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Structural Changes and the Scope of Inflation Targeting in Korea[1]

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Abstract

A small, open macroeconomic model that accounts for new financial accelerator effects (the effects of fluctuations in asset prices on bank credit and economic activity) is developed to evaluate various policy rules for inflation targeting. Given conditions in asset markets and the fragility of the financial sector, monetary policy responses can potentially amplify the financial accelerator effect. Simulations are used to compare various forms of inflation targeting using a model that emphasizes long-term inflation expectations, output changes, and the asset price channels. The simulations suggest that a successful outcome can be obtained by adhering to simple forward-looking simple rules, rather than backward-looking policy rules. Furthermore, inflation targeting can contribute to price as well as output stability by helping to keep the financial accelerator from being activated. Inflation targeting in emerging economies can provide an environment conducive to long-term capital market development.

JEL Classification Numbers: E51, F3, F41

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[1] Chief economist at the Korea Institute of Finance (KIF) and Visiting Scholar, Federal Reserve Bank of San Francisco. This paper is an abridged version of a report on financial model building for inflation targeting prepared for the Ministry of Finance and Economy. Any opinions expressed are those of the author and not those of the Korean Ministry of Finance and Economy, or the KIF or the Federal Reserve Bank of San Francisco. Helpful comments by Glenn Rudebusch, Ramon Moreno, and Richard Dennis at the Federal Reserve Bank of San Francisco were instrumental in writing this paper. Special thanks go to Dr. Moreno for his kind and useful suggestions to improve my writing, and Mr. Jinwoo Jeon for preparing the data for empirical investigation. Finally, I thank Ms. Mihyun Lee who helped me with preparing tables and figures. All errors remain my responsibility.

I. Introduction

The changes caused by Korea's recent financial crisis are both dramatic and profound. Yet, there are few empirical models that allow us to understand the dynamics surrounding the crisis. The V-shaped recovery and subsequent busts in the capital markets do not have many precedents even in economies previously struck by crises. Also, the post-crisis recession was so severe that existing models could not even roughly predict it. The difficulties in explaining macroeconomic activity around a crisis and in predicting the future course of a crisis-prone economy make it necessary to develop a robust model that would help identify better policy responses. Such a model should reflect an understanding of some of the salient features of a crisis economy, as well as the resulting structural changes in transmission channels. This study is an effort to develop a model that will address some of the questions raised by Korea's experience in the course of the financial crisis, and allows us to examine various policy options.

This paper assesses the merits of flexible inflation targeting by comparing alternative policy rules in a small, open macro model characterized by market imperfections, price rigidity and forward-looking agents. Our study attempts to take into account of structural changes resulting from financial liberalization, greater openness and crisis in at least two ways. First, we explicitly consider how monetary shocks influence stock prices, which may in turn influence economic activity through their impact on the financial condition of lenders and the supply of credit. Second, we also attempt to account for the effects on the monetary transmission mechanism of greater financial openness and greater exchange rate flexibility since the crisis.

II. Structural changes and New Transmission Channels

A reading of the recent business cycle literature (e.g. Kashyap and Stein 1995, Catao and Rodriguez, 2000, Bernanke and Gertler, 1995) suggests that credit market imperfections have contributed to the recent instability of emerging markets by amplifying the impact of shocks. Apart from affecting demand, a shock may alter the balance sheets of borrowers or lenders, inducing changes in the supply of credit or capital, with adverse effects on investment and economic activity. This phenomenon is known as the "credit channel" effect or the "financial accelerator." For example, if interest rates rise, investment may fall not only because of weaker demand, but also because a reduction in the value of real estate used as collateral by a corporate borrower reduces the willingness of banks to extend credit (Carlstrom and Fuerst 1997, Hubbard and Kashyap 1992, Kiyotaki and Moore, 1997).[2] As is well known, lenders restrict credit under these conditions because borrowers with poor balance sheets are more

[2] In the case of Korea, financial accelerator effects are influenced by the fact that large industrial conglomerates (chaebols) enjoy information advantages over small and medium enterprises. As a result, the cost of external finance does not necessarily vary inversely with the share of inside finance in total financing (as is generally predicted by models of asymmetric information). Small or medium sized firms are also more vulnerable to financial accelerator effects, or variations in the supply of credit affecting output, than are the chaebol.

likely to undertake risky projects with borrowed funds (moral hazard) or because they are more exposed to poor borrowers (adverse selection). Bernanke and Lown (1992) discuss how changes in asset prices work through changes in balance sheets of banks and firms to affect real economic activity, while Borio, Kennedy, and Prowse (1994) highlight the close relationship between asset market movements and boom and bust cycles.

In Korea, the importance of asset prices has risen partly because the value of assets and liabilities has grown faster than income. As a result, even small unexpected changes in balance sheet conditions can set off financial accelerator effects. Apart from influencing credit and economic activity, asset prices also appear to be useful in signaling changes in inflationary pressure (Bernanke and Gertler, 2000).

In short, the credit channel is a powerful mechanism in which shocks are amplified through changes in asset prices that in turn affect the supply of credit and output. Shocks can be especially large when a weak financial sector is opened, because financial strains can lead to incorrect evaluation of various risks. This may further weaken the financial system and contribute to business cycle instability. Imperfections in the capital market are therefore especially important in explaining the propagation mechanism of developing economies.

This discussion suggests that concerns about financial stability may be an important consideration in formulating monetary policy. In the case of Korea, credit market frictions open a channel for changes in asset prices to affect economic activity through the credit market. These frictions are the result of the biased industrial structure, which distorts risk evaluation.

Recent research confirms the importance of accounting for asset prices and a more open financial sector in predicting business cycle behavior. Christoffersen and Slok (2000) show that asset prices contain information about future economic conditions. Asset price and exchange rate changes are the most prominent factors that can affect increasingly important credit channels, which exercise powerful, and asymmetric impact on the economy (Goodhart and Hofmann 2001). Furthermore Choi (2001(a)) shows that in Korea, active sterilized intervention in response to capital inflow surges allowed by an open capital account may increase the government fiscal burden.

To assess the role of financial vulnerability in propagating shocks, and the exposure of the Korean economy to external shocks (the exchange rate and world interest rates), in ongoing research I estimate a vector autoregression (VAR) model similar to that described by Edwards and Vegh (1997) (detailed results are available from the author). I then perform Granger-causality tests and compute impulse responses to shocks. Apart from uncovering dynamics that are hard to detect using a traditional structural model, the VAR analysis reveals a number of features worth bearing in mind when developing such a structural model:

Financial sector variables predict output, suggesting that financial accelerator effects are present in Korea. For example, an index of financial vulnerability Granger-causes industrial production, while an analysis of impulse responses shows that an increase in financial vulnerability is associated with a reduction in industrial production.

The impact of shocks is asymmetric. Small and medium enterprises bear the brunt of financial shocks. This probably reflects an emerging financial system that inherently favors large enterprises.

The economy is exposed to external shocks, and these operate through the financial sector as well as directly. The VAR analysis reveals that the real exchange rate predicts (Granger-causes) industrial production. In addition, an increase in the rate of devaluation is followed by a contraction in bank lending.

