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N^{o}: 2005-007

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September 17, 2005

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Current version: September 17, 2005

Abstract

To evaluate the effectiveness of targeting monetary policy strategies in a small open economy, we develop a dynamic optimizing model calibrated to recent Korean data. We then explore the consequences of alternative specifications of the loss function for society and the central bank, with particular focus on exchange rate volatility. Policy simulations include variations on inflation targeting, nominal income growth targeting and exchange rate targeting. Our results indicate that inflation targeting remains the most preferred policy regime, even when an explicit motive for exchange rate smoothing is introduced. In this case, the optimal inflation targeting and nominal income growth targeting policies are characterized by a "conservative" central bank that places greater weight on both the primary target variable and on the exchange rate than in society's objective function. However, the optimal policy reacts to changes in degree of exchange rate pass-though in a non-linear fashion, complicating the robustness of inflation targeting recommendations for emerging markets.

JEL Categories: E52, F41.

Keywords: Korean economy, inflation targeting, optimal monetary policy, small open economy.

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Thanks to seminar participants at the Federal Reserve Bank of New York, the Conference of the Korea International Economic Association in Seoul, The Midwest Macroeconomics Meeting, Wesleyan University, and the Western Economics Association International Meetings for helpful comments. Hanson thanks Wesleyan University for support through a University Project Grant, and the Federal Reserve Bank of New York for hospitality during his sabbatical. Nam thanks Kookmin University for financial support. Stephen A. Lee provided excellent research support. Any remaining errors are the authors' responsibility.

1 Introduction

Since the early 1990's, several countries have adopted inflation targeting as their framework for monetary policy. In the the wake of the 1997 Financial Crisis, Korea was among the first of a growing number of emerging market economies to begin targeting inflation explicitly. In this paper, we analyze the Korean experience in the context of the extensive theoretical literature in monetary economics that explores the optimality of inflation targeting. While much of this work has been conducted with closed economy models, increasing interest has been given to small open economies, and, more recently still, to the situation of emerging market economies (EMEs). The analysis in this paper expands that exploration specifically to the case of Korea. We find the particular experience of Korea interesting in its own right, as well as a potential guide to issues that might confront other inflation targeting EMEs.

On a theoretical level, a broad consensus appears to have formed in the literature regarding the desirability of inflation targeting as a monetary framework.[1] Nonetheless, some recent research has questioned the optimality of inflation targeting in all circumstances. Specifically focusing on small open economies, McCallum and Nelson (1999) argued in favor of nominal income targeting over inflation targeting. One attractive feature of the macroeconomic model they develop is an emphasis on imported goods as inputs into production, rather than as final consumption goods (as modeled, for example, in Clarida et al., 2001, and Galí and Monacelli, 2002): for Korea, consumer goods comprised only 13% of imports in 2002; capital equipment and intermediate goods accounted for the remaining 87%. In section 2, we start with the specification of McCallum and Nelson (1999, 2001) to develop a micro-founded dynamic stochastic model calibrated to the Korean economy.[2]

However, in contrast with McCallum and Nelson (1999), we model the central bank as a dynamically optimizing agent acting under discretion, rather than imposing an estimated policy rule.[3] Using the technique of Dennis (2003), we simulate the impact of alternative specifications of the societal objective function. For a particular specification of this loss function these simulations yield the optimal discretionary monetary policy. Using a similar approach in a closed-economy framework, Jensen (2002)

[1]Whether inflation targeting has significantly improved economic outcomes of practicing countries is actively debated; see Ball and Sheridan (2003) and Levin et al. (2003) for recent contributions. Truman (2003) reports that five of seven emerging market economies exhibited higher inflation or real output growth volatility following the adoption of inflation targeting.

[2]Recently, a similar but independent approach based on this model has been undertaken by Fraga et al. (2003) for the case of Brazil. One main modeling distinction is our use of a modified open-economy version of the price-setting relationship of Fuhrer and Moore (1995), as explained below.

[3]Given the short period in which inflation targeting has been in effect, it is difficult to estimate a Taylor-type policy rule with any precision. Extending the sample to earlier years would be inappropriate in light of the regime change(s).

recently concluded that the optimal policy regime may be nominal income growth — and not inflation — targeting. In light of the results of both McCallum and Nelson (1999) and Jensen (2002), we compare inflation targeting and nominal income growth targeting regimes in section 2.

We also give particular attention to the role of the exchange rate in policy formulation. In the canonical open economy New Neo-Classical Synthesis model, the exchange rate carries the primary burden of adjustment to return the model economy back to its steady state following an exogenous shock. As Svensson (1998) and Kollmann (2002) have noted, the (nominal and real) exchange rate is quite volatile in such models, a result we can replicate for our baseline parameterization. However, exchange rate volatility can carry a significant cost in emerging markets. While a stable currency and stable prices need not be conflicting objectives (particularly over long horizons), there certainly can arise situations in which a response to currency market innovations would run counter to placing primacy on the inflation criteria. Mishkin (2000) notes that exchange rate stability may be of particular importance to emerging market economies, especially in the face of "currency mismatches" in which a large devaluation of the domestic currency can significantly worsen the balance sheets of private firms and possibly precipitate a financial crisis, such as occurred in Korea in 1997 – 1998.[4] Indeed, the monetary policies of many EMEs exhibit "fear of floating" behavior, as documented by Calvo and Reinhart (2002). Thus, in section 3 we also investigate motives for, and the consequences of, explicit exchange rate objectives in the specification of the central bank's loss function. Section 4 concludes.

