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Inflation Targeting in Korea: An Empirical Exploration

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Abstract

The revised Bank of Korea Act states that the primary goal of monetary policy is price stability, suggesting that monetary policy will move toward an inflation-targeting framework. The paper explores some of the practical aspects of this move, including such issues as the predictability of inflation, the definition of the price index, the inflation target's time horizon, and the width of the inflation-target bands. On balance, the empirical evidence suggests that Korea is likely to be successful in adopting an inflation-targeting framework over the medium term.

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Contents | Page

I. Introduction 4

II. Predictability of Inflation 6

III. Headline Versus "Underlying" Inflation 11

IV. A Pragmatic Reduced-Form Model 15
A. Control Lags and Impulse Responses 17
B. IT Simulations 20
C. Caveats 33

V. Summary and Conclusions 40

Text Tables

1. Autoregressive Models for Inflation 8
2. Autoregressive Models for Main Categories of CPI, monthly data from 1986:12-1996:12 12
3. Monetary Control Lags 19
4. Counter-Factual Simulation of Inflation Targeting, 1972-2000 23
5. Inflation Target Horizon: Bootstrap Simulations, 1997-2000 29
6. Inflation Target Band: Bootstrap Simulations, 1997-2000 32

Figures

1. Forecasting Performance of AR Models of Inflation 10
2. Impulse Responses to a Food Price Inflation Shock 14
3. Impulse Responses to a Negative M2 Shock 18
4. Hypothetical IT Counterfactual, 1997-2000 25
5. Monetary Control Lags 35
6. IT versus Money Bootstrap Shocks 38
7. Anticipated Monetary Shocks 39

Appendices

I. Advanced Economies with Explicit IT Frameworks, Selected Features 43
II. Data 44
III. VAR Model Details 45
IV. Monetary Policy and Macroeconometric Model in Korea 50
V. Inflation Pass-Through and IT Threshold 51

Appendix Tables

A1. VAR Estimates, Monthly Observations from January 1986 to December 1996 46
A2. Macroeconomic Effects of Monetary Policy in Korea 50

Appendix Figure

A1 VAR Innovations 47

References 52

I. INTRODUCTION

The revised Bank of Korea Act has recently come into effect making it clear that price stability the primary goal of monetary policy in Korea. Since April 1, 1998 the Bank of Korea (BOK) is no longer to pursue the dual objectives of the maintenance of the stability of the value of money and strengthening of 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.

The revised act also grants the central bank the independence needed to achieve price stability. The central bank's independence is boosted 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. Likewise, 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 out of office (see BOK, 1998a).

The 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[2] 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 elaborate periodic inflation reports discussing monetary policy in light of inflationary developments. In the U.K., 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.

It is unclear the extent to which these revisions will change monetary policy in the short-run. The economic crisis that erupted late in 1997 has led to a series of reforms in monetary policy and financial markets that complicate the effective implementation of the revised BOK Act. Moreover, it is also unclear whether the achievement of an inflation

[2]These countries are, in chronological order in adopting IT: New Zealand, Canada, the United Kingdom, Sweden, Finland, Australia, and Spain. Appendix I summarizes some of the main institution features of IT frameworks in these countries.

objective can be or should be the overriding objective of monetary policy in the aftermath of an external crisis and in the midst of profound structural changes.

The move toward IT in the revised Bank of Korea Act justifies, nonetheless, a forward looking exploration of the a series of practical issues that need to be determined to implement IT over the medium-term. 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.[3] 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 addresses 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. In addition the paper assesses, at a more fundamental level, the predictability of inflation in Korea which is perhaps one of the most basic practical requirements to successfully target inflation.[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.

The rest of the paper is organized as follows. Section II assesses the predictability of inflation in Korea and compares it to that in the IT countries. To address the issue of the

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[3]These difficulties are illustrated by the recent decision of the Reserve Bank of New Zealand to expand the definition of the price index that it targets. The price index used for about seven years was found wanting in its ability to capture "underlying" inflationary pressures. The most recent policy target agreement (PTA) settled on a broader definition of the targeted price index. A by-product of this revision is a more transparent price index as it is now calculated simply by excluding "credit services" from the headline index.

[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.

price index to target, Section III compares the volatility and dynamic properties of headline inflation and of its main components in Korea. Section IV presents an empirical model to assess the potentially macroeconomic consequences of IT in Korea. This model is used first to measure monetary policy transmission lags. Then the model is used to conduct counter-factual and bootstrap simulations to explore the effects of varying the inflation target horizon and the size of the inflation target band. This paper concludes by summarizing the empirical evidence for Korea.[5]

II. PREDICTABILITY OF INFLATION

In the IT framework, the inflation forecast plays the role of the operational intermediate target of monetary policy guiding monetary policy (see Svensson, 1997). Given this role of the inflation forecast, it is important to examine the difficulties in forecasting inflation, i.e., how predictable is inflation in Korea.[6] It stands to reason that the predictability inflation is directly related to the ability of the historical data to convey information about future inflation. Stable economic relationships enhance the predictability inflation as they allow economic data to be used to provide an accurate measure of underlying inflationary pressures. An accurate inflation forecast is an essential ingredient for policy makers to conduct monetary policy in an IT framework.

Even under ideal circumstances, however, an inflation forecast will be subject to some degree of error as economic shocks will affect inflation outcomes. The question then is what degree of predictability is sufficient for the inflation forecast to be used effectively as the operational intermediate target of monetary policy. A natural benchmark in this regard are the IT countries as they have effectively conducted monetary policy based on their inflation forecast. To the extent that the predictability inflation in Korea is comparable to that in the IT countries it could be argued that forecasting inflation will not present an

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[5]This paper takes for granted the language in the revised Bank of Korea Act and thus, sidesteps the issue of the optimal monetary policy framework. Alternative monetary regimes that could in some economic sense dominate IT, are not considered here. For a discussion of alternative monetary regimes see McCallum (1998).

[6]In the study a high degree of predictability of inflation is understood to mean that inflation can be accurately forecasted, i.e., *small* forecasting errors. This definition differs from the predictability measure proposed by Diebold and Kilian (1997) which is based on the short-run forecast error relative to the long-run forecast error. Arguably, the absolute size of the forecast error is relevant in the context of IT.

unsurmountable obstacle to adopt IT.[7] In this comparison it is important to note that the relevant benchmark is inflation in IT countries prior to adopting IT. Arguably, adopting an IT framework tends to reduce the variability of inflation and thus increases the predictability inflation. Thus, this study examines the inflation data prior to adoption of IT to avoid artificially increasing the degree of predictability inflation in the benchmark.

The predictability of inflation is measured by calculating the forecast error at different forecast horizons. In general, the (h periods ahead) forecast error is defined as the difference between the inflation outcome and the (h periods ahead) inflation forecast:

$$f^{E}_{t+h} = \pi_{t+h} - E_t[\pi_{t+h}] \qquad (1)$$

where the f^{E}_{t+h}, π_{t+h}, and $E_t[\pi_{t+h}]$ denote respectively the h-period ahead forecast error, the inflation outcome in period t+h, and expected inflation in period t+h given the information available in period t.[8] This forecast error is used to calculate standard measures of forecast performance, namely the root mean square error (RMSE), the mean error (ME), and the mean absolute (value) error (MAE).[9]

In these exercises, the information set will be limited to the inflation series itself to provide a convenient basis to perform cross country comparisons. Thus, the inflation forecasts are generated from univariate autoregression models, AR(p) models. Table 1 provides the details of the univariate AR models and of the inflation experiences of Korea and the IT countries prior to adopting IT.[10] These data suggest that Korea's inflationary process--the average, volatility, and loosely speaking persistence measured by the sum of AR coefficients--is similar to that in the IT countries. Note that with the exception of Sweden, the range over which 90 percent of the inflation innovations fell in Korea is wider than in the IT countries. In part this reflects the fact that the standard deviation of the inflation innovations is higher in Korea, but the range is wider even compared to Spain whose standard deviation is

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[7]Successful IT will require not only predictable inflation but also controllable inflation. The latter refers to the ability of the policymaker to affect the inflation outcome through their policies. This issue is at the heart of Section IV below.

[8]For example, the (h-period ahead) inflation forecast for an AR(1) model is $a_1^{h} * \pi_t$, where a_1 denotes the AR coefficient. Forecasting equation in more general models can be found in Granger and Newbold (1986) pp. 132-35.

[9]See Diebold (1997) pp. 343-344 for the relevant formulas.

[10]New Zealand and Australia were not included in this exercise because their price data was not available at monthly frequency. Comparing the predictability inflation in these countries based on quarterly price data to the predictability inflation based on monthly data would be misleading.

Table 1. Autoregressive Models for Inflation.

	Korea	Canada	United Kingdom	Sweden	Finland	Spain
Sample Period (ten years ending in)	1996:12	1991:07	1992:10	1993:01	1993:02	1994:07
Inflation:						
Average (annual rate)	6.06	5.67	5.56	6.70	5.22	6.54
Standard Deviation	18.31	12.53	15.63	17.24	14.80	23.04
AR Model:						
Number of Lags	16	17	14	13	17	13
Adjusted Coefficient of Determination	0.94	0.98	0.96	0.90	0.97	0.94
Sum of AR coeficients	0.93	0.95	0.96	0.89	0.98	0.95
(Standard Error)	(0.03)	(0.01)	(0.02)	(0.04)	(0.02)	(0.02)
Inflation Innovations:						
Standard error	0.44	0.30	0.33	0.72	0.30	0.41
Confidence Interval (90 percent)						
Upper bound	0.84	0.46	0.53	1.23	0.52	0.58
Lower bound	-0.62	-0.50	-0.49	-0.95	-0.46	-0.67
Range (upper bound minus lower bound	1.47	0.96	1.01	2.18	0.98	1.25
Maximum	1.25	1.58	1.29	2.50	0.73	1.34
Date	1990:04	1991:01	1990:04	1991:01	1988:05	1986:01
Minimum	-0.74	-0.95	-0.83	-2.69	-0.71	-1.53
Date	1990:11	1983:01	1983:03	1992:01	1992:01	1987:01
Jarque-Bera Test of Normality (chi^2, df=2)	6.63	149.62	6.85	63.46	0.16	19.25

Note: The number of lags included in the AR models is determined using the Akaike Information Critieria where the maximum lag tested was 18; a full set of seasonal dummies is included in each model.

similar. This suggests that the distribution of inflation innovations in Korea has fatter tails (positive kurtosis), i.e., inflation in Korea is subject more frequently to larger shocks than would be expected given its standard deviation. This issue is discussed further in Section III below.

Figure 1 depicts the forecast performance over the five years prior to adopting IT using the AR models in Table 1. The standard measures of forecasting performance, mentioned above, are calculated for forecast horizons h=1, 2, 3, ..., 24 using out-of-sample forecast errors. These measures are close to an "honest" test of real-time forecast uncertainty because the coefficient estimates used do not use data from the forecast period.[11] The forecast performance, during the five years prior to adopting an IT framework, is assessed by repeatedly re-estimating the models adding a month of data in each iteration. Since the IT countries typically set their inflation target horizon between 18 to 24 months to accommodate the lags in the monetary transmission mechanism, the comparison of the forecast performance at these horizons is of greatest interest. At 18 months the RMSE in Korea is about 1.6 percentage points. This is similar to the RMSE in Finland (1.7) that in turn is somewhere between the U.K. (2.7) and Sweden (2.7) with worse forecasting performance, and Canada (0.8) and Spain (0.8) with better forecasting performance. At 24 months the RMSE in Korea is about 1.5 percentage points (slightly lower than in the shorter horizon). This forecast performance is better than all IT countries except Canada (0.7) and Spain (0.8).

At face value these results suggest that the predictability in Korea during the past five years is comparable to the IT countries prior to adopting IT. Thus, forecasting inflation in Korea does not seem to present an unsurmountable obstacle to adopt IT. A word of caution regarding these results is in order because the price series examined are "headline" CPI that are not typically targeted by IT countries. In this regard, the predictability of inflation in Spain and in Sweden would appear to be the most relevant comparisons as these countries target headline inflation (see Appendix I). On balance, forecasting inflation will not be a major impediment for the adoption of IT in Korea.[12]

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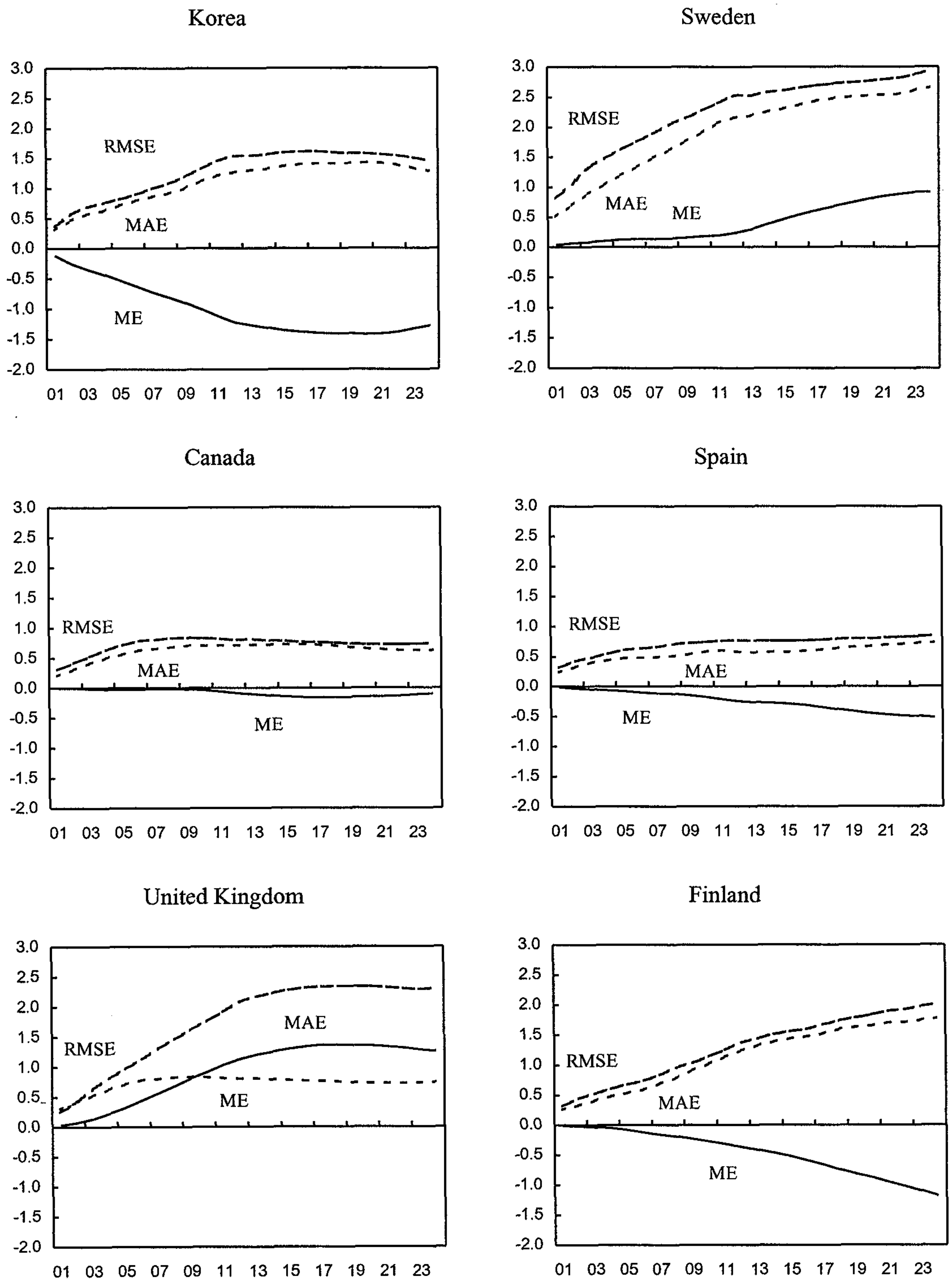
[11]In rigor, the AR models do contain "some" in-sample information because the lags included in the AR models are based on the full sample.