The Korean economy *is more sensitive to exchange rate shocks than to world interest rate shocks.* While both an increase in the rate of devaluation and in the world interest rates lead to an increase in the domestic nominal interest rates, the impact of a devaluation shock on the domestic interest rate is larger. One possible explanation is that policymakers intervene to mute the impact of a rise in world interest rates on domestic interest rates, while they do not do the same in the case of a depreciation.

The growing exposure to the external sector has had two effects on macroeconomic policy. First, it has reduced the effectiveness of monetary policy. Efforts to influence money creation have been offset by capital flows (Choi, 2001a). In Korea, the "offset coefficient" has risen continuously and is expected to continue undermining the effectiveness of monetary policy.

Second, since 1990, when the capital market began to be open, the Bank of Korea has engaged in significant intervention in foreign currency markets, sterilizing the impact on the money supply by issuing massive amounts of the Bank of Korea's own Monetary Stabilization Bonds (MSBs). The massive volume of these MSBs puts upward pressure on interest rates and implies significant quasi-fiscal costs (Choi 2001(a)). Commercial banks have been required to absorb the increased volume of MSBs, hampering their intermediation functions.

Further evidence on the importance of new transmission channels is provided in Appendix 1, where it is shown that asset prices have a significant impact on growth. We will therefore attempt to take the transmission channels cited above in modeling the Korean economy by accounting for asset price behavior. Still, utilizing asset prices for policy purposes remains a difficult task. Theoretically, changes in stock and real estate prices, or in the yields of debt instruments, reflect changes in economic fundamentals. For example, changes in expected inflation, as reflected in changes in asset prices, are important information for conducting monetary policy. However, asset prices may also be driven by non-fundamental factors, which can have long-lasting, destabilizing effects. For example, regulatory problems and market psychology can trigger irrational investor behavior. Often financial liberalization efforts are associated with non-fundamental fluctuations in asset prices, as revealed by the experiences of Scandinavian countries and of a number of developing countries (Borio, Kennedy, Prowse 1994).

III. Specification of the Model

a. Structural Changes and Model Derivation

We have argued that the choice of the monetary policy framework depends on the economic structure that defines the monetary transmission mechanism. Since each country has its own set of distinctive features, the choice of nominal anchors for monetary policy may accordingly differ. In evaluating alternative policies, we need to take two factors into account: new transmission channels and economic vulnerability. We use changes in asset prices to capture the effects of the new transmission channels.

To account for the asset price channel, the IS curve either explicitly incorporate stock price changes as an independent argument or includes real exchange rate changes whose movements may be related to those of the stock market. This reflects the reality that portfolio investment is a dominant form of capital inflow and is sensitive to changes in real exchange rate (Choi 2001(a)). Our expanded IS curve is given (all variables in logs) by:

(1) $$y_t = \lambda y_{t-1} - \gamma\left[i_t - \pi_t^c\right] + \delta g_t + \mu q_{t-1} + \theta y_{t-1}^f + \chi s_t + v_t, \gamma, \mu, \theta > 0, 0 \leq \lambda < 1$$

Here, y_t^f is the foreign output gap based on the OECD industrial production index, s_t and g_t are the stock returns and fiscal expenditure variables, respectively, i_t is the quarterly interest rate, $\pi_t^c = p_t^c - p_{t-1}^c$ is the quarterly inflation, where p_t^c is the consumer price index , and q_t is the real effective exchange rate, which is given by

(2) $$q_t = e_t + p_t^f - p_t^c$$

where p_t^f is the foreign price level. For notational convenience, when there is no chance for confusion, in what follows we will dispense with the superscript *c* when we are referring to the consumer price log level *p* or the inflation rate π.

A number of questions remain on how the variables should be entered for estimation purposes. For example, it could be argued that variables should be expressed as deviations from their trend or equilibrium level, but in the absence of a clear justification for a particular approach, an eclectic approach was taken.

Given that most capital flows are sensitive to stock market trends, changes in stock prices affect exchange rate determination, which in turn affects aggregate demand. So instead of directly inserting the stock price variable into the IS curve, we will use changes in the real exchange rate (that at least partly reflect changes in stock prices) in the aggregate demand equation. Our model specification then is:

(1a) $$y_t = \lambda y_{t-1} - \gamma(\left[i_t - \pi_t\right] + \delta g_t + \mu q_{t-1} + \theta y_{t-1}^f + v_t$$

(1a) differs from (1) in that the stock price variable is dropped and stock price information is assumed to be embedded in the real exchange rate. To sum up, asset price effects are reflected in the form of changes in stock prices in equation (1) or are incorporated in the real exchange rate in equation (1a). Along with the foreign output gap, the real exchange rate also captures open economy effects.

In this setup, policy shocks affect real variables due to price rigidity. Interest rates affect aggregate demand by affecting consumption and investment, and the exchange rate affects the price level by changing import prices. As discussed below, there is also an indirect exchange rate effect on real wages in the tradable goods sector. It should be noted that output is pre-determined by the lagged real interest rate, foreign output and exchange rate of the previous period.

Unlike most studies that emphasize the real interest variable as a transmission channel of monetary policy, we assume that accumulated changes in the interest rate affect money demand (Haldane and Salmon 1995) in defining our LM curve. Changes in money demand can be used to replace the real interest rate in the IS curve, as in the following equation:

(3) $$m_t - p^e{}_t = m_0 = m_1 + m_1(m_t - p_t) + m_2\pi_t^{\,e} + m_3 i_t + m_4 ECM_t + v_t +$$

where $ECM_t = m_{t-1} - p_{t-1} - m_5 y_{t-1} - m_6 \tilde{i}_{t-1}$ and CPI inflation π_t is a weighted average of inflation in imported goods and inflation in non-tradable goods:

(4) $$\pi_t = \mu\pi_t^M + (1-\mu)\pi_t^d \qquad 0 \le \mu \le 1$$

where the weight μ is the import ratio for aggregate consumption.

As is typical in this type of model, our specification emphasizes the indirect effect of the exchange rate on inflation via the import price, rather than a direct effect. The import price is modeled as a function of the foreign price and the nominal exchange rate (defined as the amount of domestic currency per unit of foreign currency). The import price is assumed to respond to changes in the exchange rate immediately or with a lag. In logs

(5) $$p_t^M = p_{t-1}^M + k(p_t^f + s_t - p_{t-1}^M) = (1-k)p_{t-1}^M + k(p_t^f + e_t)$$

where κ is the direct exchange rate pass-through coefficient. First-differencing (5) yields:

(6) $$\pi_t^M = (1-k)\pi_{t-1}^M + k(\pi_t^f + \Delta e_t)$$

The exchange rate affects aggregate demand through its influence on domestic and foreign goods' relative prices, and it changes domestic prices through changes in import prices. It also affects the supply side through changes in intermediate goods prices. Therefore, the exchange rate can change the price path in a non-trivial manner.