2 Model Specification

To investigate the properties of inflation targeting and other monetary policy regimes in Korea, we employ a macroeconomic model of a small open economy based upon McCallum and Nelson (1999, 2001). Rather than repeating their derivations, below we note the main equations as well as any significant differences between our specification and theirs. One key departure is the price adjustment equation: we derive an open-economy version of Fuhrer and Moore (1995) that is consistent with our assumptions about the nature of production.

In the model, a continuum of households (firms) produce differentiated products for domestic consumption and export using labor (provided inelastically by each household) and imported intermediate

[4] Amato and Gerlach (2002) also investigate how exchange rate volatility can significantly complicate the implementation of inflation targeting monetary policy in emerging market economies. For a more critical view of the importance of exchange rate issues for inflation targeting in emerging markets, see Truman (2003).

goods as the factors of production. The production technology is assumed to have a CES form:

$$Y_t = \left[\alpha\,(A_t N_t)^{-\rho} + (1-\alpha)\,IM_t^{-\rho}\right]^{-1/\rho}\,, \tag{1}$$

where Y_t is aggregate output (GDP), A_t is an exogenous technology variable, N_t is labor input, and IM_t represents imported intermediate goods used in the production of final aggregate output. In recent years nearly 90% of Korea's imports were inputs into production rather than consumption goods. Thus, for simplicity, we follow McCallum and Nelson (1999, 2001) and model imported goods solely as productive inputs; domestic households only consume domestic goods. Notice that in this case, $(1-\alpha)$ can be interpreted as a measure of "openness" of the domestic economy.

The aggregate consumption bundle of the representative household is

$$C_t = \left[\int_0^1 C_t(j)^{(1-\theta)/\theta}\,\mathrm{d}j\right]^{\theta/(1-\theta)}\,,$$

where j indexes the households and θ is the elasticity of substitution across the differentiated goods. The corresponding aggregate price index is:

$$P_t = \left[\int_0^1 P_t(j)^{1-\theta}\,\mathrm{d}j\right]^{1/(1-\theta)}\,.$$

The household also purchases (one-period) bonds, denominated in the domestic currency, B_t, and in the foreign currency, B_t^*. These bonds respectively pay real interest r_t and r_t^* at maturity. Foreign-currency denominated bonds also pay an exogenous risk premium, κ_t.

Thus the household, acting as both a differentiated goods producer and a representative consumer, faces the following intertemporal budget constraint:

$$\begin{aligned}(P_t/P_t^A)(D_t + EX_t) + (W_t/P_t^A)N_t^S + B_t + Q_t B_t^* \\ = C_t + (W_t/P_t^A)N_t^D + Q_t IM_t + B_{t+1}/(1+r_t) + Q_t B_{t+1}^*/(1+r_t^*)(1+\kappa_t)\,.\end{aligned} \tag{2}$$

Domestic production is sold either to domestic consumers (D_t) or exported abroad (EX_t). Households supply labor N_t^S in exchange for the real wage W_t/P_t^A. In addition to purchasing the composite consumption good, as a producer the household (firm) purchases labor services and imported intermediate goods as factors of production. The real exchange rate, Q_t, measures the relative price of foreign goods in terms of domestic production. In equilibrium, the general price level corresponds with the aggregate index of final goods prices set by firms ($P_t^A = P_t$) and labor supply equals labor demand ($N_t^S = N_t^D$).[5]

Agents then maximize the discounted stream of consumption,

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t) \tag{3}$$

subject to the budget constraint in equation (2). Period utility is assumed to have an isoelastic form:

$$U(C_t) = e^{\omega_t} \frac{C_t^{1-\sigma}}{1-\sigma},$$

where ω_t is an exogenous preference (demand) shock. To solve the model, we linearize the first-order conditions from the household's optimization problem around the non-stochastic steady state and impose equilibrium conditions.

The Euler equation for consumption can be expressed in a log-linearized form as:

$$c_t = E_t c_{t+1} - \sigma^{-1} (i_t - E_t \pi_{t+1}) + \nu_t, \tag{4}$$

where σ is the inverse of the intertemporal elasticity of substitution, $(i_t - E_t\pi_{t+1})$ is the *ex ante* real interest rate, and ν_t is a preference shock (a function of ω_t).[6] Domestic real output is the sum of consumption and exports, linearized around the non-stochastic steady-state. We represent exports as a function of the real exchange rate and foreign output, so the domestic output identity can be approximated as:

$$y_t = s_c c_t + (1 - s_c)\eta_q q_t + (1 - s_c)\eta_{y^*} y_t^*, \tag{5}$$

where $s_c = \left(1 - \frac{EX}{Y}\right)$ is the steady-state share of consumption in output.[7] η_q and η_{y^*} are the price and income elasticities of real export demand, respectively.

From the first-order conditions of the household's maximization problem for bond holding, an uncovered interest parity condition can be derived:

$$i_t = i_t^* + E_t \Delta s_{t+1} + \kappa_t, \tag{6}$$

[5] As labor is supplied inelastically by households, we normalize $N^S = 1$. In the flexible price case below, all workers are employed. In the sticky price case, output is demand-determined and generally less than its natural level, thus: $N_t^D \leq N_t^S = 1$.

[6] Lower-case letters are used to signify the logarithmic deviations of variables from their steady-state values.

[7] Capital letters without time subscripts represent steady-state values.

where s_t is the log of the nominal exchange rate, defined as $S_t = Q_t(P_t/P_t^*)$. Both the foreign interest rate, i_t^*, and the risk premium shock, κ_t, are treated as exogenous with respect to the small open economy.