[12]The forecasting performance of the AR models in Korea and Finland could be improved. These models imply systematic forecasting errors because the ME and the MEA have similar absolute magnitudes with opposite signs. Specifically, the AR model systematically over-predicts inflation in Korea (the ME is negative); the reverse is true in Finland. Note that modifying these models would tend to improve the inflation forecasting performance, providing further confirmation that inflation forecasting will not be an impediment for IT in Korea.

Figure 1. Forecasting Performance of AR Models of Inflation

(In percentage points, five years prior to adoption of IT)



Note: The root mean squared error (RMSE), the mean error (ME), and the mean absolute value error (MAE) for forecast horizons of one to 24 months ahead are obtained out of sample using the AR models in Table 1. The models are reestimated during the five year period before IT by adding a month in each iteration.

III. 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. 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.[13] 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.[14] 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 2 presents the basic statistics and the univariate AR models for the nine main components of CPI published by the Bank of Korea. Of these categories, two would appear especially prone to supply shocks, namely food and fuel.[15] 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 five 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 are likely to have significant impact on the headline CPI. Indeed there is a high contemporaneous correlation of food price shocks with headline

[13]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 the implicit mortgage costs. This is not an issue in Korea because the interest rate is not in the headline CPI.

[14]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.

[15]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 effort is unlikely to change the outcome.

Table 2. 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 (chi², 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 twelve 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 recreaction, (8) transportation and communication, and (9) other miscellaneous.

CPI shocks (see Table 1). Note that fuel price shocks are, however, likely to have small effects on headline CPI because of their small weight in headline CPI.[16]

A point that seems lost in this discussion is that increased short-run volatility in the price index is not what really matters for IT but what matters is the effect this volatility has on the inflation in the target policy effectiveness horizon.[17] It is important, therefore, to understand the effect of food price shocks 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 2).[18] 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.[19] Note that a food price inflation shock of one percentage point leads to an increase in the price of food relative to "non-food" price of about 0.8 percentage point mostly 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 0.30 percentage points, dropping to 0.13, 0.06, and

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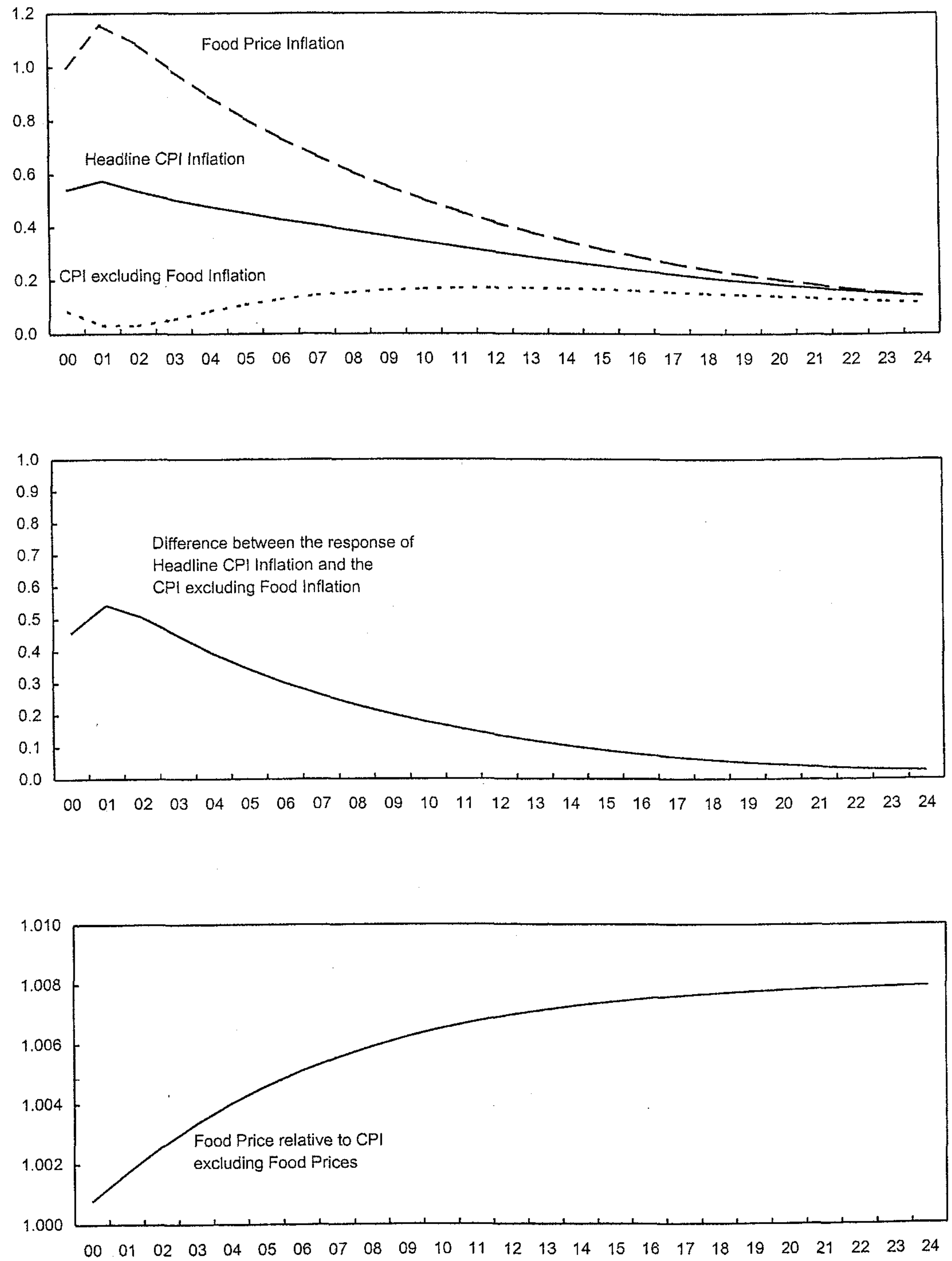
[16]Note that while the correlation of transportation shocks with headline CPI shocks is larger than that of fuel, its effect is likely to be small due to its small weight in headline CPI.

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

[18]Since the nature of the exercise is to uncover the historical responses following a food price shock, generalized impulse response functions were calculated. The main advantage of these 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).

[19]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 headline CPI inflation.

Figure 2. 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 cummulating the inflation rates (on a monthly basis).

0.03 percentage points in 12, 18 and 24 months respectively.[20] This reflects both the evolution of food price inflation--that reaches its half life within twelve months--and the second-round effects of food price inflation--that raises the rate of underlying inflation steadily during the first twelve 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 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.[21] When consideration is given to the inherent transparency of headline CPI, however, the balance tips in favor of targeting headline CPI index. The caveat 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.

IV. A PRAGMATIC REDUCED-FORM MODEL

This study formulates a pragmatic reduced-form (vector autoregression or VAR) model for Korea to model how a hypothetical IT framework would work. The dynamic linkages stemming from this model will provide a measure of the reduced-form "control lags" of the monetary transmission and provide the basis to stage a series of simulations that illustrate the potential effects of adopting IT. These simulations show the effects of varying the inflation target horizon and the size of the inflation target band on the stability of monetary policy and of the real economy.

The model is pragmatic in that the choice of variables included is guided by previous work. In particular, the VAR model includes: (1) broad money, *M2*; (2) the yield on the three-year corporate bond, *CB*; (3) the nominal (Won/U.S. $) exchange rate, *ne*; (4) industrial output cycle (actual minus trend), *cycle*; (5) headline CPI, *p* ; (6) capital flows, *flow*; and (7) import prices, *pm*. All of these variables are measured as twelve-month growth rates, except *CB* and *flow* that are expressed, respectively, as an annual percent rate and as a share

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[20]These results are not unduly sensitive to the number of lags included in the model. The "first-round" effects when the model contains six (12) lags are similar on impact, roughly 0.40 (0.34) and vanish faster.

[21]Case in point: Mishkin and Posen (1997) note that the oil price shock in the wake of the Iraqi invasion of Kuwait posed a potential threat to the inflation target in New Zealand and in October 1990 the Reserve Bank of New Zealand announced that the target range for December 1990 should apply to CPI inflation excluding oil prices. After the fact, inflation including oil prices was within the original target range, i.e., it made no difference for IT whether the index included or not oil prices.

of *M2*. Details of the definition of these variables, the sample period, and specification of VAR model are in Appendices II and III.

The inclusion of broad money follows from the recognition that it was the aggregate that the BOK targeted for most of the sample period; up to 1996 the monetary authorities conducted monetary policy by targeting M2 and when the portfolio shifts became significant in 1997 (period not included in the sample) they targeted both M2 and an expanded monetary aggregate (MCT). In Dueker and Kim (1997) words "it appears to be the best summary measure expressing the intentions of the BOK," page 8.[22] In principle, reserve money would be a more natural choice to include in the model as one would expect the BOK to have more control over this narrower monetary aggregate and it is also conceivable that the BOK affects the interest rate via changes in the supply of reserve money. In practice, however, the data does not favor this view of monetary policy in Korea: the monetary control lags from a model that uses reserve money as the instrument suggest that a reduction of one percentage point in the growth rate of reserve money would take more than eight years to reduce inflation by 0.5 percentage points and 16 years to reduce inflation by 0.75 percentage points.[23] These results suggest either that the BOK's ability to conduct monetary policy has been extremely limited or that it used alternative mechanisms to influence monetary conditions.

The CB rate is included 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. The CB rate has been used in previous work (see Barro and Lee, 1994) and this rate can be considered as "a measure of the Korean market interest rates," page 8. Despite this fact, monetary authorities did not use rely on its movements or those of any other interest rate to gauge monetary policy stance because until recently monetary policy was conducted by targeting monetary aggregates.

The exchange rate and capital flows are included to capture the 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 is used to measure cyclical movements of economic activity; it is used in the absence of a wider measure of the business cycle. Headline CPI is included in keeping with the discussion in Section III. And import prices are included to control for their effects on domestic inflation. These shocks, particularly oil price shocks,

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[22]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 (1998) and Végh (1998), although in practice short-term interest rates have been the main policy instrument in IT countries.

[23]Moreover, these control lags are even longer if the reserve money is not corrected for changes in the reserve requirements.

have been found to be a factor behind inflation in Korea (see Corbo and Nam, 1992, and Hoffmaister and Roldós, 1996)[24]

Another reason why the model is pragmatic is in the "identification" of shocks, that stem from their historical distributions, as in Koop, Pesaran, and Shin (1996). These historical or generalized responses are useful to summarize the dynamic linkages that this study is interested in. This study does not discuss issues pertaining to monetary policy measures, as in Leeper, Sims, and Zha (1996) because to do justice to these complex issues would be beyond the scope this study. Another issue that lies beyond the goals of this paper is characterizing the monetary transmission mechanism, as in Bernanke and Gertler (1995).

A. Control Lags and Impulse Responses

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.[25] This study constructs impulse responses that are equivalent to those 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).

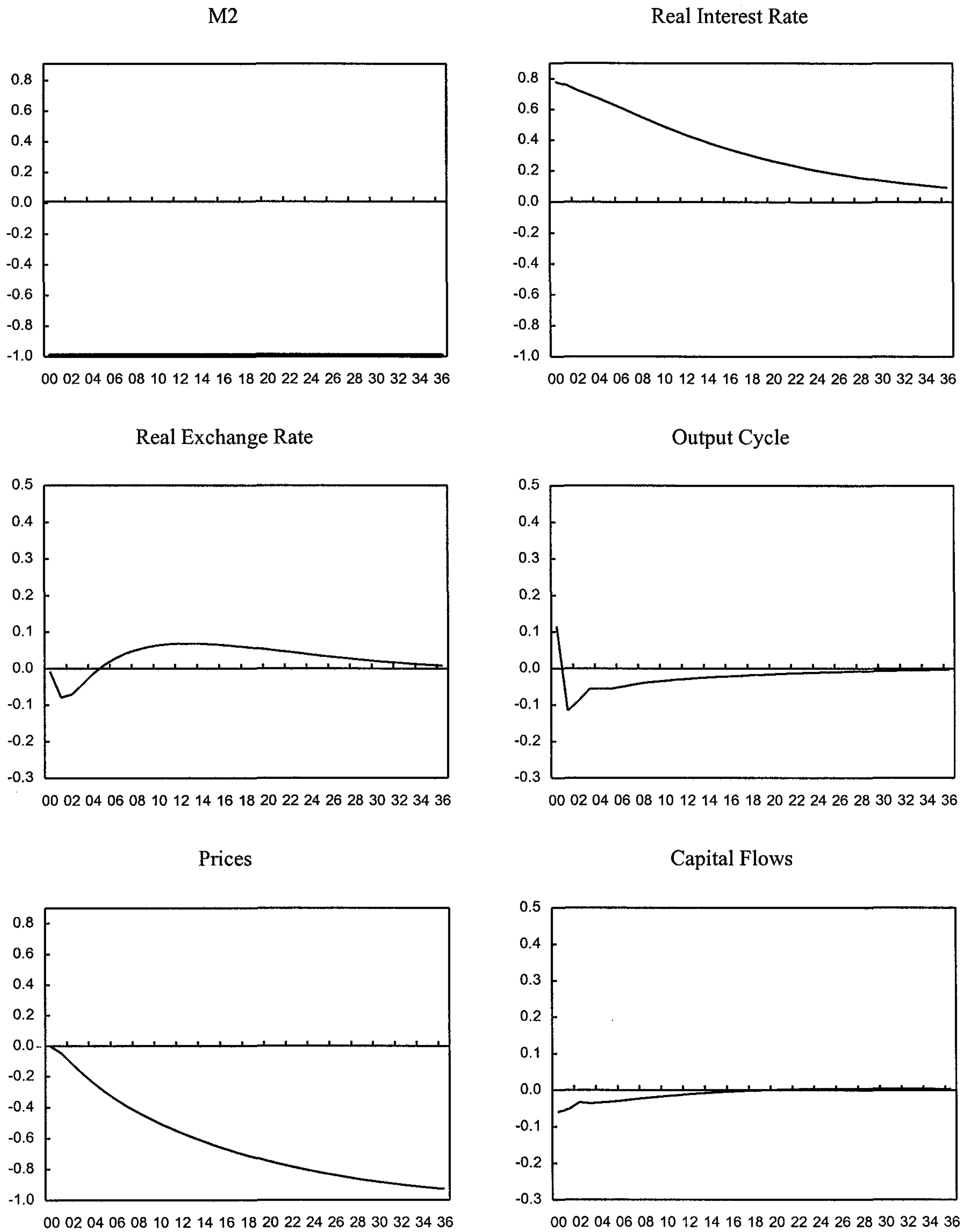
Figure 3 shows the impulse responses to an exogenous reduction of one percentage point in the rate of growth in M2.[26] Following the monetary tightening, inflation responds slowly during the first couple of months and takes more than nine months to decline 0.5 percentage points. Subsequently, inflation declines by 0.6 and 0.7 percentage points in 12 and 18 months respectively, and the bulk of the adjustment is completed in about two years. Output falls below trend for about 12 months in response to the monetary tightening, falling

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

[25]Note that standard impulse responses show the response of the economy to a single monetary shock tracing out both the dynamic responses of the economy and the endogenous response of the money.

