Inflation targeting in Korea: a model of success?

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I. Introduction

Korea has managed inflation targeting as a framework for monetary policy since 1998. In this policy setting, core inflation is the target, and the call money market rate, which the Bank of Korea (BOK) can control, is the operational target of monetary policy. Prior to the adoption of the call money market rate and inflation targeting, the BOK had exploited a variety of monetary aggregates ranging from the reserve base to M3 as an intermediate target.

After a few years of inflation averaging more than 5% per year, the rate of change of the CPI decelerated sharply to a little over 1% in 1999 - the first year of inflation targeting. Since then, the annual rates of inflation in terms of the CPI and core CPI have remained around 3-4%, mostly within the target ranges. On the surface, this record suggests that inflation targeting has been effective in sustaining price stability in Korea. However, delving deep into the operations of monetary policy, such an evaluation calls for qualifications. Since the 1997-98 financial crisis, economic downturn, instead of inflation, may have been the main concern. In addition, there has been a sharp appreciation of the won-dollar exchange rate, which has helped keep prices of imported goods, and thus price levels, low. One may claim that the new framework has not been subject to a real test of controlling inflation in such an environment with low inflationary pressure.

The BOK lowered the call money market rate continuously from 5% in February 2000 to 3.25% in November 2004. Subsequently it remained unchanged until October 2005, when it was raised by 0.25 percentage points. Understandably, monetary policy has been expansionary since 2000. However, the expansionary monetary policy has not been effective in bringing about economic recovery. Loose monetary policy appears to have done little in the way of stimulating domestic demand, specifically investment demand. Although the real interest rate has fallen and the availability of credit has increased, business firms have shown little sign of taking advantage of the low cost of financing to increase their capital investment.

The purpose of this paper is to analyse the extent to which inflation targeting has contributed to stabilising prices in Korea since 1999 when it was introduced. To this end, the paper examines the mode of operation, channels of transmission and effects on macroeconomic variables of monetary policy. Before discussing these issues, this paper summarises the history of monetary policy in Section II.

Section III is devoted to an empirical examination of the extent to which inflation targeting has contributed to sustaining price stability. To this end, raw data on the rates of inflation

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measured by the CPI and core CPI during the periods of and before inflation targeting are presented for a visual inspection. Then, following Levin, Natalucci and Piger (2004), time series models are estimated to gauge the relative role of the size of inflation shocks and the propagation of inflation shocks in explaining the volatility of inflation. This examination will help us determine whether the decrease in inflation volatility during the periods of inflation targeting is due to the fall in the size of inflation shocks or inflation targeting itself. Finally, the sensitivity of changes in inflation expectations to changes in actual inflation is estimated in terms of the method suggested by Levin, Natalucci and Piger (2004) in order to analyse whether the formation of inflation expectations changed after the introduction of inflation targeting.

In Section IV, a monetary reaction function is estimated to infer the way in which monetary policy was conducted during the period of inflation targeting. In order to account for the forward-looking nature of monetary policy, which appears to be characteristic of the monetary policy of the BOK, a modified version of the methodology suggested by Clarida, Gali and Gertler (1998, 2000) is used. This estimation will help us better understand the importance of changes in inflationary pressure and the output gap in the policy responses of the BOK.

In Section V, the transmission mechanism of monetary policy is investigated in terms of structural VAR models developed by Christiano, Eichenbaum and Evans (1996). Concluding remarks are in Section VI.

II. History of monetary policy in Korea

Before the currency crisis in 1997, the intermediate target of monetary policy of the Bank of Korea was a monetary aggregate such as M1or M2. This aggregate was then adjusted to achieve the BOK's policy objectives. After the 1997-98 financial crisis, the Bank of Korea adopted inflation targeting and began using the interest rate as the operational target. After some years of a two-pillar system in which a monetary aggregate also served as an operational target, pure inflation targeting was established in 2004. This section briefly summarises the history of monetary policy in Korea.[3]

II.1. Monetary targeting

Monetary policy in Korea has been conducted in various systematic frameworks since 1957, when the "Fiscal Financial Stabilisation Plan" was first introduced as an overall framework of macroeconomic policy in order to curb high rates of inflation resulting from the large fiscal deficit the government ran during the Korean War and the post-war reconstruction period. Under the plan, the limit for the rate of growth of M1 was pre-announced quarterly or yearly. After running current account deficits for a number of years, Korea had to accept a standby credit agreement with the IMF (March 1965). This agreement required Korea to set up a concrete value of monetary target in consultation with the IMF, which marked an important change in monetary policy operations in Korea.

In 1976, the Bank of Korea began setting its own M1 growth rate target as the current account started to improve. Three years later, the Bank changed the monetary target to a M2 growth rate since the demand for M1 became much less stable than before. In setting the target value of money supply, the BOK used the EU method of the quantity equation of money.

[3] Most of this section follows the descriptions in Bank of Korea (2002a, 2002b).

The Bank of Korea maintained monetary targeting until the mid-1990s. Largely because of the stability of M2 demand, the Bank was able to keep the M2 growth rate closer to the target value. However, changes in the trust account system in 1996 had made M2 demand unstable. As a result, from 1997 the Bank of Korea used two monetary aggregates: M2 and MCT, which is a broader measure of money that includes CDs and trust cash funds. However, the usefulness of MCT as a monetary target declined with a change in the required reserve system.[4]

After the 1997-98 crisis that forced Korea to accept IMF rescue financing with policy conditionality, the Bank of Korea adopted a broad measure of money, M3, as a reference value together with a corresponding supply limit of the monetary base. At the same time, the Bank revised the Bank of Korea law in late 1997 to adopt inflation targeting and to explicitly announce the target rate of inflation. The Bank introduced a system of monetary policy operations in which a target of inflation was made public and the growth rate of M3 was the operational target, similar to the two-pillar system of the European Central Bank.

Although the Bank of Korea did not need to consult the IMF in deciding the target rate of growth of M3 from 1999, the Bank kept the two-pillar system, setting the target rate of growth of M3, because it was concerned about the possible confusion in financial markets a sudden dropping of M3 could cause. For the two years beginning in 2001, a target M3 growth rate was not set, but only monitored. In 2003, the monitoring of M3 growth was brought to an end. This change has completed the transition from the two-pillar to a pure inflation targeting system.

II.2. Interest rate as an operational target

There had been a debate on whether the interest rate could be a more reliable operational target than a monetary aggregate since the mid-1990s. However, it was only after the 1997-98 financial crisis that the interest rate was accepted as an operational target. The BOK used the interest rate as an explicit operational target on 30 September 1998, when it lowered the call money market interest rate from 8.1% to 7%. Since 1999, the BOK's Monetary Policy Committee (MPC) has indicated the general direction of monetary policy by announcing the target call rate.

II.3. Inflation targeting

During the early years of inflation targeting (1998-99), the CPI inflation rate was adopted as the benchmark indicator because it was familiar to the Korean public and the IMF policy conditionality required such an adoption. Since 2000, the underlying or core CPI inflation rate has been chosen as the benchmark inflation indicator, which leaves out the prices of petroleum and agricultural products except cereals. One of the major reasons for excluding these prices is that it is difficult to control them through an aggregate demand policy such as monetary policy, and these prices are greatly affected by exogenous factors including the international price of oil and the weather.

The target inflation rate has been determined annually in consideration of expected changes in domestic and international economic as well as financial market conditions. The target range of ±1% is allowed to take into account various economic uncertainties. In 1998, the initial year of inflation targeting, the target had been set at 9 ± 1%. It was lowered to 3 ± 1% in 1999 and again to 2.5 ± 1% in 2000 before being raised to 3 ± 1% in 2001. Since 2000, the Bank of Korea has announced a medium-run inflation target to account for the lag in monetary policy. The medium-run target was 2.5% and 2.5-3.5% for 2002 and 2003 respectively. For the 2004-06 period, the medium-run inflation target was set at 2.5-3.5%.

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[4] Required reserves were imposed on CDs.

In setting the call rate target every month, the Monetary Policy Committee follows the look-at-everything approach that monitors movements of many variables such as production, demand, prices, real estate prices, the GDP gap, NAIRU and the P* ratio.[5] In addition to price stabilisation, economic growth, balance of payments and financial market stability are also important objectives of monetary policy. In this sense, "flexible" inflation targeting rather than strict inflation targeting and an eclectic approach characterise Korea's monetary policy. Like Greenspan's baby steps, the target call rate is adjusted gradually (0.25-0.5%), and when it has been set, open market operations are carried out to keep the rate close to the target.

In the past, much of the monetary policy process was kept in secret, but since the introduction of inflation targeting, monetary policy operations have become much more transparent than before. The Monetary Policy Committee announces the direction of monetary policy as soon as a decision is reached. The chairman publicly explains the content and background of the decision in detail. The monetary policy report is submitted to Congress every year. In addition, the chairman, MPC members and other relevant officials try to inform the public on pending monetary policy issues and future policy directions through various means such as public addresses, interviews and conferences.

III. How successful has inflation targeting been?

III.1. Basic statistics

One of the easiest ways to evaluate inflation targeting is to examine whether the actual inflation rate has remained close to or within the range of the target. Figure 1 shows the rates of CPI and core inflation rates as well as the ranges of the target since 1997. The vertical line indicates the starting date of inflation targeting (the second quarter of 1998). The inflation rates shown in Figure 1 are annualised quarterly rates. During the initial years of inflation targeting (1998-99), when the CPI was used as the benchmark index, actual inflation rates were higher than the target rates. Beginning in 2000, when the core CPI inflation rate was chosen as the benchmark, actual inflation rates have been closer to the target ranges, but in quite a few instances they moved out of the ranges.

Based on this record, inflation targeting does not appear to have been entirely successful. However, under inflation targeting, the central bank does not have to keep a short-term inflation rate such as a quarterly inflation rate within the range. Rather, it tries to keep inflation within the target range over a longer horizon. Therefore, to provide a better picture of how successful inflation targeting has been, it is more instructive to observe changes in the annual inflation rate as shown in Figure 2 (on a monthly basis). The vertical line indicates the starting month of inflation targeting (April 1998). During the initial period of inflation targeting, when CPI inflation was used as the benchmark (1998-99), actual CPI inflation rates were often outside of the target ranges. However, since 2000, when core CPI inflation was used as the benchmark, the actual core CPI inflation rate has been mostly within the range of the target. That is, in about two years after the adoption of inflation targeting, the Bank of Korea was able to keep inflation within the range.