The nominal exchange rate is determined by a weighted average of next period's expected and last period's actual exchange rate, the spread between foreign and domestic interest rates, and a stochastic risk premium:

(7) $$e_t = \delta E_{t-1}e_{t+1} + (1-\delta)e_{t-1} + i_t^f - i_t + u_t^e$$

The exchange rate risk premium u_{t+1}^e can be expressed as $u_{t+1}^e = \rho_e u_t^e + \varepsilon_{t+1}^e$.

As shown in (7), uncovered interest parity (UIP) determines the nominal exchange rate, which can be expressed a combination of forward-looking (rational) and backward-looking expectations. The expected change in the exchange rate takes the form of compensating the differences between nominal interest rate differentials. Model specification will depend on how expectations determine the exchange rate.

Benchmark Model

To estimate our model, we need to specify how agents form expectations about current inflation using past data. To make the empirical analysis more tractable, we used two price equations: a non-tradable equation, which corresponds to the wage bargaining equation and an import price equation, which is affected by the real exchange rate. Wage bargaining agents are assumed to form expectations about the current period's inflation based on last period's information, using (3). The results of wage bargaining and cost mark up that takes into account changes in real exchange rate and deviations from the equilibrium real money balance constitute the LM equation through the changes in expected inflation (equation (9) below). This yields the following estimating equations:

(8) $$y_t = \lambda_0 + \lambda_1 y_{t-1} - \lambda_2[i_t - \pi_t^e] + \lambda_3 g_t + \lambda_4 q_{t-1} + \lambda_5 y_{t-1}^f + \lambda_6 s_t + \varepsilon_t$$ (IS)

(9) $$m_t = m_0 + m_1 y_t + m_2 \tilde{i}_t + m_3(m_{t-1} - p_{t-1} - \beta_1 y_{t-1} - \beta_2 \tilde{i}_{t-1}) + m_4 \pi_t^e + m_5(i_t^f - i_t) + \nu_t$$ (LM)

(10) $$\pi_t = \rho_0 + \rho_1 \pi_{t-1} + \rho_2 y_{t-1} + \rho_3 \pi_{t+1}{}^e + u_t$$ ("Phillips" curve)

(11) $$\pi_t^e = \delta_0 + \delta_1 \pi_{t-1}^e + \delta_2 \pi_{t-1} + \delta_3 \sum_{j=0}^{k} \psi_j \pi_{t-j}^M + e_{\pi t}$$ (Inflationary expectations)

(12) $$q_t = \omega_0 + \omega_1 q_t^{\,e} + \varpi_2[i_t - \pi_t{}^e] + \varpi_3 s_t + e_{qt}$$ (Real exchange rate)

(13) $$\pi_t^M = \mu_0 + \mu_1 \sum_{j=0}^{k} \phi_j q_{t-j} + \mu_2 y_t^f + e_{mt}$$ (Import price inflation)

(14) $$s_t = s_0 + s_1 \sum_{j=0}^{k} \xi_j s_{t-j} + s_2[i_t^f - i_t] + s_3 q_t + e_{st}$$ (Stock returns)

where $\pi_{t+1}^e = \pi_t - \pi_t^e$, $q_t^e = \tilde{q}_t - \theta(q_t - \pi_t), \theta > 0$, y_t =domestic output gap, π_t = consumer price inflation, $\pi_t{}^M$ =importable goods inflation, i_t =domestic nominal interest rate, $\tilde{i}_t$ = 4-quarter accumulated interest rate, s_t = stock returns (log-differenced KOSPI), i_t^f = overseas nominal interest rate, q_t = real exchange rate, y_t^f = foreign output gap, e_t = nominal exchange rate, π_t^f =foreign inflation.

A number of features of the benchmark model are worth highlighting. First, We use an augmented Phillips curve to model CPI inflation as a function of the weighted average of expected inflation at *t*+1 is and inflation at *t*-1, and the output gap lagged one period:

Second, the forward-looking nature of expectations are emphasized. All the variables in *t*-1 are realized, and policy makers need to adjust the policy instrument during t when expectations are formulated. The mode of expectation formation is determined by parameter values, and is expressed as a mixture of forward-looking and backward-looking components. For example in equation (10) above, $\rho_1 \pi_{t-1}^e + \rho_3 \pi_{t+1}^e$ corresponds to the effects of lagged and anticipated inflation on inflation in period *t*. If we assume that $\rho_3 = 1 - \rho_1 \neq 0$ we can write.

$$(15) \qquad \pi_t = \rho E_{t-1}\pi_{t+1} + (1-\rho)\pi_{t-1} + \alpha y_{t-1} + u_t, \alpha > 0,\ 0 \le \rho \le 1$$

We take an eclectic view on modeling the impact of expectations in equation (15), given the wide variation in assumptions adopted in the literature. Ball (1999) took the polar case $\rho = 0$, which implies that inflation has a unit root. Taylor (1980) assumed that $\rho = 1$, which suggests that inflation lacks persistence. Fuhrer and Moore (1995) assume $\rho = 0.5$. We have assumed that expected inflation next period is a function of these same variables, as well as the expected real exchange rate:

$$(16) \quad \pi^e_{t+1} = \varphi_\pi \pi^e_{t+2} + (1-\varphi_\pi)\pi_t + \gamma_y y_{t+1} + \gamma_q q_{t+1} + u_{t+1}$$

In this framework, current decisions depend on the expected paths of output and inflation, as well as on expected changes in monetary policy. The inclusion of the expectations variable implies a broader set of distributed lags, including future variables. However, simulation results are mainly focused on evaluating policy rules, not so much on the implications of having a forward-looking IS curve.

Third, as in Clarida, Gali, and Gertler (hereafter CGG, 1999), the dynamic equilibrium model assumes price rigidity. However, unlike traditional models, the IS and LM are derived from the optimization exercise of households and firms. The derivation can be found in Bernanke, Gertler, and Gilchrist (1998) among others.

Fourth, we incorporate features of the small open economy along the lines of Batini and Haldane (1999), Svensson (2000), Agenor (2000), Rotemberg and Woodford (1997), McCallum and Nelson (1999). As explained earlier, we take explicit account of the exchange rate, and interpret its behavior as also capturing asset price and credit channel effects. Understanding this link is crucial in evaluating various policy rules and assessing the economic impact of various shocks since it is the feature that distinguishes this economy from advanced ones.

Fifth, the interest rate spread acts as a proxy for the effect of the external finance premium on the LM curve. These features improve the model fit and better explain the dynamics of macro variables in the post-crisis period as shown in RMSE or the multiplier effect.

Policy rules

In the final step of model development, we experiment with various policy rules in an open economy setting. Models for this purpose typically have three parts: aggregate demand, price adjustment, and policy rules. Alternative views on the transmission channel can be modeled by varying the specification of aggregate demand or the price adjustment equation.