[26]As noted before, the monetary authorities targeted M2 during the sample period and while in principle reserve money would have been a more natural choice, the data does not support the conception that BOK used reserve money to target M2. The data is unclear how the BOK was able to target M2 and this paper takes the pragmatic position that they were able to conduct monetary policy by unidentified mechanisms.

Figure 3. Impulse Responses to a Negative M2 Shock
(In growth rates, unless otherwise indicated)



Note: The impulse responses show the percentage point deviations from the baseline. All calculations are based on the VAR model described in Appendix III.

on average about 0.05 percentage point in the first six months.[27] It is interesting to note that the (expected long) real interest rate responds markedly on impact (rising about 0.8 percent) as expected inflation falls. Subsequently, the real interest rate remains substantially above its baseline value for well over a year. Also, note that the rate of depreciation of real exchange rate (Won/U.S. $) declines by roughly 0.1 percentage points for about three months following the monetary tightening. This real appreciation is subsequently undone by the increase in the rate of depreciation that occurs roughly six months following the tightening. The response of capital flows is small and has the "wrong sign" probably reflecting the extensive capital controls during the sample period.

The monetary control lags are summarized in Table 3. As illustrated in Figure 3, these lags are long taking more than nine months for inflation to adjust 50 percent, and 12 months to adjust about 60 percent. (Recall that inflation falls by one percentage point in the long-run following an exogenous reduction in M2 growth of one percentage point in the

Table 3. Monetary Control Lags

Lag	Inflation Response	Percent Completed
0	--	--
1	--	--
2	-0.12	11.9
3	-0.18	18.5
6	-0.35	35.0
9	-0.47	47.0
12	-0.57	56.6
18	-0.71	71.2
24	-0.81	81.4
36	-0.94	93.5

Note: Calculations are based on an "exogenous" decline in M2 growth rate of one percentage point, as illustrated in Figure 3. Inflation (CPI) response is measured in percentage points. Details of the VAR model are in the appendix.

[27] The "perverse" blip in cyclical output reflects the positive contemporaneous correlation between cyclical output and broad money (see Table A1). A similar perverse response of output is found in BOK (1998b) when output is allowed to behave differently during the "focal episodes" of monetary contraction. See Appendix IV for a comparison of the VAR responses to the responses of the main macroeconometric models in Korea.

VAR model.) Note that most of the adjustment in prices is completed in about 24 months,[28] suggesting that controls lags in Korea are similar to those thought to prevail in the IT countries.

These control lags suggest the potential for instrument instability for inflation target horizons of less than a year because 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 looses its meaning. This issue is considered more generally in the context of the hypothetical IT simulations discussed below.

B. IT Simulations

The VAR model is used to conduct two types of simulations designed to resemble as closely as possible the IT framework.[29] First, hypothetical counter-factual simulations are used to illustrate the IT framework and its forward looking nature. Next, bootstrap simulations are used to study the effect of the inflation target horizon and of the band width for the inflation target on monetary and real volatilities. Like all simulations exercises these results are subject to some important caveats. Specifically, the simulations assume that the true model of economy is the one that has been used and that its parameters, specifically the monetary control lags, are stable. Moreover, the simulations assume that hypothetical IT behavior of the Bank of Korea does not constitute a change in the "policy regime" subject to the Lucas critique. These caveats are discussed in Section IV.C below.

Counter-Factual Simulation

The counter-factual framework for the simulation of monetary policy under IT is as follows. The inflation forecast plays the role of the intermediate target for monetary policy. To determine whether a change in policy stance is required, the BOK evaluates whether their inflation forecast is consistent with the inflation target. Specifically, the BOK sets the growth rate of M2 as follows:

$$m_t = \begin{cases} m_{t-1} + \alpha_h \times (E_t[\pi_{t+h}] - \pi^*), & if \quad |E_t[\pi_{t+h}] - \pi^*| > b \\ m_{t-1}, & otherwise, \end{cases} \qquad (2)$$

[28]Confidence bands suggest that the adjustment of inflation can be considered to be (100 percent) complete in 24 months (see Figure 5).

[29]In general an IT framework does not pin down a monetary policy rule. In the model used here, however, the IT "rule" is pinned down by the choice of the monetary "instrument."

where m_t denotes the growth rate of M2 in period t, α_h is a constant, $E_t[\pi_{t+h}]$ is the (h-period hence) inflation forecast, and b is the width of the inflation band. Equation (2) makes evident that monetary policy is forward looking as it is governed by the deviation of the inflation forecast from its targeted rate, π^*. The (linear) VAR model used here means that for a given forecast horizon, α_h is a constant that reflects all of the parameters in the model; it equals the inverse of the inflation response in Table 3. Note that equation (2) implies that the monetary authorities control m_t and can precisely engineer changes in broad money growth; this assumption is relaxed in the bootstrap simulations below.

Although IT countries have relied on econometric models and informal methods to construct their inflation forecasts (see MSS and Svensson, 1997), this study assumes that the BOK constructs their inflation forecasts using only an econometric model, namely the VAR model discussed above. Specifically, the inflation forecast from this model can be expressed as:[30]

$$E_t[\pi_{t+h}] = e_\pi \times \{B^h \times E_t[Y_t]\}, \qquad (3)$$

where the VAR(p) model has been rewritten as a VAR(1) model, B^h is the corresponding companion matrix raised to the "h" power, Y_t is a vector of dimension (7×p) collecting the seven variables and the p lags in the model, and e_π denotes a unit (row) vector with a one in the position corresponding to the inflation rate. To fix notation, it will be useful to spell out equation (3); carrying out the multiplication leads to the expression:

$$\begin{aligned} E_t[\pi_{t+h}] = {} & b^1_{\pi,pm}(h)\times pm_{t-1} + b^1_{\pi,ne}(h)\times ne_{t-1} + \ldots + b^1_{\pi,flow}(h)\times flow_{t-1} + \\ & b^2_{\pi,pm}(h)\times pm_{t-2} + b^2_{\pi,ne}(h)\times ne_{t-2} + \ldots + b^2_{\pi,flow}(h)\times flow_{t-2} + \\ & b^3_{\pi,pm}(h)\times pm_{t-3} + b^3_{\pi,ne}(h)\times ne_{t-3} + \ldots + b^3_{\pi,flow}(h)\times flow_{t-3} \end{aligned} \qquad (4)$$

where $b^i_{\pi,j}(h)$ denotes the typical element of the π_t row in the matrix B^h. Note that the VAR(1) specification implies that $E_t[Y_t]=B\times Y_{t-1}+E_t[U_t]$ where U_t is the additional information available in period t.[31] In the counter-factual simulations below, U_t is a vector of

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[30]Note that the inflation forecast is made conditional on a constant money growth rate, i.e., $m_{t+s}=m_t$ for s=1, 2, 3, ..., h.

[31]Note that in the simulations the money equation detailed in Appendix III is replaced by equation (2). Note further that $Y_t = [y_t, y_{t-1}, y_{t-2}]'$, $U_t = [\mu_t, 0, 0]'$, and

$$B = \begin{bmatrix} C1 & C2 & C3 \\ I & 0 & 0 \\ 0 & I & 0 \end{bmatrix}$$

zeros unless the deviation from the target exceeds *b*. In this case it contains one non-zero entry that corresponds to the monetary innovation, $\alpha_h \times (E_t[\pi_{t+h}]-\pi^*)$.

This setup is used to conduct a hypothetical experiment where the BOK adopts IT beginning in January 1997 (16 months earlier than the revised BOK Act came into effect). Recall that for these simulations U_t is a vector of zeros unless the deviation from the target exceeds *b*, in which case it contains a single non-zero entry for the monetary innovation. Furthermore, the simulations assume an inflation target, π^*, of two percent with an inflation band, *b*, equal to 0.5 percentage points, and an inflation target horizon, h, equal to 18 months.

The counter-factual IT simulation would have evolved as follows. In January, 1997 the BOK would have forecasted inflation (18 months hence) to be 4.25 percent in June 1998 (see Table 4). Since this forecasts exceeds the target by more than 0.5 percentage points, the authorities would have tightened their monetary stance. Specifically, the BOK would have reduced the rate of growth of M2 by 3.28 percent so that its new inflation forecast for June 1998 would have equaled two percent.[32] In February, the BOK would have updated its inflation forecast--given the change in policy and the data for the previous month--this time focusing on the forecast for July 1998 (18 months hence). The updated forecast, 1.91 percent, would have been in the target range so that no change in the monetary policy stance would have occurred. A similar procedure would have had to take place in March and every month thereafter. The IT simulation suggests that in June 1997 (and again in September 1998) the monetary stance would have been eased because the inflation forecast for January 1999 (March 2000) would have been 1.36 (1.50). The BOK would have eased the growth rate of M2 by 0.93 (0.51) percentage points so that the revised inflation forecast would have equaled two percent. Subsequently, monetary policy would have remained unchanged during the remainder of the hypothetical counter-factual simulation ending in December 2000.

[32]Adjusting monetary stance immediately so that the resulting forecast equals π^* is consistent with an IT framework where only inflation enters the monetary authorities' objective function. Svensson (1997), however, has noted that a slower adjustment of monetary policy would follow when the objective function contains output and/or employment.

Table 4. Counter-factual Simulation of Inflation Targeting, 1997-2000
(Inflation target of two percent plus minus 0.5 percentage points over a horizon of 18 months)

Month	Inflation Forecast (24 months hence)	Policy Decision	Adjustment in the growth of M2	Inflation Forecast after the adjustment	Inflation Outcome (current period)
Jan-97	4.25	Tighten	-3.28	2.00	4.56
Feb-97	1.91				4.52
Mar-97	1.78				4.48
Apr-97	1.61				4.34
May-97	1.51				4.15
Jun-97	1.36	Ease	0.93	2.00	3.96
Jul-97	1.95				3.83
Aug-97	1.92				3.68
Sep-97	1.83				3.49
Oct-97	1.85				3.37
Nov-97	1.84				3.18
Dec-97	1.81				3.07
Jan-98	1.78				2.98
Feb-98	1.78				2.83
Mar-98	1.73				2.79
Apr-98	1.64				2.71
May-98	1.62				2.62
Jun-98	1.53				2.53
Jul-98	1.52				2.46
Aug-98	1.54				2.35
Sep-98	1.50	Ease	0.51	2.00	2.22
Oct-98	2.07				2.17
Nov-98	2.11				2.09
Dec-98	2.13				2.08
Jan-99	2.14				2.10
Feb-99	2.18				2.05
Mar-99	2.17				2.11
Apr-99	2.11				2.13
May-99	2.12				2.13
Jun-99	2.06				2.12
Jul-99	2.08				2.15
Aug-99	2.13				2.12
Sep-99	2.10				2.05
Oct-99	2.18				2.05
Nov-99	2.23				1.98
Dec-99	2.24				2.00
Jan-00	2.26				2.03
Feb-00	2.30				2.00
Mar-00	2.29				2.07
Apr-00	2.23				2.11
May-00	2.24				2.13
Jun-00	2.18				2.14
Jul-00	2.20				2.18
Aug-00	2.25				2.17
Sep-00	2.22				2.11
Oct-00	2.30				2.12
Nov=00	2.34				2.06
Dec-00	2.35				2.08

Note: Based on the hypothetical IT simulation of the VAR model discussed in the text. The inflation forecast stems from dynamic forecasts using information up to the previous month. The adjustment in the growth of M2 is the percentage point deviation from a the baseline (where money follows the standard VAR equation) required for the inflation forecast (18 months hence) to be equal two percent. The inflation forecast after the adjustment is the dynamic forecast of inflation (18 months hence) when the growth of M2 is held at is new rate for the foreseeable future. The inflation outcome is the inflation that results from the hypothetical IT simulation.

The forward looking aspect of the IT framework is highlighted by the decision to ease monetary policy in June 1997, despite the fact that inflation was outside the targeted range (3.96 percent). This is also illustrated by the fact that the inflation outcome was greater than the upper bound of the inflation target range for the first 18 months of the simulation and no tightening of the monetary policy was required. Note further that in June 1998, 18 months after the authorities adopted IT, inflation was not precisely two percent as forecasted at the outset of the simulation and this did not prompt an adjustment in monetary policy.[33]

The paths for the other variables in the model resulting from this hypothetical IT simulation are depicted in Figure 4. For reference, a baseline simulation shows the dynamic forecasts assuming that monetary policy is governed by history during the simulation period, i.e., the estimated VAR money equation is used instead of equation (2). These responses suggest that inflation is "sticky" for about two months following the monetary tightening and falls gradually to its targeted range. The path for the output cycle shows a contemporaneous blip in activity followed by a reduction of output that lasts about a year following the tightening of monetary policy. The CB rate falls gradually during the disinflation and the (expected) real interest rate remains above its baseline level during the first year of the hypothetical simulation.[34] The rate of depreciation of the Won/U.S. exchange rate also falls gradually during the disinflation and the real Won/U.S. $ rate declines about 0.25 percentage points for the first nine months and then increases slightly above the baseline. Capital flows are essentially unaffected by the change in policy.[35]

