<sup>12</sup>

Graph 2  
**The relation of the investment ceiling on foreigners in the stock market and the volatility of the stock price index**



Note: "Conditional volatility of stock return" indicates the monthly average of daily conditional standard deviations ( $\sigma_t$ ) of the rates of change in the stock price index (KOSPI).

In order to determine whether there is in fact one-way causality running from the expansion of capital movements to the volatility of domestic stock prices and the exchange rate, we examine the relationship between the international capital movements and the rate of changes of domestic stock prices or that of the exchange rate. As the proxy variable for international capital movements, we take the weight of foreign stock investment in total market capitalization, and as the proxy variables for the volatility of stock prices and the exchange rate we use the conditional volatility of the rate of changes in stock prices and that in the exchange rate respectively (Graphs 2 and 3). The period for empirical analysis is January 1994 to December 2002, and each variable was log transformed.

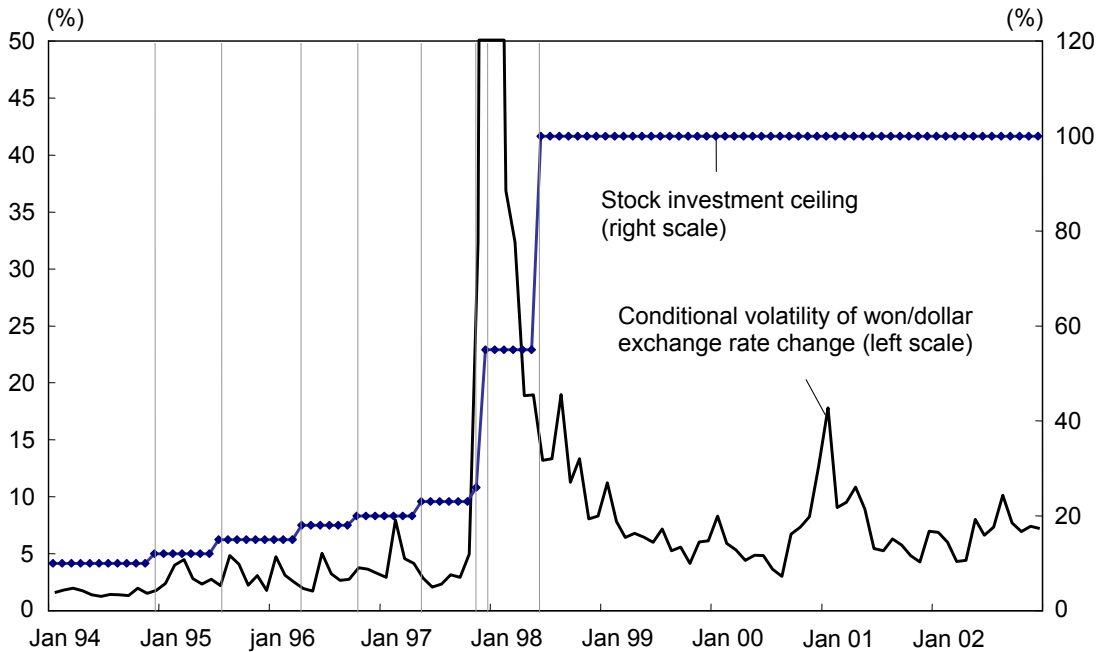
The causality test results also show that an increase in the volatility of stock prices, however, tends to decrease the weight of foreigners' stock investment.<sup>13</sup>

<sup>12</sup> The average value of conditional volatility from 1994 until just before the outbreak of the foreign exchange crisis (November 1997) stood at 2.89. But from just after the outbreak of the foreign exchange crisis until the end of 2002, it registered 11.94, showing a 4.1-fold increase. Meanwhile, even if we exclude the five-month period from just after the outbreak of the crisis (November 1997-March 1998) the average value of conditional volatility registered 8.02, showing a 2.84-fold increase in comparison to the pre-crisis period.

<sup>13</sup> Refer to Appendix 1 for detailed results.

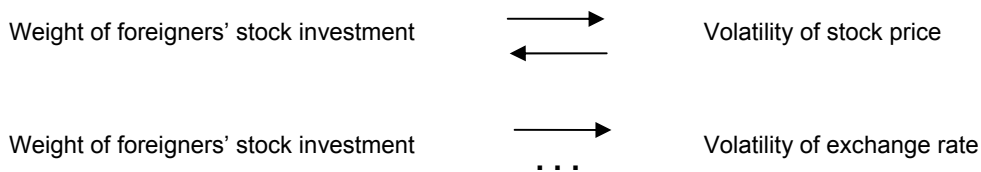
Graph 3

**The relation of the investment ceiling on foreigners in the stock market and the volatility of the won-dollar exchange rate**



Note: "Conditional volatility of won-dollar exchange rate" indicates the monthly average of daily conditional standard deviations ( $\sigma_t$ ) of rates of change in the won-dollar exchange rate.

**Results of the causality test**



It can be argued that a key price variable in the domestic financial market, such as the stock price or the exchange rate, will be closely linked with the same variable in a foreign financial market when an external shock emanating from that foreign financial market transmits quickly to the domestic financial market. The speed of transmission to the domestic financial market is more likely to increase as a result of the expansion of international capital flows in the ongoing process of financial globalization. Quicker transmission appears to be driven in part by the asset management style favored by foreign institutional investors.<sup>14</sup> For risk management purposes, these investors maintain fixed country investment ratios in the course of expanding the global distribution of their assets.

We carried out a brief empirical analysis to determine whether external shocks have tended to be transmitted more quickly to the domestic financial market since the crisis. To this end, we selected the US stock price index (S&P 500) and the yen-dollar exchange rate to proxy for external shock, while using the Korea stock price index (KOSPI) and the won-dollar exchange rate as the price variables in the domestic financial market. Daily data were used and covered the period from January 1994 to the

<sup>14</sup> Investors with a global distribution of investment generally manage their assets, while showing a tendency to maintain a fixed ratio of investment between countries. Accordingly, in the event of a fall in US financial asset prices, the weight of the US investment amount in their investment portfolio will be reduced and Korean financial assets will be sold in order to maintain the fixed ratio of the distribution of investment between countries.

