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Inflation Targeting in Korea: An Empirical Exploration

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The revised Bank of Korea (BOK) Act states that the primary goal of monetary policy is price stability and recently monetary policy has moved toward an inflation targeting framework. This study explores some of the practical aspects that need to be considered for this move. In particular, issues such as the definition of the price index, the horizon over which to target inflation, and the width of the inflation target bands are considered. On balance, the empirical evidence suggests that Korea is likely to be successful in adopting an IT framework over the medium term. [JEL E5, E3, C5]

Since the beginning of 1999, Korea has shown an impressive recovery from the financial crisis that two years earlier threatened it with bankruptcy. Economic growth has resumed and inflation has continued to fall. The exchange rate market has stabilized at around 1,300 from over 1,800 won per U.S. dollar two years earlier. Likewise, the stock market has experienced sharp rebounds, and the overnight call rate has fallen to about 5 percent from over 30 percent in late 1997—a dramatic contrast from the crisis period of sharp exchange rate depreciation, stock market losses, double digit interest rates, and a contraction of output of roughly 6 percent in 1998.

Much controversy has surrounded the causes and appropriate policy responses to the Asian crisis in general, and the Korean crisis in particular. To be sure, struc-

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tural weaknesses and policy distortions played significant roles in the crisis (Corsetti, Pesenti, and Roubini, 1998). Specific weaknesses in the financial system, such as Korea's merchant banks, have been singled out as "one of the main culprits behind Korea's meltdown in November 1997" (page 117, Kim and Koo, 1999). These weaknesses were exacerbated by an over-leveraged corporate sector, particularly Korean conglomerates, chaebol, that had invested heavily, focusing primarily on gaining market share. The resulting excess capacity weakened corporate profits and those of the financial system that financed them (IMF, 2000). These weaknesses, coupled with an abrupt change in market sentiments that followed the stock market crashes of Taiwan Province of China and Hong Kong Special Administrative Region and the downgrading of Korea's sovereign risk, "sparked off the exodus of institutional investors out of Korea" (page 3, Park and Song, 2000), triggering Korea's financial crisis.

Aside from tightening of financial policies, notably a sharp increase in domestic interest rates in late 1997, Korea enacted several important reforms in response to the crisis, including: (1) financial sector reform aimed at identifying and closing nonviable financial institutions; (2) corporate sector reform geared at restoring corporate creditworthiness and competitiveness; (3) opening of financial markets to foreigners earlier than envisaged before the crisis, and (4) passing legislation to increase labor market flexibility.[1] In addition, the Bank of Korea's policy objectives were modified and its independence enhanced. The modifications of the BOK policy objectives are the focus of this paper.

The revised Bank of Korea Act that came into effect on April 1, 1998, clearly spells out that price stability is the primary goal of monetary policy. The Bank of Korea is no longer to pursue the dual objectives of maintaining the stability of the value of money and strengthening the soundness of the banking system, and is now entrusted with the primary goal of price stability. Each year the BOK is to set a "price stability" target in consultation with the government, and to elaborate a monetary plan to achieve this target. The BOK is required to publicly announce the monetary plan, publish the minutes of the monetary policy board meetings, and prepare a detailed report on monetary policy to be submitted to the National Assembly at least once a year.[2]

The revised act also boosts the central bank's independence as the Minister of Finance and Economics is no longer the chairman of the monetary board that is entrusted with monetary policy decisions. This position is now occupied by the Governor of the BOK. Also, the monetary board members are no longer appointed mostly by the government: only one of the seven monetary board members is appointed by the Ministry of Finance and Economics. Also the members of the board are expected to remain in office during their full four-year term and can no longer be forced to resign (see BOK, 1998).

[1]A detailed discussion of the structural reforms, and the monetary and fiscal policy responses that followed the Korean crisis can be found in IMF (2000). An alternative view of the appropriate policy responses can be found in Radelet and Sachs (1999).

[2]Indeed, the inflation targets were 9, 3½, and 2½, plus/minus one percentage point, respectively, for 1998, 1999, and 2000. These targets were based respectively on the annual rate of increase of CPI, CPI excluding some extraordinary factors (weather and changes in taxes), and CPI excluding non-cereal agricultural and petroleum-based product prices.

These revisions to the central bank's charter share elements reminiscent of those in countries that set their monetary policy according to an inflation targeting (IT) framework. The IT countries all have price stability as the primary goal of monetary policy (see Debelle, 1997; and Masson, Savastano, and Sharma, 1997; henceforth MSS). In some of these countries (New Zealand, Canada, and more recently Australia) the inflation target stems from an agreement between the central bank and the government. Most IT countries publicly announce the inflation target, and issue elaborate periodic inflation reports discussing monetary policy in light of inflationary developments. In the United Kingdom, the minutes of the monthly monetary policy discussions between the Governor of the Bank of England and the Chancellor of the Exchequer are published with a short delay (see Bowen, 1995). And central banks in all of these countries have the operational independence to set monetary policy as they see fit to achieve the inflation target.[3]

The move toward IT in the revised Bank of Korea Act prompts a series of practical issues that need to be determined to implement IT. Amongst these are: (1) defining the price index that will be targeted; (2) estimating the level of inflation consistent with operational price stability; (3) establishing the horizon over which the inflation target is to be achieved; and (4) deciding on the size of the inflation target bands. These decisions involve both practical considerations as well as technical issues that have no clear-cut answer. In deciding on the price index, for instance, it is desirable to exclude prices of items dominated by supply shocks so that monetary policy does not become procyclical. But targeting too narrowly defined an index can become a meaningless exercise as it can fail to provide a guide for the formation of price expectations. Similar dilemmas arise in determining the bandwidth of the inflation target: a band that is too wide undermines the meaning of IT and a band that is too narrow (or zero) can unduly increase the need to revise monetary policy stance as small deviations from the targeted inflation rate will prompt changes in monetary policy. Many of these decisions, as noted in MSS, involve balancing the trade-off between credibility and flexibility.

This paper empirically examines some of these practical issues, notably the selection of the price index, the horizon over which inflation should be targeted, and the size of the inflation target bands.[4] The paper, however, has less to say about some other important practical issues, namely the nature of the monetary transmission mechanism and the operational definition of price stability in Korea; these are left for future research.

[3]These countries are, in chronological order in adopting IT: New Zealand, Canada, the United Kingdom, Sweden, Finland, Australia, and Spain. A detailed discussion of the rationale of and the international experience with IT can be found in Bernanke and others (1999).

[4]MSS note two prerequisites for IT in developing countries: (1) capacity to conduct independent monetary policy including the lack of fiscal dominance, and (2) no firm commitment to target the level or path of any other nominal variable such as wages and/or the nominal exchange rate. Both of these prerequisites appear to be consistent with the spirit of the revised Bank of Korea Act, and this paper takes for granted the language in the revised Bank of Korea Act. Thus, the paper sidesteps the issue of the optimal monetary policy framework, and of alternative monetary regimes that could in some economic sense dominate IT. For a discussion of alternative monetary regimes see McCallum and Nelson (1998).

I. Headline Versus "Underlying" Inflation

Several IT countries have eschewed targeting the rate of change in headline CPI in favor of targeting a measure of underlying or core CPI. To varying degrees, these countries have recognized that targeting headline CPI inflation may not be appropriate and/or feasible.[5] In part, this reflects the realization that monetary policy should not be held responsible for non-monetary factors that impinge upon prices. Top amongst these factors are supply shocks and changes in tax rates. To avoid potentially destabilizing effects, it has been argued that in these cases the scope of monetary policy should be limited to contain the second-round effects of these shocks and ignore the first-round effects.[6] From a practical point of view prices that are most subject to supply shocks typically tend to be the most volatile and consequently it may not be feasible to target a price index that includes them.[7] Thus, it may be worthwhile to explore a narrower measure of consumer prices—defined to exclude the first-round effects of supply shocks—potentially reducing the overall volatility and increasing the predictability of this index.

To address this issue, Table 1 presents the basic statistics and univariate AR models for the nine main components of CPI published by the Bank of Korea. Of these categories, two are typically prone to supply shocks, namely food and fuel.[8] The former is the single most important category in the headline CPI with a total weight of about a third; the latter is the least important category with a total weight below 5 percent. Note that the persistence of the shocks (as measured by the sum of the AR coefficients) in these categories is similar to that of other categories but they stand out in terms of the size of these shocks. In particular, shocks in the food and fuel categories are twice as large those of the headline CPI and the confidence interval containing 90 percent of the shocks is also roughly twice as wide. Thus, food price volatility is likely to have significant impact on the headline CPI. Indeed there is a high contemporaneous correlation of food price shocks with headline CPI shocks. Note that fuel price shocks are, however, likely to have small effects on headline CPI because of their small weight in headline CPI.[9]

A point that seems lost in this discussion, however, is that increased short-run volatility in the price index is not what really matters for IT. What really matters

[5]In addition, the predictability of inflation is a factor that impinges upon the choice of headline versus underlying CPI. Given the potential for a credible implementation of IT to increase the predictability of inflation, it is difficult to ascertain empirically whether Korea's inflation is sufficiently predictable for a sensible implementation of IT. Evidence of historical predictability of inflation in Korea vis-à-vis IT countries is provided in Hoffmaister (1999).