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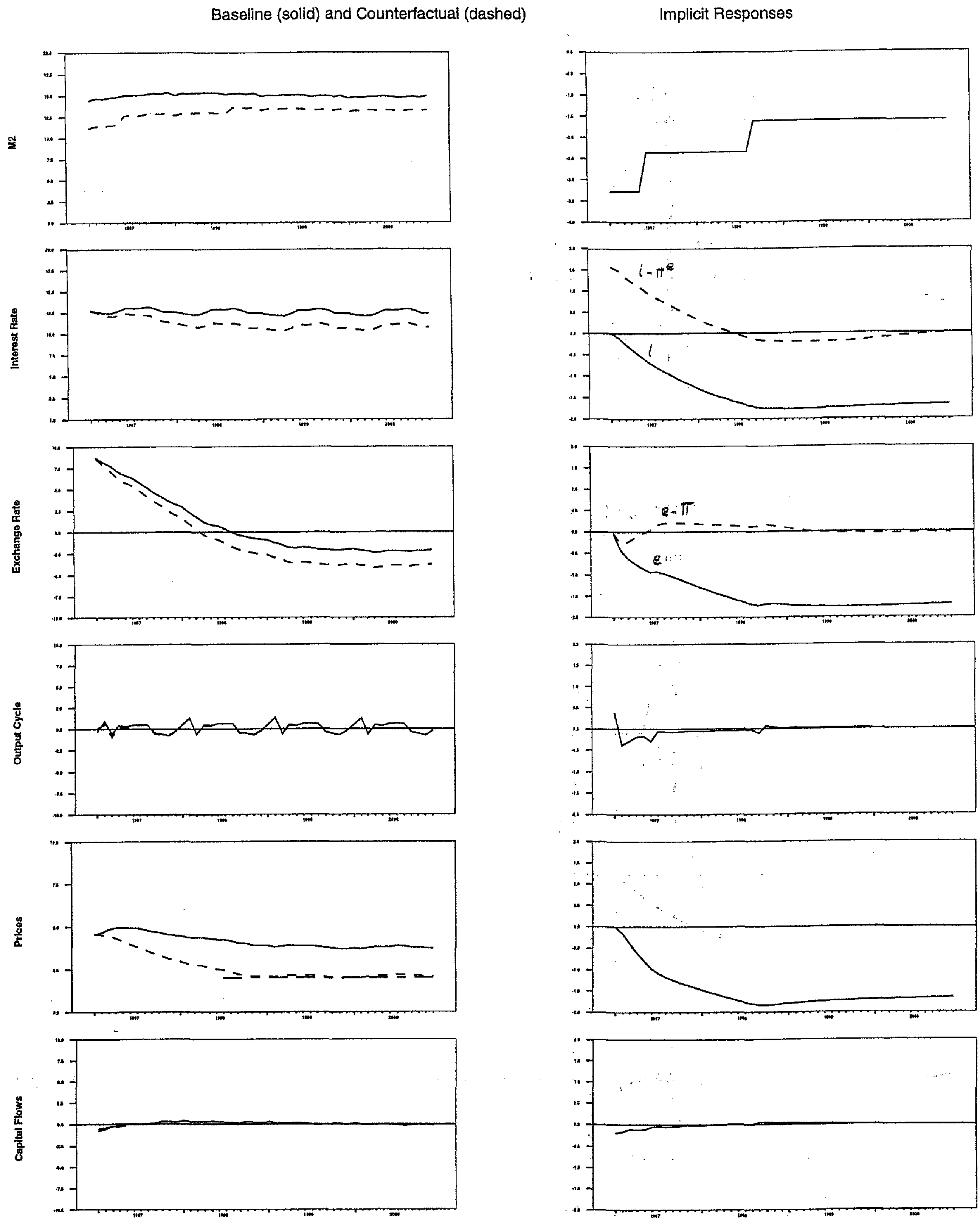
[33] Note that the deviation stems directly from the easing in monetary policy 12 months earlier. Since the inflation response 12 months hence is 55.6 percent (see Table 3), this easing (0.93 percentage points) translates into an increase in the rate of inflation of 0.53 (=0.93×0.566) percentage points, precisely the deviation from the target rate in Table 4.

[34]The impact response of the real expected interest rate mostly reflects the decline in expected inflation because the contemporaneous correlation between broad money and the CB rate is small (see Table A1). Note that the response of the real expected interest rate (the real exchange rate) is obtained by subtracting the response of expected inflation (inflation) from the response of the nominal interest rate (nominal exchange rate).

[35]These simulations stem from conditional forecasts of the VAR model and are fully consistent with the impulse responses depicted in Figure 3 because they account for the contemporaneous movements of variables. The technical difficulty involved with conditional forecasts in VAR models is that M2 is both an endogenous variable in the VAR and an exogenous variable whose path must be made consistent with the IT counter-factual simulation in Table 4. This is done here by solving for the appropriate monetary shocks that make the endogenous path of M2 consistent with its exogenous IT path. See Doan (1992, Chapter 8 pp. 26-27) for details on conditional forecasts in VAR models.

Figure 4. Hypothetical IT Counterfactual, 1997-2000



Note: See text for details of the simulation parameters and the underlying VAR model.

These counter-factual simulations show a fairly benign result of switching to IT compared to the historical monetary policy. In particular, monetary policy is very stable requiring two adjustments in four years. Inflation declines steadily and (virtually) falls within the targeted range in the target horizon, and remains in this range thereafter. On the face of it, these results suggest that an inflation target of two percent with a horizon of 18 months and a band of 0.5 percentage points would be a good choice. In part these results stem from the fact that the implicit disinflation in this exercise is relatively small, namely 2.25 percentage points. More importantly, these results stem from the fact that the hypothetical counter-factual simulation shows responses considering one source of "shocks" in the economy: those stemming from the BOK's decisions regarding M2 growth. Other shocks have been set to zero so that monetary authorities have perfect control of M2. A more "realistic" and complex exercise is to expand the IT scenario so that the economy is subject to a series of shocks so that the monetary authorities have but imperfect control of money. These expanded or "bootstrapped" simulations are discussed below to elaborate on the inflation target horizon and the target band, and the consequences for money and real volatilities.

Bootstrap Simulations

The basic setup for the bootstrap simulations is essentially unchanged: the inflation forecast is the intermediate target of monetary policy and the inflation target is two percent. The 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. In the bootstrap simulations, however, 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. Specifically, equation (3) is used to calculate the inflation forecast as before and even though $E_t[U_t]=0$, the economy is subject to shocks so that realized U_t are not zero and are unknown when the monetary authorities decide their monetary policy.[36] Consequently, broad money growth rate in these simulations is a combination of the monetary "policy" innovation and the unknown money shock:

$$m_t = \begin{cases} m_{t-1} + \alpha_h (E_t[\pi_{t+h}] - \pi^*) + \mu(m)_t, & if \quad |E_t[\pi_{t+h}] - \pi^*| > b \\ m_{t-1} + \mu(m)_t, & otherwise, \end{cases} \tag{5}$$

where $\mu(m)_t = e_m \times U_t$ is the (contemporaneously unknown) money growth innovation. This setup allows the bootstrap simulations to capture the idea that the BOK's control over broad

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[36]Note that only the first seven entries of U_t are allowed to be non-zero as these entries correspond to the seven variables in the VAR model. The remaining entries are zero because they correspond to the identities used to express the VAR(p) model as a VAR(1).

money growth is imperfect. Note, however, the monetary authorities control the expected path of broad money since $E_t[\mu(m)_t]=0$.

Adding shocks to the IT simulation, however, increases the complexity of the authorities responses as summarized in equation (5). In this regard, it is important to discuss briefly how the authorities react when they face "news" so as to clarify the specific way in which the authorities use (all) information that becomes available. Consider, for instance, an unexpected increase (shock) in the rate of nominal exchange rate depreciation in January 1997, $\mu_{ne,1997:M1}$.[37] The unexpected shock $\mu_{ne,1997:M1}$ enters the monetary policy realm in February 1997 only through its effect on the inflation forecast, $E_{1997:M2}[\pi_{1997:M2+h}]$, see equations (3) through (5). Note that the exchange rate shock will trigger a change in the monetary stance when the revised inflation forecast deviates from π^* by more $|b|$ in equation (5), i.e., only when the unexpected shock in the rate of depreciation exceeds a specific threshold value: $b/b^1_{\pi,ne}(h)$. This threshold value depends directly on the size of the inflation target band--a wide band accommodates larger shocks--and inversely on the exchange rate "pass-through" to inflation--larger inflationary effects (at the relevant inflation target horizon) reduces the size of the shock that renders monetary policy off track.[38] Subsequently, adjustments in money growth will continue to depend only on the effect of the shock has on the relevant inflation forecast.

The bootstrap simulations below, use this setup to illustrate how the economy would evolve when money decisions are based on equation (5) when the economy is subject to (historical) shocks. In particular, each month the economy is subject to historical shocks, U_t, that are drawn with equal probability (and with replacement) from the reduced-form shocks in the five years prior to January 1997, i.e., shocks are taken from January 1991 through December 1996 (see Figure A1). Note that these shocks are to all variables in the model, including shocks to *m*. Repeating the hypothetical IT bootstrap simulation a large number of times creates "pseudo-histories" that provide insights regarding the distribution of outcomes associated with IT.

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[37]For simplicity take $E_{1997:M1+s}[\pi_{1997:M1+h+s}]=\pi^*$ for all $s\geq 0$ before the shock is known.

[38]These issues are illustrated in Appendix V that depicts the inflation pass-through of exchange rate (import price) shocks in the VAR model discussed earlier, and the corresponding threshold values for these shocks for target bands of 0.5 and 1.0 percentage points, and inflation target horizons up to 24 months. For instance, the inflation pass-through of an exchange rate (imported price) shock is 0.16 (0.13) percent with an inflation target horizon of 18 months, and the corresponding threshold value of this shock is 6.2 (7.5) percentage points when the target band is one percentage point, i.e., 1.0/0.16 (1.0/0.13). Note, however, that smaller shocks (in absolute value) can prompt a change in the monetary policy to the extent that $E_t[\pi_{t+h}]\neq\pi^*$. This aspect is captured in the simulations below.

As noted above, two series of simulations are used to analyze the effect of: (1) lengthening the inflation horizon from six to 24 months with the inflation target band of 0.5 percentage points; and (2) increasing the inflation target band from 0.25 to 1.0 percentage points with a fixed inflation target horizon of 18 months.

Inflation Target Horizon

Table 5 presents the outcomes at four different inflation target horizons--six, 12, 18 and 24 months--stemming from 1,000 bootstrap simulations. For each variable, the table reports the average outcome and the standard deviation for the variables of interest. A benchmark for the hypothetical IT simulations is provided by the baseline simulations where the path for broad money is determined by the estimated broad money (VAR) equation and not by equation (5).[39]

The path of the economy for different inflation target horizons, portrayed by the average, is consistent with the counter factual simulations and with the monetary control lags discussed above. Consider the simulation results as the inflation target horizon increases. Inflation declines at a slower pace toward its targeted rate as the inflation horizon increases, as expected, and the degree of monetary tightening needed to engineer the corresponding disinflation varies inversely with the inflation target horizon. 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.

The volatility results for the economy at different inflation target horizons, measured by the standard deviation, are interesting but show relatively small differences across target horizons. The variability of inflation tends to increase a bit as the forecast horizon increases. This is 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. Not surprisingly, the percentage of the inflation outcomes that fall "in" the band declines as the target horizon increases as uncertainty regarding the inflation outcome increases. Specifically, when the target horizon is six months about 40 percent of the realizations fall in the target range (1.5 to 2.5 percent) compared to 33, 30, and 27 percent of the realizations respectively at horizons of 12, 18, and 24 months. Note that the volatility of inflation in these hypothetical IT simulations, nonetheless, was

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[39]To conserve space in Table 5, the effects on (expected) real interest rate and real exchange rate are reported instead of their nominal counterparts. The effects on capital flows are small and are omitted.

Table 5. Inflation Target Horizon: Bootstrap Simulations, 1997-2000
(Inflation target of two percent plus minus 0.5 percentage points)

	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	3.68	0.75	4.23	0.82	4.39	0.84	4.49	0.84	4.76	0.91
Jun-97	2.62	0.83	3.52	1.00	3.86	1.05	4.06	1.08	4.69	1.30
Dec-97	1.95	0.86	2.53	1.09	2.93	1.19	3.10	1.25	3.98	1.83
Jun-98	1.90	0.85	2.25	1.11	2.48	1.24	2.64	1.31	3.46	2.28
Dec-98	1.76	0.88	1.84	1.14	2.01	1.27	2.07	1.36	2.74	2.67
Dec-99	1.80	0.88	1.73	1.15	1.75	1.29	1.72	1.39	1.82	3.38
Dec-00	1.77	0.88	1.66	1.15	1.64	1.29	1.56	1.39	1.01	4.05
Broad Money Growth										
Jan-97	4.58	1.82	9.71	1.48	11.11	1.48	12.02	1.50	14.34	1.71
Feb-97	6.13	2.39	10.11	1.90	11.36	1.83	12.18	1.83	14.43	2.09
Mar-97	7.46	2.64	10.40	2.14	11.45	2.05	12.19	2.04	14.26	2.31
Jun-97	10.82	2.94	11.30	2.34	12.21	2.25	12.42	2.23	14.17	2.42
Dec-97	12.71	3.20	12.87	2.68	12.85	2.52	13.09	2.48	14.01	2.69
Jun-98	13.69	3.25	13.04	2.79	13.18	2.70	13.00	2.66	13.57	2.95
Dec-98	13.34	3.41	13.37	2.99	13.05	2.89	13.12	2.86	13.09	3.26
Dec-99	12.77	3.46	12.99	2.97	12.70	2.86	12.77	2.78	12.00	3.65
Dec-00	12.52	3.39	12.74	2.93	12.49	2.82	12.56	2.79	11.05	4.34
Output Cycle										
Jan-97	0.78	1.92	0.18	1.94	0.02	1.93	-0.08	1.93	-0.35	1.94
Feb-97	-0.33	2.04	0.39	2.01	0.57	2.01	0.68	2.01	0.96	2.01
Mar-97	-1.48	2.12	-1.04	2.11	-0.91	2.11	-0.84	2.11	-0.62	2.12
Jun-97	0.17	2.05	0.25	2.03	0.30	2.03	0.33	2.03	0.44	2.03
Dec-97	-0.30	2.16	-0.35	2.14	-0.36	2.14	-0.37	2.14	-0.35	2.14
Jun-98	0.65	2.10	0.60	2.08	0.58	2.07	0.57	2.07	0.56	2.06
Dec-98	-0.30	2.01	-0.33	1.98	-0.35	1.98	-0.36	1.98	-0.40	1.98
Dec-99	-0.41	2.05	-0.40	2.03	-0.40	2.03	-0.40	2.03	-0.45	2.03
Dec-00	-0.33	2.07	-0.31	2.07	-0.31	2.07	-0.31	2.06	-0.36	2.07
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	7.29	1.33	7.93	1.34	8.10	1.35	8.22	1.35	8.51	1.34
Mar-97	6.62	1.73	7.43	1.76	7.67	1.77	7.83	1.78	8.26	1.76
Jun-97	5.64	2.61	6.30	2.63	6.61	2.65	6.77	2.67	7.35	2.61
Dec-97	3.36	3.81	3.84	3.87	4.14	3.92	4.29	3.95	5.02	3.89
Jun-98	1.24	4.43	1.57	4.50	1.81	4.57	1.95	4.63	2.69	4.58
Dec-98	-0.01	4.48	0.19	4.57	0.36	4.65	0.45	4.71	1.10	4.80
Dec-99	-1.09	4.51	-1.09	4.60	-1.05	4.68	-1.05	4.75	-0.88	5.18
Dec-00	-1.26	4.63	-1.33	4.73	-1.36	4.82	-1.41	4.89	-1.90	5.72
Real Interest Rate										
Jan-97	10.84	0.63	10.66	0.81	10.49	0.91	10.43	0.99	9.98	2.32
Feb-97	10.29	0.80	10.28	0.94	10.19	1.03	10.15	1.09	9.82	2.39
Mar-97	9.65	0.90	9.86	1.02	9.86	1.10	9.86	1.16	9.68	2.44
Jun-97	9.28	1.06	9.79	1.16	9.96	1.24	10.04	1.30	10.22	2.55
Dec-97	7.89	1.19	8.54	1.28	8.85	1.36	9.03	1.42	9.81	2.72
Jun-98	7.94	1.17	8.38	1.28	8.69	1.37	8.86	1.44	10.03	2.75
Dec-98	7.60	1.16	7.87	1.26	8.08	1.37	8.24	1.44	9.65	2.79
Dec-99	7.68	1.22	7.75	1.34	7.81	1.44	7.89	1.51	9.56	2.88
Dec-00	7.74	1.21	7.76	1.33	7.78	1.44	7.82	1.52	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 (see Figure A1). The simulations stem from 1,000 bootstrap replications.

lower than in the baseline scenario, reflecting the fact that inflation was targeted by monetary policy.