On the supply side, log linearizing equation (1) for production yields:

$$y_t = (1-\delta)(a_t + n_t) + \delta\, im_t\,,$$

where $\delta = (1-\alpha)(IM/Y)^{-\rho}$. In a (symmetric) flexible-price equilibrium, output achieves its "potential" level, $\overline{Y}_t$, which implies that

$$\overline{y}_t = (1-\delta)a_t + \delta\,\overline{im}_t\,. \tag{7}$$

With flexible prices the markup rate will be constant; in conjunction with the first-order condition for import demand by firms yields the following relationship between the (log) real exchange rate and the (log) ratio of imports to GDP:

$$q_t = -(1+\rho)(\overline{im}_t - \overline{y}_t)\,. \tag{8}$$

Equations (7) and (8) imply potential output is determined as:

$$\overline{y}_t = a_t - \left(\frac{1}{1+\rho}\right)\left(\frac{\delta}{1-\delta}\right) q_t\,. \tag{9}$$

Notice that, due to the role of imported goods in production, potential output depends upon the value of the real exchange rate, q_t, as well as an exogenous technology shock, a_t. The output gap is then defined as $\tilde{y}_t = y_t - \overline{y}_t$.

The flexible price equilibrium defines a baseline situation for the model. The firms in our model produce differentiated products that enter positively into the consumption bundle of the representative household, so these firms have market power that allows them to set prices. Following much of the New Neoclassical Consensus literature, we posit that firms do not adjust their prices every period. Although we remain agnostic about the source of such price rigidities, for convenience we adopt the approach of Fuhrer and Moore (1995) for the determination of the aggregate price level and inflation dynamics.

Unlike Fuhrer and Moore (1995), our production function in equation (1) includes both labor and imported intermediate goods. The corresponding unit cost function has the form:

$$C(W_t, P_t^{IM}) = \left[\left(\frac{W_t}{\alpha^{-1/\rho}}\right)^{\rho/(1+\rho)} + \left(\frac{P_t^{IM}}{(1-\alpha)^{-1/\rho}}\right)^{\rho/(1+\rho)}\right]^{(1+\rho)/\rho}\,,$$

where W_t denotes the wage facing the firm and P_t^{IM} denotes of the price of imported intermediate goods. For simplicity, assuming that the wage contracts are fixed for two periods and re-negotiated by one-half of the firm's workers each period (as in Fuhrer and Moore, 1995), the log linear approximation for the markup price charged by a firm can be written in the form

$$p_t = \frac{1}{2}(w_t + w_{t-1}) + \chi p_t^{IM}. \tag{10}$$

In Fuhrer and Moore's two-period labor contacting specification, agents care about relative real wages over the length of the employment contract.[8] As a result, the current contract wage (in real terms) is a weighted average of past and expected future real contract wages — adjusted for excess demand as measured by the output gap:

$$w_t - p_t = \frac{1}{2}\left[(w_{t-1} - p_{t-1}) + E_t(w_{t+1} - p_{t+1})\right] + \phi\,\tilde{y}_t. \tag{11}$$

Combining equations (10) and (11) yields an equation for the dynamics of the domestic inflation rate:

$$\pi_t = \frac{1}{2}(\pi_{t-1} + E_t\pi_{t+1}) + \phi(\tilde{y}_t + \tilde{y}_{t-1}) + \chi(\Delta p_t^{IM} - E_t\Delta p_{t+1}^{IM}). \tag{12}$$

Under complete exchange-rate pass through, $P_t^{IM} = P_t^* \cdot S_t$. We assume that P_t^*, the foreign price of the imported goods, is exogenous with respect to a small open economy like Korea. More generally, we allow for an exogenous deviation from the law of one price, as in Monacelli (2003). Such a specification gives rise to an exogenous shock in equation (12), denoted below by μ_t, that resembles a "cost-push" shock like that cited by Clarida et al. (2001) and others as the source of a meaningful trade-off between output and inflation stabilization. Thus, the equation for inflation dynamics in our model is:

$$\pi_t = \lambda\pi_{t-1} + (1-\lambda)E_t\pi_{t+1} + \phi(\tilde{y}_t + \tilde{y}_{t-1}) + \chi(\Delta s_t - E_t\Delta s_{t+1}) + \mu_t. \tag{13}$$

Notice we also have generalized the relative weights on future and past inflation in this specification, which allows us to examine the robustness of our findings to more general specifications of the relative importance of the forward- and backward-looking components of the inflation process.

To close the model, we again follow McCallum and Nelson (1999) and assume an exogenous AR(1)

[8] Note that wages are still negotiated in nominal terms.

process for foreign output, y_t^*, while assuming foreign prices and interest rates are exogenously held constant. We also assume that shocks to technology, preferences, the risk premium, and inflation (the "cost push" shock) follow exogenous AR(1) processes:

$$
\begin{array}{rcll}
y_t^* &=& \rho_{y^*}\, y_{t-1}^* + \varepsilon_t^{y^*} & \text{Foreign Output} \\
a_t &=& \rho_a\, a_{t-1} + \varepsilon_t^a & \text{Productivity} \\
\nu_t &=& \rho_\nu\, \nu_{t-1} + \varepsilon_t^\nu & \text{Preferences} \\
\mu_t &=& \rho_\mu\, \mu_{t-1} + \varepsilon_t^\mu & \text{"Cost-push" inflation} \\
\kappa_t &=& \rho_\kappa\, \kappa_{t-1} + \varepsilon_t^\kappa & \text{Risk Premium}
\end{array}
$$

The baseline parameter values for the simulations in the next section are based primarily on data and research on the Korean economy. They are discussed in some detail in the appendix.