[6]Another item that is commonly excluded from the CPI is some measure of the interest rate. The interest rate is included in the CPI measure in several countries to impute mortgage costs. This is not an issue in Korea because the interest rate is not in the headline CPI.

[7]Alternatively, escape clauses could be defined to stipulate (ex-ante) the shocks that will be ignored by monetary policy. See MSS and Debelle (1997) for a discussion on the escape clauses in IT countries.

[8]In principle, individual items could be examined. These data are not published by the BOK and their analysis would be beyond the scope of this study. More importantly, the evidence presented here suggests that this additional effort is unlikely to change the results discussed in the text.

[9]Note that while the correlation of transportation shocks with headline CPI shocks is larger than that of fuel, its effect is likely to be small due to its small weight in headline CPI.

Table 1. Autoregressive Models for Main Categories of CPI, monthly data from 1986:12–1996:12

	Headline	Food	Housing	Fuel	Furniture	Clothing	Medical	Education	Transportation	Other
Number of items	470	167	20	9	62	53	27	71	26	35
Weight in headline index	100.0	32.5	14.2	4.5	6.2	8.8	5.5	14.2	9.4	4.7
Annual percent change										
Average	6.06	6.89	6.43	3.33	4.17	5.40	4.81	7.49	4.76	3.75
Standard deviation	18.31	11.69	13.79	2.97	10.92	7.42	9.80	31.72	7.77	5.94
AR Model										
Number of lags included	16	15	9	13	14	13	13	1	14	13
Adjusted R^2	0.94	0.90	0.99	0.93	0.89	0.96	0.84	0.72	0.85	0.81
Sum of AR coeficients	0.93	0.92	0.98	0.98	0.95	0.98	0.86	0.85	0.95	0.90
(standard error)	(0.03)	(0.05)	(0.01)	(0.03)	(0.04)	(0.02)	(0.08)	(0.05)	(0.05)	(0.06)
Inflation Innovations										
Standard error (SEE)	0.44	0.99	0.29	0.88	0.48	0.69	0.86	0.78	0.99	0.93
Confidence interval, 90 percent										
Upper bound	0.84	1.57	0.42	1.44	0.74	1.21	1.66	1.12	1.68	0.71
Lower bound	–0.62	–1.50	–0.43	–1.22	–0.84	–1.01	–1.31	–0.92	–1.34	–0.99
Range (upper bound minus lower bound)	1.47	3.07	0.86	2.66	1.58	2.22	2.97	2.04	3.01	1.71
Maximum	1.25	2.94	1.18	4.31	2.11	2.84	3.06	3.71	3.41	5.21
(date)	90:04	87:8	92:5	96:3	95:2	96:7	88:6	92:1	89:1	92:1
Minimum	–0.74	–2.60	–0.98	–2.32	–1.70	–1.95	–1.72	–2.81	–2.91	–2.88
(date)	90:11	88:4	90:1	90:12	90:1	91:6	88.2	90:1	90:1	91:1
Jarque-Bera Test of Normality (chi^2, *df*=2)	6.63	26.99	130.99	63.4	99.71	22.25	197.76	15.08	821.06	285.84
Correlation with headline innovation	1.00	0.78	0.21	–0.03	0.41	0.31	0.26	0.33	0.26	0.21

Note: Annual percent change is calculated as the 12-month percent change. The number of lags included in the AR models is determined using the Akaike Information Criteria where the maximum lag tested was 18. All models contain a full set of seasonal dummies. The price categories correspond to the categories published in the Bank of Korea's *Monthly Statistical Bulletin*, respectively (1) foods, (2) housing, (3) fuel, light, and water, (4) furniture and utensils, (5) clothing and footware, (6) medical care, (7) education, culture, and recreation, (8) transportation and communication, and (9) other miscellaneous.

is the effect this volatility has on the inflation in the target policy effectiveness horizon.[10] It is important, therefore, to understand the effect of food price shocks, at the relevant target horizon, on the headline CPI. A simple way to assess the effect of food price inflation shocks on headline CPI inflation and on "underlying" CPI inflation is to model these effects with a reduced-form model. A three variable model—containing both measures of CPI inflation together with food price inflation—was used to calculate the impulse responses to a food price inflation shock (see Figure 1).[11] A historical shock to food price inflation translates into a large response in headline CPI inflation on impact—reflecting the high correlation between headline and food price inflation shocks—and a much smaller response in underlying CPI inflation (top panel). By construction the direct effects of food price are excluded from the underlying CPI inflation, thus a crude measure of the first-round effects of food price inflation (shocks) is obtained from the difference between the response of the headline CPI and underlying CPI inflation (middle panel). On impact, the first-round effects of a one percentage point shock to food price inflation is about half a percentage point.[12] Note that a food price inflation shock of one percentage point leads to an increase in the price of food relative to the "non-food" price of about 0.8 percentage point, most likely reflecting a substitution effect associated with the increased food prices (bottom panel).

Perhaps the most interesting aspect of these responses is how quickly the difference between headline CPI inflation and underlying CPI inflation disappears. Six months following a one percentage point shock of food prices, the difference between the response of headline and underlying inflation is about 30 basis points (bps, 0.30 percentage point) dropping to 13, 6, and 3 bps in 12, 18, and 24 months, respectively.[13] This reflects both the evolution of food price inflation—that reaches its half life within 12 months—and the second-round effects of food price inflation—that raises the rate of underlying inflation steadily during the first 12 months.

In practical terms, these results indicate that food price inflation shocks do increase the short-run volatility of headline CPI inflation in Korea. But more importantly for IT is the fact that the differences in responses of headline and underlying CPI inflation are quite small after the first year. This suggests that with

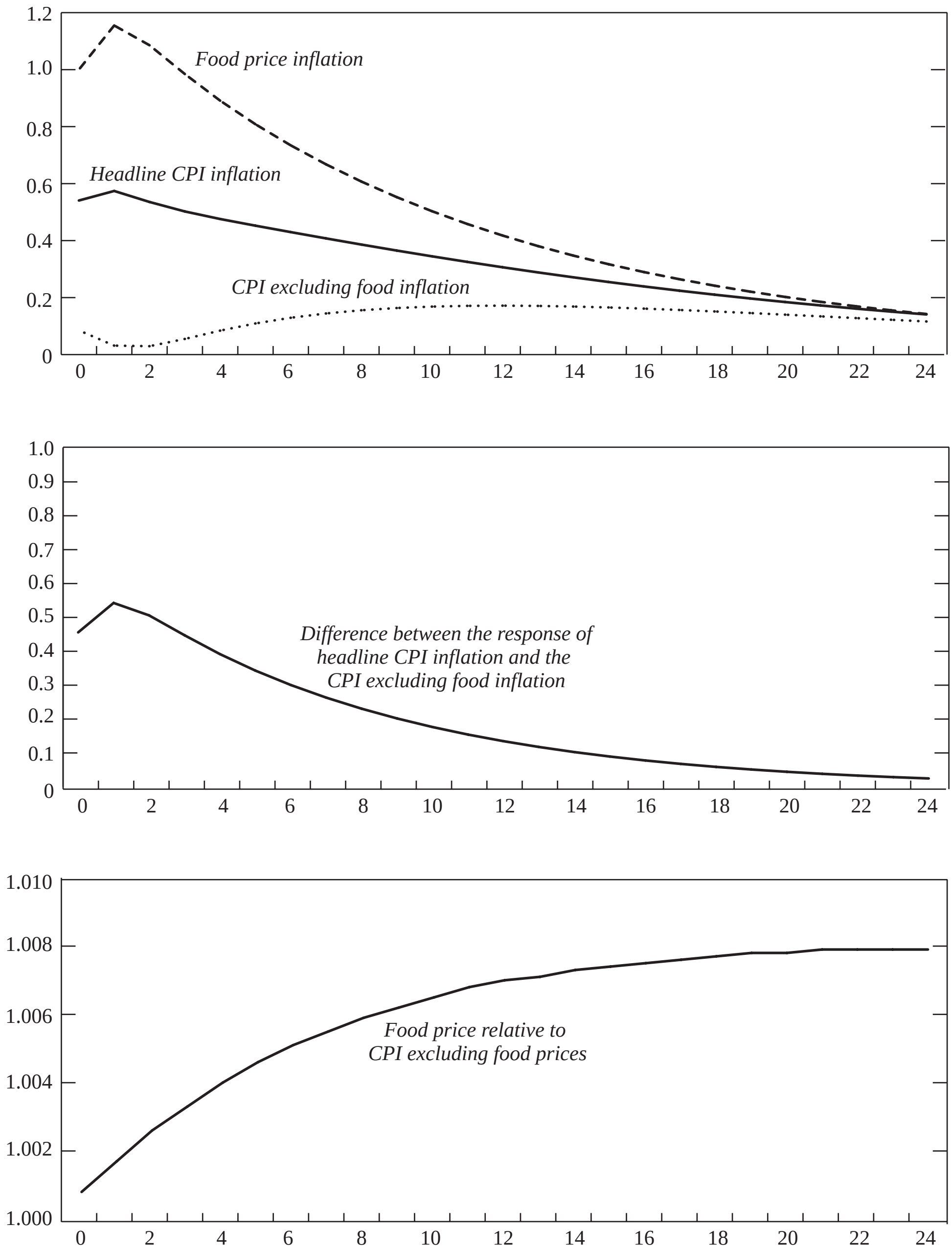
[10]Henceforth, this paper will refer to the "target policy effectiveness horizon" simply as the "target horizon."