If the transmission channel is defined as an n-dimensional vector y_t, an exogenous variable x_t, a stochastic shock u_i^t, and a_i parameters, we can write the policy rules as follows:

$$(17) \qquad f_i = (y_t, y_{t-1}, ..., y_{t-p}, E_t y_{t+1}, ..., E_t y_{t+q}, a_i, x_t) = u_i^t, i = 1, ..., n.$$

$$(18) \qquad i_t = g_\pi \pi_t + g_y y_t + g_{e0} e_t + g_{e1} e_{t-1} + \rho i_{t-1}$$

where i_t is the nominal interest rate, π_t is annualized inflation, y_t is the output gap and e_t is the nominal exchange rate. The parameter values are choice variables, so that it can alternatively be assumed that g=0 (Taylor), or g=1 (Woodford).

In the following simulation exercises, policy rules that respond to changes in expected inflation are evaluated. CGG (1999) explain why a forward-looking response function is appropriate, reporting that policy rules that include asset prices give results equivalent to rules that include output gap. As long as policy rules respond to changes in expected inflation, changes in the output gap do not affect the results significantly. We also consider cases in which policy rules also respond to changes in stock prices. The policy rules used are explicitly written out below.

IV. Data and Estimation

To estimate our model and assess economic performance under alternative policy rules we collected a number of macroeconomic data for Korea. All data series except those of OECD are from the Bank of Korea database. OECD data sources are explained in Goodhart and Hofmann (2001). Since Korea only recently adopted the call rate as a policy instrument, term structure information is not available for empirical analysis. Instead we use a representative interest rate in the Korean market, the three-year corporate bond yield.[3] This series has shortcomings as an indicator of financial market conditions, but no better indicator is available. Most data used in the simulation exercise begin in the 1970s.[4] With the exception of interest rate series, all data are log-differenced. The Financial Conditions Index (FCI) and the Monetary Conditions Index (MCI) are constructed using quarterly data for 1975-2000.

Inflation Targeting

As a first step in analyzing alternative policy rules, we inquire how Korea's economic performance would have changed if an inflation target had been adopted since the 1970s (such a target was adopted in 1998). We simulate economic performance over the period 1973 to 1996 under an inflation target and compare it to actual performance. We assume that a target inflation of 4 percent is reasonable, and that the authority raises the interest rate if the actual inflation of the previous period exceeds target inflation.

We use three alternative assumptions about how inflationary expectations are formed: Backward Looking Rule (BLR), Forward Looking Rule (FLR), and Spontaneous Adjustment Rule (SAR). BLR can be expressed as $i_t = i_t^* + \alpha(\pi_{t-1} - \pi^*) + \beta(y_{t-1} - y^*)$. FLR is $i_t = i_t^* + \alpha(\pi_{t+1}^e - \pi^*) + \beta(y_{t+1} - y^*)$. We also consider a situation (labeled SAR) where the expected inflation converges to a target π^* and price adjusts instantaneously through changes in expected inflation (Clarida, Gertler, and Gali (1998)).

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[3] Rudebusch and Svensson(1999) use a four quarter average of the one period real interest rate in the output equation, while Fuhrer and Moore(1995) used a 10 year real rate.

[4] EMBI starts from 1991 and OECD industrial production starts from 1995. KOSPI runs from 1980 to 2000.Q2.

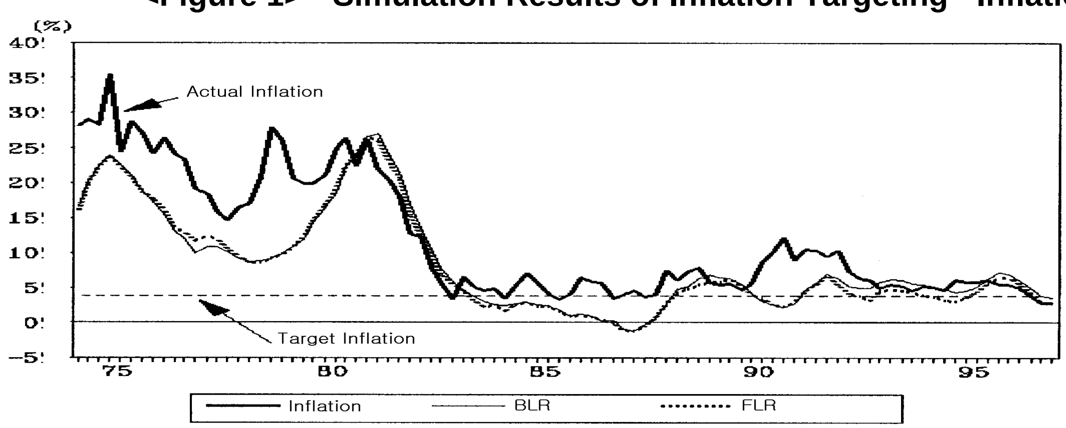
As indicated by Table 1 and Figures 1 and 3, in historical counter-factual simulations, adopting a four percent inflation target during 1973-1996 reduces inflation from an average of 11 percent to 8.5 percent. The current target level of 4 percent is approached after 1985. However, reduced inflation is associated with slower economic growth (Table 1, Figures 2 and 4). The real growth rate during 1973-96 falls from an actual 8.1% to a simulated 3.8%. One explanation for this stark difference in growth performance is that the inflation targeting forces inflation expectations to converge to the target level quickly and non-neutrality becomes dominant feature of the adjustment process. An interesting research question is how inflation targeting may help stabilize output during the crisis period when the Korean economy experienced deflation. The differences under the alternative expectation assumptions show that SAR allows a quicker adjustment to lower inflation with a lower sacrifice ratio. Since the speed of expectation formation depends critically on policy credibility, the confidence building exercise seems very important for the successful introduction of inflation targeting. However, in the absence of more empirical evidence for the pre-crisis period, these results should be interpreted with caution.

<Table 1> Effect of Inflation Targeting

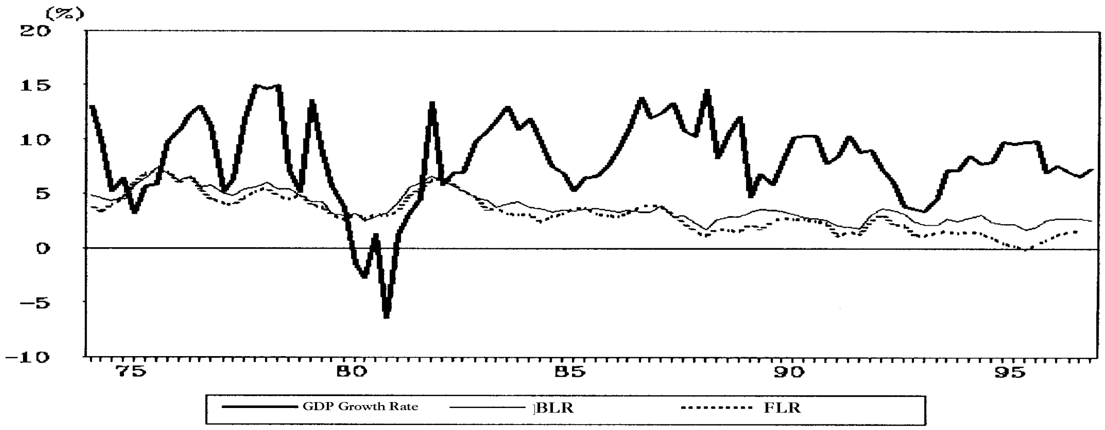
	Inflation(%)		Real GDP (%)	
	All periods	After 1985	All periods	After 1985
Actual	11.83 (8.68)	6.01 (2.16)	8.12 (3.84)	8.44 (2.58)
BLR	8.50 (7.02)	4.06 (2.29)	3.77 (1.34)	2.83 (0.56)
FLR	8.17 (7.15)	3.49 (2.04)	3.16 (1.67)	2.00 (1.00)
SAR	9.67 (4.47)	4.69 (1.68)	5.45 (1.73)	6.05 (0.76)