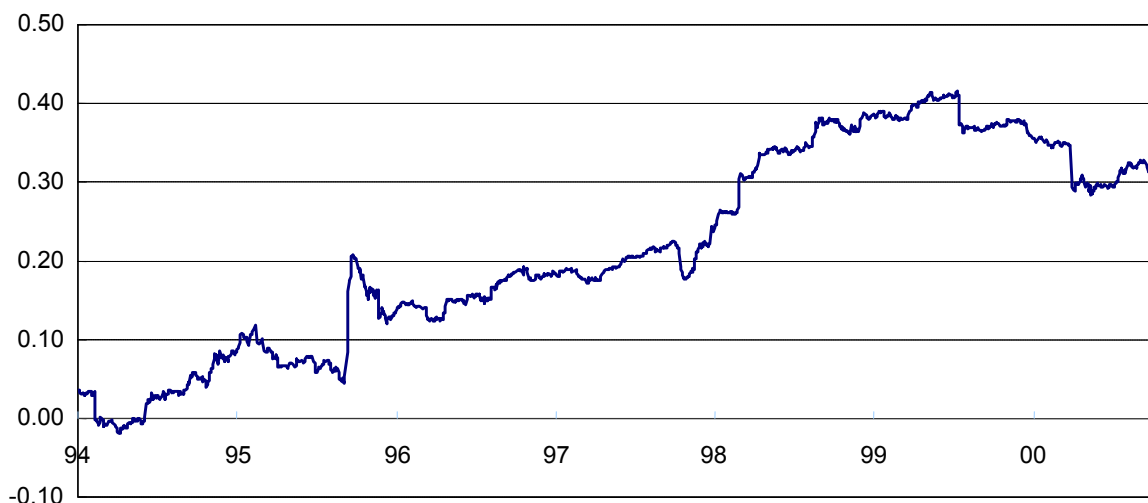


end of 1997 for the pre-crisis period and from January 1998 to September 2003 for the post-crisis period. We found that the daily KOSPI appears not to have depended at all on the daily US stock price over the pre-crisis period. In the post-crisis period, however, the US stock price on one day significantly affects the KOSPI for the following day. Similarly, there is evidence that today's yen-dollar exchange rate significantly influences today's won-dollar exchange rate, in contrast to the results for the pre-crisis period. This evidence may imply that the liberalization measures implemented after the crisis, such as the capital account liberalization and the adoption of the floating exchange rate system, have helped create a more flexible and efficient market environment. As a result, an external shock can now be transmitted to the domestic financial market more quickly than during the pre-crisis period.

To gain additional perspective on changes in the speed of transmission of external shocks, we also calculated the correlation coefficients between price variables in the foreign financial markets and those in the domestic financial market. The evidence generally suggests much quicker transmission. First, the correlation coefficient between US stock prices and domestic stock prices (Graph 4) has increased significantly since the foreign exchange crisis. Second, the linkage appears also to be reflected in the negative correlation between US stock prices and the won-dollar exchange rate, which has emerged since the foreign exchange crisis (Graph 5). As the domestic stock prices are expected to rise when the US stock prices rise, a rise in the US stock prices can stimulate inflows of foreign capital into the domestic stock market, and decrease the won-dollar exchange rate.

Graph 4

**Trends in the correlation coefficient between the rates of change in US stock prices and those in Korean stock prices**



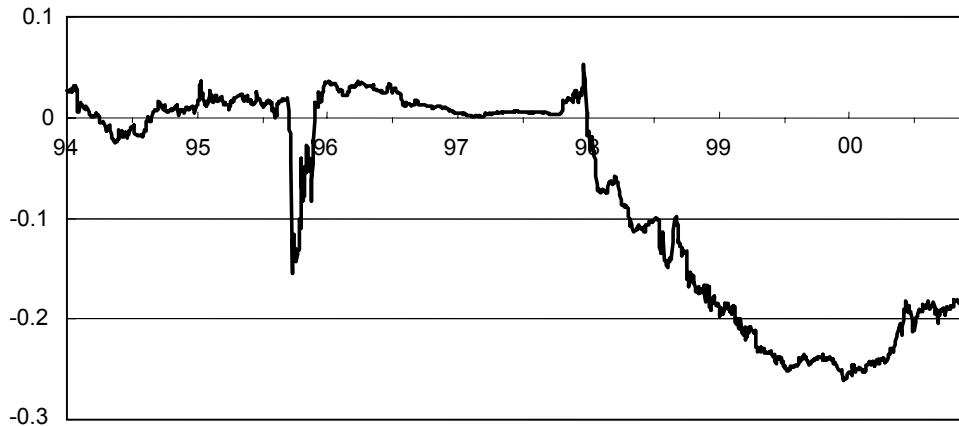
Note: Correlations between the rates of change in US stock prices and those in Korean stock prices are calculated for a period of 500 business days up until year-end 2002 using a method of rollover moving one day forward.

Third, there has been a marked increase in the correlation coefficients between US Treasury rates and Korean government bond rates (with maturities of either three years or five years) since the second half of 1998 (Graph 6). This appears to stem mainly from the brisk arbitrage activities through the bond markets since the complete opening of the domestic bond market in July 1998.

Another feature worth highlighting is that movements of the won and the yen have become more synchronized, as reflected in the rise in correlation coefficients between the levels of the two currencies since the crisis (Graph 7). This seems to have been driven mostly by market expectations that the won will move in tandem with the yen when the latter changes in the foreign exchange market. Such expectations may be closely tied to increased export competition between Korea and Japan, and to the floating exchange rate system introduced in Korea at the end of 1997.