3 Policy Simulations

Equations (4), (5), (6), (9) and (13), derived from the intertemporal optimizing choices of households in equilibrium, form the basis of the log linearized model that we simulate in this section and the next. These structural equations, as well as the AR(1) processes for the exogenous shocks (and appropriate identities) can be written in the following matrix form:[9]

$$
\mathbf{A}_0\,\mathbf{y}_t = \mathbf{A}_1\,\mathbf{y}_{t-1} + \mathbf{A}_2\,E_t\mathbf{y}_{t+1} + \mathbf{A}_3\,\mathbf{x}_t + \mathbf{A}_4\,E_t\mathbf{x}_{t+1} + \mathbf{A}_5\,\mathbf{v}_t \tag{14}
$$

where $\mathbf{y}_t$ is the $(n\times 1)$ vector of endogenous variables, including the structural disturbances $(a_t, \nu_t, \mu_t, \kappa_t, y_t^*)$.

The $(s \times 1)$ matrix $\mathbf{v}_t$ of independent white-noise forcing shocks $(\varepsilon_t^a, \varepsilon_t^\nu, \varepsilon_t^\mu, \varepsilon_t^\kappa, \varepsilon_t^{y^*})$ is distributed as:

$$
\mathbf{v}_t \sim iid(\mathbf{0}, \mathbf{\Omega}),
$$

in which

$$
\mathbf{\Omega} \equiv \begin{bmatrix} \sigma_a & 0 & 0 & 0 & 0 \\ 0 & \sigma_\nu & 0 & 0 & 0 \\ 0 & 0 & \sigma_\mu & 0 & 0 \\ 0 & 0 & 0 & \sigma_\kappa & 0 \\ 0 & 0 & 0 & 0 & \sigma_{y^*} \end{bmatrix}.
$$

[9]The $\mathbf{A}_j$ matrices are defined conformably, given the equations for the exogenous processes and endogenous variables.

In equation (14), $\mathbf{x}_t$ represents the $(p \times 1)$ vector of policy variables. For most of the simulations below, the central bank is assumed to use the interest rate, i_t, as the sole instrument of policy.[10] The Bank of Korea's policy instrument is a short-term rate. Later we consider alternative policy arrangements in which the exchange rate can be viewed as the primary instrument of monetary policy.

In this model, the central bank chooses the values of the instruments in $\mathbf{x}_t$ to minimize the quadratic loss function:

$$\mathscr{L} = E_0 \sum_{t=0}^{\infty} \beta^t \left[\mathbf{y}_t' \mathbf{W} \mathbf{y}_t + \mathbf{x}_t' \mathbf{Q} \mathbf{x}_t\right], \tag{15}$$

subject to the constraints imposed by the structure of the economy, summarized in equation (14).

We solve the joint intertemporal optimization problem established above by utilizing the approach of Dennis (2003). This technique allows one to find solutions under both optimal discretionary and optimal precommitment policies. Given the relatively recent adoption of inflation targeting in Korea, we find the discretionary case more analogous to the current situation facing the Bank of Korea.[11]

3.1 Simulation Results: Flexible Targeting

To this point, we have not specified the values for the objective function (**W** and **Q** in equation 15). Following other work in this literature, we assume households wish to stabilize output around potential and the inflation rate around a target (normalized to zero). That is, we consider "flexible" targeting regimes. We normalize the weight on inflation in society's loss function to one in the **W** matrix.

Given a specification of the loss function for society, the central bank chooses its policy parameters to minimize this loss function. We allow the central bank to have weights that differ from those of society, as well as various policy instruments and primary targets: our modeling framework can accommodate inflation targeting (IT), nominal income growth targeting (NIGT), and exchange rate management. Each of these three regimes is illustrated in table 1 for two different benchmark values of the relative weight on the output gap in society's objective function.[12]

When society's objective function depends only on inflation (whose weight is normalized to one) and

[10] That is, $p = 1$. Notice that there is no explicit role for monetary aggregates in this model.

[11] Results for the precommitment case are available upon request from the authors. The main advantage of following Dennis (2003) is that alternative approaches, such as Söderlind (1999), do not permit solutions of our model when the inflation dynamics (equation 13) include the change in the nominal exchange rate. For the case $\chi = 0$, we have confirmed that Söderlind's approach can reproduce those found with Dennis's technique.

[12] These values are common reference points in the literature. Because the weights are relative, we scale the central bank's weight on the output gap in each case to coincide with that of society, and solve for the optimal weight on the primary objective of the central bank: inflation, nominal income growth, or the change in the nominal exchange rate. This approach leads to a natural interpretation of the resulting optimal weights for the central bank as "conservative" or not, as discussed below.

Table 1: Optimal Policy: Flexible Targeting Regimes

	Inflation Target		Nominal Income Growth Target		Exchange Rate Target	
Weight on output gap	0.05	0.25	0.05	0.25	0.05	0.25
Optimal central bank weight on target variable	1.48	1.45	0.13	0.43	0.04	0.18
Societal loss	0.441	2.185	4.967	6.801	10.776	12.264

Notes: For inflation and nominal income growth targeting, the nominal short-term interest rate, i_t, is the policy variable, $\mathbf{x}_t$. For exchange rate targeting, the nominal exchange rate, s_t, is the policy variable.

the output gap (with the relative weights given in table 1), the best policy for the central bank (given the parameterized model developed in the previous section) is inflation targeting. The ability of a "conservative" central bank — i.e. one whose relative weight on inflation exceeds that of the societal loss function — to address the time consistency problem inherent under discretionary policy is confirmed here. In contrast with Jensen (2002) or Bae and Ratti (2003), nominal income growth targeting is a less desirable policy in the sense that it results in a larger loss to society. This difference likely is due to the lack of a backward-looking (lagged) component in the output gap specification.[13] If the central bank pegs the exchange rate — in a flexible manner that allows it to respond to fluctuations in the output gap — but does not respond directly to inflation (that is, inflation is not an explicit argument in the central bank's loss function), the loss to society is even larger.