[11]Since the nature of the exercise is to uncover the historical responses following a food price shock, generalized impulse response (GIR) functions were calculated. GIR are obtained as the difference of the expectation following a shock and the expectation in the absence of the shock, where the shocks are assumed to come from a multivariate normal distribution. This differs from standard impulse responses in that they are not identified using contemporaneous restrictions that typically lead to orthogonal shocks from recursive systems. The main advantage of GIR over standard impulse response functions is that they are unique and not subject to the compositional effects of traditional Choleski decompositions (see Koop, Pesaran, and Potter, 1996; and Agénor and Hoffmaister, 1997).

[12]Historically, 90 percent of food price inflation shocks are contained in the interval of plus or minus three quarters of a percentage point (see Table 2). Thus, 90 percent of food price inflation shocks will translate on impact to roughly three eighths of a percentage point of headline CPI inflation.

[13]"First-round" effects with six (12) lags are similar on impact, roughly 40 (34) bps, and vanish quicker.

Figure 1. Impulse Responses to a Food Price Inflation Shock
(In percentage points)



Note: Generalized impulse responses to a food price inflation shock based on a three variable VAR comprising the percent change of food prices, CPI, and CPI excluding food prices. Two lags are included in the estimated model consistent with the results of Hannan-Quinn and Scharwz criteria; a full set of seasonal dummies is included in each equation. The relative price is calculated by cumulating the inflation rates (on a monthly basis).

an inflation target horizon greater than a year it will make virtually no difference whether food prices are included or not in the CPI index that is targeted. When consideration is given to the inherent transparency of headline CPI, however, the balance tips in favor of targeting headline CPI index. The point to remember is that targeting headline CPI or targeting “underlying” CPI will be essentially the same in Korea as long as the target horizon is at least a year.

II. A Pragmatic Reduced-Form Model[14]

This paper formulates a pragmatic reduced-form (vector autoregression or VAR) model for Korea to model how a hypothetical IT framework could work. The dynamic linkages stemming from this model provide a measure of the “control lags” of the monetary transmission and provide the basis to stage a series of simulations that illustrate the potential effects of adopting IT.

Reduced-Form Model. The VAR model used in this paper can be expressed as follows:

$$\begin{bmatrix} c_{1,1}(L) & c_{1,2}(L) & c_{1,3}(L) \\ c_{2,1}(L) & c_{2,2}(L) & c_{2,3}(L) \\ c_{3,1}(L) & c_{3,2}(L) & c_{3,3}(L) \end{bmatrix} \begin{bmatrix} \hat{p}_m \\ x_N \\ x_R \end{bmatrix} = \begin{bmatrix} \mu_{pm} \\ \mu_N \\ \mu_R \end{bmatrix},$$

where $c_{i,j}(L)$ are arrays containing lag polynomials, $\hat{p}_m$ is growth rate of import prices, x_N and x_R are vectors of nominal and real domestic variables defined below, and μ_i are the shocks of the model, with $E[\mu] = 0$, and $E[\mu\mu'] = \Omega$. The model restricts $c_{1,2}(L) = c_{1,3}(L) = 0$ to capture the fact that domestic shocks do not affect import prices; that is, Korea is a small open economy. The model also restricts the impact of nominal variables so that a (sustained) reduction of one percentage point in the growth rate of money translates into a one percentage point decline in the growth rate of all nominal variables in the long run, and has no long-run effect on real variables. This is imposed by estimating the model so that the sum of the elements in the rows of $c_{2,2}(L)$ and $c_{3,2}(L)$ equal one and zero respectively. These restrictions are not rejected by the data.

The model is pragmatic in that the definitions of x_N and x_R are taken from previous empirical work.[15] Specifically, $x_N = [\hat{m}2,\ i^{CB},\ \hat{e},\ \hat{p}]'$ and $x_R = [\hat{y},\ flow]'$ where $\hat{m}2$, i^{CB}, $\hat{e}$, $\hat{p}$, $\hat{y}$, and *flow* are respectively broad money, the yield on the three-year corporate bond, the nominal exchange rate (Won/U.S. \$), headline CPI,

[14]To conserve space, this section summarizes section IV in Hoffmaister (1999). The reader is referred to that paper for details of the tests of the restrictions imposed on the VAR model, of the impulse responses and control lags, and for complete discussion of the counterfactual IT simulation exercise.

[15]The model is also pragmatic in the way shocks are “identified,” that is, following Koop, Pesaran, and Potter (1996). They propose studying historical or generalized shocks that are particularly useful to summarize the dynamic linkages that are of interest in this study. This study does not discuss issues pertaining to monetary policy measures, as in Leeper, Sims, and Zha (1996), or to monetary transmission mechanism, as in Bernanke and Gertler (1995).

industrial output cycle (actual minus trend), and capital flows as a share of broad money; the symbol "^" over a variable denotes its growth rate.[16]

The definitions of x_N and x_R allow the model to capture the main macroeconomic stylized facts in Korea. Broad money, *m*2, is included in the model in recognition that it was the aggregate that the BOK targeted for most of the sample period and "it appears to be the best summary measure expressing the intentions of the BOK" (Dueker and Kim, 1997, page 8).[17] In principle, reserve money would be a more natural choice but the data do not support this choice. The corporate bond rate, i^{CB}, is included in the model as it reflects money market conditions better than "shorter" run interest rates that were either regulated or reflected specific risk premia in particular segmented markets during most of the sample period, and is "a measure of the Korean market interest rates" (Barro and Lee, 1994, page 8). The nominal exchange rate, *e*, and capital flows, *flow*, are included in the model to capture linkages with the foreign exchange market and potentially with capital flows as there is some empirical evidence that capital flows have become more responsive to interest rate differentials (see Lee, 1998). The industrial output cycle, *y*, is used to measure cyclical movements of economic activity; it is used in the absence of a wider measure of the business cycle.[18] Headline CPI is included in keeping with the discussion in Section I. And import prices are included to control for their effects on domestic inflation. These shocks, particularly oil price shocks, have been found to be a factor behind inflation in Korea (see Corbo and Nam, 1992, and Hoffmaister and Roldós, 2001).[19]

Impulse Responses and Control Lags. This model is estimated and used to calculate the impulse responses to a shock in broad money and compute monetary control lags. These responses suggest that following a monetary tightening, inflation responds slowly during the first couple of months and takes more than nine months to decline 0.5 percentage points, and output falls below trend for about 12

[16]The VAR model in this paper is estimated with three lags using 132 monthly observations from January 1986 to December 1996. Formal tests for lag length provided conflicting answers regarding the number of lags. The Schwarz Bayesian Criteria, the Akaike Information Criteria, and the Hannan and Quinn test selected, respectively, one, two, and six lags. Three lags were chosen, however, in light of the serial correlation displayed in models with fewer lags. Data for 1997 and 1998 were excluded from the estimation on a priori grounds as these data are dominated by the effects of bankruptcies (Hanbo Steel and Sami) early in 1997, and by the exchange rate crisis that erupted toward the end of the year. Details of the definition of these variables and the sample period are in the appendix.

[17]M2 has also been used to examine monetary policy in the U.S. (see Feldstein and Stock, 1994; and Lebow, Roberts, and Stockton, 1992). In principle a myriad of policy instruments could be used to achieve a given inflation target as noted by McCallum and Nelson (1998) and Végh (1998), although in practice short-term interest rates have been the main policy instrument in IT countries.

[18]The output cycle is estimated as the difference between the actual (log) level and the trend level of output. The trend used is the random walk portion of output obtained from a Beveridge-Nelson decomposition when output is modeled as an ARIMA(2, 1, 2). See Hamilton (1994) pp. 504–5 for details of the Beveridge-Nelson decomposition. The estimated trend is reasonably robust to increases in the autoregressive and moving-average specification of the ARIMA model. Note also that output responses to shocks in money growth in this paper are similar to those obtained from the main macroeconometric models in Korea that use alternative measures of output (see appendix IV in Hoffmaister, 1999).

[19]Agénor and Hoffmaister (1997) argue, however, that these effects are likely to have become less important the mid-1980's.

months in response to monetary tightening, falling on average about 0.05 percentage points in the first six months.[20] Monetary control lags are long, taking more than nine months for inflation to adjust 50 percent, and 12 months to adjust about 60 percent. Most of the adjustment in prices is completed in about 24 months.[21] Qualitatively, the impulse responses and the control lags following a monetary tightening are similar to those found in IT countries. Specifically, output response tends to be faster and shorter lived than price responses, and the full effect on prices takes roughly six to eight quarters to be completed.[22]

The control lags suggest the potential for instrument instability for inflation target horizons of less than a year in Korea because only about 60 percent of the effect on prices has been completed. As noted above, supply side shocks are also likely to complicate monetary policy at these horizons. Thus, the question seems to be how much longer should the horizon be to reduce, on the one hand, the potential of instrument instability without, on the other hand, becoming so long that IT loses its meaning. This issue is considered more generally in the context of the hypothetical IT simulations discussed below.