[5] The P* ratio is the ratio of the long-run equilibrium price level to the current price level.

Figure 1

Inflation rates

Quarterly inflation rates using quarterly data

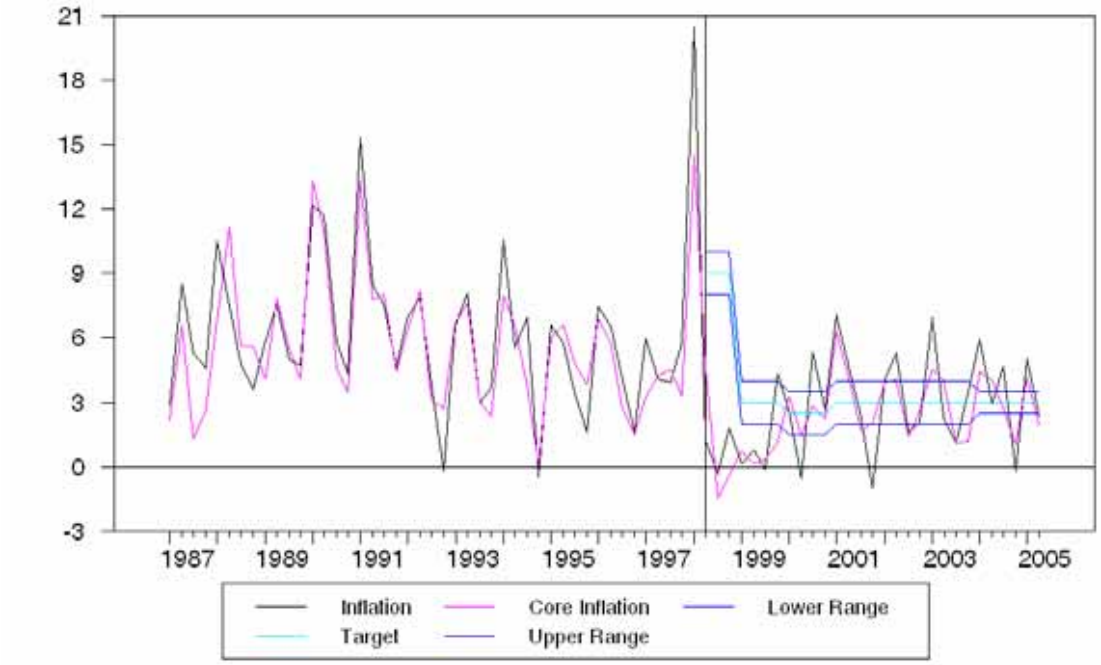
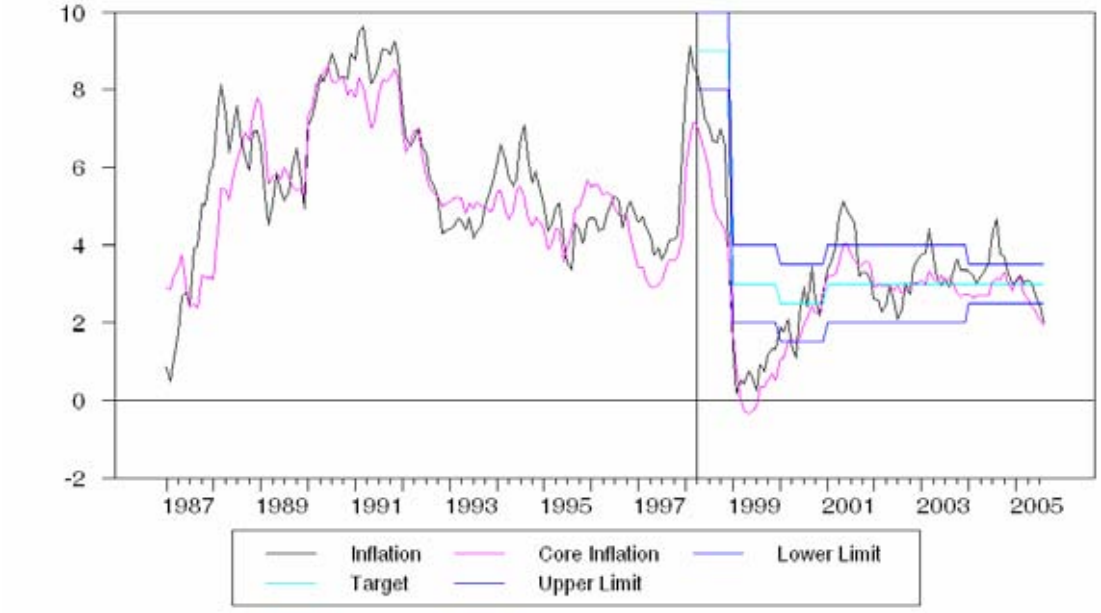


Figure 2

Inflation rates

Annual inflation rates using monthly data



Figures 1 and 2 show that the average rates of inflation have come down since the introduction of inflation targeting. In addition, the volatility of inflation has decreased. To examine these developments further, the sample means and standard deviations of inflation before and after inflation targeting are calculated. The two different periods before inflation

targeting, the 10-year period from 1987 to 1996 and the seven-year period from 1990 to 1996, are considered. In both cases, 1997 and 1998 are excluded from the samples to eliminate the bias caused by the financial crisis and the announcement of inflation targeting. For the inflation targeting periods, two periods, one from April 1998 to August 2005 and the other from January 1999 to August 2005, are considered. Again, 1998 is excluded in the latter period to avoid the effects of the financial crisis and to account for the fact that price increases in 1997 (when inflation targeting was neither announced nor adopted) are counted in measuring the annual inflation rates in 1998.

Table 1 confirms that the inflation rate has been lower and less volatile during than prior to the period of inflation targeting. Note that the reduction in the sample mean and volatility of inflation tends to be larger for the core than the CPI inflation rate, which is related to the fact that the Bank of Korea targeted the core CPI inflation rate during the periods of inflation targeting. From these simple plots and data, the BOK was able to bring inflation down and keep it within the target range after a few years of learning.

Table 1

Sample mean and standard deviation of the inflation rate

(1) Mean

	Quarterly rate (quarterly)		**Annual rate (monthly)**	
	CPI	**Core CPI**	**CPI**	**Core CPI**
1987-96	6.0	5.6	5.9	6.2
1990-96	6.1	5.8	5.6	5.9
Apr 1998-Aug 2005	2.7	2.4	3.2	2.7
1999-Aug 2005	2.9	2.6	2.8	2.4

(2) Standard deviation

	Quarterly rate (quarterly)		**Annual rate (monthly)**	
	CPI	**Core CPI**	**CPI**	**Core CPI**
1987-96	3.2	3.0	1.9	1.6
1990-96	3.6	3.2	1.8	1.5
Apr 1998-Aug 2005	2.3	1.8	1.7	1.1
1999-Aug 2005	2.3	1.6	1.4	1.1

However, the lower mean and volatility of inflation may not necessarily have been the consequences of successful inflation targeting. Weaker and less frequent shocks that change the rate of inflation may have been responsible for its lower volatility. In order to shed light on the causes of the lower and less volatile inflation rate during the periods of inflation targeting, first time series models of inflation are estimated to examine the relative role of the size and propagation of inflationary shocks in explaining the volatility of inflation. If the size of the shocks was smaller during rather than prior to the periods of inflation targeting, it is difficult to conclude that the reduction in the volatility of inflation is a result of inflation targeting. Second, data on inflation expectation are used to investigate how the private sector adjusts its expectations on inflation during and prior to the period of inflation targeting.

III.2. Inflation persistence and inflation shocks

Inflation targeting, if successful, should reduce the persistence of the inflation rate and weaken the propagation of inflation shocks. By being more eager to achieve the target inflation rate and actively stabilising the inflation rate around the target rate, the monetary policy's countering actions to inflation shocks may reduce inflation persistence and weaken the propagation of inflation shocks. In addition, to the extent that policy operations of the monetary authority to achieve the target inflation are perceived to be credible, economic agents may respond less sensitively to inflation shocks as they are less likely to change their expectation on inflation rates.

This section first examines the persistence of inflation. Then, simple time series models are estimated to examine the relative role of shocks to inflation and propagation of these shocks in generating inflation volatility. This examination may explain the relative roles of monetary policy and the size of inflation shocks in reducing inflation volatility during periods of inflation targeting. For example, if the decrease in inflation volatility is mostly due to a decrease in the size of inflation shocks, then one cannot conclude that inflation targeting has been effective.[6]

Table 2 reports autocorrelations of the two inflation rates. For the quarterly inflation data, the fourth quarter autocorrelations are lower during the periods of inflation targeting than those during the periods before inflation targeting in the case of CPI inflation, but they are similar in the case of core CPI inflation. For the annual inflation rates on a monthly basis, the autocorrelations at most horizons are lower during the periods of than prior to inflation targeting. The reduction in autocorrelation tends to be larger for longer horizons. Overall, the persistence of inflation is lower during the periods of inflation targeting.

Table 2

Autocorrelation

(1) Quarterly inflation rate (quarterly data)

	CPI				Core CPI			
Quarter	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
1987-96	0.07	–0.23	0.12	0.51	0.14	–0.28	0.06	0.51
1990-96	0.13	–0.16	0.10	0.61	0.23	–0.28	0.02	0.65
Feb 1998-Feb 2005	–0.02	–0.06	0.05	0.28	0.25	-0.09	0.13	0.46
1999-Feb 2005	–0.11	–0.16	–0.10	0.20	0.23	–0.20	–0.04	0.50

(2) Annual inflation rate (monthly data)

	CPI				Core CPI			
Month	**1**	**3**	**5**	**12**	**1**	**3**	**6**	**12**
1987-96	0.95	0.84	0.67	0.15	0.96	0.85	0.70	0.38
1990-96	0.96	0.87	0.78	0.43	0.97	0.89	0.81	0.60
Apr 1998-Aug 2005	0.93	0.70	0.35	–0.40	0.97	0.80	0.44	–0.39
1999-Aug 2005	0.91	0.75	0.53	0.09	0.97	0.87	0.65	0.14

[6] Levin, Natalucci and Piger (2004) used similar methods.

As for the relative role of shocks to inflation and their propagation, a univariate AR process for inflation of the following form is estimated:

$$\pi_t = \mu + \sum_{j=1}^{K} \alpha_j \pi_{t-j} + \varepsilon_t \quad (1)$$

where π_t is inflation rate at time *t*, μ and α_j are constants, and ε_t is a serially uncorrelated error term, which is interpreted as shocks to inflation. The order (*K*) of the AR process is determined by the Akaike criterion. The total variance of inflation can be decomposed into the part due to inflation shocks ε_t and another part due to the propagation of inflation shocks.