Note: 1) Figures inside the parentheses are standard errors.
2) RMSE(root mean squared error): BLR = 2.373%, FLR = 2.427%, SAR =1.486%
3) Pre-crisis experiment deals with small open economic structure with no changes in transmission channel, while post-crisis experiment incorporates recent developments in related literature. Instead of the original specification, real exchange rate in IS curve is replaced with real money balance as interest rate channel was not well defined in the pre-crisis credit-rationing period (Appendix 3).

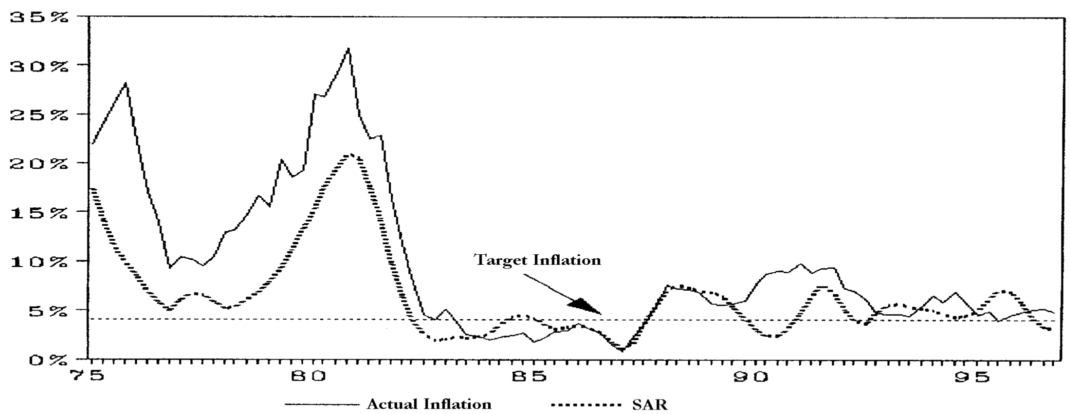
<Figure 1> Simulation Results of Inflation Targeting - Inflation



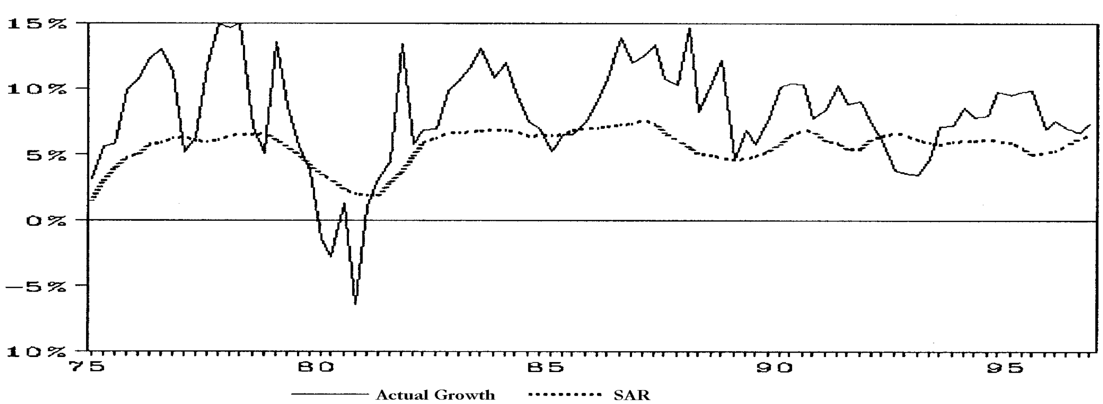
<Figure 2> Simulation Results of Inflation Targeting - GDP Growth Rate



<Figure 3> Simulation Results – SAR-Inflation



<Figure 4> Simulation Results – SAR GDP Growth Rate



a. Comparison of Alternative Policy Rules

While inflation targeting appears to successfully reduce inflation, it is useful to examine whether the outcome is better under alternative policy rules. In this context, a number of points are worth bearing in mind. First, the outcome from applying various policy rules can be quite different from those of advanced countries. In developing countries, some policy rules—such as strict inflation targeting—may have destabilizing effects by leading to large fluctuations in the exchange rate or asset prices. Such fluctuations can lead to significant side effects (such as the whiplash effect on output described by Kasa (2001)). To avoid excessive volatility, long-term inflation may be a better choice for an inflation target.

Second, initial conditions (such as balance sheet positions) can also make a sizable difference in the final outcomes. For example, a devaluation may be highly contractionary in the presence of sizable foreign debt. If firms have a significant foreign currency exposure, a devaluation reduces the firms' value and raises the cost of financing. The resulting decline in capital expenditure may further depress asset prices. This balance sheet effect is especially important in developing economies, where there is heavy reliance on borrowing. Finally, credibility bias exists due to a long history of market instability.

Third, lack of capital market development and a proper taxation scheme often forces the authority to finance through central banks, resulting in fiscal dominance. In this case, policy credibility invariably suffers and inflation targeting can be costly.

The following are subsets of policy rules discussed in the literature. They differ in the coverage of available information set, expectations formation, and lag structures. As can be seen, the rules differ in being either forward-looking or backward-looking, or in taking into account output, the nominal exchange rate, or the real exchange rate.

(19) $$i_t = i_t^* + \alpha(\pi_{t-1} - \pi^*) + \beta(y_{t-1} - y^*)$$ (Backward-looking)

(20) $$i_t = i_t^* + \alpha(\pi_{t+1}^e - \pi^*) + \beta(y_{t+1} - y^*)$$ (Forward-looking)

(21) $$i_t = 1.01 E_t \pi_{t+1}$$ (Bernanke-Gertler1)

(22) $$i_t = 2.0 E_t \pi_{t+1}$$ (Bernanke-Gertler2)

(23) $$i_t = 1.01 \pi_{t+1} + 0.1 s_{t-1} \quad \text{where } s_{t-1} = \log(S_{t-1}/S_t)$$ (Bernanke-Gertler3)

(24) $$i_t = 2.0 E_t \pi_{t+1} + 0.1 s_{t-1} \quad \text{where, } s_{t-1} = \log(S_{t-1}/S_t)$$ (Bernanke-Gertler4)

(25) $$i_t = c + p i_{t-1} + \lambda(E_t \pi_{t+1} - \pi^*) + \gamma(y_t - y^*) + \theta \Delta \tilde{q}_t$$ (Clarida-Gertler-Gali 1)