To illustrate why these various policies exhibit such different losses for society in our baseline specification, table 2 shows the standard deviations of the endogenous variables implied by each policy regime. Both nominal income growth targeting and exchange rate targeting are far less successful in stabilizing the inflation rate (annualized here to facilitate comparison with the data) than is inflation targeting; given the relatively large weight on inflation in society's loss function these policies yield substantially higher losses than inflation targeting. Neither nominal income growth targeting nor exchange rate targeting manage to offset the much higher inflation rate with substantially lower volatility in the output gap; indeed; NIGT worsens the variability of both arguments of society's loss function.

In all three policy regimes, placing greater weight on the output gap reveals a "Taylor curve" trade-

[13] McCallum and Nelson (1999) allow for the possibility of habit formation in consumption, which would introduce such persistence. We plan to investigate the consequences of such a specification in subsequent research.

Table 2: Simulation Results: Flexible Targeting Regimes

Standard deviations, reported as percentage deviations from steady-state

	Inflation Target		Nominal Income Growth Target		Exchange Rate Target	
Weight on output gap	0.05	0.25	0.05	0.25	0.05	0.25
$\pi_t \times 4$	0.12	0.60	8.56	8.59	13.10	13.12
$\widetilde{y}_t$	2.99	2.97	3.07	3.03	2.76	2.73
$i_t \times 4$	19.70	19.95	16.81	16.85	19.77	19.88
Δx_t	2.05	2.06	0.35	0.52	3.26	3.29
Δs_t	2.22	2.19	2.62	2.57	1.24	1.32
y_t	2.98	3.00	3.34	3.36	3.71	3.70
$\overline{y}_t$	4.03	4.03	3.99	3.98	3.90	3.90
c_t	2.87	2.88	3.14	3.15	3.27	3.26
q_t	9.08	9.21	10.02	10.17	12.46	12.44

Notes: See table 1 notes.

off between stabilization of the output gap and of inflation. The effect on the variability of the other endogenous variables of increasing the relative weight on the output gap is not uniform, but depends on which policy regime is adopted by the central bank.

3.2 Simulation Results: Exchange Rate Objectives

The previous simulation results involve a high degree of variability in the nominal interest rate, and, to a lesser extent, the exchange rates. As was discussed previously, such situations may be particularly unpalatable in emerging market economies. As a result, we now consider situations in which the volatility of the exchange rate enters the loss functions the central bank or society (or both).

Situations in which the central bank alone possesses an explicit target for the exchange rate are treated as "extrinsic" exchange rate objectives. That is, the reasons why the central bank might target the exchange rate largely reside outside the model. These include signaling or reputation effects: to the extent that movements in the exchange rate may be interpreted by financial markets as indicators of the stance or credibility of monetary policy, the central bank may wish to directly manage exchange rate fluctuations. The potential costs of financial fragility, which may be exacerbated by volatile exchange rates in emerging market economies, are additional motivation for explicit concern about exchange rates by policy makers.[14] While equation (9) does suggest that a large depreciation of the real exchange rate could significantly lower potential output, modeling of the effect of exchange rate crises on the level of output through a credit channel is beyond the scope of this paper and an area for future research.

An alternative theoretical reason for the exchange rate to explicitly enter into the loss function of society (and the central bank) follows from our particular specification of imported intermediate goods in production. We label this an "intrinsic" motivation for a distinct exchange rate objective on behalf of both society and the central bank, as it follows from the model specification. In the canonical New Neo-Classical Synthesis model, the forward-looking nature of the price setting relationship implies stabilization of the variability of the output gap is an important means for stabilization of inflation expectations. In this model, the output gap and the exchange rate (as proxies for marginal costs) both warrant attention from the central bank in order to stabilize inflation expectations. Variability in both measures preclude firms who infrequently adjust prices from achieving their optimal levels of output. Other small open economy models in the literature do not include this channel.

Finally, the recent evidence of "fear of floating" behavior in many emerging market economies (see Calvo and Reinhart, 2002) justifies an investigation of the potential costs of such behavior. Such an analysis can be informative even in the absence of any theoretical justification for such behavior. That is, regardless of the particular reasons why a central bank might care about exchange rate fluctuations, the fact that such behavior does occur warrants further investigation of it.

To this end, table 3 considers the effects of introducing some degree of concern into the objective function of first the central bank and then society. For two common weights on the output gap (0.05 and 0.25), we vary society's weight on exchange rate stabilization from zero to one-half. The parameterizations of the societal objective function are shown in the first two rows of table 3. Given these specifications, the central bank optimally choses both the weight on inflation and the weight on exchange rate stabilization. The case in which the societal weight on the exchange rate equals zero represents cases in which the central bank's motivation for exchange rate smoothing is "extrinsic;" the remaining cases are "intrinsic," in the sense discussed above.

For the "extrinsic" targeting cases, the optimal weight on the exchange rate for the central bank turns out to be quite small. However, as was found in table 1 earlier, the optimal policy has a strongly "conservative" weight on inflation, roughly 50% greater than society's weight of one. As society's concern

[14] Analogously, in recent years the U.S. Federal Reserve has acted in response to domestic stock market crashes or international liquidity crises, yet such events are not a standard part of a tractable theoretical model.