Table 3 reports the standard deviations of inflation shocks ("Shocks"), the standard deviations of inflation due to the propagation of inflation shocks ("Propag"), and the ratio of the variance of inflation shocks to the variance of inflation ("Ratio"). Both the size of inflation shocks and the standard deviation of inflation due to the propagation of inflation shocks decrease during the periods of inflation targeting, but the decrease in the size of the standard deviation of inflation due to the propagation of inflation shocks is larger than that of inflation shocks itself. This finding suggests that the reduction in inflation volatility is not mainly due to the decrease in shocks to inflation. This finding is consistent with the claim that inflation targeting has contributed to reducing the volatility of inflation, although it neither proves the claim nor explains why and through what process inflation targeting has been effective in reducing the volatility of inflation.

Table 3

Inflation volatility due to inflation shocks

(1) Quarterly inflation rate (quarterly data)

	CPI inflation rate			Core CPI inflation rate		
	Shocks	**Propag**	**Ratio**	**Shocks**	**Propag**	**Ratio**
1987-96	3.0	1.2	0.86	2.6	1.5	0.75
1990-96	2.9	2.1	0.66	2.2	2.4	0.45
Apr 1998-Aug 2005	2.4	0.0	1.00	1.6	0.9	0.74
1999-Aug 2005	2.3	0.0	1.00	1.6	0.3	0.97

(2) Annual inflation rate (monthly data)

	CPI inflation rate			Core CPI inflation rate		
	Shocks	**Propag**	**Shocks**	**Propag**	**Shocks**	**Propag**
1987-96	0.6	1.8	0.09	0.4	1.5	0.07
1990-96	0.5	1.7	0.07	0.3	1.4	0.05
Apr 1998-Aug 2005	0.5	1.6	0.11	0.3	1.4	0.06
1999-Aug 2005	0.4	1.0	0.15	0.3	1.1	0.06

III.3. Inflation expectations

Under inflation targeting, it is important that the monetary authority maintain transparency in the conduct of its monetary policy. As summarised in Section II, the BOK has tried to improve

its transparency by communicating with the private sector. If firms and households believe that the monetary authority will be able to sustain price stability, their expectations on inflation may become less sensitive to changes in actual inflation. For example, in response to inflationary shocks, the private sector would not change its inflation expectations, if inflation targeting convinced the private sector that inflationary shocks would be countered and hence lead to a weaker inflationary outcome.

To examine this possibility, the following equation is estimated:

$$\Delta\pi^{e}_{t,t+q} = \lambda + \beta\Delta\pi_{t-k,t} + \varepsilon_t \qquad (2)$$

where $\pi_{t-k,t}$ is the inflation rate (CPI) from time $t-k$ to t, $\pi^{e}_{t,t+q}$ is an expectation of inflation from time t to $t+q$ formed at time t. Coefficient β shows the sensitivity of changes in inflation expectations to changes in inflation. The data on inflation expectations are obtained from the quarterly KDI economic outlook. The estimation takes 1, 2, 3 and 4 for the expectation horizon q and 4 and 8 for the actual inflation horizon k. Two estimation periods are chosen: 1999-February 2005 (2000-February 2005 for $k = 8$) for the period of inflation targeting and 1987-96 for the period before. CPI inflation is chosen as the dependent variable because of the lack of expectation data on core inflation.

Table 4 (1) reports estimated values of β. "*" and "**" show that the estimates are significant at the 10% and 5% levels, respectively. It can be seen that the estimated β is smaller for the period of inflation targeting than for the period before. In addition, the estimates are often not statistically significant, but there are more cases where they are significantly different from zero at the 10% level during the period before than during the period after inflation targeting. This finding suggests that inflation expectations were more sensitive to changes in actual inflation in the period before than in the period after inflation targeting.

Table 4

Sensitivity of changes in inflation expectation to changes in inflation rate

(1)

	1987-96		**1999-2005**	
	***k* = 4**	***k* = 8**	***k* = 4**	***k* = 8**
q = 1	0.48* (0.27)	0.77 (0.55)	0.05 (0.13)	0.42 (0.25)
q = 2	0.34 (0.23)	0.91* (0.50)	–0.03 (0.10)	0.29 (0.17)
q = 3	0.28 (0.24)	1.02* (0.51)	0.02 (0.88)	0.32* (0.15)
q = 4	0.28 (0.28)	1.10* (0.59)	0.04 (0.10)	0.32* (0.15)

(2)

	1987-96		**1999-2005**	
	***k* = 4**	***k* = 8**	***k* = 4**	***k* = 8**
q = 1	0.43* (0.24)	0.81 (0.53)	–0.03 (0.19)	0.48 (0.16)
q = 2	0.35 (0.24)	0.93* (0.51)	0.01 (0.15)	0.43* (0.21)
q = 3	0.31 (0.25)	1.05* (0.52)	0.08 (0.14)	0.46** (0.19)
q = 4	0.36 (0.29)	1.12* (0.61)	0.12 (0.14)	0.46** (0.19)

To examine the robustness of the results, changes in the output growth rate are included as an additional regressor to control the effect of changes in the real sector of the economy on inflation expectations. For this purpose, the following equation is estimated:

$$\Delta\pi^{e}_{t,t+q} = \lambda + \beta\Delta\pi_{t-k,t} + \gamma\Delta yg_{t-k,t}\varepsilon_t \quad (3)$$

where $yg_{t-k,t}$ is the growth rate of real GDP from $t - k$ to t. Table 4 (2) reports estimates of β. The main conclusion does not change; changes in inflation expectations respond less to changes in actual inflation during the periods of inflation targeting than during those before it.

To summarise, the sample mean and volatility of inflation dropped during the period of inflation targeting. A decrease in the size of inflation shocks explains only a small part of the drop in inflation volatility. The persistence of inflation also fell, and the drop in inflation volatility is mostly due to the changes in the propagation of inflation shocks. The sensitivity of changes in inflation expectations to changes in actual inflation rates is lower during the periods of inflation targeting.

However, these pieces of evidence do not necessarily prove that inflation targeting has been successful, unless one can clearly show the process through which it has been effective. It is possible that the introduction of inflation targeting has contributed to lowering inflationary expectations by publicly setting the target range of inflation. This argument might hold if the public understood the mechanism of inflation targeting and believed in the resolve of the central bank to sustain price stability. For a long time before 1999, the public had paid little attention to the policy announcements and had little confidence in the ability of the monetary authorities to control inflation. Therefore, it might not be so easy to argue that the mere introduction of the new system was able to convince the public that the monetary authorities would be able to meet the target rate of inflation from the first year of inflation targeting. At the same time, since 2001 the monetary authority appears to have placed more emphasis on reviving domestic demand (as shown in the continuous drop in the interest rate) and thus has maintained an expansionary stance of monetary policy, which may not have anchored inflation expectations as firmly as the results suggest.

IV. Monetary reaction function

This section analyses how monetary policy was conducted to achieve various objectives such as controlling the inflation rate and stabilising the output gap during the period of inflation targeting. First, raw data and facts are examined, and then a formal analysis of estimating the monetary reaction function of the BOK follows.

IV.1. Facts and data

Figure 3 shows the call money rate and annualised inflation rates (using monthly data). As discussed earlier, the rates of inflation measured by the CPI and core CPI were relatively stable during the periods of inflation targeting, but the call money rate was even more stable. But this simple graphical representation may not provide a clear picture of the BOK's policy reactions since the target range of inflation has changed over time and so has the target rate of inflation (from the CPI inflation rate to the core CPI inflation rate). To adjust for these changes, deviations of the actual from the target rates of inflation are calculated.

Figure 3

Call money rate and inflation rates

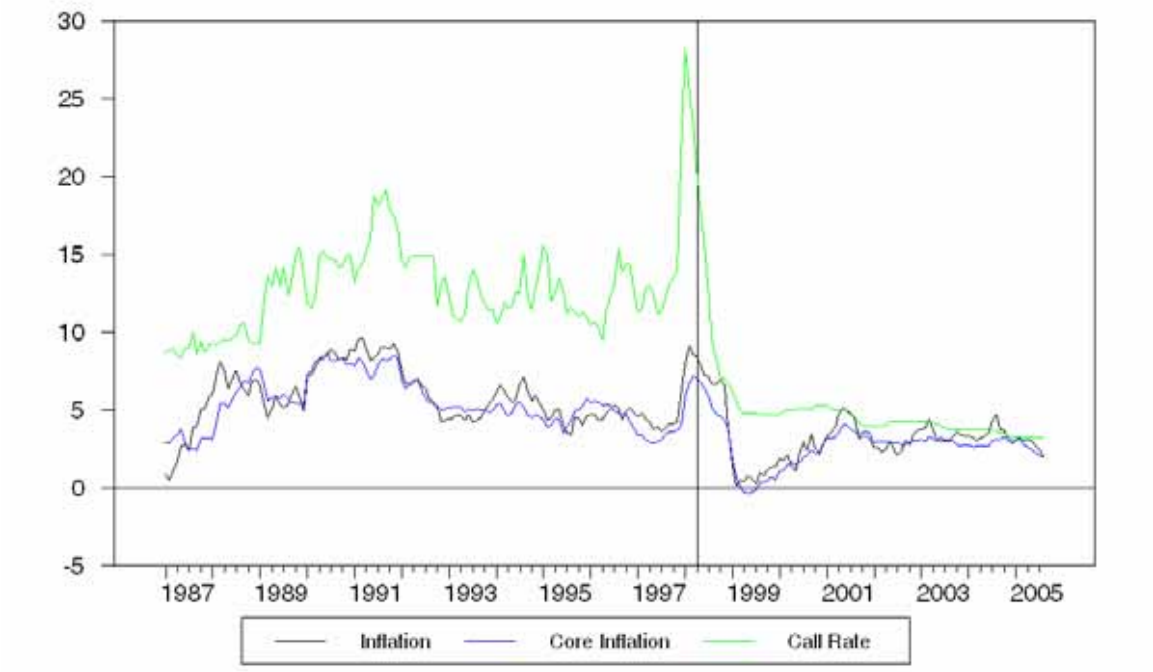
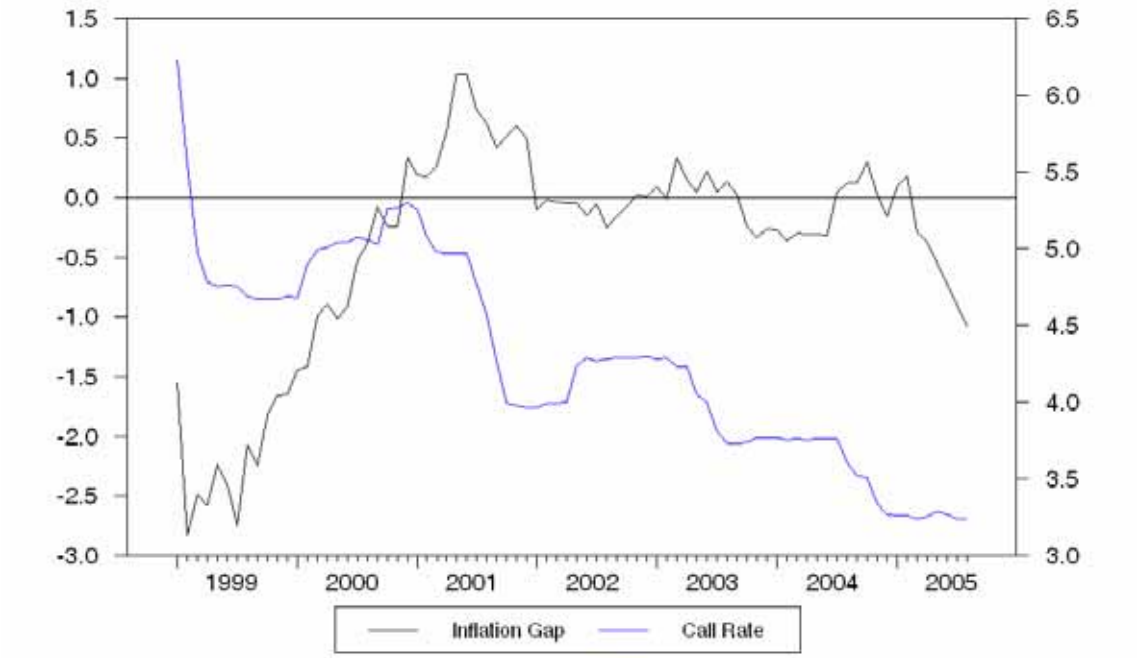