Graph 5

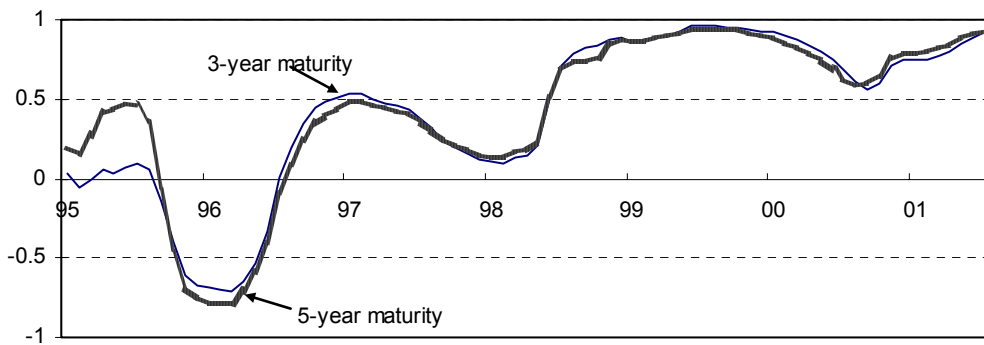
**Trends in the correlation coefficient between the rates of change in US stock prices and those in the won-dollar exchange rate**



Note: Correlations between the rates of change in US stock prices and those in the won-dollar exchange rate are calculated for a period of 500 business days up until year-end 2002 using a method of rollover moving one day forward.

Graph 6

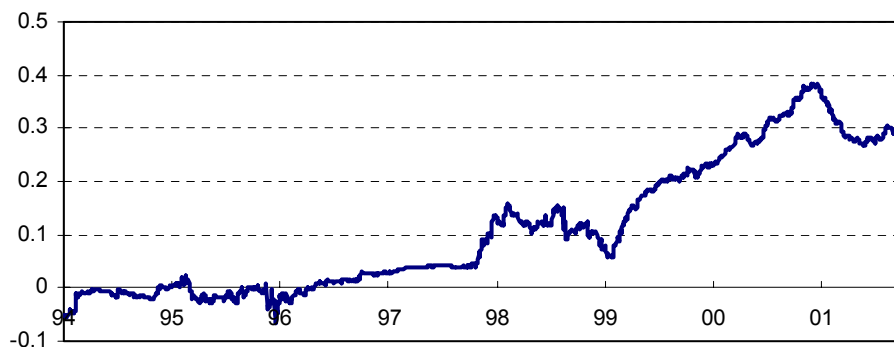
**Trends in the correlation coefficient between Korean government bond rates and US Treasury bond rates**



Note: Correlations between Korean government bond rates and US Treasury bond rates are calculated for a period of 24 months up until October 2003, using a method of rollover moving one month forward.

Graph 7

**Trends in the correlation coefficient between the won-dollar and yen-dollar exchange rates**



Note: Correlations between the rates of change in won-dollar exchange rates and those in yen-dollar exchange rates are calculated for a period of 500 business days up until 20 November 2003 using a method of rollover moving one day forward.

## **2. Effects of an increased proportion of foreign enterprises in the market on the real effects of monetary policy**

According to theory on the transmission of monetary policy, an increase in a central bank's policy interest rate, such as its overnight call rate, raises market interest rates, reducing desired investment and consumption with time lags, and finally resulting in a reduction in aggregate demand. The resulting excess aggregate supply is one of the factors which decrease prices through the adjustment of prices and quantities with relatively long time lags. However, in the case where there are many foreign enterprises (including foreign financial institutions), a decrease in domestic credit supply through a policy interest rate hike can lead to increased foreign capital inflows by foreign enterprises. Thus, the reduction in aggregate demand and prices could be smaller in that case, since domestic market interest rates would increase less than they would if the share of foreign enterprises were smaller. By the same token, a larger share of foreign enterprises can reduce the effect of a decrease in the policy interest rate on aggregate demand.

In order to check if an increase in the proportion of foreign enterprises in the market decreases the effect of changes in the central bank's policy interest rate (overnight call rate) on real variables (income, prices and so on), we estimated both an income equation and a price equation using a co-integration model. Most of the estimators of the income equation and the price equation coefficients are significant. The results broadly suggest that, with the expansion of foreign capital investments in domestic enterprises (including financial institutions) by way of shareholdings after the foreign exchange crisis, the effect of call rate changes on income and price levels appears to have declined somewhat (Appendix 2 provides more details).

It is widely recognized that monetary policy indicators (such as the call rate or base money) operate via equilibrium in the asset markets to influence yields and asset prices, and these in turn influence desired consumption and investment spending. It should be noted that international capital mobility has become increasingly important in discussing the monetary transmission mechanism, in the context of the ongoing process of financial globalization. Thus, if the central bank raises its policy interest rate, the differential between domestic and foreign interest rates will rise, leading to foreign capital inflows for investment in domestic bonds. This may in turn lead to an appreciation of the domestic currency. It seems likely that the impact of a rise in domestic interest rates on capital inflows will be even stronger if there is a high portion of foreign enterprises in the domestic market.

Counteracting this effect is the tendency for an increase in the policy interest rate to lower the domestic stock price by raising domestic interest rates. The lowered domestic stock price is then likely to lead to a depreciation in the domestic currency by causing foreign capital outflows, and thus to influence aggregate demand via net exports. Further, a negative wealth effect arising from the decreased domestic stock price may come into play, reducing consumption spending and thus aggregate demand. In this respect, the external value of the domestic currency may fall to a greater extent in the case where the portion of foreign enterprises in the market is greater, because the foreign investment in domestic stocks is likely to shrink further than it would otherwise.

To sum up, an increase in domestic interest rates provoked by a monetary disturbance (ie a hike in the policy interest rate) will tend to result in an appreciation of the domestic currency to the extent that foreign capital inflows are attracted via the domestic bond market, but will tend to have the opposite effect if net foreign capital outflows emanating from reduced foreign investment in domestic stocks occur. As the ratio of foreign holdings in Korea's domestic stock market has increased substantially since the crisis, as shown in Table 1, a hike in the policy interest rate could well lead to a depreciation in the won against the US dollar by increasing foreign capital outflows as foreign investment in domestic stocks declines. Thus, it is possible that the presence domestically of a high proportion of foreign enterprises may dampen the real effects of domestic monetary policy or even reverse them.