IT Simulations. The VAR model is used to conduct simulations designed to resemble as closely as possible a hypothetical IT framework. Monte Carlo simulations are used to study the effect of the inflation target horizon and of the bandwidth for the inflation target on monetary and real volatilities, and to provide ex-post evaluation of the success of keeping inflation in the targeted range. The setup for the Monte Carlo simulations is as follows: the inflation forecast is the intermediate target of monetary policy, and the inflation target is 2 percent. Monetary authorities meet monthly—from January 1997 through December 2000—to update their inflation forecast at the relevant inflation target horizon and, given the inflation target band, decide whether a change in monetary policy is warranted.[23] The economy is subject to external and domestic shocks, so that when the monetary authorities update their inflation forecast each month, they do so in light of the shocks in the previous month. These shocks are the historical shocks, U_t, that are drawn with equal probability with replacement from the reduced-form shocks in the five years prior to the beginning of the simulation period (January, 1991 through December, 1996). Repeating the simulation a number of times creates “pseudo-histories” that are used to compute the distribution of outcomes associated with IT. Details of the forecasts and the monetary policy rule are discussed in turn.

[20]To measure the control lags, the pragmatic VAR model is used to calculate impulse responses to “exogenous” monetary policy. These impulse responses are obtained by shutting down the endogenous response of money implicit in standard impulse response functions, that are equivalent to the impulse responses in Sims and Zha (1995) where money is “exogenized.” These responses are obtained by subjecting the model to an initial “non-policy” shock followed by a series policy shocks that are just sufficient to offset the endogenous response of money, as in Hoffmaister and Végh (1996).

[21]Confidence bands suggest that the adjustment of inflation can be considered to be (100 percent) complete in 24 months (see Figure 2).

[22]For a empirical evidence of monetary policy and transmission lags in Australia, England, and New Zealand, see, respectively, Bank of England (1999); Gruen, Romalis, and Chandra (1997); and Ha (2000).

[23]The sample period used in this paper covers the period of 1986:M1 through 1996:M12. The data for 1997–98 were not used to avoid the increased volatility in the data associated with the Korean crisis.

This study assumes that the BOK constructs their inflation forecasts using only an econometric model, namely the VAR model discussed above, although IT countries typically rely on econometric models and informal methods to construct their inflation forecasts (see MSS; and Svensson, 1997). Specifically, the inflation forecast can be expressed as:

$$E_t\left[\pi_{t+h} \middle| \hat{m}_{t+s} = \hat{m}^*_{t+s}\right] = e_\pi \times \left\{B^h \times E_t\left[Y_t \middle| \hat{m}_{t+s} = \hat{m}^*_{t+s}\right]\right\}, \qquad (1)$$

where the VAR(p) model has been rewritten as a VAR(1) with $Y_t = [y_t, y_{t-1}, y_{t-2}, \ldots, y_{t-(p-1)}]'$ and $y_t = [\hat{p}_m, x_N, x_R]'$, B^h is the companion matrix,

$$B = \begin{bmatrix} b_1 & b_2 & \cdots & b_{p-1} & b_p \\ I & 0 & \cdots & 0 & 0 \\ 0 & I & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & I & 0 \\ 0 & 0 & \cdots & I & 0 \end{bmatrix},$$

raised to the h^{th} power, b_k contains the coefficients associated with the k^{th} lag of variables in the model, and e_π denotes a unit (row) vector with a one in the position corresponding to the inflation rate. Note that the expectation is calculated conditional on $\hat{m}_{t+s} = \hat{m}^*_{t+s}$ for all $s = 1, 2, 3, \ldots$ to be consistent with the rule discussed below; the expected value of future period innovations, $E_t[U_{t+s}] = E_t[\mu_{t+s}, 0, 0, \ldots, 0]'$, is zero.

Monetary authorities use equation (1) to gauge the broad money growth consistent with their inflation objective, not knowing the realization of the current period innovation facing the economy. In particular, this policy can be summarized by the following rule:

$$\hat{m}^*_t = \hat{m}_{t-1} + \begin{cases} \alpha_h \times \left(E_t\left[\pi_{t+h}\right] - \pi^*\right) + \mu(\hat{m})_t, & if \ |E_t\left[\pi_{t+h}\right] - \pi^*| > b \\ \mu(\hat{m})_t, & otherwise \end{cases} \qquad (2)$$

where $\mu(\hat{m})_t = e_m \times U_t$ is the (contemporaneously unknown) money growth innovation, π^* is the inflation target, α_h parameterizes the degree of monetary transmission at horizon h, b is the bandwidth of the target, and $E[\pi_{t+h}]$ is obtained from equation (1).

Equation (2) states that the monetary authorities revise this period's money growth only when the forecasted inflation, h periods hence, deviates from its targeted level (in absolute value) by more than b. Equation (2) also makes clear that authorities use all information that is available to the extent that it affects the inflation forecast in equation (1) at the relevant horizon. This rule is similar to what Haldane (1997) calls "the generic form of the feedback rule under an inflation target" that "encapsulates quite neatly the operational practice of most inflation targeters." Note that this rule reflects the fact that BOK's control over broad money growth is imperfect because money growth also reflects $\mu(\hat{m})_t$. The BOK controls the expected path of broad money because $E_t[\mu(\hat{m})_t] = 0$.

This framework is used to carry out two series of simulations: (1) lengthening the inflation horizon from 6 to 24 months with the inflation target band of one percentage point; and (2) increasing the inflation target band from 0.50 to 2.0 percentage points with a fixed inflation target horizon of 18 months. These simulations are discussed in turn.

Inflation Target Horizon. Table 2 presents the results of simulation that use four different inflation target horizons—6, 12, 18, and 24 months—stemming from 1,000 Monte Carlo simulations. For each variable, the table reports the average outcome and the standard deviation. A benchmark for the hypothetical IT simulations is provided by the baseline simulations where the path for broad money is determined by the estimated VAR equation and not by equation (2). To conserve space in Table 2, the effects on real interest rate and real exchange rate are reported instead of their nominal counterparts; the effects on capital flows are small and are omitted.

Consider the simulation results as the inflation target horizon increases. As expected, inflation declines at a slower pace toward its targeted rate and the degree of monetary tightening needed to engineer the corresponding disinflation declines. Compared to the baseline, broad money growth would need to decline at the outset by about 10 percentage points when the horizon is six months compared to a decline of about five, three, and two percentage points respectively for horizons of 12, 18, and 24 months. Note also that the outcomes of the real variables are consistent with the degree of monetary tightening. In particular, note that as the inflation target horizon increases the decline in output, the appreciation of the real exchange rate, and the real interest rate are smaller during the disinflation period.

Changes in the volatility of the economy, measured by the standard deviation, as the inflation target horizon increases, are interesting but are relatively small. The variability of inflation tends to increase a bit as the forecast horizon increases, in large part because the authorities base monetary policy decisions on inflation further into the future so that shocks occurring in the longer intervening period between the time the authorities calculate their inflation forecasts and the realization of this future inflation will tend to increase the volatility of inflation. The counterpart to the higher inflation variability is reduced volatility of broad money growth that appears to reflect the fact that as the horizon is lengthened, monetary policy focuses on future inflation where it is increasingly more effective, and where the effect of shocks to inflation have worked themselves out.[24]

Turning to the volatility of real variables, output volatility declines when the target horizon is increased from six to twelve months, and is mostly unchanged at greater target horizons. The higher volatility associated with shorter horizons is suggestive of the output instability discussed in Jadresic (1998) that can arise when monetary policy focuses on a target horizon where some prices are "fixed." The volatility of the real exchange rate increases slightly as the target horizon is lengthened, reflecting the higher volatility of the inflation rate; for the most part it remains slightly below the baseline volatility throughout the simulation period.

[24]In particular, when $h = 6$ the response of inflation is only 35 percent complete compared with 56 (81) percent complete when $h = 12$ (24). See Table 3 in Hoffmaister (1999).

Table 2. Inflation Target Horizon: Monte Carlo Simulations, 1997–2000
(Inflation target of 2 percent plus/minus 1.0 percentage point)