The counterpart to the higher inflation variability, when the inflation target horizon is lengthened, is reduced volatility of broad money growth. The differences are small and appear 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.[40] At the outset of the simulation period (January 1997) the standard deviation of broad money growth is 1.8 percentage points when the target horizon is six months compared to 1.5 percentage points at longer target horizons. Note that this difference becomes larger as the simulation unfolds. For instance, in December 1997 the standard deviation of broad money growth was estimated at 3.2, and 2.7 percentage points respectively for target horizons of six and 12 months, and at 2.5 percentage points for target horizons of 18 and 24 months. Note that the volatility of broad money is lower, nonetheless, than the baseline in all cases except during the first 24 months of the simulation in the case where the target horizon is six months. It is interesting that with a target horizon of six months the authorities adjusted monetary policy every 2.3 months (20.5 adjustments) during the 48 months of the hypothetical simulation. The average time between monetary policy adjustments is 2.5 months (19.1 and 19.5 adjustments) with a target horizons of 12 and 18 months, and 2.4 months (20.2 adjustments) with a target horizon of 24 months.

The volatility of real variables does not vary consistently as the inflation target horizon increases. Output volatility is slightly higher than the baseline volatility when the target horizon is six months, 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." Note that for longer target horizons output volatility is slightly lower than in the baseline during the first few months of the simulation period. In contrast, the volatility of the real exchange rate increases slightly as the target horizon is lengthened reflecting the higher volatility of the inflation rate; it remains slightly below the baseline volatility throughout the simulation period for target horizons of six and 12 months. The (expected) real interest rate volatility also increases slightly when the target horizon is lengthened, and reflecting inflation volatility that is below baseline, remains significantly below the baseline volatility.

In sum, 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

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[40]In particular, recall that for h=6 the response of inflation is only 35 percent complete compared to 56 (81) percent when h=12 (24), see Table 3. Note that the effect of nominal exchange rate shocks on inflation decline from their peak at about 6 months, to about halve in 18 months (see Appendix V). Also, the effect of food price inflation shocks on headline CPI are more apparent when h<12 (see Figure 2).

the short-run. 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 these 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 6 presents the outcomes from 1,000 bootstrap simulations for three inflation target bands of 0.25, 0.50, and 1.00 percentage points holding the target horizon at 18 months. As before, the table reports for each variable the average outcome and the standard deviation.[41] Note that the columns corresponding to a band of 0.50 percentage points in Table 6 are comparable to those in Table 5 where the horizon is 18 months.

The dynamic path of the economy for different sizes of the inflation target bands is essentially the same. 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 exercises monetary policy is adjusted so that the inflation forecast returns to the mid-point of the band (see equation 5) which seems to impart a consistent "average" behavior to inflation.

Increasing the band width from 0.25 percentage points to 1.0 percentage point does, however, have some effect on volatility, albeit small. The volatility of inflation increases a bit, particularly after the disinflation period, i.e., from June 1998 onward. Despite the increased volatility the percentage of inflation outcomes that lie in the targeted range increases. Specifically, the percentage of inflation outcomes in the targeted range increases from 15 percent when the target band is 0.25 to 30 and 50 percent, respectively, when the target band is 0.5 and 1.0 percentage points.[42]

The volatility of broad money increases very little as the bandwidth increases, particularly during the disinflation period; subsequently volatility remains higher. Note that this occurs even as the number of adjustments to monetary policy declines from an average of 30.0 to 19.5 and 9.4 as the bandwidth is 0.25, 0.5, and 1.0 percentage points respectively.

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[41]The effects on capital flows are small and are not reported in Table 6.

[42]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 (5), accounts for changes in the target horizon and in the target band.

Table 6. Inflation Target Band: Bootstrap Simulations, 1997-2000
(Inflation target of two percent and a horizon of 18 months)

	Band of 0.25 percentage point		Band of 0.5 percentage point		Band of 1.0 percentage point		Baseline	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
Inflation								
Jan-97	4.51	0.43	4.51	0.43	4.51	0.43	4.52	0.44
Feb-97	4.44	0.65	4.44	0.65	4.44	0.65	4.59	0.68
Mar-97	4.39	0.83	4.39	0.84	4.39	0.84	4.76	0.91
Jun-97	3.86	1.04	3.86	1.05	3.83	1.07	4.69	1.30
Dec-97	2.93	1.19	2.93	1.19	2.89	1.23	3.98	1.83
Jun-98	2.49	1.23	2.48	1.24	2.45	1.28	3.46	2.28
Dec-98	2.02	1.26	2.01	1.27	1.99	1.32	2.74	2.67
Dec-99	1.76	1.28	1.75	1.29	1.73	1.34	1.82	3.38
Dec-00	1.64	1.28	1.64	1.29	1.62	1.34	1.01	4.05
Broad Money Growth								
Jan-97	11.11	1.48	11.11	1.48	11.12	1.50	14.34	1.71
Feb-97	11.39	1.83	11.36	1.83	11.30	1.95	14.43	2.09
Mar-97	11.47	2.05	11.45	2.05	11.33	2.10	14.26	2.31
Jun-97	12.24	2.26	12.21	2.25	12.09	2.29	14.17	2.42
Dec-97	12.84	2.52	12.85	2.52	12.80	2.59	14.01	2.69
Jun-98	13.17	2.71	13.18	2.70	13.12	2.77	13.57	2.95
Dec-98	13.06	2.89	13.05	2.89	13.05	2.95	13.09	3.26
Dec-99	12.71	2.84	12.70	2.86	12.69	2.88	12.00	3.65
Dec-00	12.50	2.82	12.49	2.82	12.47	2.88	11.05	4.34
Output Cycle								
Jan-97	0.02	1.93	0.02	1.93	0.02	1.93	-0.35	1.94
Feb-97	0.56	2.01	0.57	2.01	0.58	2.00	0.96	2.01
Mar-97	-0.91	2.11	-0.91	2.11	-0.91	2.12	-0.62	2.12
Jun-97	0.30	2.02	0.30	2.03	0.30	2.02	0.44	2.03
Dec-97	-0.36	2.13	-0.36	2.14	-0.37	2.14	-0.35	2.14
Jun-98	0.58	2.07	0.58	2.07	0.59	2.08	0.56	2.06
Dec-98	-0.35	1.98	-0.35	1.98	-0.35	1.98	-0.40	1.98
Dec-99	-0.40	2.03	-0.40	2.03	-0.40	2.03	-0.45	2.03
Dec-00	-0.31	2.07	-0.31	2.07	-0.30	2.08	-0.36	2.07
Real Exchange Rate								
Jan-97	8.75	0.78	8.75	0.78	8.75	0.78	8.79	0.78
Feb-97	8.10	1.35	8.10	1.35	8.10	1.35	8.51	1.34
Mar-97	7.68	1.77	7.67	1.77	7.67	1.76	8.26	1.76
Jun-97	6.61	2.65	6.61	2.65	6.58	2.64	7.35	2.61
Dec-97	4.14	3.92	4.14	3.92	4.11	3.90	5.02	3.89
Jun-98	1.82	4.57	1.81	4.57	1.79	4.55	2.69	4.58
Dec-98	0.37	4.66	0.36	4.65	0.34	4.63	1.10	4.80
Dec-99	-1.05	4.68	-1.05	4.68	-1.08	4.67	-0.88	5.18
Dec-00	-1.36	4.83	-1.36	4.82	-1.38	4.81	-1.90	5.72
Real Interest Rate								
Jan-97	10.49	0.91	10.49	0.91	10.52	0.95	9.98	2.32
Feb-97	10.19	1.02	10.19	1.03	10.22	1.05	9.82	2.39
Mar-97	9.86	1.10	9.86	1.10	9.89	1.13	9.68	2.44
Jun-97	9.96	1.24	9.96	1.24	9.97	1.26	10.22	2.55
Dec-97	8.85	1.36	8.85	1.36	8.84	1.38	9.81	2.72
Jun-98	8.70	1.37	8.69	1.37	8.68	1.41	10.03	2.75
Dec-98	8.09	1.36	8.08	1.37	8.08	1.40	9.65	2.79
Dec-99	7.82	1.44	7.81	1.44	7.81	1.48	9.56	2.88
Dec-00	7.78	1.43	7.78	1.44	7.77	1.47	9.64	2.96

Note: Based on the VAR model discussed in the text. The innovations are sampled with replacement from the reduced-form innovations from January 1991 through December 1996 (see Figure A1). The simulations stem from 1,000 bootstrap replications.

This reflects the fact that the monetary "rule" used in the simulations adjusts money so that the revised forecast equals the target only when the band is breached, which occurs less often with a wider bandwidth. However, the size of the adjustment to monetary policy needed to bring the inflation forecast back to the target level when the band is breached increases proportionally with the bandwidth. Thus, although the number of times monetary policy is adjusted falls with the band width, the size of the money shocks increases proportionally to the size of the band.[43] The simulations suggest that the latter effect dominates the volatility results.

The volatility of real variables displays an interesting pattern as the bandwidth increases. Output volatility is a bit higher at the beginning of the simulation and these small differences tend to vanish within 12 months. Contrary to the target horizon simulations, the volatility of the real exchange rate and the real interest rate do not vary in the same direction. In particular, the volatility of the real exchange rate appears to decline as the band width increases but the volatility of the real interest rate increases. The latter would seem to reflect the higher volatility of inflation. The differences, however, are fairly small and without a specific objective function are unlikely to tip the balance in favor of a particular bandwidth. Note, however, that the most important difference from these simulation results is the percentage of the inflation outcomes that lie in the targeted band. This is important from the perspective of ex-post evaluation of the BOK's successfulness in attaining the stated inflation target. In this light, a target band of plus/minus one percentage point seems reasonable.

C. Caveats

Two words of caution regarding the IT counter-factual and bootstrap 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, i.e., the relation between money and prices, α_h, is constant and measured accurately. Second, the parameters of the VAR model are presumed to be to be invariant to the IT simulations, i.e., the model is immune to the Lucas critique. To the extent, however, that the IT framework and the corresponding monetary policy decisions discussed above 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 such a change in the regime.

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[43]Note that for a given horizon α_h is a constant in equation (5). Thus, the adjustment of monetary policy when the band is 1.0 is twice (four times) as large as when the band width is 0.5 (0.25) percentage points.

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).[44] At each iteration, the VAR estimates are used to recalculate the impulse responses to a negative M2 shock of one percentage point and the corresponding monetary control lags (analogous to those in Table 3). 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 in Section IV.B.

The resulting monetary control lags of these repeated estimation of the VAR model are reported in Figure 5.[45] The figure traces out how the dynamic response of inflation have changed at four representative lags following the monetary tightening, namely six, 12, 18 and 24 months. Note that, as before, the monetary control lags result from an "exogenous" reduction in broad money and by construction the final response depicted in each panel replicates the corresponding monetary control lag in Table 3.

Monetary control lags exhibit some variability in the 1990's, 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 1990's and appears to 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 the exercise.

These results suggest the simulations performed in Sections IV.B and IV.C 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 captured in Figure 5, the simulations discussed above may underestimate the degree of monetary tightening needed to achieve an inflation target. The "under-estimation" of needed monetary tightening required 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

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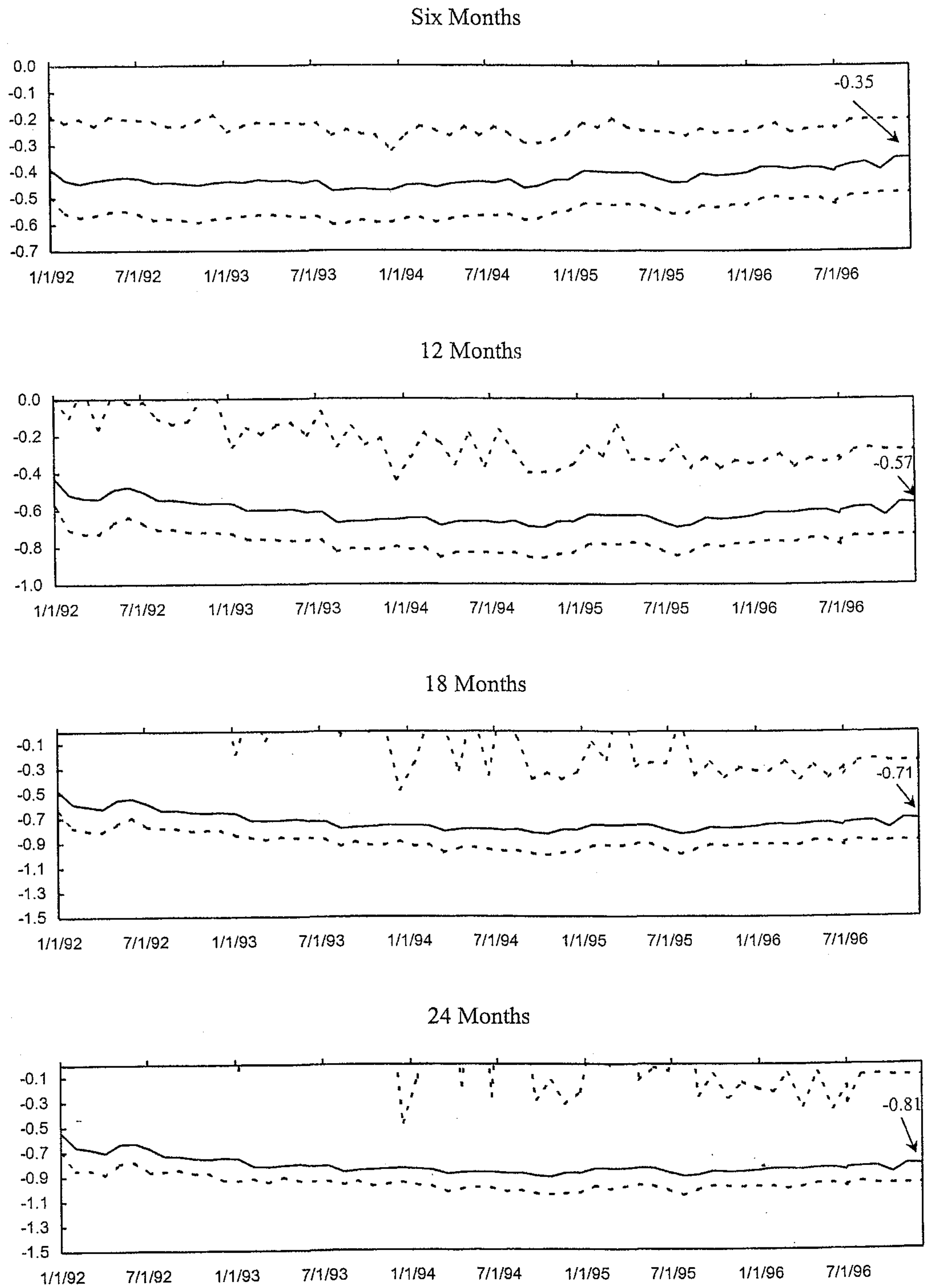
[44]Alternatively, the stability of monetary control lags could be examined by moving forward the start of the estimation period so that the number of observations remains constant in the regressions. This would be analogous to a "rolling-regression" and was not done here because those results would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

[45]One standard-error band is calculated using bootstrap techniques.