Figure 4 shows the call money rate and deviation of inflation from the target for the period 1999-2005, in which the call money rate has been firmly used as the operational instrument.[7] The left scale is for inflation while the right scale is for the call money rate. In the graph, a more systematic monetary policy towards inflation stabilisation around the target is found. In early 1999, when the inflation rate was dropping, the central bank decreased the interest rate. In 1999 and 2000, when the inflation gap was increasing, the central bank increased the interest rate. Again, when the inflation gap was decreasing in 2001, the central bank decreased the interest rate. Since 2002, the inflation gap has fluctuated around the target, and the call money rate seems to have moved together with the inflation gap. However, it is not clear whether the interest rate movement is strong enough to stabilise the inflation rate around the target, although the direction of the interest rate adjustments broadly matches the inflation changes. A simple theory suggests that in order to stabilise the inflation rate, the central bank should adjust the interest rate to the inflation rate changes more than one-to-one and thus change the real interest into the opposite direction to the inflation rate change. The answer to this issue is not clear from the graph. The issue will be further addressed by estimating the formal monetary reaction function.

[7] The inflation rate is constructed as a deviation from the target rates that are relevant for each period. In addition, the relevant inflation rate is used for each period; the CPI inflation rate is used for 1999 and the core CPI inflation rate is used for other periods.

Figure 4

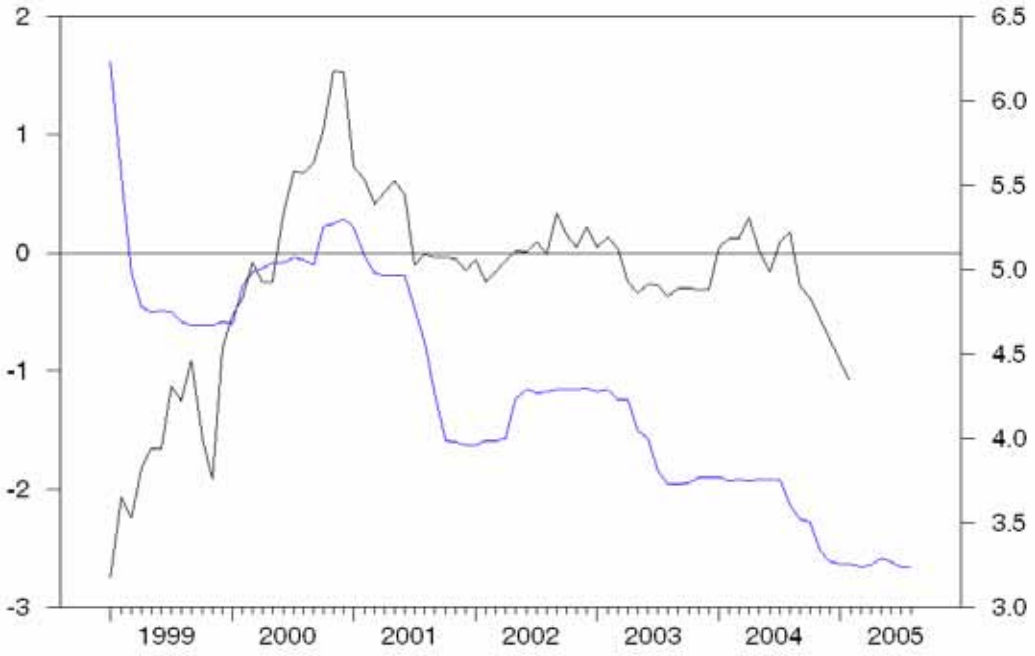
Inflation rate (deviation from target) and call money rate



However, a closer look at Figure 4 shows that the interest rate movements tend to lead the inflation rate movements. For example, the inflation rate increase in the early sample peaked in the middle of 2001, but the interest rate peaked early that year. The inflation rate used in the graph is backward-looking in nature since it is the inflation rate from one year before, but central bank action may be forward-looking by responding to expected inflation rates. In this regard, another graph was plotted with a moving average inflation rate (from six months past to six months ahead) in Figure 5. Now the timing is more synchronised. If the central bank has the correct expectations on the inflation rate, this may imply that the BOK's inflation stabilisation was forward-looking in nature.

Figure 5

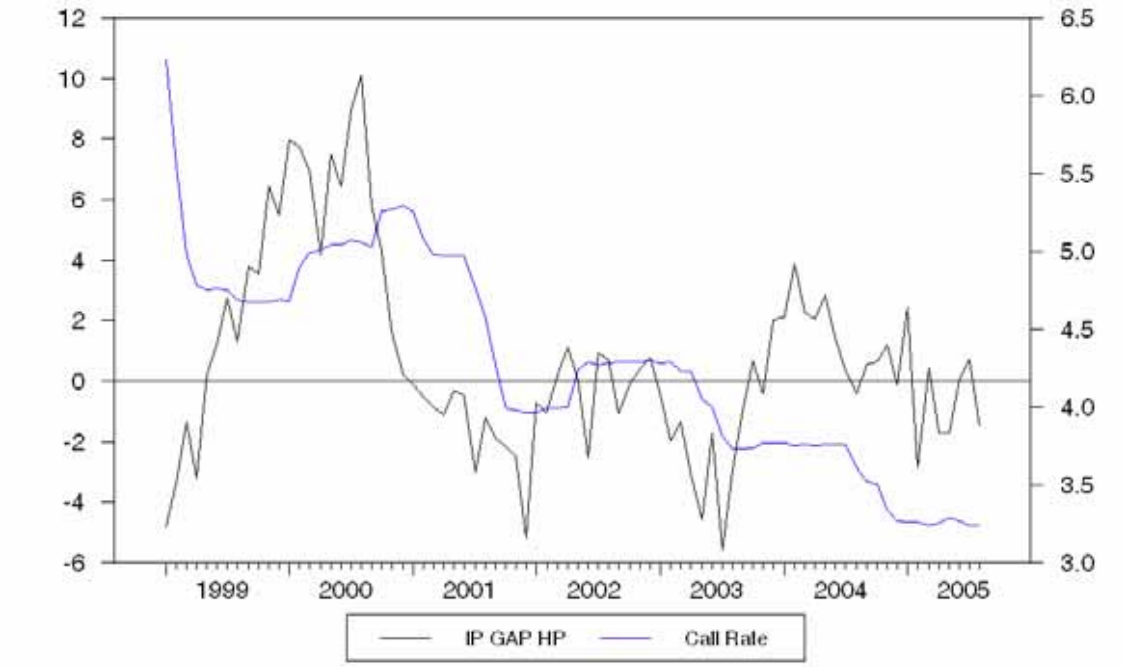
Inflation rate (moving average) and call money rate



The BOK may stabilise the output gap in addition to inflation rates. Therefore, the output gap and the call money rate are reported in Figure 6. The output gap is constructed by applying an HP filter, and industrial production is used as the output measure.[8] The right scale (per cent deviation from the trend) is for the output gap while the left scale is for the call money rate. During the period 2000-03, the interest rate tended to move together with the output gap, which may imply that the BOK was trying to stabilise the output gap.

Figure 6

Output gap and call money rate



From the graphs, it seems that the BOK has tried to stabilise the (expected) inflation rate (deviation from target) and output gap. Such explanations are also found in the records of the MPC meetings. There are many occasions where the BOK changed the call money rate in order to stabilise the inflation rate and output gap. For example, the BOK increased the rate by 0.25% in October 2000 and May 2002 in response to expected inflation or inflationary pressure. In 2001, the BOK undertook monetary easing by gradually decreasing the rate from 5.25% to 5%, 4.75%, 4.5% and 4.0% in order to stimulate the economy. In 2003, the BOK again decreased the rate gradually to boost economic conditions.

Although simple graphical analysis suggests that the BOK tries to stabilise both the inflation rate and the output gap, one might argue that the monetary authority should have been more aggressive in reviving the economy than controlling inflation. Since 2001, there has been a declining trend in the deviation of inflation from the target. The Korean economy has also suffered from a lack of domestic demand that has resulted in prolonged slow growth of output.

[8] We also experimented with a linear trend and a quadratic trend in output. The results with a quadratic trend in output are qualitatively very similar, but the results with a linear trend in output are somewhat different.