	Inflation Targeting								Baseline	
	Horizon 6 months		Horizon 12 months		Horizon 18 months		Horizon 24 months			
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
Inflation										
Jan-97	4.49	0.43	4.51	0.43	4.51	0.43	4.51	0.43	4.52	0.44
Feb-97	4.13	0.61	4.37	0.64	4.44	0.65	4.48	0.65	4.59	0.68
Mar-97	3.65	0.75	4.23	0.82	4.39	0.84	4.50	0.84	4.76	0.91
Jun-97	2.52	0.85	3.48	1.03	3.83	1.07	4.06	1.10	4.69	1.30
Dec-97	1.91	0.92	2.47	1.14	2.89	1.23	3.09	1.29	3.98	1.83
Jun-98	1.89	0.90	2.20	1.15	2.45	1.28	2.62	1.35	3.46	2.28
Dec-98	1.76	0.96	1.80	1.19	1.99	1.32	2.05	1.40	2.74	2.67
Dec-99	1.81	0.96	1.71	1.20	1.73	1.34	1.70	1.43	1.82	3.38
Dec-00	1.77	0.94	1.64	1.19	1.62	1.34	1.54	1.44	1.01	4.05
Broad money growth										
Jan-97	4.58	1.82	9.74	1.53	11.12	1.50	12.10	1.50	14.34	1.71
Feb-97	5.45	2.60	9.96	2.01	11.30	1.95	12.21	1.95	14.43	2.09
Mar-97	7.05	2.94	10.21	2.19	11.33	2.10	12.16	2.11	14.26	2.31
Jun-97	10.59	3.13	11.16	2.42	12.09	2.29	12.39	2.27	14.17	2.42
Dec-97	12.87	3.38	12.76	2.76	12.80	2.59	13.01	2.51	14.01	2.69
Jun-98	13.65	3.39	13.00	2.83	13.12	2.77	12.97	2.74	13.57	2.95
Dec-98	13.33	3.65	13.31	3.12	13.05	2.95	13.08	2.90	13.09	3.26
Dec-99	12.77	3.64	12.96	3.05	12.69	2.88	12.72	2.85	12.00	3.65
Dec-00	12.58	3.61	12.70	3.02	12.47	2.88	12.52	2.84	11.05	4.34
Output cycle										
Jan-97	0.78	1.92	0.18	1.93	0.02	1.93	–0.09	1.92	–0.35	1.94
Feb-97	–0.26	2.01	0.41	2.00	0.58	2.00	0.70	2.01	0.96	2.01
Mar-97	–1.59	2.16	–1.06	2.13	–0.91	2.12	–0.83	2.12	–0.62	2.12
Jun-97	0.17	2.06	0.24	2.03	0.30	2.02	0.33	2.03	0.44	2.03
Dec-97	–0.29	2.14	–0.35	2.14	–0.37	2.14	–0.37	2.14	–0.35	2.14
Jun-98	0.65	2.10	0.61	2.08	0.59	2.08	0.58	2.08	0.56	2.06
Dec-98	–0.29	2.00	–0.33	1.99	–0.35	1.98	–0.36	1.98	–0.40	1.98
Dec-99	–0.41	2.06	–0.39	2.04	–0.40	2.03	–0.41	2.03	–0.45	2.03
Dec-00	–0.31	2.08	–0.31	2.08	–0.30	2.08	–0.31	2.07	–0.36	2.07

Table 2. *(concluded)*

	Inflation Targeting								Baseline	
	Horizon 6 months		Horizon 12 months		Horizon 18 months		Horizon 24 months			
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
Real exchange rate										
Jan-97	8.67	0.78	8.73	0.78	8.75	0.78	8.76	0.78	8.79	0.78
Feb-97	7.28	1.32	7.93	1.34	8.10	1.35	8.23	1.36	8.51	1.34
Mar-97	6.54	1.73	7.41	1.75	7.67	1.76	7.84	1.78	8.26	1.76
Jun-97	5.56	2.61	6.26	2.62	6.58	2.64	6.77	2.66	7.35	2.61
Dec-97	3.34	3.80	3.79	3.86	4.11	3.90	4.28	3.94	5.02	3.89
Jun-98	1.21	4.42	1.53	4.49	1.79	4.55	1.94	4.61	2.69	4.58
Dec-98	–0.01	4.49	0.14	4.55	0.34	4.63	0.43	4.70	1.10	4.80
Dec-99	–1.09	4.51	–1.11	4.58	–1.08	4.67	–1.07	4.74	–0.88	5.18
Dec-00	–1.24	4.63	–1.34	4.72	–1.38	4.81	–1.43	4.89	–1.90	5.72
Real interest rate										
Jan-97	10.85	0.67	10.70	0.83	10.52	0.95	10.45	1.02	9.98	2.32
Feb-97	10.29	0.82	10.32	0.96	10.22	1.05	10.18	1.12	9.82	2.39
Mar-97	9.63	0.92	9.90	1.04	9.89	1.13	9.89	1.19	9.68	2.44
Jun-97	9.21	1.07	9.79	1.19	9.97	1.26	10.06	1.32	10.22	2.55
Dec-97	7.83	1.22	8.51	1.30	8.84	1.38	9.05	1.44	9.81	2.72
Jun-98	7.92	1.19	8.35	1.31	8.68	1.41	8.87	1.47	10.03	2.75
Dec-98	7.78	1.72	7.85	1.30	8.08	1.40	8.24	1.46	9.65	2.79
Dec-99	10.71	9.20	7.75	1.37	7.81	1.48	7.89	1.55	9.56	2.88
Dec-00	14.51	22.40	8.60	4.28	7.77	1.47	7.81	1.55	9.64	2.96

Note: Based on the VAR model discussed in the text. The innovations are sampled with replacement from reduced-form innovations from January 1991 through December 1996.

The real interest rate volatility also increases slightly when the target horizon is lengthened.[25]

In short, a shorter horizon reduces the volatility of inflation, thereby increasing the likelihood that the inflation outcome will lie in the targeted range, an important consideration for ex-post evaluation of the IT policy. These gains, however, come at the cost of increases in broad money volatility and the concomitant increases in the volatility of output, at least in the short run. These results are consistent with the common wisdom that a central bank can in principle meet its inflation target, but the cost of rapidly correcting a deviant inflation rate is increased output volatility.

In rigor, an objective function reflecting the authorities' preferences would be needed to choose the optimal horizon. Note, nonetheless, that to the extent that these preferences value stability of real variables, a horizon of 24 months is dominated by the horizon of 18 months, since output volatility is similar but real interest and exchange rate volatility are higher. Moreover, the prevalence of the supply side shocks in inflation outcomes in target horizons of less than a year would tend to rule these out as well. Thus, a target horizon of 18 months appears to be a reasonable balance of these issues.

Inflation Target Bands. Table 3 presents the outcomes using four inflation target bands of plus/minus 50, 100, 150, and 200 bps with a target horizon of 18 months, from 1,000 Monte Carlo simulations. As before, the table reports for each variable the average outcome and the standard deviation; the effects on capital flows are small and are omitted. In addition, the table reports the percentage of inflation simulations that lie in the target range, $\pi^* \pm b$.

The main effect of increasing the bandwidth is an increase in the percentage of inflation simulations that lie in the target range. With a band of (plus/minus) 50 basis points, about 30 percent of the resulting inflation lies in the target range. This percentage increases to about 50, 70, and 80 percent when the inflation target band is increased respectively to 100, 150, and 200 basis points. From the point of view of an ex-post evaluation of the BOK's ability to deliver the target range, a band of 50 bps is not appropriate. Increasing the band to 100 bps improves the BOK's ability to deliver the targeted inflation, albeit it would not be much better than the probability of obtaining heads when flipping a balanced coin. A band of 150 bps improves the BOK's ability to deliver the targeted inflation to over two thirds. Increasing the band further to 200 bps leads to a small increase of the percentage of inflation that lies in the band. Thus, a reasonable bandwidth from an ex-post evaluation point of view would seem to be 150 basis points provided that the dynamic path or volatility of economy is not dominated by a different bandwidth; as discussed below, the effect on the dynamic path and volatility is small.[26]

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[25]The instability of horizons of less than a year also shows up in increases in the volatilities of the real exchange rate and real interest rates toward the end of the simulation period. For the real interest rates these increases are very large.

[26]Previous empirical evidence on inflation target bands (see Stevens and Debelle, 1995, and Haldane and Salmon, 1995) stems from simulating small open economy models with a monetary policy rule that approximates IT behavior. The ex-post inflation outcomes from a small open economy model typically lie in a wider range than those found in this study where the monetary policy "rule," equation (2), accounts for changes in the target horizon and in the target band.

Table 3. Inflation Target Band: Bootstrap Simulations, 1997–2000
(Inflation target of 2 percent and a horizon of 18 months)