Table 3: Simulation Results: Inflation Targeting Regimes with Exchange Rate Smoothing

Standard deviations reported as percentage deviations from steady-state

	Weights in societal objective function							
$\widetilde{y}$	0.05	0.05	0.05	0.05	0.25	0.25	0.25	0.25
Δs	0.0	0.05	0.25	0.5	0.0	0.05	0.25	0.5
	Optimal weights in central bank's loss function							
π	1.51	1.25	0.89	0.90	1.46	1.41	1.29	1.28
Δs_t	0.001	0.06	0.21	0.44	0.002	0.07	0.30	0.61
	Value of societal loss function							
	0.441	0.677	1.520	2.402	2.185	2.414	3.237	4.104
	Standard deviations of endogenous variables							
$\pi_t \times 4$	0.12	0.37	1.40	2.45	0.60	0.76	1.61	2.56
$\widetilde{y}_t$	2.99	2.98	2.96	2.95	2.97	2.96	2.94	2.93
$i_t \times 4$	19.70	19.68	19.62	19.56	19.70	19.69	19.63	19.57
Δx_t	2.05	2.03	2.00	2.00	2.06	2.04	2.02	2.01
Δs_t	2.22	2.17	1.99	1.81	2.19	2.14	1.97	1.80
y_t	2.98	2.99	3.04	3.09	3.00	3.02	3.06	3.11
$\overline{y}_t$	4.03	4.03	4.02	4.01	4.03	4.02	4.02	4.01
c_t	2.87	2.88	2.90	2.93	2.88	2.89	2.91	2.94
q_t	9.08	9.15	9.38	9.62	9.21	9.26	9.47	9.69

Notes: See table 1 notes.

for exchange rate stability increases, the central bank places progressively less weight on the inflation objective and greater weight on the exchange rate. There is a significant difference between the case in which the weight on the output gap in the loss function (of both society and the central bank) is 0.05 and 0.25: in the latter case, the behavior of the central is “conservative” with respect to both the inflation and exchange rate objectives, in the sense that both central bank's weightings exceed those for society. However, in the former case the optimal policy calls for the central bank to act more like a “dove” than a “hawk” towards both variables for the cases in which the weight on Δs in society's loss function exceeds 0.05. We explore this aspect further in the next subsection.

Not surprisingly, the more weight that is placed on objectives other than inflation, the more volatile is the inflation rate. While adding additional weight to either the output gap or exchange rate smoothing objectives results in slightly less variation in both of these variables, the effect is small relative to the increase in inflation volatility. As a result, the value of the loss function rises.

Table 4: Effect of Variation in Inflation Expectation Formation on Optimal Policy, Extrinsic Cases

λ	0	0.2	0.5	0.8	1
			0.05 weight on output gap, $\widetilde{y}$		
Optimal weight on π	1.35	1.63	1.51	1.47	1.33
Optimal weight on Δs_t	0.00	0.00	0.00	0.01	0.03
Societal Loss	0.441	0.441	0.441	0.438	0.436
			0.25 weight on output gap, $\widetilde{y}$		
Optimal weight on π	1.34	1.63	1.46	1.32	1.06
Optimal weight on Δs_t	0.00	0.00	0.00	0.03	0.11
Societal Loss	2.202	2.206	2.185	2.129	2.067

3.3 Simulation Results: Robustness

The specification of the dynamics of inflation ought to play a fundamental role in the determination of the optimal monetary policy regime. In this section we investigate the sensitivity of the coefficients in the optimal policy to variation in two key parameters of equation (13).

First we examine variation in λ, the coefficient on the lagged inflation rate in equation (13). The Fuhrer and Moore (1995) model of two-period staggered wage setting results in a value of one-half for λ. Alternative specifications of the nature of price setting yield equations similar in structure to equation (13), but with different values for λ. For example, forward-looking firms in a Calvo model of optimal price setting yield a New Keynesian Phillips Curve with $\lambda = 0$. If some firms are assumed to be "rule-of-thumb" price setters in this framework, values of λ greater than zero can arise. For example, Galí and Gertler (1999) estimate a "hybrid" New Keynesian Phillips Curve and find empirical support for $\lambda \approx 0.2$.

Table 4 reports the sensitivity of the optimal policy weights and the resulting minimized value of the societal loss function as λ varies between 0 and 1. In table 4 we presume the objective function for society includes only inflation and the output gap. The central bank is allowed to engage in smoothing the exchange rate based on "extrinsic" concerns — although it chooses to place a non-trivial weight on this objective only in the case in which price setters are primarily backward-looking. As λ rises from zero to one, the societal loss function evaluated at the optimal policy declines slightly, suggesting that it is easier for an optimizing central bank under discretion to stabilize inflation expectations (in particular) the larger the proportion of "rule of thumb" price setters. Moreover, as λ rises, the optimal weight on the "extrinsic" exchange rate objective rises as well, albeit to very low levels.

Table 5 considers two possible "intrinsic" cases for exchange rate stabilization in which society places

Table 5: Effect of Variation in Inflation Expectation Formation on Optimal Policy, Intrinsic Cases

λ	0	0.2	0.5	0.8	1
			0.05 weight on $\tilde{y}$ and Δs		
Optimal weight on π	1.15	1.41	1.25	1.28	1.33
Optimal weight on Δs_t	0.06	0.07	0.06	0.05	0.05
Societal Loss	0.671	0.673	0.677	0.679	0.680
			0.25 weight on $\tilde{y}$ and Δs		
Optimal weight on π	1.18	1.37	1.29	1.32	1.45
Optimal weight on Δs_t	0.30	0.34	0.30	0.26	0.21
Societal Loss	3.141	3.177	3.237	3.291	3.315

equal weight on stabilizing both the output gap and the exchange rate. In general, the optimal behavior of the central bank is to be "conservative" with respect to both the inflation rate and exchange rate objectives regardless of the value of λ. As above, the greater the relative weight society places on stabilizing the exchange rate, the less "conservative" the optimal central bank policy with respect to inflation. Qualitatively, tables 4 and 5 confirm that the nature of the optimal policy is largely invariant to the degree of forward- or backward-looking behavior in inflation.