(26) $$i_t = i_t^* + \lambda(E_t \pi_{t+12} - \pi^*) + \gamma(y_t - y^*) + \theta(i_t^* - 2.0(\Delta e_t - \Delta w_t))$$ (Clarida-Gertler-Gali 2)

(27) $i_t = f_\pi \widetilde{\pi}_t + f_y y_t$, where $\widetilde{\pi}_t = \sum_{\tau=0}^{4} \pi_{t-\tau}$ (Annualized CPI inflation) (Taylor rule)

(28) $i_t = f_\pi \widetilde{\pi}_t + f_y y_t + f_{\Delta e} \Delta e_t$ (Extended Taylor rule)

(29) $i_t = f_\pi \widetilde{\pi}_t + f_y y_t + f_q q_t$

(30) $i_t = f_y y_t + f_\pi \widetilde{\pi}_t + f_{q1} q_t + f_{q2} q_{t-1}$ where f_y=1.93, f_π=2.51, f_{q1}=-0.43, f_{q2}=0.3 (Ball's rule)

(31) $i_t = f_\pi \widetilde{\pi}_t + f_y y_t + f_{\Delta q} \Delta q_t$ (Modified Ball)

(32) $i_t = f_i i_{t-1} + f_\pi E_t \pi_{t+1}$ where j=5, f_i=0.5, f_π=5 (Inflation forecast based rule)

(33) $i_t = \pi_t - \mu q_t$ where μ=1/3[5] (MCI based rule)

(34) $i_t = \pi_t - 10.1 * q_t - 7.4 * ph_t + 0.02 * ps_t$ (FCI1 rule)

(35) $i_t = \pi_t - q_t - ph_t + ps_t$ (FCI2 rule)

Tables 2 and 3 show the relative performance of these alternative policy rules. In Table 3, the model is expanded in a way that allows stock price changes or the Emerging Market Bond Index (EMBI) spread to also influence the money market (LM) equilibrium.

It is desirable to achieve higher average output and lower inflation, as well as smaller fluctuations in interest rates and the exchange rate. The results show that a form of policy rules that respond to expected inflation, the output gap, and real exchange rate deviation from the trend show superior stabilization properties. Policy rules that are forward-looking, such as the inflation forecast based rule or the forward-looking rule contribute significantly to macroeconomic stability, as measured by either inflation or output. Overall, a Taylor rule performs reasonably well despite its simple structure, while Ball's rule, which targets the exchange rate as well as output and inflation, tends to be associated with higher interest rate as well as exchange rate volatility induced by output changes. Rules based on a monetary conditions index (MCI) or a financial conditions index (FCI) tend to be associated with much higher exchange rate volatility. Despite the emergence of new transmission channels (i.e. financial accelerator effects induced by asset price changes), policy rules that respond to stock price changes do not always

[5] That is, a 3% appreciation of real exchange rate is given the same weight as a 100 basis point increase in the real interest rate.

work well. Given the dominance of the exchange rate channel in influencing CPI, policy rules that rely on exchange rate information do better than rules that rely on the stock price (compare CGG1 with others). Also, a comparison of Table 2 and Table 3 show that the relative superiority of a given set of policy rules remain robust even with different assumptions on transmission channels. So even though different transmission channels imply different economic response to various shocks, the choice of policy rules is not very sensitive to how we specify the model.

In short, the results suggest that responding to output changes, longer-term changes in expected inflation, and trend deviation of real exchange rate in the manner consistent with CGG1 gives better outcomes than either a simplistic Taylor type rule or a comprehensive strategy utilizing MCI or FCI. In addition, slightly modified transmission channels do not yield different results with the choice of policy rules. Although increased exposure of domestic money demand and real exchange rate to changes in yield spreads (emerging market risk premium) and stock returns tend to exert a more stabilizing performance in interest and exchange rate volatility(compare Table 2 and Table 3). The superiority of the CGG rule and Taylor rule is observed in both cases, while the use of FCI leads to a destabilizing economy. Part of the reason for the danger of using broader sets of information is that it is likely to misrepresent structural changes that took place recently and activates unstable path by triggering drastic responses to given shocks.

If interest stability is given more weight, Taylor type rules tend to fare better, while nominal GDP and BG rule are better in achieving exchange rate stability. Above all, the inflation is most stable under BG and Taylor rules and when inflation as well as other volatilities are taken into account, CGG turned out to be the best choice for Korean economy as it equally contribute to the stability of both inflation and asset prices. When the role of stock price is given particular attention as explained in model derivation, we obtain more stabilizing results. In short, stock price needs to be carefully utilized in applying policy rules given the dominance of asset price effect, yet major part of stabilization is achieved by responding to changes in expected inflation, which is a smoothed version of market information.

<Table 2> Comparison of Policy Rules

(Unit : %, yoy)

	Output	Inflation	Interest Rate	Exchange Rate	Objective function	RMSE(%)
Backward	-0.25 (13.10)	0.12 (1.17)	0.2	87.5	14.3	0.04
Forward	-0.20 (0.89)	0.11 (0.29)	0.1	17.3	1.2	0.04
Monetary	99.23 (9464)	-0.18 (374)	863	38064	10054	0.25
Nominal GDP	-0.11 (6.61)	0.08 (0.24)	1.1	3.3	7.1	0.02
BG1	0.23 (20.24)	0.006 (2.21)	0.5	7.4	22.6	0.01
BG2	0.21 (18.89)	0.008 (2.05)	2.1	8.4	21.5	0.01
BG3	0.22 (15.39)	0.006 (2.06)	20.4	30.9	22.5	0.008
BG4	0.21 (14.34)	0.008 (1.99)	20.5	32.6	21.4	0.02
CGG1	-0.14 (1.06)	0.09 (0.13)	0.3	2.5	1.3	0.02
CGG2	-0.86 (5406)	7.15 (689)	1050	7606	6358	0.62
Taylor1	0.19 (15.40)	0.01 (1.83)	0.6	10.9	17.4	0.008
Taylor2	0.19 (15.15)	0.01 (1.83)	0.6	10.7	17.1	0.009
Taylor3	0.19 (15.34)	0.01 (1.80)	0.4	9.5	17.3	0.01
BALL1	0.28 (6.18)	-0.01 (2.43)	200	263	58.6	0.02
BALL2	0.08 (1.73)	0.03 (1.39)	330	222	85.6	0.01
IFB	0.06 (14.42)	0.04 (1.03)	12.4	6.4	18.6	0.01
MCI1	1.39 (301)	-0.15 (11.73)	325	325	395	0.06
MCI2	1.24 (83.52)	-0.12 (8.41)	4.1	4.1	93.0	0.06
FCI1	NA	NA	7.58E+29	9.17E+31	5.67E+30	1.32E+11
FCI2	3.84E+12 (842599)	88.63 (23189)	1101396	3163454	1141137	1.46