## **3. Experiences in dealing with a sudden stop in foreign capital flows**

From the end of 1996, Korea was hit by the deterioration of financial institutions' loan assets as a result of a series of corporate insolvencies (Hanbo, Sammi, Kia, Jinro etc). At that time, the fragility of the corporate and financial sectors emerged as a serious issue. In addition, from around July 1997, there was a sudden stop in foreign capital flows to a number of South East Asian countries including Thailand and Malaysia. Korea was sucked into this vortex through contagion as foreign investors grew increasingly ill at ease with the fragility of the corporate and financial sectors, and began to withdraw their funds from domestic financial institutions from the beginning of the fourth quarter of 1997.

Although the Korean government responded with desperate efforts to increase foreign capital inflows by raising the ceiling on foreign stock investment, early repayment of foreign currency loans taken out by public enterprises, and borrowing of foreign funds through government-run banks, it was nevertheless unable to prevent large scale foreign capital outflows from taking place. The result was the foreign exchange crisis at the end of November 1997. Right after the outbreak of the crisis, Korea received emergency structural financing from the IMF. Overseas capital flowed in for a while during the first half of 1998 as the country's external credit standing was partially rebuilt. From early in the second half of 1998, however, there was again a massive outflow of foreign capital, leading to a net outflow for 1998 as a whole of USD 290 million.

Table 5  
**Net inflows of portfolio investment**  
In 100 millions of US dollars

	1995	1996	1997			1998					1999
			3Q	4Q	During a year	1Q	2Q	3Q	4Q	During a year	
Net inflows	138.7	211.8	53.6	-20.9	112.9	25.9	17.3	-37.9	-8.2	-2.9	69.9

Source: BOP, The Bank of Korea.

In response to the sudden stop in capital flows, the government and the central bank took measures to attract foreign capital by improving the soundness of companies and financial institutions, soothing financial markets and liberalizing foreign entry into domestic financial markets. In December 1997, ceilings on foreign investment in corporate, government and public bonds were abolished. This was followed in May 1998 by the abolition of ceilings on foreign investment in stocks. In November 1998, the Foreign Investment Promotion Act, which was principally concerned with tax incentives (tax reductions and exemptions), was enacted. In November 1999 improvements were made in the system for foreign investment in securities so that foreigners were not only able to borrow in domestic markets<sup>15</sup> but were also allowed to engage in over-the-counter sales of stocks acquired through direct investment.

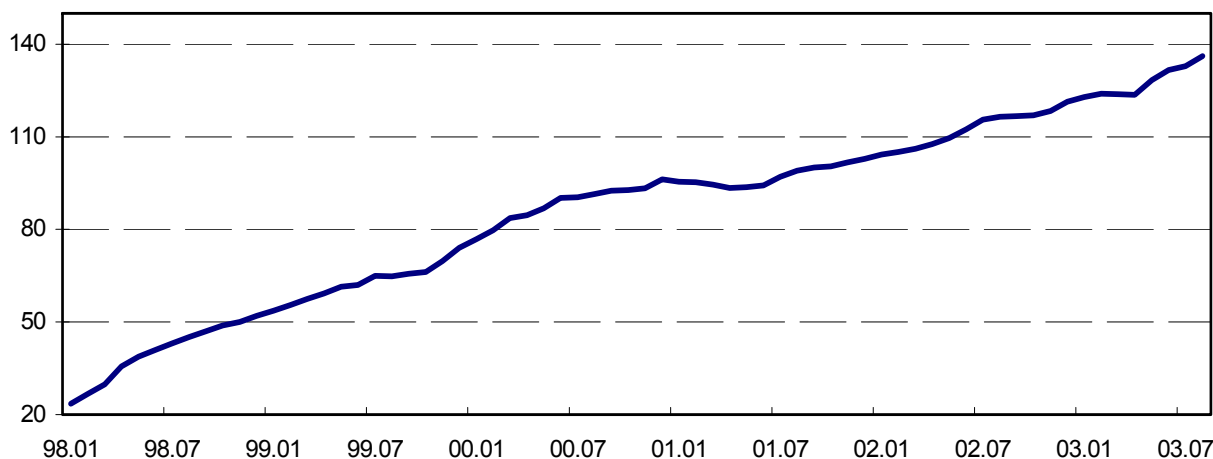
The government also took steps to galvanize the commercial paper and corporate bond markets: in February 1998 it allowed banks to take part in commercial paper operations by way of their bank (and also trust) accounts while giving the green light for large companies to issue corporate bonds (up to three years) until the end of 1998. In March 1998 measures were put in place to avert the failure of otherwise sound enterprises because of liquidity or cash flow problems by arranging joint lending support for them by financial institutions. In April 1998, an agreement with the IMF led to the phased reduction of interest rates in order to ease the credit crunch in the financial markets. In addition, foreign exchange reserves were progressively built up to avoid short-lived speculative attacks involving large scale inflows and outflows of funds and to promote exchange rate stability (Graph 8).

In order to enhance the soundness of the financial sector, in June 1998 the government forced the exit of five of the 15 banks that failed to meet the 8% BIS capital adequacy requirements, while striving to bring a turnaround in the management of 10 other banks by assisting them with public funds and by promoting mergers and acquisitions. Additionally, emphasis was placed on the recovery of corporate soundness through the improvement of corporate governance and financial structures. For the improvement of corporate governance, the election of outside directors was made mandatory in February 1998 and an audit committee system was made obligatory in December 1999. Meanwhile, with a view to a historic improvement of corporate financial structures, major companies with large debts (ie with outstanding bank credits of about 250 billion won) were required to enter into an

<sup>15</sup> In the case of some 20 investment targets including Korea Electric Power Corporation, Dacom, KT, SK Telecom, Korea Gas Corporation, Korean Air Line and so on, foreigners were allowed to take out borrowings from securities companies.

agreement with their major creditor bank for the improvement of their financial structure. The result was an unprecedented improvement in corporate financial structure through debt ratio reductions.

Graph 8  
**Trends in foreign reserves outstanding**  
 In billions of US dollars



Source: *Monthly Bulletin*, The Bank of Korea.