	Band of Plus/Minus															Baseline	
	25 basis points			50 basis points			100 basis points			150 basis points			200 basis points				
	Average	Standard deviation	Percentage in band	Average	Standard deviation	Percentage in range	Average	Standard deviation	Percentage in range	Average	Standard deviation	Percentage in range	Average	Standard deviation	Percentage in range	Average	Standard deviation
Inflation																	
Jan-97	4.51	0.43	0.00	4.51	0.43	0.00	4.51	0.43	0.00	4.51	0.43	0.00	4.51	0.43	15.30	4.52	0.44
Feb-97	4.44	0.65	0.00	4.44	0.65	0.00	4.44	0.65	1.30	4.45	0.64	8.40	4.47	0.63	22.30	4.59	0.68
Mar-97	4.39	0.83	0.60	4.39	0.84	1.60	4.39	0.84	4.50	4.40	0.83	14.80	4.45	0.81	28.40	4.76	0.91
Jun-97	3.86	1.04	4.00	3.86	1.05	9.20	3.83	1.07	22.50	3.83	1.11	38.40	3.89	1.12	54.20	4.69	1.30
Dec-97	2.93	1.19	13.20	2.93	1.19	23.20	2.89	1.23	42.80	2.84	1.29	64.60	2.82	1.35	78.60	3.98	1.83
Jun-98	2.49	1.23	14.10	2.48	1.24	28.40	2.45	1.28	53.30	2.38	1.33	71.30	2.36	1.41	83.50	3.46	2.28
Dec-98	2.02	1.26	16.80	2.01	1.27	29.90	1.99	1.32	56.10	1.92	1.39	71.20	1.88	1.46	82.80	2.74	2.67
Dec-99	1.76	1.28	15.80	1.75	1.29	31.10	1.73	1.34	56.00	1.68	1.41	71.20	1.65	1.50	81.30	1.82	3.38
Dec-00	1.64	1.28	14.40	1.64	1.29	29.40	1.62	1.34	53.20	1.58	1.40	68.60	1.54	1.49	80.70	1.01	4.05
Broad money growth																	
Jan-97	11.11	1.48		11.11	1.48		11.12	1.50		11.34	1.60		11.83	1.90		14.34	1.71
Feb-97	11.39	1.83		11.36	1.83		11.30	1.95		11.35	2.09		11.69	2.29		14.43	2.09
Mar-97	11.47	2.05		11.45	2.05		11.33	2.10		11.26	2.27		11.48	2.47		14.26	2.31
Jun-97	12.24	2.26		12.21	2.25		12.09	2.29		11.91	2.40		11.82	2.50		14.17	2.42
Dec-97	12.84	2.52		12.85	2.52		12.80	2.59		12.70	2.64		12.60	2.73		14.01	2.69
Jun-98	13.17	2.71		13.18	2.70		13.12	2.77		13.00	2.85		12.93	2.90		13.57	2.95
Dec-98	13.06	2.89		13.05	2.89		13.05	2.95		13.02	3.03		13.00	3.10		13.09	3.26
Dec-99	12.71	2.84		12.70	2.86		12.69	2.88		12.72	2.93		12.69	2.98		12.00	3.65
Dec-00	12.50	2.82		12.49	2.82		12.47	2.88		12.49	2.94		12.46	3.05		11.05	4.34
Output cycle																	
Jan-97	0.02	1.93		0.02	1.93		0.02	1.93		0.00	1.93		–0.06	1.94		–0.35	1.94
Feb-97	0.56	2.01		0.57	2.01		0.58	2.00		0.62	2.03		0.70	2.03		0.96	2.01
Mar-97	–0.91	2.11		–0.91	2.11		–0.91	2.12		–0.90	2.11		–0.86	2.11		–0.62	2.12
Jun-97	0.30	2.02		0.30	2.03		0.30	2.02		0.29	2.04		0.28	2.04		0.44	2.03
Dec-97	–0.36	2.13		–0.36	2.14		–0.37	2.14		–0.36	2.15		–0.38	2.15		–0.35	2.14
Jun-98	0.58	2.07		0.58	2.07		0.59	2.08		0.58	2.07		0.58	2.07		0.56	2.06
Dec-98	–0.35	1.98		–0.35	1.98		–0.35	1.98		–0.34	1.98		–0.35	1.97		–0.40	1.98
Dec-99	–0.40	2.03		–0.40	2.03		–0.40	2.03		–0.39	2.04		–0.39	2.04		–0.45	2.03
Dec-00	–0.31	2.07		–0.31	2.07		–0.30	2.08		–0.31	2.07		–0.30	2.09		–0.36	2.07

Table 3. *(concluded)*

	Band of Plus/Minus															Baseline	
	25 basis points			50 basis points			100 basis points			150 basis points			200 basis points				
	Average	Standard deviation	Percentage in band	Average	Standard deviation	Percentage in range	Average	Standard deviation	Percentage in range	Average	Standard deviation	Percentage in range	Average	Standard deviation	Percentage in range	Average	Standard Deviation
Real exchange rate																	
Jan-97	8.75	0.78		8.75	0.78		8.75	0.78		8.75	0.78		8.76	0.78		8.79	0.78
Feb-97	8.10	1.35		8.10	1.35		8.10	1.35		8.13	1.36		8.19	1.37		8.51	1.34
Mar-97	7.68	1.77		7.67	1.77		7.67	1.76		7.69	1.77		7.76	1.80		8.26	1.76
Jun-97	6.61	2.65		6.61	2.65		6.58	2.64		6.56	2.63		6.59	2.65		7.35	2.61
Dec-97	4.14	3.92		4.14	3.92		4.11	3.90		4.08	3.90		4.05	3.90		5.02	3.89
Jun-98	1.82	4.57		1.81	4.57		1.79	4.55		1.72	4.54		1.71	4.52		2.69	4.58
Dec-98	0.37	4.66		0.36	4.65		0.34	4.63		0.28	4.63		0.25	4.61		1.10	4.80
Dec-99	–1.05	4.68		–1.05	4.68		–1.08	4.67		–1.12	4.65		–1.15	4.63		–0.88	5.18
Dec-00	–1.36	4.83		–1.36	4.82		–1.38	4.81		–1.42	4.80		–1.46	4.79		–1.90	5.72
Real interest rate																	
Jan-97	10.49	0.91		10.49	0.91		10.52	0.95		10.57	0.99		10.60	1.05		9.98	2.32
Feb-97	10.19	1.02		10.19	1.03		10.22	1.05		10.28	1.09		10.32	1.14		9.82	2.39
Mar-97	9.86	1.10		9.86	1.10		9.89	1.13		9.95	1.17		10.01	1.21		9.68	2.44
Jun-97	9.96	1.24		9.96	1.24		9.97	1.26		10.02	1.31		10.09	1.35		10.22	2.55
Dec-97	8.85	1.36		8.85	1.36		8.84	1.38		8.86	1.44		8.89	1.49		9.81	2.72
Jun-98	8.70	1.37		8.69	1.37		8.68	1.41		8.67	1.47		8.68	1.55		10.03	2.75
Dec-98	8.09	1.36		8.08	1.37		8.08	1.40		8.04	1.45		8.05	1.53		9.65	2.79
Dec-99	7.82	1.44		7.81	1.44		7.81	1.48		7.79	1.53		7.80	1.63		9.56	2.88
Dec-00	7.78	1.43		7.78	1.44		7.77	1.47		7.77	1.52		7.77	1.60		9.64	2.96

Note: Based on the VAR model discussed in the text. The innovations are sampled with replacement from reduced-form innovations from January 1991 through December 1996.

Regarding the dynamic path of the economy, we note briefly that they are essentially unchanged as the inflation target band increases. This suggests that the width of the bands has no appreciable effect on "expected" outcome of the economy. This is probably due to the fact that in these experiments monetary policy is adjusted so that the inflation forecast returns to the midpoint of the band (see equation (2)), which seems to impart a consistent "average" behavior to inflation.

Regarding the changes in the volatility of the economy, these are relatively small as the inflation target band increases from 0.50 to 2.0 percentage points. The volatility of inflation and money growth tends to increase after the initial disinflation period (June 1998 and onward). This reflects the fact that the adjustments governed by the "rule" (equation (2)) increase proportionally with the bandwidth, and these larger adjustments more than offset the decline in the number of adjustments associated with a wider bandwidth.[27] Turning to the volatility of real variables as the inflation target band increases, output volatility is virtually unchanged, and real exchange rate and real interest volatility are respectively slightly less and slightly more after the initial disinflation period. Thus, changes in the volatility of the economy do not appear to matter much for the choice of the bandwidth.

Caveats. Two words of caution regarding the IT Monte Carlo simulations are in order. First, as in all simulations exercises, the estimated VAR model is presumed to be the "correct model." Concretely, the simulations assume that the BOK has perfect knowledge of the monetary transmission mechanism and the control lags, and that this knowledge is accurately captured in the VAR model underlying the simulation results. Thus, for example, there is no problem of "model uncertainty" nor are there "long and variable lags" in the monetary transmission mechanism, that is, the relation between money and prices, α_h in equation (2) is constant and measured accurately. Second, the parameters of the VAR model are presumed to be to be invariant to the IT simulations; that is, the model is not subject to the Lucas critique. To the extent, however, that the IT framework and the corresponding monetary policy imply a fundamental change in the monetary regime in Korea, the simulation results would not accurately reflect the outcomes of forward looking agents knowledgeable of the regime change. These issues are discussed in turn.

Stability of the Inflation Response. To assess the stability of the inflation response, taken for granted in the simulations, the VAR model is estimated repeatedly from December 1992 to December 1996, each time adding a single monthly observation to the end of the sample period; the start of the sample is held constant (January 1986).[28] At each iteration, the VAR estimates are used to recalculate the impulse responses to a negative M2 shock of one percentage point and

[27]Note that for a given horizon α_h is a constant in equation (2). Thus, the adjustment of monetary policy when the band is 200 bps is twice (four times) as large as when the bandwidth is 100 (50) bps

[28]Alternatively, the stability of monetary control lags could be examined by moving forward the start of the estimation period so that the number of observations remains constant in the regressions. This would be analogous to a "rolling-regression" and was not done here because this does not capture the updating nature of real-time decisions, and is not directly comparable to the control lags used in the simulations.

the corresponding monetary control lags. In all, the VAR model is estimated 60 times with the final estimation on the full sample replicating the monetary control lags underlying the simulations exercises above.

Figure 2 depicts the monetary control lags of these repeated estimations, at four representative lags following the monetary tightening, namely 6, 12, 18, and 24 months. (The bands correspond to a one standard-error band obtained from 1,000 Monte Carlo simulations.) Monetary control lags exhibit some variability in the 1990s, especially at longer lags. In particular, the inflation responses to a monetary tightening at 12, 18, and 24 months appear to have increased (become more negative) in the early 1990s and have declined (become less negative) from 1995 onwards. These declines are suggestive of a gradual change in the response of inflation to monetary policy, perhaps reflecting portfolio movements between monetary aggregates as financial markets liberalization proceeded during this period (see Kim, 1997). The inflation response at six months, however, has been fairly stable and has remained between –0.3 to –0.4 percentage points throughout.