Notes: Sample covers the1991.Q1 to the 2002.Q3. Simulation period covers the 1998.Q1 to 1999.Q4
The figures for interest rates and exchange rates are variances. Figures inside the parentheses are variances

<Table 3> Comparison of Policy Rules under Different Transmission Channels

	Output	Inflation	Interest Rate	Exchange Rate	Objective function	RMSE(%)
Backward-looking	-0.34 (66.9)	0.20 (7.26)	1.1	497.2	74.4	0.05
Forward-looking	-0.27 (8.63)	0.16 (1.75)	0.1	64.3	10.6	0.05
Monetary	11.24 (4661)	-0.13 (282.1)	254.5	32125	5007	0.20
Nominal GDP	-0.14 (9.39)	0.11 (0.14)	1.6	25.6	9.9	0.03
BG1	0.34 (38.2)	-0.02 (4.59)	0.5	18.6	43.0	0.02
BG2	0.32 (35.3)	-0.02 (4.63)	2.1	14.4	40.1	0.02
BG3	0.31 (27.5)	0.02 (3.98)	22.7	35.5	37.2	0.03
BG4	0.29 (25.5)	-0.02 (3.75)	22.0	32.7	34.8	0.01
CGG1	-0.18 (1.12)	0.12 (0.08)	0.4	1.3	1.3	0.04
CGG2	-0.86 (14360	50.07 (2292)	1259.1	31716	16966	1.07
Taylor1	0.27 (26.7)	-0.01 (3.50)	0.7	10.4	30.4	0.02
Taylor2	0.28 (27.0)	-0.01 (3.52)	0.8	10.2	30.7	0.02
Taylor3	0.26 (24.9)	-0.01 (3.23)	0.6	8.1	28.3	0.01
BALL1	0.26 (8.05)	-0.03 (3.21)	362.2	584.0	101.8	0.02
BALL2	0.09 (2.07)	0.02 (2.33)	678.2	572.3	173.9	0.02
IFB	0.07 (20.52	0.04 (1.53)	12.4	23.2	25.1	0.01
MCI1	1.10 (309.6	-0.16 (15.5)	472.8	3340.1	443.3	0.07
MCI2	1.23 (128.9	-0.14 (11.1)	16.1	844.4	144.0	0.06
FCI1	NA	NA	1.57E+58	1.51E+57	3.93E+57	9.31E+23
FCI2	1.54E+12 (741801)	159.5 (33159)	738102	4311576	959486	1.72

Note: <Table 3> differs from <Table 2> because the LM curve and real exchange rate are influenced by the EMBI spread and KOSPI changes, respectively. Figures for interest rates and exchange rates are sample variances. Number of iteration for simulation exercise is 1000, and NA shows non-convergent cases.

V. Conclusions and policy implications

Financial developments since the 1997-1998 crisis in Korea clearly suggest that financial market imperfections play a significant role in amplifying the impact of shocks on real economic activity. In particular, financial sector vulnerability as well as structural changes brought about by liberalization and greater opening has had significant influences on macroeconomic conditions in Korea. As a result, asset prices emerge as an important indicator of financial vulnerability and economic imbalances that may impair timely adjustment and have implications for inflation. A faulty financial system is responsible for many abnormal patterns of economic behavior observed in emerging economies, as shocks are channeled through highly volatile asset price and exchange rate channels to impinge on the economy.

In this environment, which characterizes emerging markets like Korea, policy responses need to be devised that do not precipitate drastic changes in asset prices and exchange rates. That is, stabilization policy should take into account financial fragility and the implications of asset price fluctuations for such fragility. This has at least two implications. First, if bubbles driven by non-fundamental factors cause fluctuations in asset prices and financial accelerator effects, we can expect increased pressure for adjustment which cannot be dealt with policy rules that focus on the short-run. The suggests the special need to go beyond a straightforward stabilization exercise typically undertaken in developed economies by expressing a full commitment to long-term price stability. Second, given the importance of asset markets, suitable attention should also be given to forward-looking expectations in policy formulation. Policies that assume backward-looking expectations can lead to errors, because they can ignite financial accelerator and amplify economic fluctuations.

Using a macroeconomic model that takes these factors into account, we found that inflation targeting in Korea can contribute to greater economic stability. Inflation targeting provides a consistent policy framework in which policy response can be made without triggering accelerator effect as well as satisfying some of the preconditions for financial market development. It helps attenuate serious instability associated with increased asset price and exchange rate volatility in an economy with a fragile financial market structure and significant structural changes. We recognize that when serious market weaknesses exist, strict inflation targeting can trigger increased volatility in exchange rates or interest rates. However, simulation exercises show that forward-looking simple policy rules with moderated responses to asset price changes can contribute to improved stabilization outcomes, including less volatile exchange rates, over the post-crisis sample period. Simulations also reveal that best policy rule for stabilization policy in Korea is a form of flexible inflation targeting that emphasizes output changes, longer-term changes in expected inflation, and changes in exchange rate as deviations from the equilibrium level. To be specific, inflation forecast-based policy rules and Clarida-Gertler-Gali (CGG)-type policy rules work best in implementing inflation targeting.

Optimal policy responses can be achieved by carefully analyzing the changes in transmission channels resulting from financial liberalization and development and the endogenous changes associated with economic fluctuations. However, the dynamic characteristics of the Korean economy, and the constraints imposed by financial sector weaknesses, suggest the following considerations must inform policy:

First, policy responses need to be gradual. Otherwise they may trigger drastic changes in stock prices or exchange rates that ignite accelerator effects due to the limited ability of financial markets to absorb shocks.

Second, policy responses need to be linked with forecasts of inflation and other useful information on future inflation, due to the importance of forward-looking expectations in successful policy implementation. Proactive responses that remains ahead of or keep abreast with market expectations are desirable for more efficient stabilization. Successful stabilization policy that follows these criteria can then have favorable effects on the credibility of monetary authorities.

Third, by stabilizing expectations, long-term inflation targeting may be seen as a pre-requisite for strengthening financial markets and overcoming structural deficiencies that contribute to financial accelerator effects and boom and bust cycles. Structural deficiencies can impair the credibility of policy by creating a bias for increasing liquidity and delayed restructuring. For this reason, structural reforms that strengthen and develop the financial market would be a useful complement to stabilization policy and facilitate its successful implementation.