#### 4. **Effects of increased foreign reserves on the exchange rate and the operation of monetary policy**

In order to assess the effect of an increase in foreign reserves on the level and volatility of the won-dollar exchange rate, we estimated equations in which the yen-dollar exchange rate, the net inflows of foreign stock investment and foreign reserves are the major explanatory variables in determining the won-dollar exchange rate.<sup>16</sup> The relevant coefficients in the estimated equations are all significant. In the case of Korea, an increase in foreign reserves is associated with a fall in the long-run level of the won-dollar exchange rate (appreciation) and a reduction in its volatility.

An increase in foreign reserves can affect the operation of monetary policy by promoting stability in the foreign exchange and domestic financial markets. In other words, it appears likely that an increase in foreign reserves tends to stimulate inflows of foreign capital, because it increases the stability of the exchange rate. In addition, a central bank can adjust its policy interest rate more flexibly thanks to the enhanced stability in the domestic financial market stemming from increased foreign reserves.

There is a particular instance in Korea showing that an increase in foreign reserves can help the stability of the foreign exchange and domestic financial markets. During March 2003, the won-dollar exchange rate rose rapidly (depreciated) as foreign capital inflows declined and there was an increasing expectation that the won would depreciate due to the problem of North Korea's nuclear program (the won depreciated by 5.1%). The Bank of Korea (BOK) intervened in the foreign exchange market, selling US dollars out of its foreign reserves to prevent a rapid won depreciation. Stability in the foreign exchange and domestic financial markets was then restored when the likelihood of a peaceful resolution of the nuclear problem increased and the situation at home and abroad improved. As the BOK had sufficient foreign reserves at that time, it was able to restore stability in the foreign exchange and domestic financial markets, and prevent a speculative attack on the exchange rate from taking place, as had happened just before the Korean foreign exchange crisis.

It has been argued that foreign capital flows tend to take place mostly through the stock market rather than the bond market in Korea, in the sense that the share of foreign stock holdings in total stock

<sup>16</sup> Refer to Appendix 3 for details.

market capitalization has increased substantially since the crisis. In line with this, a recent empirical study by Jung-Kun Oh (2000) shows that a fall in the call rate, one of the factors causing stock prices to rise, turns out to increase foreign capital inflows as foreign stock investment soars. Considering this result, it seems likely that the possibility of capital outflows need not restrain the BOK from decreasing the call rate when necessary. By the same token, capital outflows might occur should the call rate increase. The BOK, however, would not have much need to reduce the extent of the call rate increase due to fear of capital outflows, provided that its foreign reserves were sufficient.

Meanwhile, the issuance of monetary stabilization bonds (MSBs) has increased greatly due to the need to absorb the excess liquidity accompanying increased foreign reserves. This makes it more difficult for the BOK to conduct monetary policy, as payments of interest on MSBs increase.

According to theories of the optimal level of foreign reserves, the level of foreign reserves increases as opportunity costs decrease (as reflected in a narrowing gap between domestic and foreign interest rates), or as the volatility in the balance of payments or in foreign reserves increases. We can therefore expect that when the proportion of foreign assets in a central bank's balance sheet is increasing, domestic interest rates are low or there is a greater need to stabilize the foreign exchange market.

### **III. Important issues relating to monetary policy**

#### **Deepening the liquidity of the government and public bond markets**

An urgent task for monetary authorities has been to counter the reduced effectiveness of monetary policy associated with the widespread financial globalization of recent years. This requires more efficient implementation of open market operations by deepening the liquidity of the public bond market. The Korean government has recently pursued a series of measures to achieve this goal. These include the establishment of a fixed schedule for the issuance of public bonds (January 1999), the creation of an inter dealer market on the Korea Securities Exchange (March 1999), the introduction of a primary dealer system for public bonds in which 24 institutions - 12 banks, 11 securities companies and one merchant banking corporation - were designated as primary dealers (July 1999), the creation of a public bond futures market (September 1999), the introduction of the fungible-issue system (May 2000)<sup>17</sup> and the initiation of the issuance of 10-year Treasury bonds so as to diversify the range of maturities (November 2000).

Although the volume of government and public bonds supplied increased after the foreign exchange crisis, it was insufficient for active liquidity management via open market operations by the central bank. As a result, the BOK was forced to greatly expand its issuance of MSBs in order to mop up excess market liquidity. To make long lasting changes in market liquidity, the BOK employs outright sales and purchases (principally sales) of MSBs. To change liquidity temporarily, or on a day to day basis, however, it makes use of repo transactions (purchases and sales under condition of repurchase). A serious side-effect of the large-scale expansion in the volume of MSBs issued was the sharp rise in interest charges on MSBs outstanding. This has acted as a factor weakening the effectiveness of monetary policy.

#### **Market expectations reflected in interest rates and call option prices**

According to the expectations hypothesis on the term structure of interest rates, market expectations of future short-term interest rates may be calculated using current long-term and short term interest rates. But generally, actual short-term interest rates do not coincide with calculated future expectations

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<sup>17</sup> The system of issuing the same kinds of government bonds by keeping the remaining maturities and interest rates of all government bonds issued during a certain period (three months or six months) the same.

of these rates because of a number of factors including the uncertainty concerning future interest rates, risk aversion, the degree of liquidity of bonds and the effect of taxes.<sup>18</sup>

In particular, because of the progress of financial globalization, external factors tend to exercise an increasing influence over domestic financial market price variables. It is possible that the divergence between market expectations of future short-term interest rates and actual realized rates will widen due to the heightened uncertainty about future long term and short term rates. In order to address this possibility we compared the gap between actual rates and market expectations of future short-term interest rates using actual US and Korean interest rate data for the period January 2001 to September 2003. Analysis of the data reveals that in Korea the gap between the actual interest rate observed and the market expectation of the interest rate on the one-year maturity MSB 12 months later averaged 2.04%.<sup>19</sup> In the United States, using interest rates on one-year and two-year Treasury bonds, the interest rate gap reached 2.52%. In addition, the gap between the actual interest rate and the market expectations of the interest rate on one year public bonds 12 months later (using the interest rate on one-year and three-year maturity public bonds) was much lower in Korea (1.81%) than in the United States (2.64%).<sup>20</sup> The small interest rate differential suggests that estimated future short-term interest rates forecast actual rates comparatively well in Korea.