Figure 5. 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 response in each panel are for the full sample and by construction equal those in Table 3.

mid-1995 to end-1996--suggesting that the bias in the simulation results discussed above are 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 would 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 could be 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' judgement "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, i.e., the information contained in the data can be used to extrapolate within the historical experience.[46] "Valid" equations in Sims' judgement 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 of capturing agents' expectations, however, it is far from obvious that the IT experiments resemble the historical experience in Korea.

In an effort to understand how far removed the historical experience is from the IT experiments, it may be useful to consider two polar cases. The first case: the BOK adopts IT without announcing the change. In keeping with the simulations in Section IV.B-C, the hypothetical adoption date is January 1997 and the exercise is conducted for 48 months. In this case agents would presume that monetary policy is conducted as before, i.e., agents envisage monetary shocks to follow their historical that distribution that can be characterized by bootstrapping the observed historical shocks. Contrasting these historical shocks that are "expected" by the agents to the hypothetical shocks that underlie the IT simulations provides a way of gauging how far are the historical monetary policy is from the IT policy as summarized by equation (5). In other words: "Concern about extrapolating the model too far is justified when the implied sequence of policy disturbances differs substantially by size or serial correlation properties from what has been observed historically," Leeper, Sims and Zha (1996, p. 11).

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[46]This is one of the most used arguments in the literature to justify the validity of policy or counterfactual simulations despite the theoretical complications of the Lucas critique. For a survey of the empirical evidence on Lucas critique and a discussion of other arguments found in the literature see Ericsson and Irons (1995).

Consider the histograms in Figure 6 that depict the distribution of the IT shocks--with h=18, b=1.0, and $\pi^*=2.0$--versus the "business as usual" monetary shocks in the simulation exercise. Each histogram represents a month in the simulation period and the bars correspond to the frequency of observing a monetary shock. The nine bars in the histogram show the distribution around zero of the shocks and represent the percentage of shocks in each range; the center bar corresponds to a range around zero, the four bars to the left and right of center show respectively the frequency of tightening (negative) and easing (positive) shocks. The black bars correspond to the IT monetary shocks, from equation (5),[47] and the shaded bars correspond to the historical monetary shocks, $\mu(m)_t$. Since the target horizon is 18 months, the first three rows in Figure 6 correspond to the initial disinflation period when the inflation has not yet reached its target.

As expected, the distribution of the IT shocks (black bars) during the disinflation period shows a higher frequency (or density) of negative shocks than the historical distribution (shaded bars). Following the initial disinflation, 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 above equaled the average forecast of inflation--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 the change in order to modify agents inflation expectations and gain credibility for the central bank. In this second 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.

To isolate the change in monetary policy regime aspect of the IT exercise and avoid the effect of the implicit disinflation, Figure 7 depicts the monetary shocks that follow when the inflation forecast breaches the upper target range. Clearly, these IT shocks are not consistent with the historical distributions of shocks that are white noise process. In fact, the IT shocks are highly correlated and are distributed as AR(2) processes--with coefficients equal to 1.07 and -0.12. This would suggests that a fully credible adoption of IT would lie beyond the historical experience of Korea, so that the simulations above would not accurately depict the change in the monetary framework.

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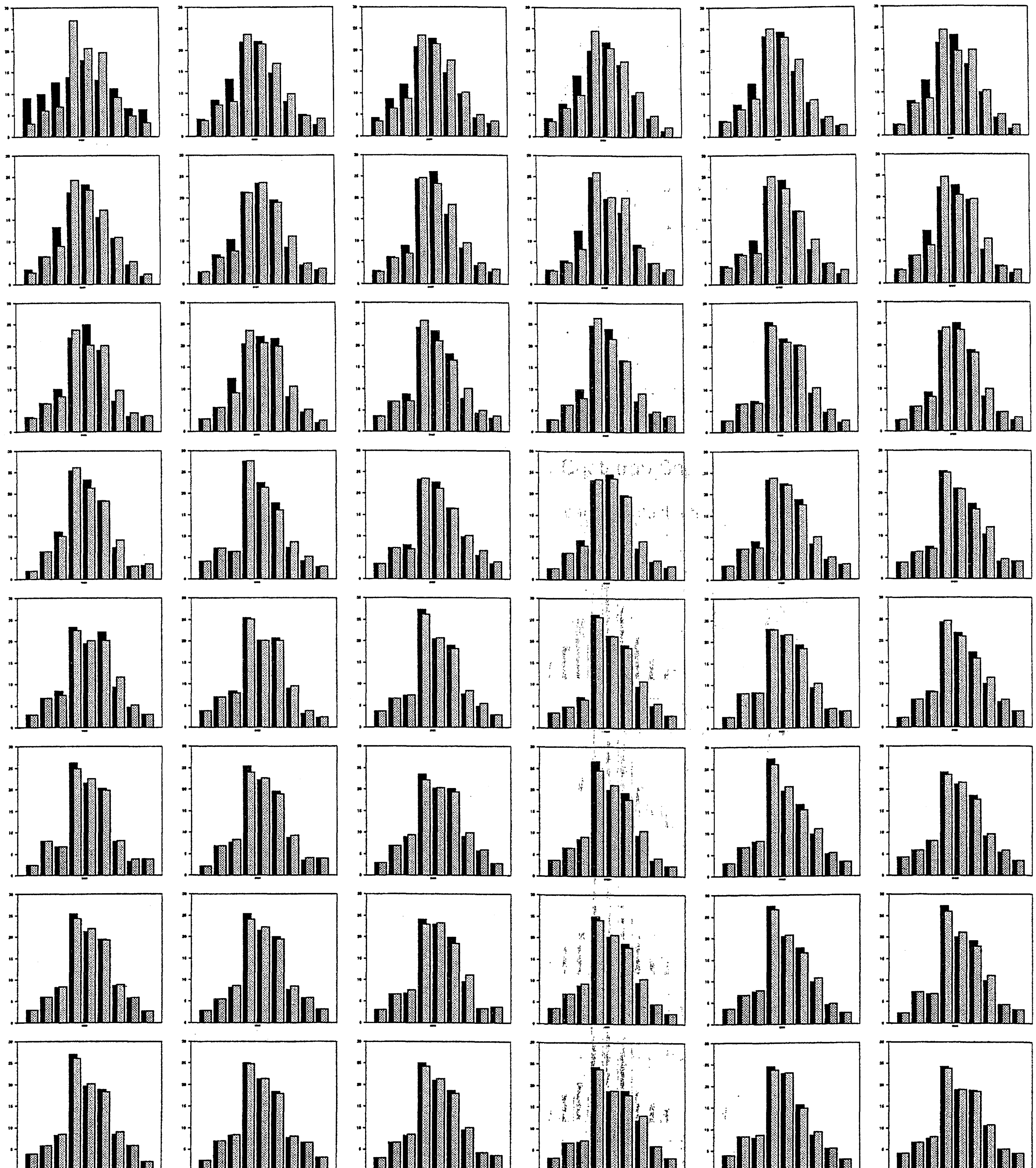
[47]Note that the IT shocks depicted in Figure 6 show the "full" monetary shock vis-a-vis the VAR model comprising the elements explicit in equation (5) and the implicit shock required for $m_t=m_{t-1}$.

Figure 6. IT versus Money Bootstrap Shocks

(Solid bars denote the IT innovations and shaded bars denote the historical innovations)

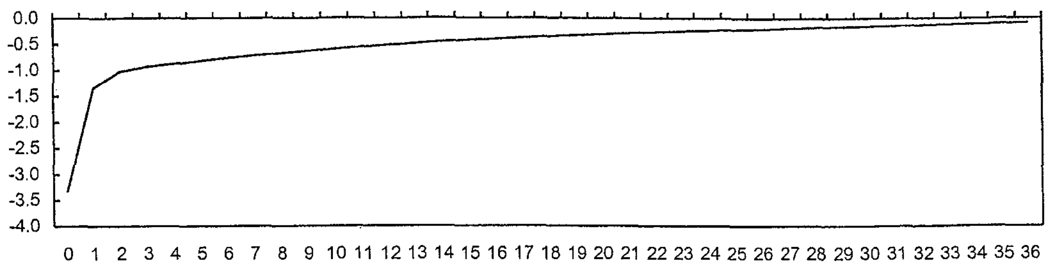


Note: The target band equals plus minus 100 basis points and the target horizon is 18 months.

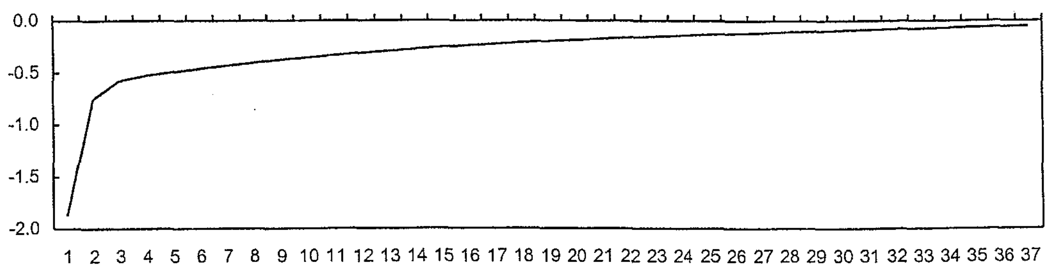
Figure 7. Anticipated Monetary Shocks

(In percentage points)

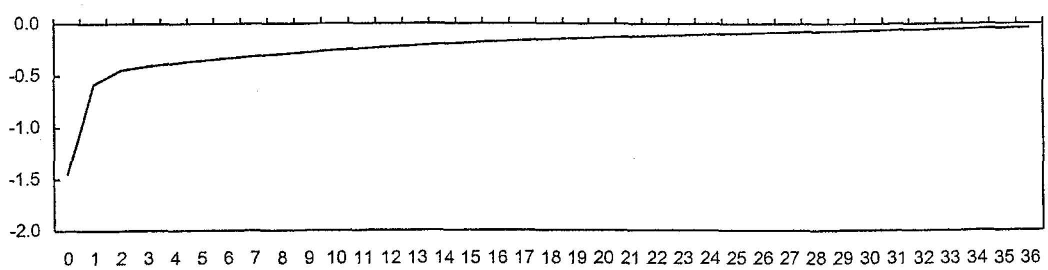
Target Horizon of Six Months



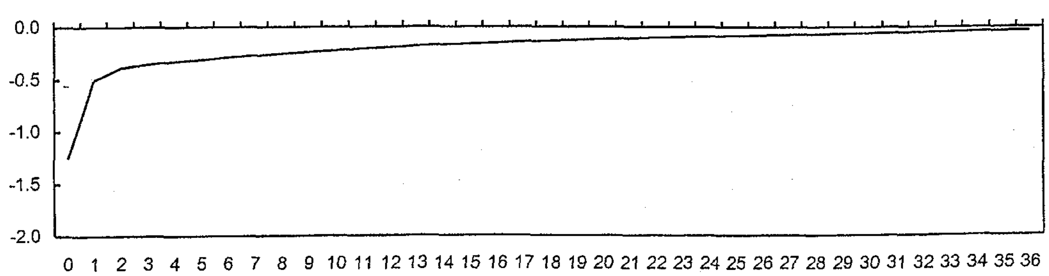
Target Horizon of 12 Months



Target Horizon of 18 Months



Target Horizon of 24 Months



Note: Calculated as the monetary shocks that occur in the hypothetical IT framework when the inflation forecast at a specific horizon breaches the upper band of the target range.

In short, the simulations discussed in Section IV. should be taken to characterize an unannounced (or "non-credible") 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 a smaller increases in the real interest rate than that those predictedabove. In this light, the simulation results would seem to provide an "upper bound" or a worst case scenario of adopting IT.

V. SUMMARY AND CONCLUSIONS

Recently, MSS have discussed the preconditions needed to adopt successfully IT in developing countries. Among these is the capacity to conduct independent monetary policy including the lack of fiscal dominance, and no firm commitment to target the level or path of any other nominal variable such as wages and/or the nominal exchange rate. The revisions to the Bank of Korea Act provide the potential for BOK to pursue independent monetary policy, particularly over the medium-term when the uncertainties surrounding the aftermath of the external crisis subside, and the profound structural reforms take hold. Given that fiscal policy does not and is not expected to dominate monetary policy, the independence of the BOK is the critical element to provide the monetary authorities the required instrument independence to pursue IT. And adopting IT will require that monetary policy to focus primarily on the inflation forecast and that movements in other nominal variables, in particular the nominal exchange rate, enter into the monetary policy realm *only* to the extent that they affect the inflation forecast.

In light of the revised Bank of Korea Act, this paper undertakes a forward looking examination of series of practical issues elicited by the move toward IT implicit. More concretely, the paper provides an empirical exploration into IT in Korea. The first part of this exploration can be summarized as follows:

- **Inflation predictability**. Forecasting inflation is not likely to present an unsurmountable obstacle to implement IT in Korea. This study finds that inflation in Korea is just as predictable as it was in the IT countries prior to their adoption of IT. An accurate inflation forecast is an essential ingredient for policy makers to conduct monetary policy in an IT framework.

- **Price Index**. Targeting headline CPI is appropriate in Korea, as long as the inflation target horizon exceeds a year. Food price shocks, that 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 advantage of being well suited to coordinate economy-wide inflationary expectations because it is used in wage contract negotiations in Korea

Building on these results, the second part of this exploration specifies an econometric (VAR) model to perform a series of simulations exercises designed to mimic an IT framework. An important feature of the IT framework 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 hypothetical IT simulations conducted here provide insights into what this framework could imply for Korea; specifically the results can be summarized as follows:

- **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. Longer horizons are less appealing because the volatility are all real variables increases and shorter horizons are vulnerable to supply-side shocks. The differences in volatility for different horizons are small however.

- **Target band**. A target band of one percentage point seems appropriate from the perspective of ex-post evaluation of the BOK's success in attaining the stated inflation target. The effect of the width of the band on real volatility is small and thus does not matter 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 un-announced (or non-credible) adoption of IT. To the extent that the adoption of IT is credible these simulations are subject to Lucas Critique.

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 policy making of the Bundesbank, that is also found to be very similar to IT (see Bernanke and Mihov, 1997, and Clarida, Gali and Gertler, 1997). 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 provided. This study has not assessed how IT compares to alternative monetary policy frameworks nor has it considered the issue of the timing of the implementation. The empirical exploration suggests that the main differences in adopting IT are associated with the path of disinflation. Thus, it appears important to study alternative IT "rules" to better understand whether the output losses associated with the disinflation in other monetary regimes. On balance, the empirical evidence should be taken to point to the feasibility of IT in Korea, but care should be exerted to avoid misconstruing this paper and its empirical evidence as suggesting that it is optimal to do so or as implying any specific timing for the implementation. Further research on the relative costs of disinflation in alternative monetary policy frameworks could be conducting along the lines of McCallum and Nelson (1998). Note, however, that given greater degree of disagreement regarding the relevant developing country paradigm compared to industrial countries, this research agenda could be quite long.