IV.2. Estimating a monetary reaction function

In order to further examine the conduct of monetary policy in response to changes in inflationary pressure and the output gap, this section estimates a monetary reaction function of the BOK, based on Clarida, Gali and Gertler (1998 and 2000). The monetary reaction function allows for interest rate smoothing or gradual changes in the interest rate, which is an important feature of monetary policy in Korea.

The following form of the monetary policy rule is estimated:

$$r_t = (1-\rho)\alpha + (1-\rho)\beta\left(E\left[\pi_{t+n} - \pi_t^* \mid \Omega_t\right]\right) + (1-\rho)\gamma\left(E\left[y_t - y_t^* \mid \Omega_t\right]\right) + \rho r_{t-1} + \varepsilon_t \quad (4)$$

where r_t is the nominal interest rate, π_{t+n} is the rate of inflation between periods t and $t+n$, y_t is real output, π_t^* is the target rate of inflation, y_t^* is the potential output, E is the expectation operator, Ω_t is information available to the central bank at the time it sets the interest rate, t, ρ captures the degree of interest rate smoothing, β and γ measure the strength of the response of the central bank to any deviation from the target inflation rate and change in the output gap.

As discussed in Clarida, Gali and Gertler (1998, 2000), equation (4) implies the following set of orthogonality conditions that can be exploited for estimation:

$$E\left[r_t - (1-\rho)\alpha - (1-\rho)\beta\left(\pi_{t+n} - \pi_t^*\right) + (1-\rho)\gamma\left(y_t - y_t^*\right) + \rho r_{t-1} \mid u_t\right] = 0 \quad (5)$$

where u_t includes any lagged variables that help forecast inflation and output, as well as any contemporaneous variables that are uncorrelated with shocks to the interest rate smoothing equation.[9]

Equation (4) is estimated by the generalised method of moments, following Clarida, Gali and Gertler (1998, 2000) for the period 1999-August 2005.[10] Monthly data is used since the estimation period is relatively short. Industrial production represents output, and the output gap is obtained by applying the HP filter. In this estimation, the actual target rate of inflation is used as a proxy for the target. The inflation rate for 1999 is the rate of change of the CPI and thereafter core CPI inflation.

The results are reported in Table 5. The estimated value of β is 1.58, which is positive and significantly different from zero. This result suggests that the BOK adjusts interest rates in response to changes in inflationary pressure. The estimated value of β, which is greater than one, also implies that the BOK is prepared to make changes in the interest rate large enough to change the real interest rate to the same direction, which is necessary to stabilise the inflation rate. The estimate of γ is 0.32, which is statistically significant, and implies that the policy objectives of the BOK also include stabilising the output gap.

Table 5

Estimated monetary reaction function

	ρ	α	β	γ
Point estimate	0.915	4.24	1.58	0.32
Standard error	0.007	0.06	0.29	0.04

[9] Refer to Clarida, Gali and Gertler (1998, 2000).

[10] For instruments, a constant; 1, 2, 3, 4, 5, 6, 9, 12 lags of the call money rate; CPI inflation rate; core CPI inflation rate; and IP are used.

V. Channels and effects of monetary policy

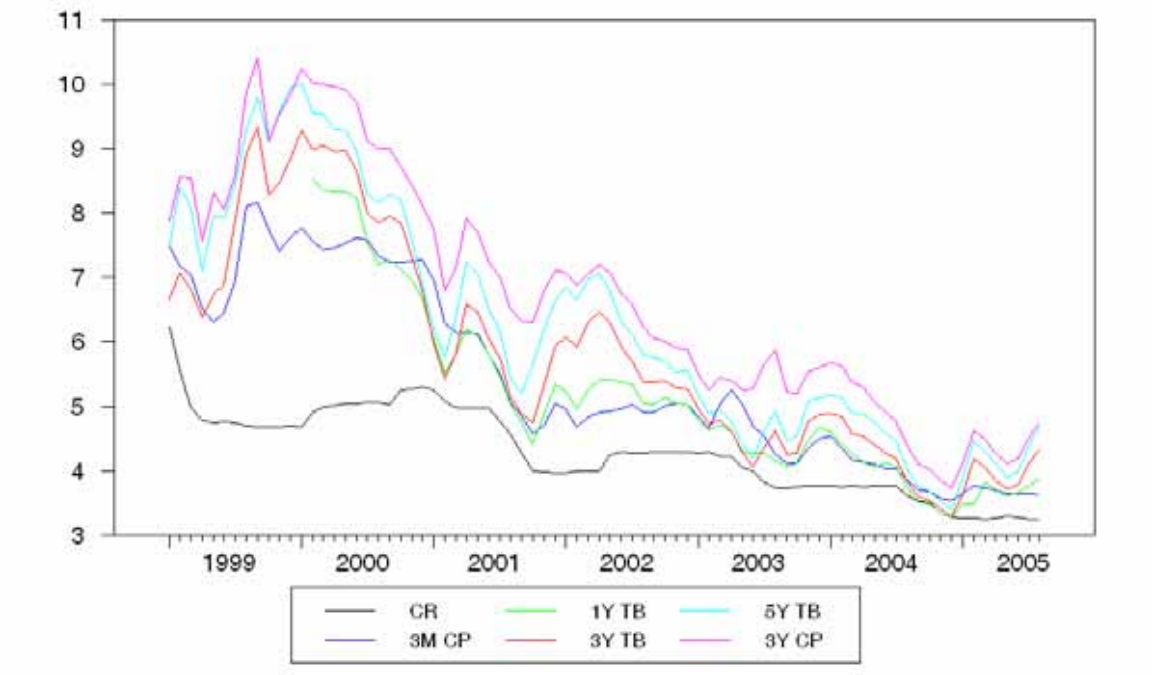
V.1. Policy developments

Changes in the call money rate that the BOK controls send signals to financial markets as to the direction of monetary policy. The changes in the call money rate are then expected to change the behaviour of financial institutions in their lending and firms and households in their spending. As discussed in Section III.3, the BOK pursues not only price stability, but also output stability. Since late 2000, the monetary authorities have been sending a clear signal to the market that they are prepared to pursue an expansionary monetary policy to the extent that such a policy does not endanger price stability. Although the BOK has tried to stabilise the output gap by adjusting its operational instrument, the call money rate, it is not clear whether the BOK's monetary operations have exerted significant effects on aggregate demand and if so, what channels of monetary policy have been effective. This section discusses whether the monetary policy actions of the BOK have an influence on the real economy effectively and how the monetary policy affects the real economy.

The channels of monetary policy in the setting of inflation targeting are rather straightforward. A cut in the call money rate would under normal circumstances lead to lower rates of interest in financial markets, which would in turn stimulate investment and consumption. Figure 7 shows the call money rate and the yields on three-month corporate bonds, three-year corporate bonds with an AA rating, one-year treasury bonds, three-year treasury bonds and five-year treasury bonds from 1999. Over the long run, these interest rates move together with the call money rate. Correlations of the yield on three-month corporate bonds, three-year corporate bonds with an AA rating, one-year treasury bonds, three-year treasury bonds and five-year treasury bonds with the call money rate are 0.95, 0.88, 0.88, 0.83 and 0.81, respectively. As the call money rate decreased from late 2000, so did other interest rates. For example, the yield on three-year corporate bonds with an AA rating fell off from about 8% to below 5% in recent periods. It is also clear that the real interest rate declined during this period since the inflation rate was relatively stable.

Figure 7

Nominal interest rates

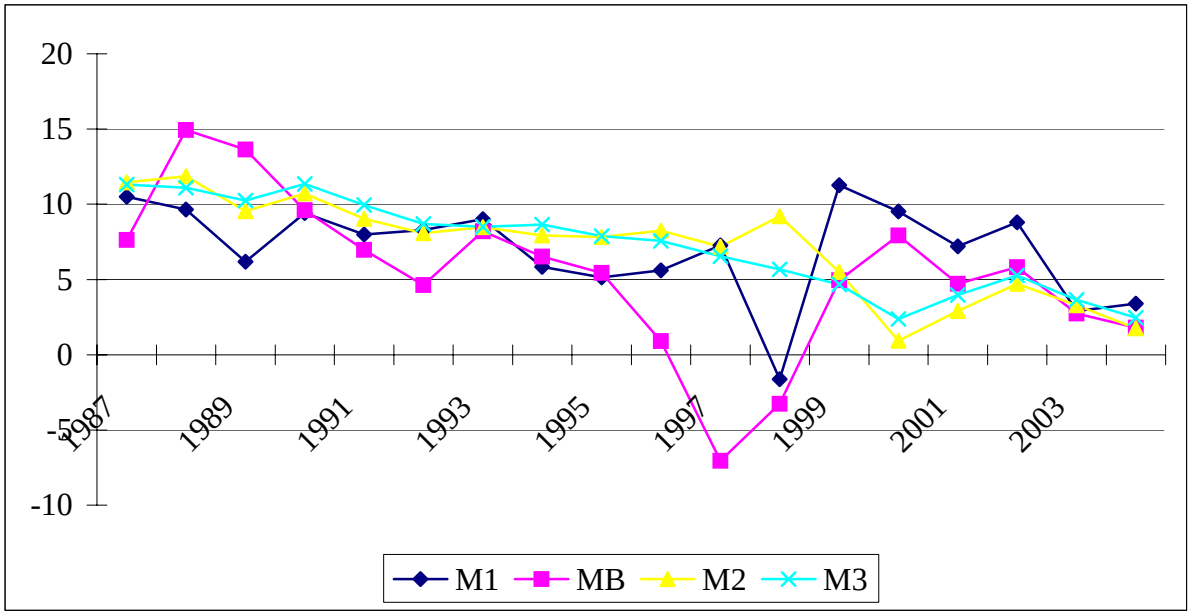


However, movements of these interest rates digress substantially from those of the call money rate in the short run, as shown in Figure 7. Correlations of the differences in the yields on three-month corporate bonds, three-year corporate bonds with an AA rating, one-year treasury bonds, three-year treasury bonds and five-year treasury bonds with the differences in the call money rate are 0.45, 0.05, 0.26, 0.12 and –0.01, respectively.

Following sharp rises after the currency crisis, however, the rate of growth of M3, a measure of liquidity of the economy, has also slowed down since 2003, as have the rates of growth of M1 and M2 (Figure 8). By looking at changes in the interest rates and monetary aggregates, the monetary authority might have not been aggressive enough in stimulating domestic demand. It is possible that the contraction of domestic demand caused by non-monetary factors has been so strong that it has offset monetary expansion to reduce the aggregate demand for credit by firms and households to result in a decrease in the interest rate and lower the rates of change of monetary aggregates.