Overall expectations concerning future short-term interest rates using long-term and short term interest rates are deemed to be useful as an information variable for monetary policy.

Call option prices generally provide important information concerning market expectations. In the case of Korea, it may be implausible for market expectations to be reflected in options prices for bonds in view of the very small trading volume in the call option market for bonds. In contrast, the call option market for stocks, although not on a par with that in advanced countries, is comparatively well developed. Thus, it is conjectured that market expectations are incorporated in the call option prices in the stock market. Call option prices in the foreign exchange market, even though their trading volume is not large, appear to reflect market expectations to a certain degree, given that the pricing of call options by and large runs ahead of changes in the spot exchange rate.

### **Relative influence on domestic bond rates of external and internal factors**

As financial globalization progresses, the influence of external factors over bond market interest rates and other domestic financial market price variables tends to rise while that of domestic factors tends to fall. In line with this, interest rates on US Treasury and Korean government bonds showed a very high correlation (0.9) in the period October 2000 to September 2003. However, an empirical analysis of the determinants of Korean bond interest rates over this period suggests that not only external factors were important during this period. Korean government bond interest rates were influenced not just by US Treasury bond interest rates but also by domestic factors including the call market rate and the money supply (M1).

### **The conduct of monetary policy in response to external shocks**

There is an ongoing debate on whether an inflation targeting country should ease its monetary policy stance when inflationary pressures weaken as a result of significant appreciation of its currency induced by an external shock. The BOK has implemented a system of inflation targeting whereby it seeks to maintain inflation within a target range whose upper and lower bands are established each

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<sup>18</sup> Where the tax on interest income from long-term public bonds is higher (lower) than that from short-term public bonds, holders of long-term public bonds will require a higher (lower) interest compensation resulting in an increase (a decrease) in long term public bond interest rates. Consequently, the gap between expectations concerning the future short term interest rates and actual rates will be widened (narrowed).

<sup>19</sup> Expected future one-year maturity bond interest rates 12 months later are calculated using the relation of (current one-year maturity bond interest rate)  $\times$  (interest rate on one-year maturity bond 12 months later) = (current interest rate on two-year maturity bond)<sup>2</sup>.

<sup>20</sup> Expected one-year maturity bond interest rates 12 months later are calculated using the relation of (current one-year maturity bond interest rate)  $\times$  (interest rate on one-year maturity bond 12 months later)  $\times$  (interest rate on one-year maturity bond 24 months later) = (current interest rate on three-year maturity bond)<sup>3</sup>.

year (at the the end of 2003 this was replaced by an intermediate inflation target system). In the operation of this system, consideration is given not only to the inflation target itself but also to the state of the real economy and financial markets and asset prices. This means that the policy rate may not be adjusted in compliance with the inflation target alone even though actual inflation may deviate from its target level. For example, even when actual inflation is running below its target range, the policy interest rate will not necessarily be adjusted downward if there is a possibility of a real estate or other asset price bubble.

Another factor that may influence monetary policy is exchange rate volatility. Exchange rate stability has not been a principal goal of monetary policy in Korea since the adoption of a floating exchange rate regime at the end of 1997. Nevertheless, if the exchange rate deviates by a relatively large margin from its long-term equilibrium level because of the influence of speculative forces (or other reasons), exchange rate stability may be restored through appropriate policy responses including the adjustment of foreign exchange supply and demand.

The recent financial sector disturbances in certain emerging market countries have raised concerns about whether each country's central bank expanded its liquidity in line with rises in the exchange rate and interest rates. During the 2002 episode of financial instability centering on South American countries, Korean domestic market interest rates and the won-dollar exchange rate generally trended downward. However, the BOK did not expand liquidity by lowering the call rate. Instead, it raised its policy rate by one notch (May 2002) in order to bring the rapid growth of housing loans under control. The effect of financial disturbances in other emerging market countries on Korean financial markets was not so great as to require monetary easing on the part of the BOK. In part this is because the scale of Korean claims on South America is generally not large and the region absorbs a relatively small share of Korea's total exports. Relatively robust Korean macro economic fundamentals (eg ample foreign reserves) also played a part.

Recently there has been growing concern as to whether greater consideration should be given in the conduct of the monetary policy to external or to domestic factors. Looking at the external factors facing Korea of late, the world economy is expected to recover gradually, leading to a continued favorable export environment. In addition, the value of the U.S. dollar will likely continue to fall in the near future, because the US is running a huge current account deficit (about 5% of GDP). Further, international oil prices are more likely to show a downward trend. But the North Korean nuclear issue could be a key factor aggravating the current economic situation.

The BOK is largely concerned with domestic factors because they are more likely to come into play as a drag on the Korean economic recovery. The Korean economy has continued its downward trend (showing low growth rates in the first and second quarters of 2003), mainly due to a rapid contraction of consumption and investment. Since the share of mortgage loans in bank lending remains high, the relationship between the real estate business and the risk faced by banking institutions has become greater. Household debt has risen markedly since the end of 2001, due to increased loans extended by banks and credit card companies in the climate of long-run low interest rates. The number of credit delinquents, which surged during 2002, has continued to increase in 2003.

#### **IV. Monetary policy implications of privatization receipts and operations of state-owned exporters**

##### **Monetary policy implications of privatization receipts**

The increased integration and globalization of financial markets has exposed private agents and governments to greater international competition. This exposure manifests itself in the movement of capital to countries that offer the highest rate of return. This creates an incentive for the large-scale privatization of government-owned enterprises by increasing the costs of maintaining inefficient and overly regulated market structures. The purpose of privatization is to redeploy assets in the economy from the public sector to the private sector. The privatization proceeds for a group of 20 large emerging market economies have been estimated to average 1.75% of GDP a year, mostly in the first half of 1990s, when many governments embarked on active privatization programs. Since privatization entails an exchange of assets that does not affect the net worth of the government sector, or reduce that of the private sector, privatization proceeds should be treated as financing and not as (tax or other) revenue. Privatization may have important monetary policy implications, but the precise effect



depends on what the government does with the proceeds, and on the modes of the privatization. The following modes of privatization may be considered with a view to identifying their differing implications for monetary policy.