These results suggest the simulations performed in this paper may underestimate the true uncertainties of "real-time" monetary policy. To the extent that the decline in the response of inflation at horizons of a year or more continue the gradual upward trend depicted in Figure 2, the simulations discussed above may underestimate the degree of monetary tightening needed to achieve an inflation target. The "under-estimation" of needed monetary tightening to achieve a target will tend to impart a positive bias to inflation outcomes. These changes, however, are small—roughly 0.1 percentage point difference from mid-1995 to end-1996—suggesting that the bias in the simulation results discussed above is likely to be small.

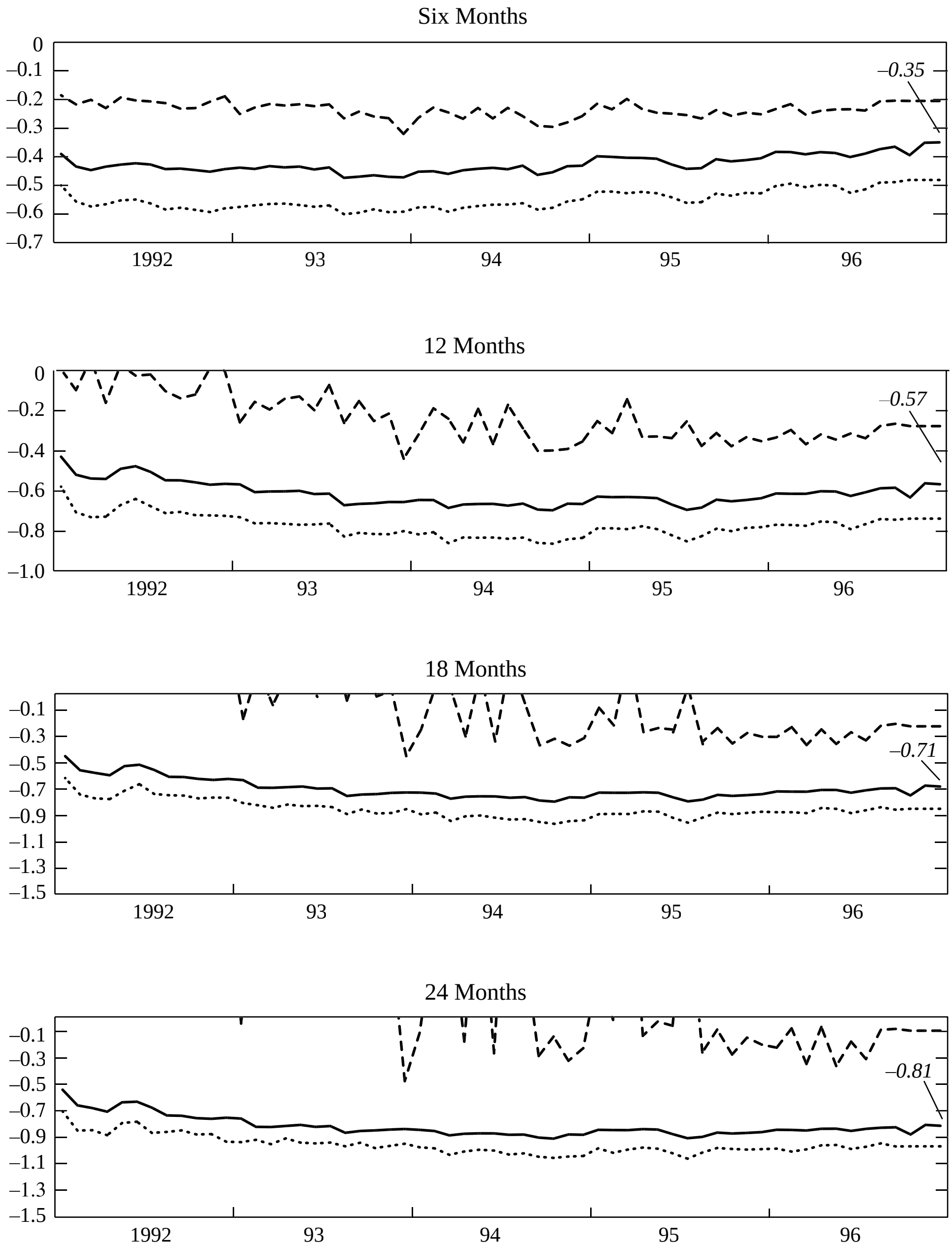
The Lucas Critique. The hypothetical IT simulations are vulnerable to the Lucas critique since they are based on estimates from data corresponding to a different monetary regime. Forward-looking agents will understand how the behavior of the monetary authorities changes when monetary policy is guided by an IT framework, and they would use this information to revise their expectations, thereby modifying the effect of monetary policy. Moreover, since this regime has not been observed, extrapolating the likely impact of monetary policy in this "imaginary" construct from the historical data is potentially misleading.

As argued by Sims (1982, 1986) the Lucas critique should not be taken to be a blank indictment of all policy analysis. In particular, "judicious" use of "valid" reduced form equations can produce reasonable policy analysis. In Sims' judgment "judicious" experiments are those that are not far removed from the historical experience so that the observed data contain information useful to understand the experiment at hand, that is, the information contained in the data can be used to extrapolate within the historical experience.[29] "Valid" equations in Sims' judgment are those that are able to capture implicitly agents expectations; VAR models are contained in a class of equations that are valid. In this light, it can be argued that the VAR model used in the IT experiments would qualify as capable

[29]This argument was used in Hoffmaister and Végh (1996) to analyze the effect of exchange rate-based versus monetary-based stabilization in Uruguay.

Figure 2. Monetary Control Lags

(Inflation response in percentage points)



Note: Inflation responses at the corresponding lag following a monetary tightening of one percentage point. The responses are obtained by repeatedly estimating the underlying VAR model from January 1986 to the month shown along the horizontal axis; the last responses in each panel are for the full sample and by construction equal those in Table 3.

of capturing agents' expectations; however, it is not clear that the IT experiments resemble the historical experience in Korea.

In an effort to understand how far removed the IT experiments are from Korea's historical experience, this paper compares the distribution of historical monetary shocks with the distribution of the IT shocks. Figure 3 depicts the distributions of the IT and historical shocks when $h = 18$, $b = 1.0$, and $\pi^* = 2.0$. In rigor, the figure shows the distribution of IT shocks that correspond to an "unannounced" IT policy since changes in agents' expectations are not captured.

As expected, the distribution of the IT shocks during the disinflation period—depicted in the first two rows—shows a higher frequency (or density) of negative (or contractionary) shocks than the historical distribution. Following the disinflation period, however, the distribution of shocks is very similar. A provocative observation follows from these histograms: the main difference in the distribution of shocks is associated with the disinflation and not the IT framework itself. Put differently, had the inflation target in the IT simulations equaled the average inflation forecast—so that adopting IT would not have implied a disinflation—agents would have been hard pressed to observe any change in the monetary policy regime simply by observing the monetary shocks.

However, an important ingredient of adopting an IT framework making monetary policy more transparent is the change in order to modify agents' inflation expectations and gain credibility for the central bank. In this case, the BOK would fully explain the details of the new monetary policy framework, the target and its band, the horizon over which it will be targeted, and how monetary policy will be used to keep the inflation forecast within the targeted range. In this fully credible adoption of IT, agents will be able to back out the exact series of shocks that this switch implies and will modify their behavior accordingly.