Advanced Economies with Explicit IT Frameworks, Selected Features

Country	Date of Adoption	Prevailing Inflation Rate at adoption	Target Rate and Horizon	Price Index	Weight of Items excluded from headline (percent)	Institutional Arrangement of the Inflation Target
New Zealand	March 1990	5.8	0-2 percent /1 through the 5-year tenure of the Governor of the Reserve Bank	Consumer Price Index excluding credit services. /5	6.5	Target set in Policy Target Agreements (PTA) between the Minister of Finance and Governor of the Reserve Bank of New Zealand
Canada	February 1991	4.8	1-3 percent through 1998	CPI excluding food, energy, and the effect of indirect tax changes	25 /4	Target set by the Minister of Finance and the Governor of the Bank of Canada
United Kingdom	October 1992	3.8	2 1/2 percent, plus or minus 1 percent	Retail price index excluding mortgage interest payments (RPIX)	5.0	Target set by the Chancellor of the Exchequer /2
Sweden	January 1993	2.3	2 percent (with a tolerance band of plus/minus 1 percent)	CPI	0.0	Target set by the Bank of Sweden
Finland	February 1993	2.6	About 2 percent in 1996 and beyond (with no explicit band)	CPI, excluding indirect taxes, government subsidies, house prices, and mortgage interest payments	33.0	Target set by the Bank of Finland
Australia	1993	1.0	Underlying inflation of 2-3 percent , on average, over the cycle	CPI, excluding the impact of interest rates on mortgage and other interest rate payments, indirect tax changes, and certain other volatile price items	48.9	Target set by the Reserve Bank of Australia and endorsed by the government in the Statement on the Conduct of Monetary Policy by the Treasurer and the Governor of the Reserve Bank
Spain	November 1994	4.7	Less than 3 percent by 1997, 2 percent by 1998 /3	CPI	0.0	Target set by the Bank of Spain

1/ Subsequently increased to 1-3 percent in December 1996.
2/ In May 1997, the Chancellor of the Exchequer announced that the Bank of England would be given operational independence to set interest rates in order to achieve the inflation target (which would still be set by the U.K. Treasury). Inflation outside the target range would require the Governor to write an open letter to the Chacellor to explain the reasons for the deviation.
3/ Announced in December 1996.
4/ Corresponds to food (home and restaurants) and energy weight. The effect of indirect taxes is calculated on a case by case basis.
5/ Prior to December 1997, the targeted price index excluded the interest cost components, indirect taxes and subsidies, government charges, and significant price effects from changes in the terms of trade.

Data

Variable	Definition	Source
CPI	line 64	IFS
Price indexes for Basic Groups	categories published in the Statistical Bulletin	Statistical Bulletin, BOK
Nominal exchange rate (Won per U.S. $)	line ae	IFS
Industrial output (seasonally adjusted)	line 66..cz	IFS
Industrial output cycle	actual minus trend, from a Beveridge-Nelson decomposition based on an ARIMA(2,1,2)	Author's calculations
M2	line 34 plus line 35	IFS
Reserve money	line 14	IFS
Corporate bond rate	line 60bc	IFS
Import prices	line 76x divided by line ae	IFS
Capital inflows	current balance times minus one divided by nominal exchange rate (line ae) as a percent of M2 (line 34 plus line 35) or reserve money (line 14)	Statistical Bulletin, BOK and IFS

VAR Model Details

The pragmatic VAR model discussed in Section IV can be written explicitly as:

$$\begin{aligned} y_t &= C(L)y_{t-1} + \mu_t \\ &= C1 \times y_{t-1} + C2 \times y_{t-2} + C3 \times y_{t-3} + \mu_t \end{aligned}$$

where y_t= [pm_t, m_t, CB_t, ne_t, $cycle_t$, p_t, $flows_t$]', the lag polynomial matrix $C(L)=C1\times L + C2\times L^2 + C3\times L^3$, and μ_t is the VAR innovation that is assumed to have zero mean and $E[\mu_t \mu_t']=\Omega$. The variables in the model--import prices, broad money, corporate bond rate, nominal exchange rate (Won/$), output cycle, CPI, and capital flows--are expressed as twelve month percent changes except the CB rate, the output cycle, and capital flows, that are expressed respectively as an annual percent, the log of the ratio of actual output to trend output, and as a percentage of broad money.

The "annual growth" specification of the series accommodates the need for a non-zero inflation rate in the steady-state baseline that underlies the impulse responses and the simulations. Note that a (stable) model specified in levels has a steady-state where prices are constant making this specification uninteresting to examine IT as inflation returns to zero in the long-run. Note also that the model contains a full set of monthly seasonal dummies to capture any deterministic seasonal patterns in the data.

The VAR model is estimated with three lags using 132 monthly observations from January 1986 to December 1996 (see Table A1 and Figure A1). 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. Note that 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.

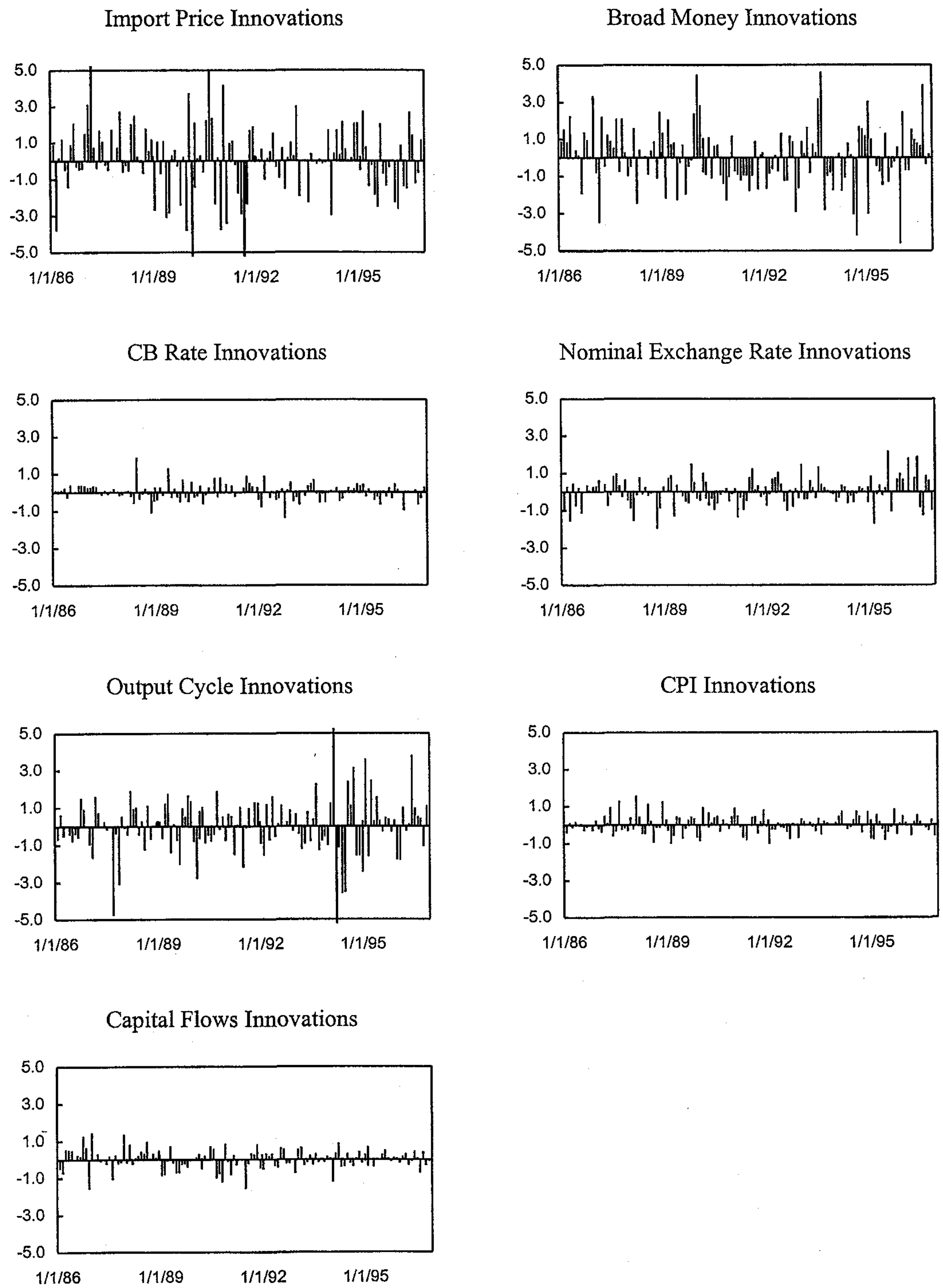
Conditional on three lags, the study proceeds to test whether Korea can be modeled using a near VAR that reflects a small open economy (SOE): Korea does not affect the world price of its imports. In this VAR model, thus the import price equation is block exogenous. This test is performed with a multivariate generalization of the Granger causality test proposed by Doan (1992). It is a multivariate likelihood ratio test that compares the likelihood under the null hypothesis of the near-VAR specification to the likelihood under the alternative hypothesis of a "full-VAR" specification.

Table A1. VAR Estimates, Monthly Observations from January 1986 to December 1996.

	Import Prices	Broad Money	CB Rate	Exchange Rate	Industrial Output Cycle	CPI	Capital Flows	System
Coefficient of								
Determination (R^2)	0.96	0.51	0.96	0.99	0.33	0.95	0.70	...
Adjusted R^2	0.95	0.35	0.95	0.98	0.12	0.94	0.61	...
Sum of Squared Errors	4.89	3.21	0.24	0.68	3.02	0.27	0.34	...
Standard Error of Estimate	2.04	1.79	0.49	0.83	1.74	0.52	0.58	...
Significance of Lagged Regressors:								
Import Prices	898.25 *	1.17	0.66	4.07 **	0.20	1.18	2.27	...
Broad Money	...	14.64 **	1.13	1.97	1.95	2.93 *	0.87	...
CB Rate	...	0.97	223.79 *	1.76	0.66	0.42	1.21	...
Exchange Rate	...	1.18	0.68	432.95 **	1.38	1.19	2.71 *	...
Industrial Output Cycle	...	0.46	1.34	0.67	4.14 **	2.02	1.31	...
CPI	...	0.40	2.60	0.08	0.97	185.06 **	1.68	...
Capital Flows	...	0.29	0.44	4.81 **	0.73	2.04	19.71 *	...
Correlation with VAR innovations of:								
Import Prices	3.77	-0.03	0.05	-0.37	0.10	0.12	-0.03	...
Broad Money	...	2.67	**0.00**	0.04	**-0.12**	0.01	0.18	...
CB Rate	...	...	0.19	0.12	0.09	0.14	0.00	...
Exchange Rate	...	...	...	0.55	0.04	-0.11	-0.07	...
Industrial Output	...	...	...	...	2.45	-0.01	0.02	...
CPI	...	...	...	...	...	0.25	-0.02	...
Capital Flows	...	...	...	...	...	...	0.28	...
Small Open Economy Test	...	...	...	...	...	...	...	22.37
Homogeneity Tests:								
Individual Equation		4.47 *	0.02	3.63	0.11	0.43	1.28	...
System	...	...	...	...	...	...	...	8.62

Note: The VAR model is estimated with three lags; each equation contains a full set of seasonal dummy variables. The significance of regressors tests are F-tests for the joint significance of all of the lags of the corresponding variable; these tests have respectively three and 99 degrees of freedom in the numerator and the denominator. The small open economy tests for the block exogeneity of the import price equation using a multivariate generalization of the Granger causality test proposed by Doan (1992); the test statistic is distributed Chi^2 with 18 degrees of freedom corresponding to the 18 coefficients that are constrained under the null to zero. Individual (equation) homogeneity tests are F-tests for the null hypothesis that the sum of the coefficients of the nominal variables equals one in the equations for nominal variables and zero in the equations for output and capital flows. The joint homogeneity tests the six individual equation tests jointly and is a multivariate likelihood ratio test distributed Chi2 with six degrees of freedom. An asterisk (*) denotes significant at the five percent level and a double asterisk (**) denotes significant at the one percent level.

Figure A1. VAR Innovations



Sources: Based on the VAR model in Table A1. See Appendix II for the definition of the variables.

In the full VAR specification, the import price equation is:

$$
\begin{aligned}
pm_t = \; & c1_{11}\, pm_{t-1} + c2_{11}\, pm_{t-2} + c3_{11}\, pm_{t-3} + c1_{12}\, m_{t-1} + c2_{12}\, m_{t-2} + c3_{12}\, m_{t-3} \\
& c1_{13}\, CB_{t-1} + c2_{13}\, CB_{t-2} + c3_{13}\, CB_{t-3} + c1_{14}\, ne_{t-1} + c2_{14}\, ne_{t-2} + c3_{14}\, ne_{t-3} \\
& c1_{15}\, cycle_{t-1} + c2_{15}\, cycle_{t-2} + c3_{15}\, cycle_{t-3} + c1_{16}\, p_{t-1} + c2_{16}\, p_{t-2} + c3_{16}\, p_{t-3} \\
& c1_{17}\, flow_{t-1} + c2_{17}\, flow_{t-2} + c3_{17}\, flow_{t-3} + u_{1t},
\end{aligned}
$$

where cx_{ij} is the typical element in Cx for x =1, 2, and 3; seasonal dummies are omitted for notational convenience here and below. But in the near VAR specification, this equation is constrained so that elements $cx_{ij} = 0$ for all i, j where i+j exceeds two. The corresponding test statistic is distributed χ^2 with degrees of freedom equal to the number of coefficients constrained to be zero. Performing this test, conditional on three lags, does not reject the SOE assumption at the five percent significance level; the value of the statistic is 22.37 (see Table A1) and it has 18 degrees of freedom (six variables each with three lags).

Thus, the VAR model is specified as a near VAR, where the import price equation is block exogenous and the other equations in the model are standard. For instance, the broad money equation is:

$$
\begin{aligned}
m_t = \; & c1_{21}\, pm_{t-1} + c2_{21}\, pm_{t-2} + c3_{21}\, pm_{t-3} + c1_{22}\, m_{t-1} + c2_{22}\, m_{t-2} + c3_{22}\, m_{t-3} \\
& c1_{23}\, CB_{t-1} + c2_{23}\, CB_{t-2} + c3_{23}\, CB_{t-3} + c1_{24}\, ne_{t-1} + c2_{24}\, ne_{t-2} + c3_{24}\, ne_{t-3} \\
& c1_{25}\, cycle_{t-1} + c2_{25}\, cycle_{t-2} + c3_{25}\, cycle_{t-3} + c1_{26}\, p_{t-1} + c2_{26}\, p_{t-2} + d3_{26}\, p_{t-3} \\
& c1_{27}\, flow_{t-1} + c2_{27}\, flow_{t-2} + c3_{27}\, flow_{t-3} + u_{2t}.
\end{aligned}
$$

The near VAR model is tested further to establish whether the restriction of homogeneity of degree one (zero) of the nominal variables in the nominal (real) equations is not rejected by the data. These assumptions imply that in the long-run the growth rates of nominal variables converge to the same value and that they have not long-run effect on real variables. Specifically, if the growth rate of the monetary aggregate is systematically reduced, say by one percentage point, the long-run value of nominal variables declines by the same amount (one percentage point), and output and capital flows are unaffected.

In the VAR model this translates into the restriction that the sum of the coefficients of all lagged nominal variables equals one in the nominal variable equations (second, third, fourth and sixth equations) and equals zero in the output (fifth) and capital flows (seventh) equations. Specifically, under the null hypothesis the restriction is that:

$$c1_{i2}+c2_{i2}+c3_{i2}+c1_{i3}+c2_{i3}+c3_{i3}+c1_{i4}+c2_{i4}+c3_{i4}+c1_{i6}+c2_{i6}+c3_{i6} = r,$$

where r=1 for i=2, 3, 4, 6 (nominal equations) and r=0 for i=5, 7 (real equations). These six restrictions are tested with a multivariate likelihood ratio test proposed by Sims (1980). Once again the likelihood under the null hypothesis of the homogenous (near) VAR model is compared to the likelihood of unrestricted (near) VAR model. The resulting test statistic is distributed χ^2 with degrees of freedom equal to the number of restrictions. The value of the test statistic--conditional three lags and the SOE assumption--is 8.62 (see Table A1) and it has six degrees of freedom and does not reject the homogeneity assumption at the standard significance levels. Note that individual equation homogeneity tests are also shown in Table A1.