Figure 8

Growth rates of monetary aggregates



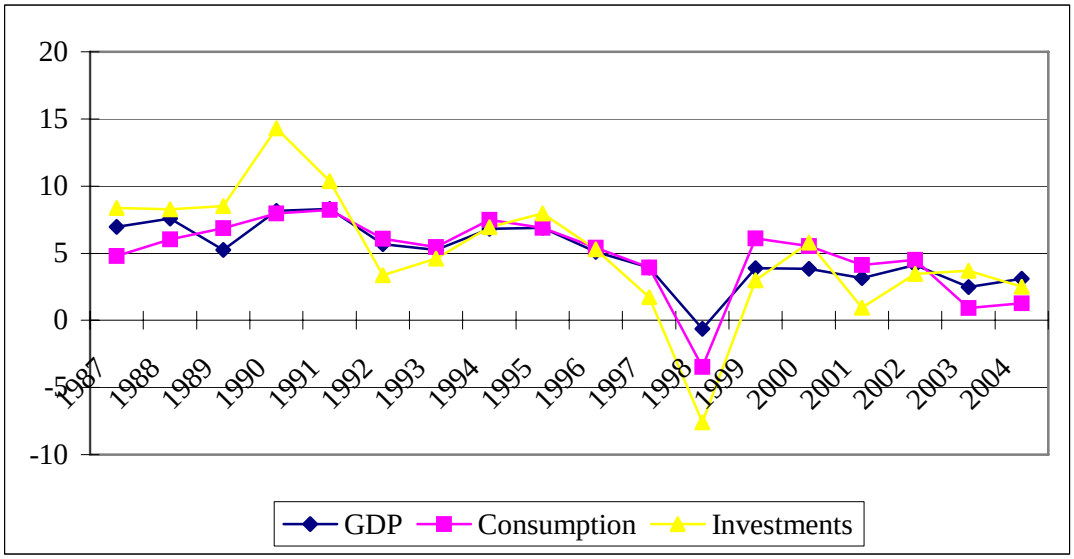
This possibility may be backed up by the saving and investment behaviour of firms. In recent years, the flow of funds estimated by the BOK shows that the business sector has been a net saver of the economy. When they are sitting on huge amounts of retained earnings, it is not surprising that a small change in the call rate will not have effects on their investments. Although the available evidence is sketchy, it appears that business firms have invested their savings in stocks and real estate on a large scale, thereby becoming a major source of asset speculation and inflation. Should the BOK have lowered the call rate further until they observed a pickup in the economy? In this regard, the Japanese experience with monetary policy that has lowered the interest rate to zero is instructive. It indicates the possibility that any further monetary expansion may push the economy into a liquidity trap, even in Korea.

Large firms, in particular those belonging to Korea's industrial groups, have developed access to international financial markets; a marginal increase in the call money rate is not likely to affect their investment behaviour to the extent that they can raise funds on international financial markets at a lower rate.

It is also unclear whether the lower interest rate that has prevailed has exerted expansionary effects on capital investment. Figure 9 shows the growth rates of real fixed investments, real private consumption and real GDP. The growth rate of real fixed investment picked up from 2002, but it was still low, and investment overall has remained stagnant since the 1997-98 crisis.

Figure 9

Growth rates of real GDP, real fixed investments and real consumption



In many economies, in particular advanced ones, monetary policy mostly works through the markets for housing, commercial buildings, other real estate and financial assets. The lower interest rates have fuelled speculation in markets for real estate and equities, thereby accelerating asset inflation. Housing prices have risen about 30% on average since 2001. However, a series of measures, including the imposition of heavy taxes and administrative control on trading and holding real estate, have squelched a further boom in the real estate markets.

Figure 10

Housing prices and call money rate

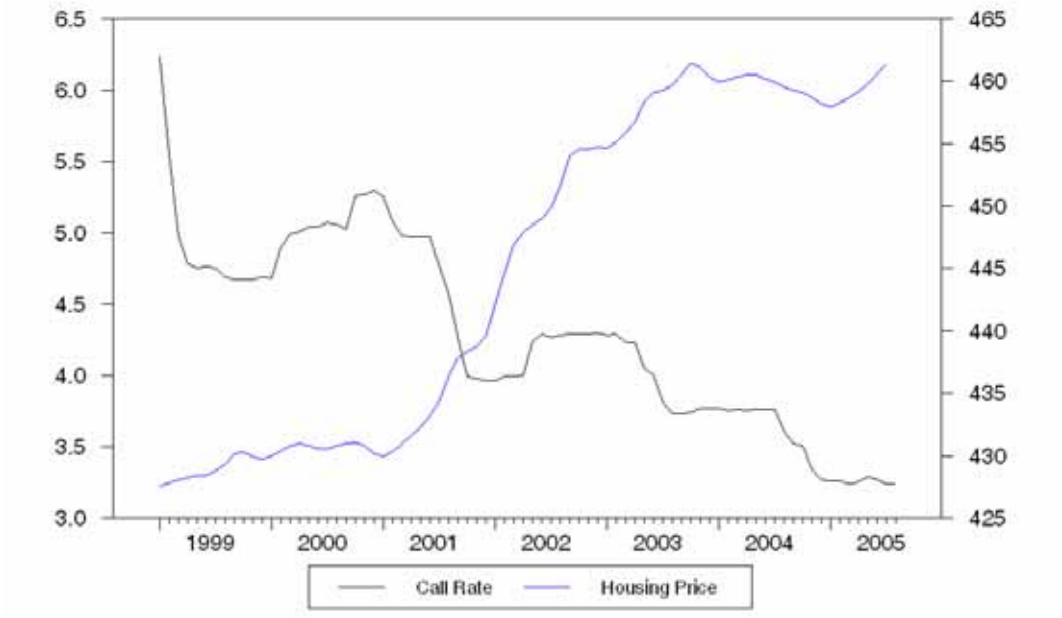
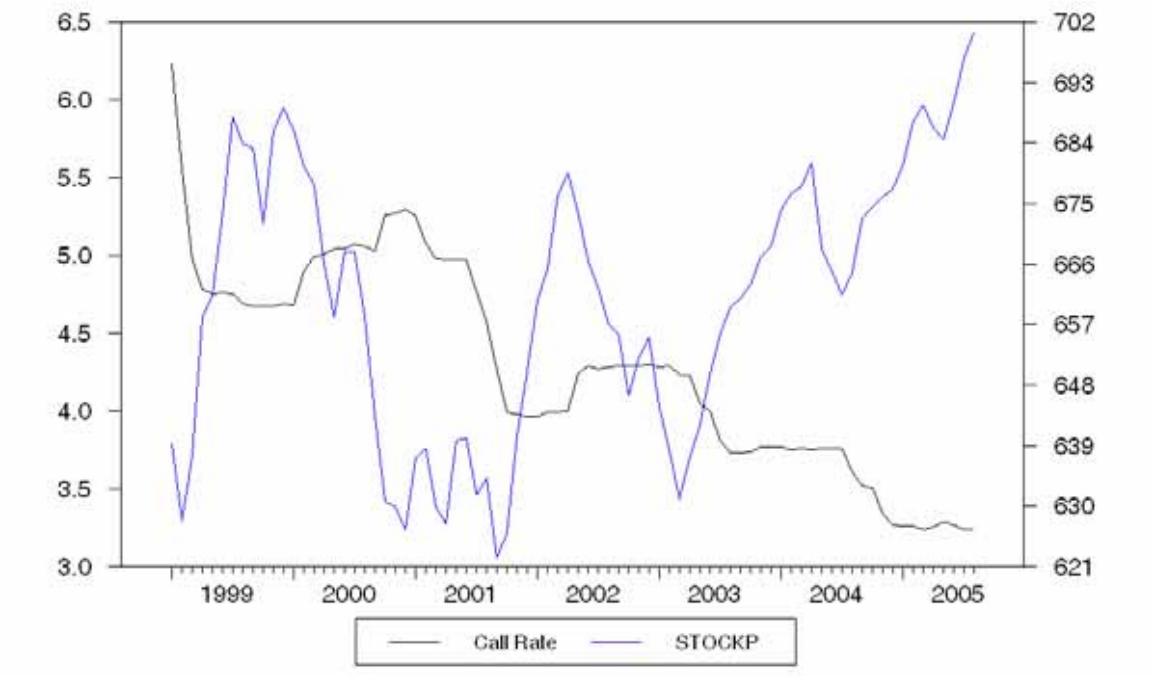


Figure 10 reports the log of housing prices multiplied by 100, which depicts the booming housing market. Stock prices jumped by about 70% from 2001, as shown in Figure 11 (the log of stock prices multiplied by 100). Although the stock market and housing boom could have produced a significant wealth effect to induce consumption spending, banks and other non-bank financial institutions have been reluctant to extend loans to households in the aftermath of the credit card crisis in 2001 and 2002, which may have contributed to a very low level of consumption growth in 2003 and 2004 (Figure 9).

Figure 11

Stock prices and call money rate



It is often pointed out that monetary expansion, among other factors, has created a bubble in the real estate market. When asset market speculation accelerates, the expansionary effects of monetary policy are likely to be visible. The bubble will in turn help increase capital investment and consumption spending, but it will eventually burst, inflicting serious damage on the economy. Policy authorities may then need to step in to curb the speculation, thereby reducing the effects of expansionary policy, which Korean policymakers did by imposing heavy taxes and administrative control on trading and holding real estate. In some respects, Korean policymakers have been contradictory in managing macroeconomic policies. While pursuing expansionary monetary policy, they have also blocked off one main channel of monetary policy, that of housing market.