First, privatization can be implemented by selling shares to residents (private sector). The government can choose not to use privatization proceeds to finance additional public expenditure, but instead to reduce the government's indebtedness to the central bank. Then, the initial impact of the privatization operation on the government's account is to reduce its net indebtedness to the central bank - since the proceeds are simply deposited in the Treasury account there - and to decrease its stock of illiquid, real assets. The initial impact of the operation on the private sector is to reduce its holdings of money or near money, and increase its holdings of financial assets (eg shares) at the long end of the maturity spectrum. Domestic interest rates could rise, especially since the private sector has become less liquid. An increase in interest rates, by reducing the market value of the financial assets held by the private sector, would reduce its wealth. This effect can, however, be offset if the government uses the proceeds to purchase public debt held by the private sector, or if the central bank conducts an open market operation. If the government uses the proceeds for government expenditure, the private sector's holdings of money or near money increase, and thus the effect of the initial rise of domestic interest rates can be offset. In this respect, privatization in which shares are sold to residents may have a negligible impact on liquidity and domestic interest rates.

A privatization in which shares are sold to non-residents (foreigners) can have an expansionary effect on monetary aggregates because of the associated capital inflows, resulting in an increase in liquidity and a fall in domestic interest rates. How can the central bank deal with these consequences of privatization-related inflows of foreign capital? In general, conventional monetary policy tools to sterilize the excess foreign exchange inflows are likely to be less effective or have undesirable consequences if applied to very large privatization-related capital inflows. An alternative approach would be to use the privatization proceeds to pay off public sector external debt. This policy automatically redirects the inflows abroad and so limits the impact on the local economy. But a potential disadvantage is that debt repayment may trigger other capital inflows, by signaling an improvement in the investment climate, and thus increase rather than eliminate the need for sterilization.

Second, privatization can be implemented by means of a capital transfer by the government to the private sector (a voucher privatization). In this case, the government's property holdings decline, but its liquid assets do not increase. The private sector, however, enjoys an increase in its wealth. If it can borrow against this wealth, it is likely that market interest rates will rise.

In Korea, government privatization programs have largely involved the non-viable financial institutions that came under government control in the process of the financial sector restructuring following the crisis. Privatization has been implemented by selling shares to both residents and non-residents. For example, two government-owned banks were privatized by selling shares to foreigners. First, Korea First Bank (KFB) was taken over by NewBridge Capital in December 1999 (at 500 billion won). Second, Commerzbank acquired Korea Exchange Bank (KEB) in July 1998 (at 350 billion won), and then Loan Star acquired KEB from Commerzbank in December 2003 (at 175 billion won). Privatization receipts have been used for government debt retirement and government expenditure. However, privatization receipts remained very small relative to GDP (around 0.03% during the period 1998 to 2002) and did not result in large and unpredictable shocks to the market. Thus, it appears that privatization proceeds in Korea did not have a major impact on either monetary aggregates or interest rates.

### **Monetary policy implications of operations of state-owned exporters**

The monetary impact of large revenue streams from commodity and other exports of state owned enterprises would be pronounced if their export earnings became subject to massive swings due to unpredictable changes in commodity prices and world demand. In this case, export earnings can create shocks that affect the domestic exchange rate through a number of channels. For example, if foreign exchange earnings from commodity exports are converted into domestic currency and are spent on non tradables, this can lead to exchange rate appreciation and weaken a country's export competitiveness. Policy makers then face a dilemma; they can let the currency appreciate, or the central bank can buy up the foreign exchange earnings and increase foreign reserves to avoid nominal appreciation. The central bank, however, may have difficulty sterilizing large inflows of excess foreign exchange using conventional monetary tools. Thus, this consideration leads some commodity

(eg oil or other resources) exporting countries to rely on alternative approaches to managing large swings of export earnings, such as export revenue stabilization funds (eg Chile, Venezuela, Mexico and Colombia).

In Korea, aggregate data on the export earnings of government-owned enterprises are not available, but it is conjectured that almost all government-owned enterprises do not rely on export earnings. Thus, there has been no need to establish unconventional policy tools to deal with large swings of foreign exchange earnings such as export earnings stabilization funds or compulsory foreign exchange surrender rules.

## Appendix 1: Granger causality test

### Test equation

$$y_t = a_0 + \sum_{i=1}^n a_{1,i} y_{t-1} + \sum_{i=1}^n a_{2,i} x_{t-1} + \varepsilon_t$$

\* In the case where  $y_t$  is the series of the proportion of stock investment by foreigners, the test equation includes a dummy variable which has the value of 1 when the ceiling of stock investment by foreigners is expanded, and 0 otherwise.

Causality test result				
Causality	PSIF <sup>1</sup> → Stock volatility	PSIF <sup>1</sup> → ER volatility	Stock volatility → PSIF <sup>1</sup>	ER <sup>2</sup> volatility → PSIF <sup>1</sup>
F(n,102-n)	1.84 (0.09)	2.02 (0.06)	2.51 (0.02)	0.63 (0.72)
$\sum_{i=1}^n a_{2,i}$	0.012	0.059	-0.16	-0.03
Number of lags(n)	6	7	6	7

Note: In F(n,df), df represents the degree of freedom and n represents the number of lags of independent variables, which was determined according to the significance of F(n,df). F(n,df) is F-test statistics with the null hypothesis of  $a_{2,1} = a_{2,2} = \dots = a_{2,n} = 0$ , figures inside parentheses are the level of significance.

<sup>1</sup> PSIF stands for the proportion of stock investment by foreigners. <sup>2</sup> ER stands for KRW/USD exchange rate.