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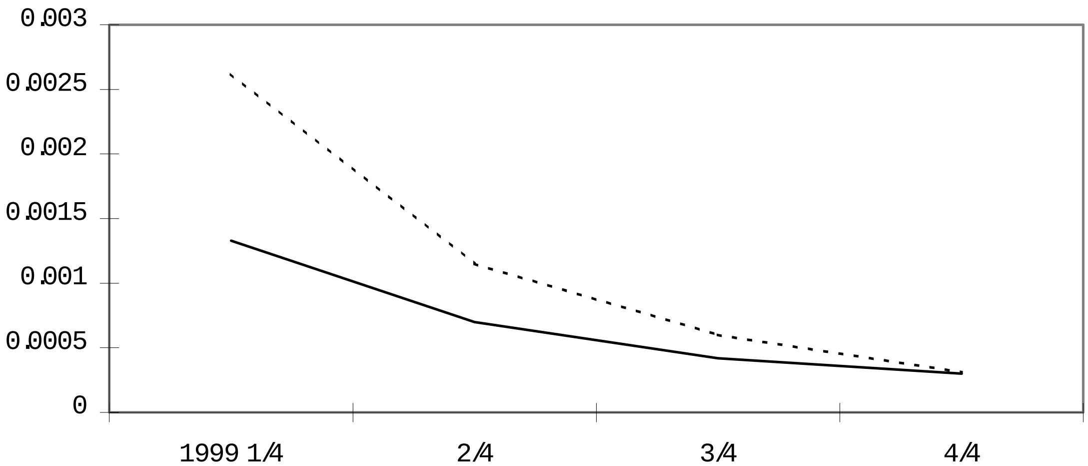
Appendix 1. The Effects of Asset Prices on Growth

The financial crisis in Korea prompted us to incorporate asset prices into the model. In this section we report some evidence that this is indeed appropriate. Using a structural VAR model, Choi (2001(b)) shows that in the aftermath of the recent financial crisis, macroeconomic variables became sensitive to asset price changes. Similar conclusions can be reached using the current model, which focuses on multiplier effects. Unlike exchange rate shocks, stock price shocks show dramatic changes even in the short run. Without adding the new channels of monetary transmission we have discussed earlier, it is difficult to explain the dynamics and stress that show up so dramatically in the recent Korean data.

<Figure A1.1> Multiplier Effect of a Stock Price Shock to the Growth Rate



Note: *Solid line*: No asset price channel. *Broken line*: with asset price channel.

<Table A1.1> Response of Key Variables to Various Economic Shocks (Multiplier Effect)*

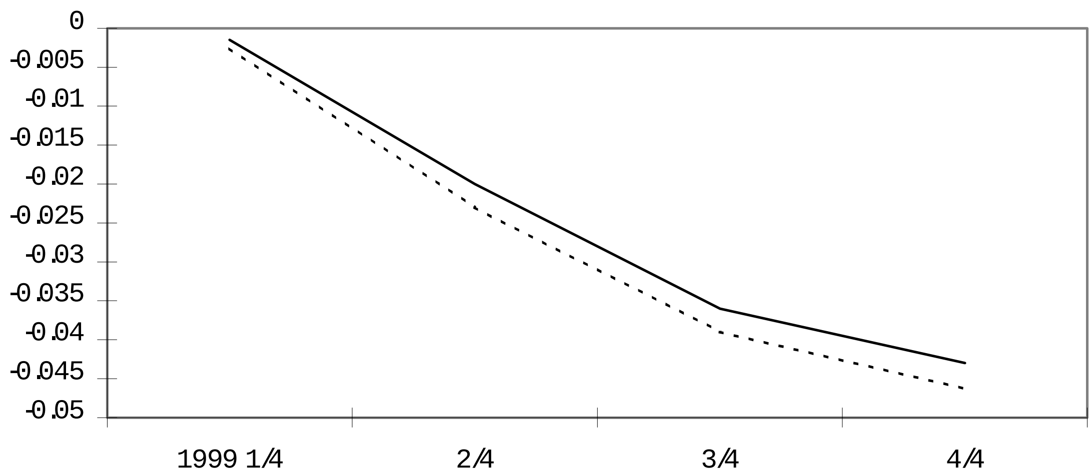
	Growth	Real exchange rate	CPI inflation	Import price
Stock return (10%)	1.09	-3.75	-0.10	-0.35
Overseas spread (1% point)	0.39	-1.83	-0.06	0.52
Real exchange rate (10% depreciation)	-0.5	-	0.13	0.12

* Sample period spans 1991.Q1 to 2000.Q2. Overseas spread is the difference between the Emerging Market Bond Index (EMBI) and the three-month Treasury bill, used as a proxy for the external finance premium.

The figures show impulse responses to shocks using the model, measured as end of period deviations from baseline (no shock). Figure 1 and Table 1 show that a 10 percent stock price increase is followed by an increase in output growth of up to 1.1% annually. An increase in stock price is typically associated with sizable capital inflow and real appreciation, thereby stabilizing inflation despite increased market liquidity.

The model also reveals that a real exchange rate depreciation (Figure 2, Table 3) is associated with an output contraction. It appears that any gains in competitiveness from a depreciation are more than offset by contractionary effects, presumably reflecting declines in the supply of loans, or the higher cost of intermediate goods imports on the supply side, and adverse terms of trade effects on the demand side (these last two effects are reflected in higher import prices).

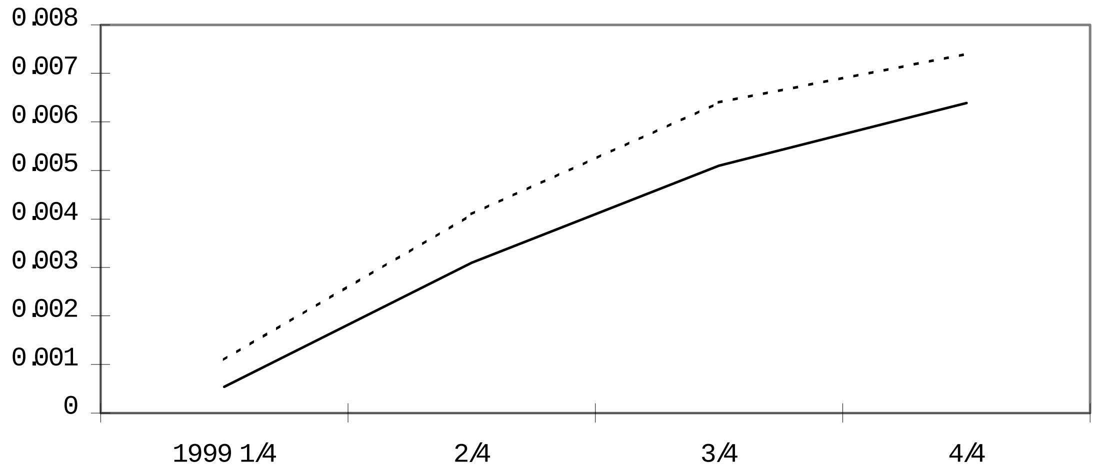
<Figure A1.2 > Multiplier Effect of a Real Exchange Rate Shock to the Growth Rate



Note: *Solid line*: No asset price channel. *Broken line*: with asset price channel.

Finally, figure A1.3 and Table A1.1 reveal that a rise in the spread between Emerging Market Bond Index (EMBI) yield and the Treasury bill rate has a positive impact on growth, however the effects occurs with a long lag and is not captured in the 1.5 year time span considered in our analysis.

<Figure A1.3> Multiplier Effect of an Interest Rate Spread Shock to the Growth Rate



Note: *Solid line*: No asset price channel. *Broken line*: with asset price channel.

In short, the sensitivity results show that asset prices can have an immediate impact on real output as well as inflation in the short run. These results serve as backdrop against which various candidate policy rules are evaluated.