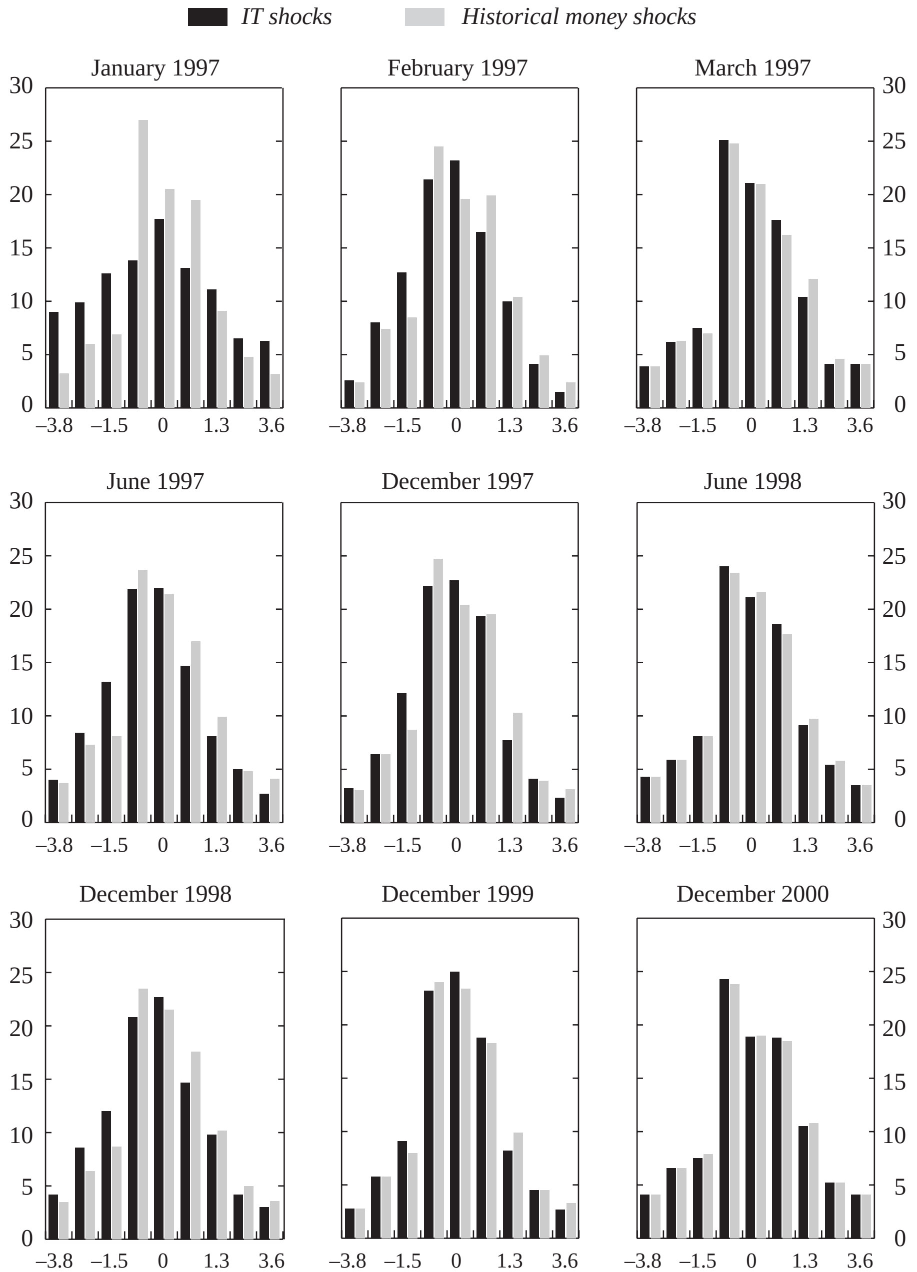
In short, the simulations discussed in this paper should be taken to characterize an unannounced adoption of IT. To the extent that the adoption of IT is viewed as credible, agents will tend to revise their inflationary expectations downward, possibly resulting in smaller increases in the real interest rate than those predicted above. In this light, the simulation results would seem to provide an "upper bound" or a worst case scenario of adopting IT.

III. Summary and Conclusions

Aside from tightening of financial policies amidst the exchange crisis that enveloped Korea late in 1997, Korea enacted several important reforms including changes in the central bank's charter that increased the importance of inflation targeting as the main policy objective of the Bank of Korea. The revisions to the central bank's charter are reminiscent of those revisions in countries that adopted an IT framework. This move toward IT prompts a series of practical issues that need to be determined to implement IT that are the focus of this paper. Specifically, this paper examines the definition of the price index to be targeted, the horizon over which the inflation target is to be achieved, and the size of the inflation target bands.

Econometric (VAR) models are used to shed light on these issues. The first model contrasts the behavior of headline CPI inflation and that of underlying

Figure 3. Histograms of IT and Historical Money Shocks
(Frequency in percent)



Note: Categories along the *x*-axis correspond to the midpoint of the range. The IT shocks depicted reflect the full monetary shock vis-à-vis the VAR model, where $\pi^* = 2$, $h = 18$, and $b = 1.0$. These shocks consist of the elements in equation (2), and the shock required for money growth to be constant. The historical depicted shocks are shocks from the estimate VAR model. Distributions stem from 1,000 Monte Carlo replications.

inflation following a shock in those prices that are excluded from headline CPI. The second model is formulated to capture the main macroeconomic features of Korea, and is used to perform a series of experiments designed to mimic an IT framework, and examine the effect of changing the target horizon and the size of the inflation band. An important feature of the IT experiments is that monetary policy is forward looking and contemporaneous information (including the prevailing rate of inflation) affects monetary policy *only* through its effect on the inflation forecast at the relevant horizon. Moreover, shocks to the exchange rate and to other variables do not lead to change in policy, unless they are of such a magnitude that the (revised) inflation forecast at the relevant horizon breaches its targeted range, regardless of their impact on inflation at shorter horizons.

The main results can be summarized as follows:

- **Price Index.** Targeting headline CPI is appropriate in Korea, as long as the inflation target horizon exceeds a year. Food price shocks, which contain an important supply-side element, increase short-run volatility of headline inflation but these effects vanish within a year. Targeting headline CPI has the additional advantage of being particularly well suited to coordinate economy-wide inflationary expectations because it is used in wage contract negotiations in Korea
- **Target Horizon.** A target horizon of 18 months seems to provide a reasonable balance between the volatility of real variables and the prevalence of the supply-side shocks in inflation outcomes. There appears to be a trade-off between the volatility of real variables as the horizon increases: the volatility of output falls but the volatilities of the real interest rate and the real exchange rate increase. Horizons exceeding 18 months are less appealing because the volatility of real interest rates and real exchange rates increases and shorter horizons are vulnerable to supply-side shocks.
- **Target Band.** A target band of 150 bps seems appropriate from the perspective of ex-post evaluation of the BOK's success in attaining the stated inflation target. The simulation exercises suggest that with a band of 100 bps roughly half of the time inflation will lie in the band, which does not bode well from an ex-post evaluation perspective. A band of 150 bps increases the rate in band to over two thirds, which is more reasonable from an ex-post evaluation perspective. Increasing the band further results in relatively smaller gains in the BOK's ability to deliver the targeted inflation and tends to make the targeted range less meaningful (0–4 percent). The effect of the width of the band on the path of disinflation or on real volatility is small so that it does not factor in when determining the size of bandwidth.

This study cautions, however, that the degree of uncertainty underlying these simulations is likely to understate the true uncertainties of "real-time" policy decisions. In particular, monetary control lags are found to have changed gradually. These changes are small and tend to impart an upward bias to the inflation outcomes compared to the simulation results. This study also cautions that the simulation results reflect the impact of an unannounced (or non-credible) adoption of IT. To the extent that the adoption of IT is announced, and as it gains credibility, the ability to control inflation and the predictability of inflation would be expected to increase. These gains are difficult to measure but would suggest that the target horizon could be shorter and the bandwidth could be smaller than those discussed in this paper.

The simulation results suggest that conducting monetary policy according to an IT framework in Korea—with a target horizon of 18 months and a band of one percentage point—is remarkably similar to the way the BOK has conducted monetary policy historically. This is an intriguing result that is reminiscent of recent studies on the monetary policymaking of the Bundesbank, which is also found to be very similar to IT (see Bernanke and Mihov, 1997; and Clarida, Gali, and Gertler, 1998). The Bundesbank and the BOK have both publicly emphasized the importance of money targets in their monetary policy decisions. Their money targets stem from a quantity equation relationship that ties the projections of inflation, velocity, and output (see, respectively, von Hagen, 1995; and BOK, 1993). Moreover, the Bundesbank has noted that money targeting is superior when traditional monetary relationships are stable and that IT should be viewed as a second-best solution when these relationships have broken down. For its part, the BOK had been very successful at keeping inflation low by targeting money facilitated by fairly stable (until recently) traditional monetary relationships in Korea. Although there does not appear to be any reason to expect that an observational equivalency between money targeting and IT when monetary relationships are stable—as they appear to be in Germany and during much of the sample period in Korea—it may be difficult, nonetheless, to distinguish between these policies empirically. Thus, it is important to caution that the similarity of the IT simulations here and the historical money targeting in Korea is associated with the particular historical experience in Korea, and care is needed when considering the more recent experience in Korea and the experiences of other countries.

A final note regarding the empirical exploration of IT in this paper. This study has not assessed how IT compares to alternative monetary policy frameworks. On balance, the empirical evidence points to the feasibility of IT in Korea, but care should be exerted to avoid misconstruing IT as the optimal choice. The empirical exploration suggests that the main differences in monetary policy in adopting IT, compared to the current monetary policy, are associated with the path of disinflation. Thus, it appears important to study alternative monetary policy rules to better understand whether the output losses associated IT are no larger than those obtained with other monetary regimes. There is some evidence for IT countries that the short-run output losses associated with disinflation did not change with the implementation of IT (see Bernanke, and others, 1999). Further research on the relative costs of disinflation in alternative monetary policy frameworks could be conducted along the lines of McCallum and Nelson (1998).

APPENDIX

Variable	**Definition**	**Source**
p	Consumer Price Index, line 64	IMF's *International Financial Statistics*
Price indexes for basic groups	Categories published in the *Statistical Bulletin*	*Statistical Bulletin*, BOK
e	Nominal exchange rate (won per U.S. dollar) line ae	*International Financial Statistics*
Output	Industrial output (seasonally adjusted), line 66cz	*International Financial Statistics*
y	Output cycle, output minus random walk component from a Beveridge-Nelson decomposition using an ARIMA(2, 1, 2)	Author's calculations
*m*2	Broad money, line 34 plus line 35	*International Financial Statistics*
i^{CB}	Yield on a 3-year corporate bond, line 60bc	*International Financial Statistics*
p^m	Import prices, line 76x divided by *e*	*International Financial Statistics*
flow	Capital inflows, current balance (in Won) times minus one divided by *e*, divided by *m*2	*Statistical Bulletin*, BOK, and *International Financial Statistics*

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