## Appendix 2: Test concerning the effects of an increased proportion of foreign enterprises in the market on the effects of monetary policy

In order to assess whether an increase in the proportion of foreign enterprises in the market decreases the effect of changes in the central bank's policy interest rate (overnight call rate) on real variables (income, prices and so on), an empirical estimation was carried out with the co-integration equations described below. The estimation period is from January 1992 to July 2003. The logarithm of each series is used for each variable in the estimation equations. The coefficient  $a_{2,t}$  in the following estimation equations represents the effect of changes in the call rate on income (or prices), and it could vary if the coefficient  $b_1$  has a significant non-zero value. As a proxy for the proportion of foreign enterprises in the market, the ratio of the value of foreign equity investment (including equity holdings through direct investment) to the total value of equities is used. Results of  $b_0 < 0$  and  $b_1 > 0$  in the following equations would indicate a decrease in the effect of the policy interest rate on real variables due to an increased proportion of foreign enterprises.

### Variables

$m_t$ : real money,  $er_t$ : won-dollar exchange rate,  $R_t$ : overnight call rate

$y_t$ : real industrial production,  $p_t$ : consumer price index (CPI)

$\theta_t$ : a proxy variable representing the proportion of foreign enterprises in the market

### Estimation equations

$$y_t = a_0 + a_1 t + a_{2,t} R_{t-1} + a_3 m_{t-1} + a_4 er_{t-1} + e_t \quad (\text{Income equation})$$

$$a_{2,t} = b_0 + b_1 \theta_{t-1}$$

$$p_t = a_0 + a_1 t + a_{2,t} R_{t-1} + a_3 m_{t-1} + a_4 er_{t-1} + e_t \quad (\text{Price equation})$$

$$a_{2,t} = b_0 + b_1 \theta_{t-1}$$

The results of the estimation of the co-integration equation show the existence of a stable co-integration relationship between the variables over a long period. In particular, the estimators of the income equation and the price equation coefficients  $b_0$  and  $b_1$  show significant positive and negative values.

### Estimation results

	$b_0$	$b_1$	$a_0$	$a_1$	$a_3$	$a_4$	Adj R <sup>2</sup>	ADF
Income equation	-0.718 (-2.16)*	0.268 (2.54)**	12.969 (22.56)**	0.015 (9.43)**	0.006 (0.16)	-0.271 (-9.54)**	0.99	7.49
Price equation	-0.522 (-2.94)**	0.283 (5.03)**	5.236 (16.98)**	0.011 (13.48)**	-0.086 (-3.92)**	-0.002 (-0.19)	0.99	9.66

Notes: Figures in parentheses indicate t-values, and ADF represents the statistics from the Augmented Dickey-Fuller test with the error term. \*\* significant within 1%, \* significant within 5%.

### Appendix 3: Test concerning the effects of increased foreign reserves on the exchange rate

In order to assess the effect of an increase in foreign reserves on the level and volatility of the won-dollar exchange rate, an empirical estimation is carried out with a co-integration model and a GARCH model which include the yen-dollar exchange rate, the net inflows of foreign stock investment and foreign reserves as independent variables and the won-dollar exchange rate as the dependent variable. The estimation period is from December 1997 to July 2003, as a fully floating exchange rate system was introduced in Korea in November 1997. The first order difference of the logarithm of each series is used in estimation.

#### Variables

$E_t$ : KRW/USD exchange rate,  $FR_t$ : Foreign Reserves

$E_{J,t}$ : JPY/USD exchange rate,  $SI_t$ : Net inflows of foreign stock investment

#### Estimation equation

##### 1. Co-integration model

$$E_t = a_0 + a_1 FR_{t-1} + a_2 E_{J,t} + a_3 SI_{t-1} + \varepsilon_t$$

##### 2. GARCH model

$$\Delta E_t = a_0 + a_1 \Delta E_{t-1} + a_2 \Delta E_{t-2} + a_3 \Delta FR_{t-1} + a_4 \Delta E_{J,t} + a_5 \Delta SI_{t-1} + a_6 \sigma_t^2 + \varepsilon_t \quad (\text{Mean equation})$$

$$\varepsilon_t | \Phi_t \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = b_0 + b_1 \varepsilon_{t-1}^2 + b_2 \sigma_{t-1}^2 + b_3 \Delta FR_{t-1} + b_4 \Delta E_{J,t} + b_5 \Delta SI_{t-1} \quad (\text{Variance equation})$$

#### Estimation results

##### 1. Co-integration model

Coefficients	$a_0$	$a_1$	$a_2$	$a_3$	Adj R <sup>2</sup>	ADF
Estimators (t-value)	5.022 (9.41)***	-0.067 (-4.71)***	0.694 (8.71)***	0.033 (1.62)	0.69	-3.82

Notes: ADF represents the statistics from the Augmented Dickey-Fuller test with the error term. Figures in parentheses represent t-values, \*\*\* represents significance within 1%, \*\* within 5%, \* within 10%.

## 2. GARCH model

	$a_0$	$a_1$	$a_2$	$a_3$	$a_4$	$a_5$	$a_6$
Mean equation	0.009 (1.75)*	0.361 (2.55)**	-0.315 (-2.33)**	-0.498 (-3.73)***	0.338 (3.79)***	0.007 (0.53)	-0.347 (-0.05)
Variance equation	$b_0$	$b_1$	$b_2$	$b_3$	$b_4$	$b_5$	
	0.0002 (1.79)*	0.266 (0.73)	0.622 (2.41)**	-0.005 (-1.80)*	-0.001 (-0.46)	0.0004 (1.53)	

$$R^2 = 0.59, \text{ Adjusted } R^2 = 0.50$$

Notes: Figures in parentheses represent t-values, \*\*\* represents significance within 1%, \*\* within 5%, \* within 10%.

The result of the estimation using the co-integration equation shows that the co-integration relationship exists, and thus that a long term stable relationship exists among the variables in the co-integration equation. The result that the estimator of  $a_1$  has a significant negative value implies that an increase in foreign reserves decreases the won-dollar exchange rate (causes Korean won appreciation) in the long term.

The result of estimation with the GARCH model shows that the estimator of  $b_3$  has a significant negative value to some extent, which implies that an increase in foreign reserves in Korea decreases the volatility of the won-dollar exchange rate.

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