V.2. VAR analysis

This section examines the effects and the transmission channels of monetary policy in terms of VAR methodology.[11] The structure of the VAR model under consideration is similar to the one developed by Christiano, Eichenbaum and Evans (1996), which has been one of the

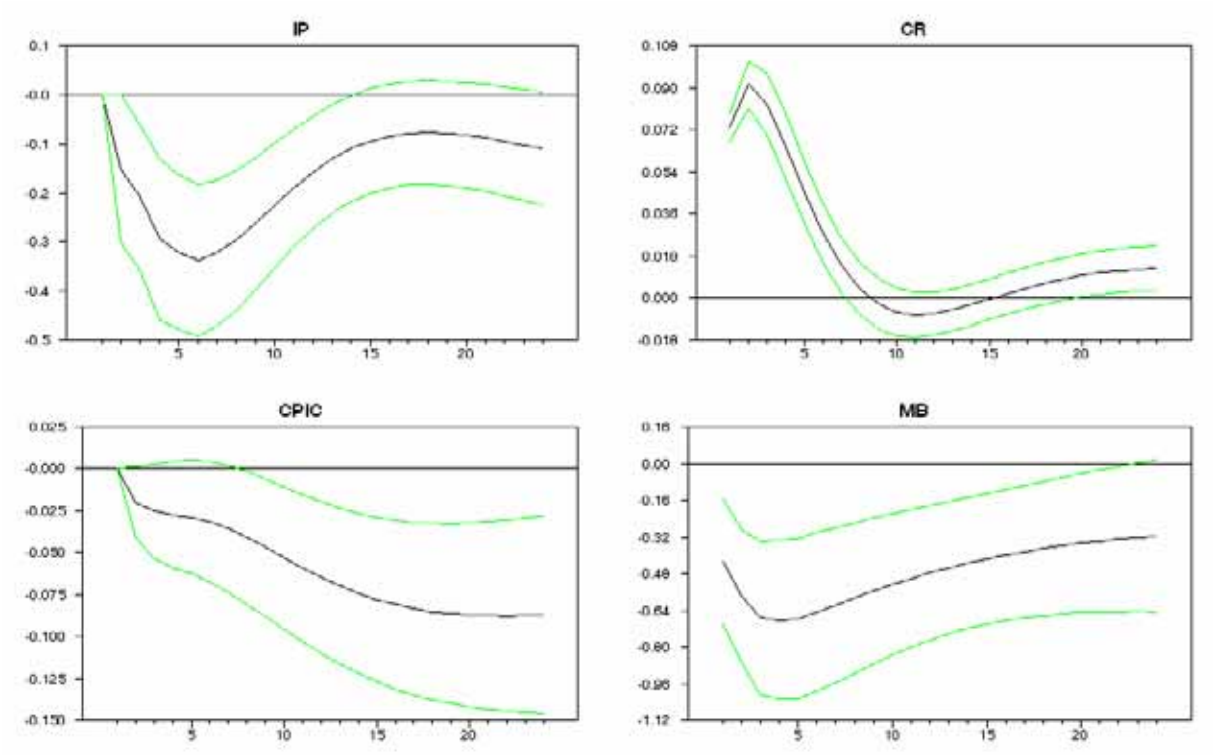
[11] Leeper, Sims and Zha (1996) and Christiano, Eichenbaum and Evans (1996) provide a good summary of the literature.

most widely used methods of identifying monetary policy shocks.[12] As the basic model, a four-variable recursive VAR system is constructed. The data vector is {IP, CPIC, CR, MB}, where IP is the log of industrial production, CPIC is the log of the core Consumer Price Index, CR is the call money rate and MB is the log of the monetary base.

The core CPI, instead of the CPI, is used since the BOK targeted the core CPI for most of the sample period. The call money rate is included in the model since it is the operational instrument of monetary policy during the sample period. Following Christiano, Eichenbaum and Evans, a measure of a monetary aggregate is also included. The ordering is {IP, CPIC, CR, MB}, where contemporaneously exogenous variables are ordered first, and monetary policy shocks are identified as shocks to the operational instrument, the call money rate. The sample period is from 1999 to August 2005. A constant term is included in the model. Two lags are chosen based on the Akaike criterion.[13] Figure 12 shows the impulse responses to monetary policy shocks with a 68% error band in the basic model over a 24-month horizon. On the top of each graph, the names of the responding variables are denoted.

Figure 12

Impulse responses to monetary policy shocks: basic model



In response to typical shocks to monetary policy, the call money rate moves up by about 0.7% first and then rises further by 0.9% in the next month. Then, the rate decreases over time and is back at the initial level in about nine months. The monetary base decreases on

[12] For example, Christiano, Eichenbaum and Evans (1996, 2004) and Kim (2001) use similar identification methods.

[13] For the effects of monetary policy shocks during the period before inflation targeting, refer to Kim (1999), in which a structural VAR model was also used.

impact by about 0.45%, and then falls further by 0.65% in about three to five months. Thereafter it continues to be below the initial level for the next two years or so.

Industrial production falls off to a maximum of about 0.33% in about six months, and then returns to the initial level in about 15 months or so. The core CPI gradually decreases over time until it turns up about three years later. In general, these responses are not inconsistent with the textbook effects of monetary policy actions, except that the effects of monetary policy on the real variables last for a relatively short period of time.

In order to examine the channels of transmission of monetary policy shocks, the basic model is extended to construct a five-variable model. The data vector is {IP, CPIC, CR, MB, X}, where X is an additional variable to infer the transmission mechanism. The model is then estimated to examine: the responses of various interest rates including longer-term interest rates to the changes in the call money rate; the responses of various monetary aggregates such as M1, M2 and M3 to examine the extent to which changes in monetary policy affect credit conditions of the economy; changes in asset prices such as housing and stock prices; and, finally, the responses of business fixed investment and retail sales.

Figure 13 shows the impulse responses of various interest rates such as the yield on three-month corporate bonds, three-month CDs, 3-year corporate bonds with an AA rating and five-year treasury bonds from 1999. On impact, short-term interest rates such as the yields on three-month corporate bonds and three-month CDs rise in the short run. In about three months, the yields on three-month corporate bonds and three-month CDs increase by 0.075% and 0.06% respectively. However, the responses of the long-term rates are not significantly different from zero. The call money rate shocks do not last very long. This may explain why the long-term rates do not respond and why the real effects of monetary policy peter out in a short period of time.