Note that in this restricted model a sustained reduction in the growth rate of a nominal variable can, however, lead to non-neutrality as the levels of real money balances and the real exchange rate are allowed to vary across growth rates. Super-neutrality, however, was not imposed on the VAR model for Korea because it lead to unstable dynamic behavior. In large part, the instability is associated with the fact that the growth rate of velocity is consistently negative during the sample period. This translated into upward trending real money balances that are not consistent with super-neutrality. The declining velocity of money suggests that a deterministic trend could capture this "financial deepening." However, the (in)stability of the VAR is unchanged when a trend and/or a trend squared term is included in the model. Note that using a single lag "stabilizes" the model, at the expense of serially correlated VAR innovations.

Monetary Policy and Macroeconometric Model in Korea

There are three large macroeconometric models in Korea: the BOK model, the Korea Development Institute (KDI) model, and the Korea Institute of Finance (KIF) model. The first two models examine the effects of monetary policy focusing on shocks to M2 and the KIF does so through model shocks to domestic credit. The BOK model also examines monetary policy by shocking a broader definition of money, MCT.

The price and output effects of monetary policy obtained in these models are summarized in Table A2. For consistency with the VAR model used in this study, the inflation responses are scaled as a percentage of the long-run response of inflation. For instance, the KDI model suggests that after twelve months inflation has adjusted about 35 percent of its long-run response, this is more than the BOK model but less than the VAR model. The output responses are consistently small across models. For instance, the output growth response six months after the tightening is -0.07, -0.15, and -0.06 percentage points respectively for the KDI, KIF and the pragmatic VAR. Note that the main difference in the output response of the VAR is that it is somewhat shorter lived than in the large macroeconometric models.

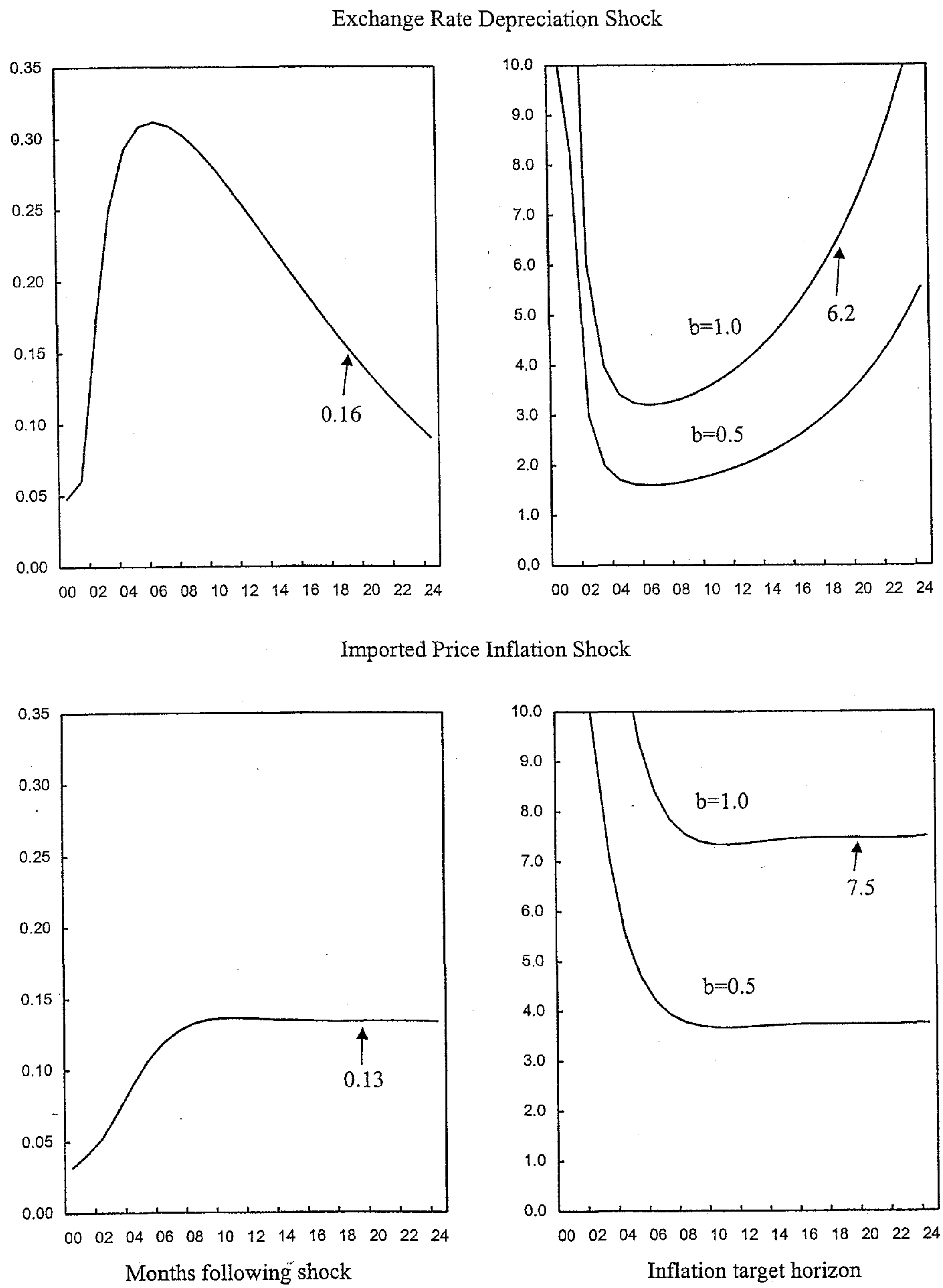
Table A2. Macroeconomic Effects of Monetary Policy in Korea
(In percent)

	Months following the monetary shock				
	3	6	9	12	24
Inflation Response:					
Bank of Korea Model	...	...	...	-10.49	-46.91
Korea Development Institute Model	-6.17	-12.35	-23.46	-35.80	-65.43
Korea Institute of Finance	-77.72	-90.37	-92.00	-91.97	-94.98
VAR Model	-18.50	-35.00	-47.00	-56.60	-81.40
Output Response:					
Bank of Korea Model	...	...	...	-0.08	-0.11
Korea Development Institute Model	-0.05	-0.07	-0.09	-0.11	-0.15
Korea Institute of Finance	-0.15	-0.15	-0.14	-0.13	-0.26
VAR Model	-0.10	-0.06	-0.04	-0.02	--

Note: Inflation and output responses are for a decline in the growth rate of M2. The inflation response is calculated as the ratio to the adjustment in 60 months. The output response is for GDP growth versus baseline growth, except for the VAR model that is for cyclical industrial activity. The simulations for the BOK model are from Kim, Chang, and Lee (1998); the KDI and KIF model simulations were provided to the author respectively by Messrs. Dong Chul Cho and Gongpil Choi.

Inflation Pass-Through and IT Threshold

Inflation Response to: Threshold to:



Note: The inflation responses are normalized to show the response to a one percentage point shock. The thresholds values are calculated by dividing the inflation target band (b) by the normalized inflation response, assuming that the inflation forecast equals the target inflation. All calculations are based on the VAR model described in the Appendix III.

REFERENCES

Agénor, Pierre-Richard, and Alexander W. Hoffmaister, "Money, Wages and Inflation in Middle-Income Developing Countries," IMF Working Paper, WP/97/174 (December, 1997).

Bank of Korea, "Monetary Policy and Its Instruments," Research Department of the Bank of Korea (April, 1993).

Bank of Korea, "The Monetary Policy Framework in Korea," mimeo, Bank of Korea (February, 1998a).

Bank of Korea, "Korea's Experience of the Monetary Transmission Mechanism," in The Transmission of Monetary Policy in Emerging Market Economies, Bank of International Settlements, Basle Switzerland (1998b), 140-54.

Barro, Robert J., and Jong-Wha Lee, "Real Interest Rates in Korea," Korean Institute of Finance, May 1994.

Bernanke, Ben S., and Mark Gertler, "Inside the Black Box: The Credit Channel of Monetary Policy Transmission," *Journal of Economic Perspectives*, Vol. 9 (Fall, 1995), 27-48.

_____, Mark Gertler, and Mark Watson, "Systematic Monetary Policy and the Effects of Oil Price Shocks," *Brookings Papers on Economic Activity: 1* (1997), 91-142.

_____, and Frederic S. Mishkin, "Inflation Targeting: A New Framework for Monetary Policy?," *Journal of Economic Perspectives*, Vol. 11 (Spring, 1997), 97-116.

_____, and Ilian Mihov, "What does the Bundesbank Target?," *European Economic Review*, Vol. 41 (June, 1997), 1025-53.

Bowen, Alex, "Inflation Targetry in the United Kingdom," in *Targeting Inflation*, edited by Andrew G. Haldane, Bank of England, 1995, 59-74.

Clarida, Richard, and Jordi Gali, and Mark Gertler, "Monetary Policy Rules in Practice: Some International Evidence, European Economic Review,"Vol. 42 (June, 1998), 1033-67.

Cho, Dong Chu, and Youngsan Koh, "Liberalization of Capital Flows in Korea: Big-Bang or Gradualism?," NBER Working Paper No. 5824 (November, 1996).

Corbo, Vittorio, and Sang-Woo Nam, "Recent Evolution of the Macroeconomy," in Structural Adjustment in *A Newly Industrialized Country: The Korean Experience*, edited by Vittorio Corbo and Sang-Mok Suh, John Hopkins University Press (Baltimore, Md, 1992).

Debelle, Guy, "Inflation Targeting in Practice," IMF Working Paper, WP/97/35 (March, 1997).

Diebold, Francis X., *Elements of Forecasting*, South-Western College Publishing, Cincinnati, Oh., 1997.

______, and Lutz Kilian, "Measuring Predictability: Theory and Macroeconomic Applications," mimeo, University of Pennsylvania (July, 1997).

Doan, Thomas A., "RATS, User's Manual Version 4," Chapter 8 (Estima, Evanston, Il., 1992)

Dueker Michael, and Gyuhan Kim, "A Monetary Policy Feedback Rule in a Fast-Growing Economy: Empirical Results for Korea," mimeo, Federal Reserve Bank of St. Louis, July 1997.

Ericsson, Neil R., and John S. Irons, "The Lucas Critique in Practice: Theory without Measurement," Board of Governors of the Federal Reserve System, International Finance Discussion Papers, #506, March 1995, forthcoming in *Macroeconometrics: Developments, Tensions, and Prospects*, ed. Kevin D. Hoover, Kluwer Academic Publishers.

Feldstein, Martin, and James H. Stock, "The Use of Monetary Aggregate to Target Nominal GDP," in *Monetary Policy* edited by N. Gregory Mankiw, The University of Chicago Press, (Chicago, 1994), 7-69.

Granger and Newbold, *Forecasting Economic Time Series*, Academic Press, London U.K., Second Edition, 1986.

Haldane, Andrew, and Christopher, Salmon, "Three Issues on Inflation Targets," in *Inflation Targeting* edited by Andrew Haldane, Bank of England, 1995, 170-201.

Hansen, Bruce E., "Testing for Parameter Instability in Linear Models," *Journal of Policy Modeling*, Vol. 14, (August, 1992), 517-33.

Hoffmaister, Alexander W., and Jorge E. Roldós, "The Sources of Macroeconomic Fluctuations in Developing Countries: Brazil and Korea," IMF Working Paper, WP/96/20 (February, 1996) revised September 1996.

_____, and Carlos A. Végh, "Disinflation and the Recession-Now-Versus-Latter Hypothesis: Evidence from Uruguay," *IMF Staff Papers*, Vol. 43 (June, 1996), 355-94.

Holbrook, Robert S., "Optimal Economic Policy and the Problem of Instrument Instability," *American Economic Review*, Vol. 62 (March, 1972), 57-65.

Jadresic, Esteban, "Inflation Targeting as a Rule," IMF Mimeo (August, 1998).

Kim, Chiho, "Monetary Policy in a Changing Financial Environment--Searching for an Efficient Monetary Policy Framework in Korea," Center for Pacific Basin Monetary and Economic Studies, Federal Reserve Bank of San Francisco, Working Paper #PB97-05 (June, 1997).

Kim, Yang Woo, Dongkoo Chang, and Geung-Hee Lee, "A Macroeconometric Model of the Korean Economy," *Economic Papers*, Vol. 1 (January, 1998), 1-72.

Koop, Gary, M., Hashem Pesaran, and Simon N. Potter, "Impulse Response Analysis in Nonlinear Multivariate Models," *Journal of Econometrics*, Vol. 74 (September, 1996), 119-47.

Lebrow, David E., John M. Roberts, and David J. Stockton, "Economic Performance Under Price Stability," Board of Governors of the Federal Reserve System, Working Paper #125 (April, 1992).

Lee, Seugho, "Capital Mobility in Korea: Empirical Evidence from the Correlation between Interest Rate and Exchange Rate," *Economic Papers*, Vol. 1 (January, 1998), 129-47.

Leeper, Eric M., Christopher A. Sims, and Tao Zha, "What Does Monetary Policy Do?," *Brookings Papers on Economic Activity: 2* (1996), 1-63.

McCallum, Bennet T., and Edward Nelson, "Nominal Income Targeting in an Open-Economy Optimizing Model," mimeo, Carnegie Mellon University (June, 1998).

Masson, Paul R., Miguel A. Savastano, and Sunil Sharma, "The Scope for Inflation Targeting in Developing Countries," IMF Working Paper, WP/97/130 (September, 1997).

Mishkin, Frederic S., and Adam S. Posen, "Inflation Targeting: Lessons from Four Countries," *Economic Policy Review*, Vol. 3 (August, 1997), 9-110.

Sims, Christopher A., "Macroeconomics and Reality," *Econometrica*, Vol. 48, (January, 1980), 1-49.

_____, "Policy Analysis with Econometric Models," *Brooking Papers on Economic Activity: 1* (1982), 107-64.

_____, "Are Forecasting Models Usable for Policy Analysis?," *Federal Reserve Bank of Minneapolis Quarterly Review*, Vol. 10, (Winter, 1986), 2-16.

_____, and Tao Zha, "Does Monetary Policy Generate Recessions?," mimeo, Yale University (December, 1995).

Stevens, Glenn, and Guy Debelle, "Monetary Policy Goals for Inflation in Australia," in *Inflation Targeting* edited by Andrew Haldane, Bank of England, 1995, 81-100.

Svensson, Lars, "Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets," *European Economic Review*, Vol. 41 (June, 1997), 1111-46.

Végh, Carlos, "Monetary Policy, Interest Rate Rules, and Inflation Targeting: Some Basic Equivalences," mimeo, University of California, Los Angeles (January, 1998).

von Hagen, Jürgen, "Inflation and Monetary Targeting in Germany," in *Inflation Targets*, eds. Leonardo Leiderman and Lars Svensson, (Centre for Economic Policy Research, London, 1995).