The second parameter whose variation we examine in more detail is χ. This parameter is an increasing (non-linear) function of the measure of openness, α, and the degree of exchange rate pass through. For concreteness, we consider variation in χ between zero and one, which should be thought of as reflecting changes in the exchange rate pass-through coefficient for a given α.[15]

In figure 1 we plot the effect of varying χ in the baseline model, *ceteris paribus*, for a societal loss function with a weight of one on inflation and 0.25 on the output gap. The optimal policy for the central bank searches over weights for both the inflation rate and the exchange rate, although the latter are generally quite small; for values of χ between roughly 0.18 and 0.75 they are effectively zero. The most significant finding in figure 1 is the non-linear effect of varying the degree of exchange rate pass-through on the optimal weight on inflation for the central bank (acting under discretion). In particular, over moderate ranges of pass-through (from 0.2 to nearly 0.4), the central bank can minimize the social loss function by behaving more like a "dove" on inflation — choosing a weight less than one — than as a "hawk" (relative to society's preferences for inflation stabilization). But as χ increases from one-third to one-half, the optimal weight on inflation more than doubles: from below 0.8 to above 1.6. In other words,

[15]Recall that δ in equation (9), which is held fixed for these experiments, also is a function of α.

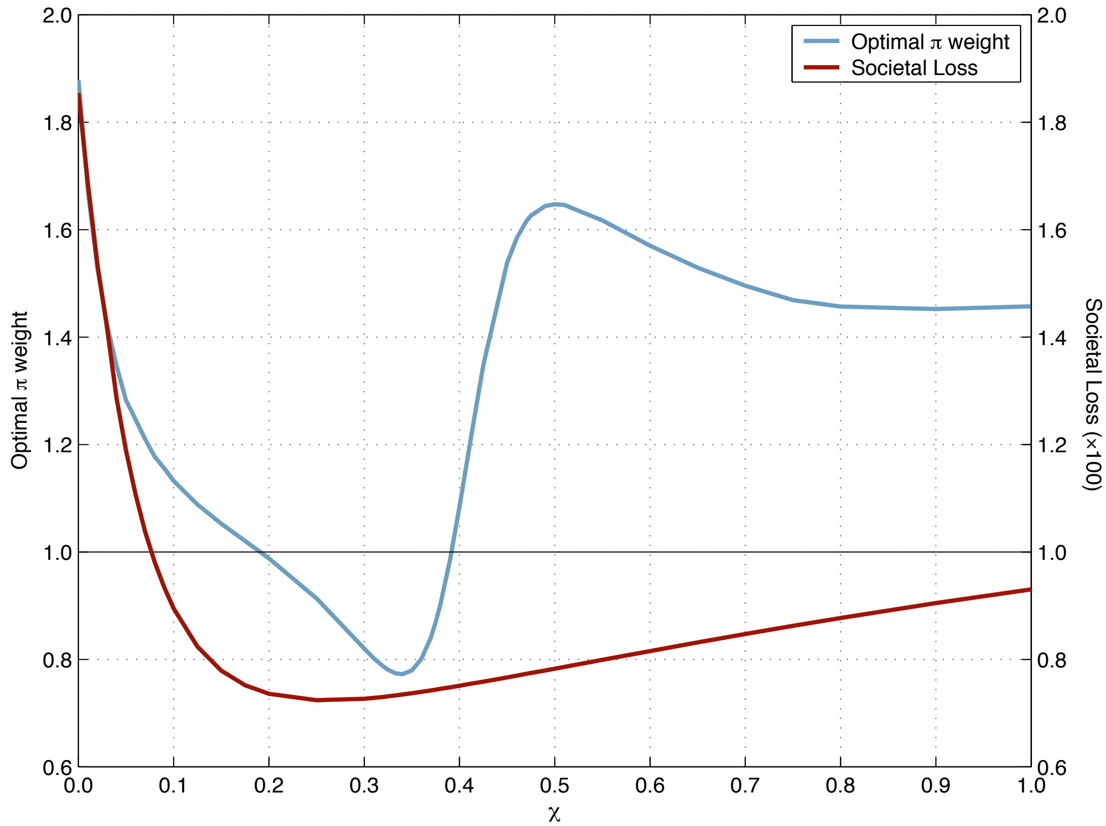

Figure 1: Optimal Policy and Loss Evaluation as a function of Exchange-Rate Pass Through

over a fairly small range of the exchange-rate pass-through parameter, the nature of optimal monetary policy changes dramatically. Quantitatively similar results occur with a weight of 0.05 on the output gap.

As society places greater relative weight on the exchange rate stabilization objective, the region corresponding to the inflation "dove" behavior gets smaller — but never disappears completely in the neighborhood of $\chi = 0.2$ to 0.3. However, in the 0.4 to 0.6 range, these results also imply extraordinarily high relative weights on inflation for the optimal policy: often in the range of 2 to 5.