Figure 13

Impulse responses to monetary policy shocks: interest rates

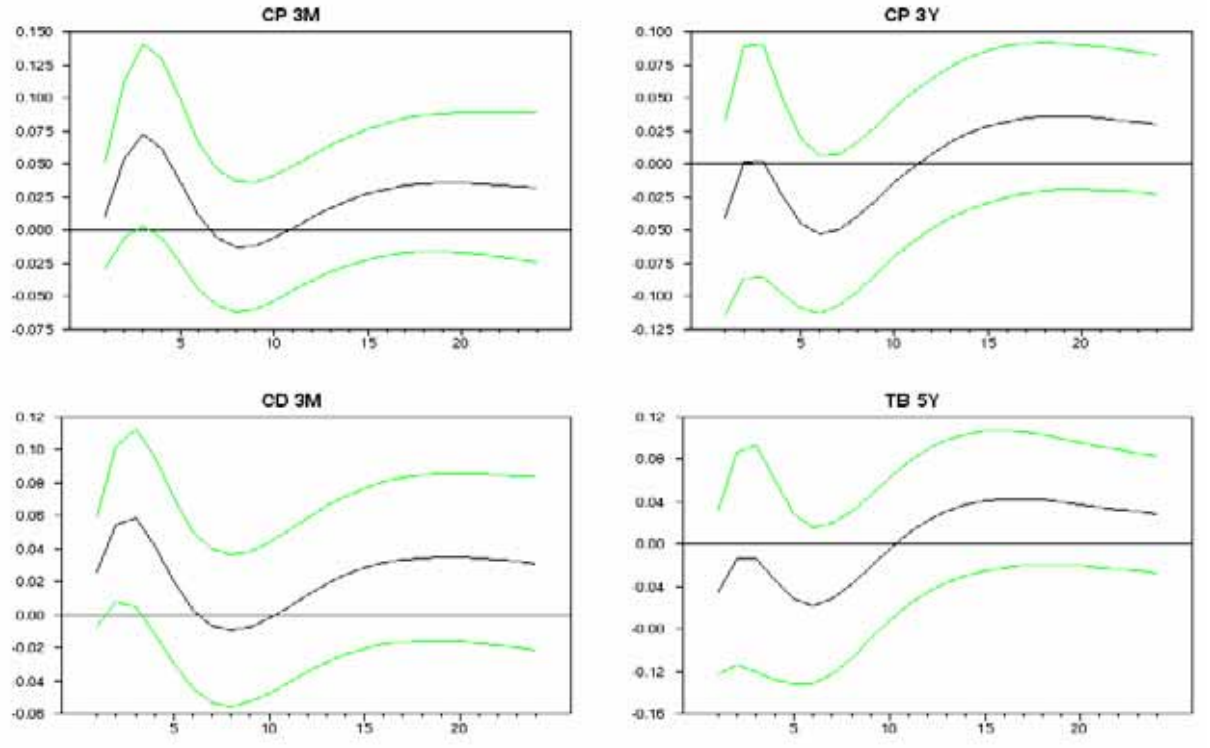


Figure 14

Impulse responses to monetary policy shocks: monetary aggregates

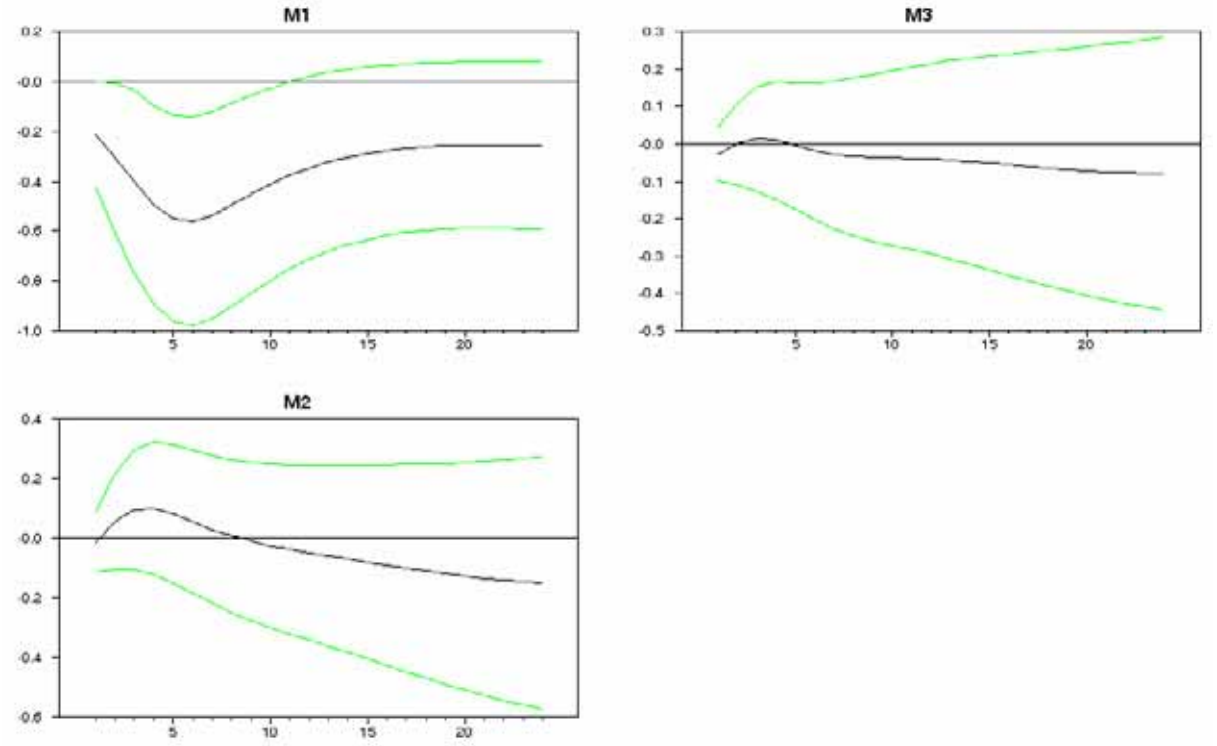
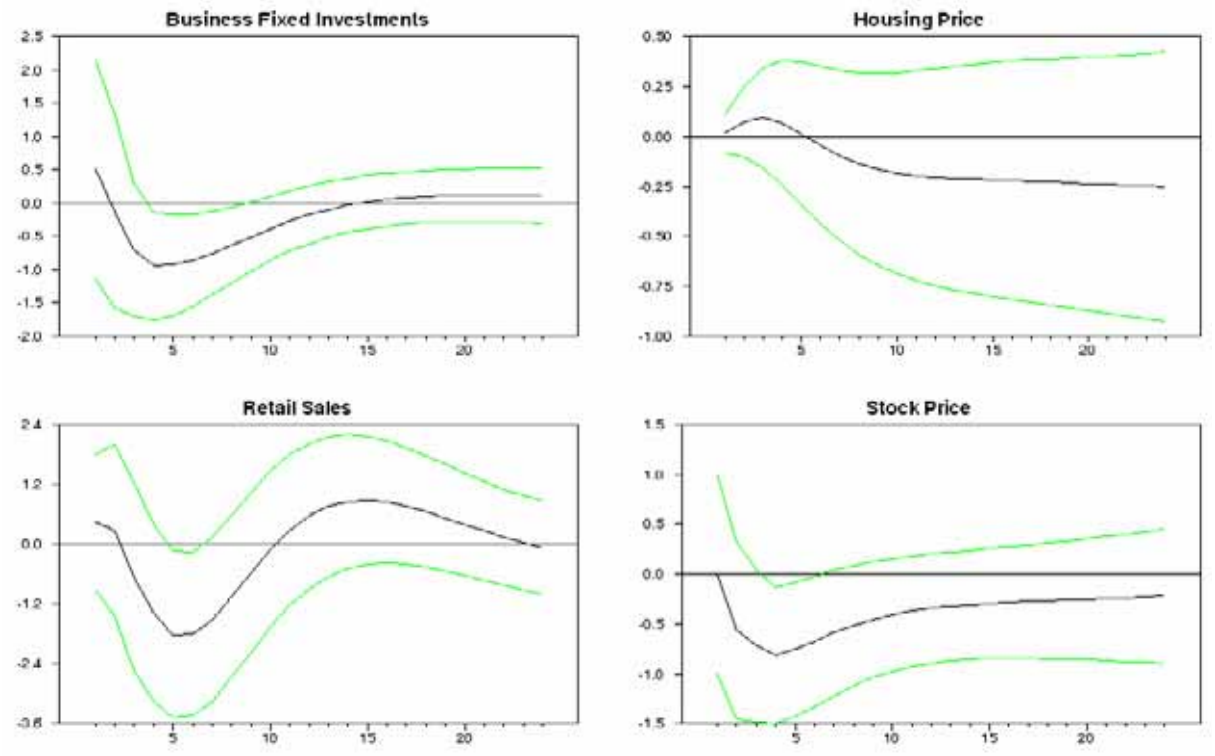


Figure 14 shows the responses of monetary aggregates to a change in the call money rate. M1 declines by about 0.6% in five months, but the responses of M2 and M3 move very little, if at all; this may also be related to the short-lived effect of monetary policy. Figure 15 depicts the responses of business fixed investments, retail sales, housing prices and stock prices. Business fixed investments decrease sharply in the short run. The maximum effects of a 1% drop are observed in about four months. Retail sales also decrease sharply in the short run. The maximum effect of a drop of about 1.8% is seen in about five months. Housing prices do not change but stock prices decline significantly. Probably due to various regulations and control on the housing market, housing prices do not change much.

The results of the VAR analyses should be taken with some caution as to both the channels and the effects of monetary policy changes, because some results do not seem consistent with the conventional effects of monetary policy: for example, the sharp short-run response of business investment to the monetary shock, although the long-term interest rates do not move, which is not easily explained by the standard theory on the effects of monetary policy.

Figure 15

Impulse responses to monetary policy shocks:
business fixed investments, stock prices, housing prices



VI. Concluding remarks

The pieces of empirical evidence presented in this paper tend to lead to the conclusion that inflation targeting in Korea has been effective in sustaining price stability. The level and the volatility of inflation dropped after adopting the inflation targeting framework. The size of inflation shocks has not been the main cause of the reduction in inflation volatility. Inflation expectations have become less sensitive to inflation shocks. The estimated reaction function of the BOK shows the evidence of inflation stabilisation.

However, this conclusion requires some qualifications, because one cannot ignore other developments that may have weakened inflationary pressure more than the targeting itself. First, as noted earlier, the economic environment of Korea has been favourable for stable inflation. During most of the inflation targeting period, the Korean economy has suffered from a lack of domestic demand, which has in turn suppressed inflationary pressure. In addition, the appreciation and stability of the Korean won against the US dollar has also clearly stabilised import prices and, in turn, helped to keep the inflation rate low. At the same time, wage increases have been modest, and international prices of imported goods have in fact declined. In the future, when the Korean economy starts to recover and faces stronger inflationary pressure, the new monetary policy framework will go through the real test.

Second, although we did not discuss international or open economy perspectives in this paper, Korea is considered a small open economy where the exchange rate policy constitutes an important part of monetary policy. Recent changes in international economic linkages of the Korean economy may put inflation targeting to a real test for its effectiveness in the future.

Among other developments, trade liberalisation has limited the scope for controlling core inflation in Korea. Prices of tradables, which account for a substantial part of the index measuring core inflation, are mostly exogenous to an open economy like Korea's, and changes in the prices of non-tradables are likely to be dictated by changes in nominal wages. Korea has developed an open trade regime in which imports of a large number of goods and services whose prices constitute the core CPI index are subject to low rates of tariffs and other non-tariff barriers. As a result, an expansion of domestic demand for tradables that is not met by domestic suppliers is easily satisfied by their imports; there is little room for domestic prices of tradables to deviate from their international levels, especially when the nominal exchange rate is stable.

In this case, monetary policy works through the non-tradable sector of the economy in influencing core inflation. Prices of tradables in China and Japan, the two major sources of Korea's imports, have moved little if not declined in recent years. Nominal wages of regular employees in manufacturing have been rising at an annual rate of almost 10% since 2001. Given the low inflation rate in Korea in recent years, it might be reasonable to argue that most of the increase in core inflation has come from the wage increases. In the future, when there is more inflationary pressure originating in the tradable sector, it may be far more challenging for the BOK to keep the inflation target.

Although it is a controversial issue, some studies suggest that the monetary authorities of Korea have intervened in the foreign exchange market and controlled capital movements to stabilise the nominal exchange rate despite of its official announcement of free floating after the currency crisis.[14] The trade surplus has been sterilised in Korea, which may be interpreted as the result of the policy of maintaining the exchange rate in effective terms stable. The tight control of the exchange rate with massive foreign exchange intervention, if it turns out to be the de facto exchange policy of Korea, means that the monetary authority has operated its monetary policy in a framework of two nominal anchors.

Since 2001 when the IT bubble burst, there has been a contraction of domestic demand. In the absence of any inflationary pressure, Korea's policymakers have found room for undertaking expansionary monetary and fiscal policy to revive the weakening economy. Therefore, the monetary authority has been able to accommodate an exchange rate policy that has been geared to stabilising a nominal exchange rate in effective terms that has in turn necessitated the sterilisation of surpluses on both the current and financial accounts. The surplus has not been fully mopped up, and the instrument of sterilisation has been monetary stabilisation bonds, many of which have had maturities of less than three months and hence are good substitutes for M3. Stabilisation of the exchange rate has therefore been supportive of the expansionary stance of monetary policy.

However, when the economy is overheated and tightening of monetary policy is called for, the two-anchor system may break up. The tighter monetary policy may induce capital inflows and may not deteriorate the current account much if it reduces import demand and policy authorities try to prevent the exchange rate from appreciation. An exchange rate policy that attempts to stabilise the nominal effective exchange rate will necessitate the sterilisation of capital inflows, which will frustrate the efforts of the monetary authorities in managing a tighter monetary policy.

To the extent that the monetary authorities operate an intermediate exchange rate regime, they cannot fully liberalise the capital account unless they are prepared to give up monetary policy. The interest rates in Korea have not deviated by any substantial degree from those

[14] For example, Park, Chung and Wang (2001) provided some evidence of strong foreign exchange intervention in Korea, while Kim (2005) and Kim, Kim and Wang (2005) provided some evidence of weak foreign exchange intervention in Korea.

prevailing in the financial markets of its major trading partners. While restricting the range of movement of the nominal exchange rate, the monetary authorities could push down the market interest rates, probably because capital account transactions can be controlled. However, given the many legal and illegal routes through which capital moves in and out of the country, there is likely to be a limit to which any difference in the interest rates in domestic and international capital markets can be maintained.

Does the preceding argument mean that Korea should adopt a standard model of inflation targeting with free floating and capital account liberalisation or its variant for a framework of monetary policy? If Korea continues with an intermediate regime, not free floating, it will have to retain capital controls. Even then, the open trade regime will reduce the scope of monetary policy. Sooner or later the public may realise the limit of the ability of the monetary authorities in controlling inflation. The announcement of the target range of core inflation then runs the danger of falling on deaf ears, thereby making the expectation channel inoperative.

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