The main implication of this experiment is that the specification of optimal policy very sensitive to small variation in the degree of exchange-rate pass through (or, more generally, the combination of pass-through and the degree of openness). Since accurately estimating the extent of exchange-rate pass through is difficult, and its value may change over time (or across states of nature), these results suggest a much more complicated problem exists for policy makers in small open economies — even in the absence of an explicit role for the exchange rate in society's objective function. As with Monacelli (2003), these results stand in contrast to the "isomorphism" result of Clarida et al. (2001).

4 Conclusions

In contrast with more industrialized economies that have adopted inflation targeting, many emerging market economies (EMEs) have only limited experience with inflation targeting. Korea was among the first of the emerging markets to implement an explicit inflation target, following the Financial Crisis of late 1997. In the years since, many Korean macroeconomic aggregates, including inflation, were more volatile than they were prior to the Crisis. We develop and simulate a dynamic stochastic equilibrium model for a small open economy, calibrated to Korean data, to investigate the effects of various targeting regimes. In contrast with some other findings in the literature, we find inflation targeting to be substantially better at minimizing fluctuations that adversely impact social welfare relative to nominal income growth targeting and exchange rate targeting.

For many EMEs, recent research suggests that "fear of floating" is an important aspect of monetary policy. Anecdotal evidence suggests that Korean officials have been concerned about the value of the won since the Crisis, and have been active in stabilizing the currency. Moreover, our model of production, in which imports serve as intermediate goods, can motivate an explicit concern for the value of the currency in an inflation targeting regime. We investigate the implications of such factors in an optimizing policy framework and find that inflation targeting is still preferred to other policy regimes, even when society places as much weight on stabilizing the exchange rate as it does on stabilizing inflation.

For baseline parameter values, the optimal inflation targeting policy for a discretionary central bank in our small open economy model is to behave more "conservatively" than society with respect to both inflation and the exchange rate — that is, to assign greater weight to these objectives for its loss function than society does. The nature of these results is insensitive to the degree of inflation persistence built into the open-economy price setting relationship through backward-looking ("rule-of-thumb") inflation expectations. However, changes in the degree of exchange rate pass through in this equation have a significant non-linear effect on the specification of optimal policy. In particular, for a model otherwise calibrated to the baseline parameter values, a range of moderate values for the pass through coefficient result in optimal policy being characterized as the discretionary central bank pursuing a less aggressive stance on inflation vis-à-vis the preferences of society. Moreover, the optimal weight on inflation doubles — and shifts from an inflation "dove" to a "hawk" — over a very narrow range of values for the degree of exchange rate pass through. We interpret these findings to suggest that, for emerging market economies, inflation targeting should not be perceived — nor posited — as a "one-size-fits-all" policy.

A Appendix: Parameter Values

Baseline parameter values for the model are based primarily on Korean data and sources. The elasticity between domestic goods and imported goods in the production function (ρ) is set to 5 so as to produce variability of the model economy comparable with that in the data from 1987Q2 to 2000Q4. In line with the literature, the time discount rate (β) and coefficient of relative risk aversion (σ) are assigned values of 0.99 and 5, respectively.[16] Following Park and Shin (2000), we set the mark-up ratio ($\frac{\theta}{\theta-1}$) to 11% so that the elasticity of demand for consumption varieties (θ) equals 10.09. The average of the import share of GDP ($Q(\frac{IM}{Y})$) over this period was equal to 0.20, implying that $\delta = (\frac{\theta}{\theta-1}) \times Q(\frac{IM}{Y}) \approx 0.222$. During the same period, the average consumption share of GDP (s_c) was 0.786.

The elasticity of exports to the real exchange rate (η_q) is set to 0.538, following Lee and Kim (1991). They estimated an export equation by regressing export volume on the real exchange rate and control variables. The estimated elasticity does not reflect changes in the price (implying this is its maximum possible value). We set the elasticity of exports to foreign income (η_{y^*}) to 1, in light of the fact that exports have a sizable effect on the Korean economy.

The coefficient on lagged inflation in the price-setting equation, λ, is set to 0.5 per Fuhrer and Moore (1995). In section 3 we test the sensitivity of this assumption by varying λ from 0 to 1. The coefficient of the output gap in the Phillips curve (ϕ) is set to 0.086 as in McCallum and Nelson (2001). The import price component of the Phillips curve, χ, represents the degree of pass-through, and is a function of the production parameter, ρ, and the degree of openness, α. In our baseline parameterization we set χ to 0.79 to coincide with the estimates from Choi (2000), who estimated the coefficient of the exchange rate in the import price equation. In section 3, we consider variation in χ between 0 to 1 as a sensitivity test.

Following Nam and Pyo (1997), we specify domestic and foreign technological shock processes such that AR(1) coefficient of the domestic technology shock (ρ_a) is given as 0.89, and that of the foreign output (technology) shock (ρ_{y^*}) as 0.81. We parameterize the standard deviations of the domestic (σ_a) and foreign technological shocks (σ_{y^*}) to equal 0.02 and 0.0075, respectively. The AR(1) coefficient on the preference shock process (ρ_v) is set to 0.3 and its standard deviation (σ_v) to 0.01. Those values are close to values reported by McCallum and Nelson (1998). The AR(1) coefficient of risk premium process (ρ_κ) is set to 0.50 and its standard deviation (σ_κ) to 0.04, as in McCallum and Nelson (1999). The cost-push shock process, μ_t, is assumed to be white noise (i.e. $\rho_\mu = 0$) and we set its standard deviation (σ_μ)

[16] The optimal policy results are fairly insensitive to the value of σ.

Table A.1: Baseline Parameter Values for Model Simulation

Parameter	*Description*	*Value*
β	Time discount rate	0.99
σ	Coefficient of relative risk aversion	5
θ	Elasticity of demand for consumption varieties	10.09
ρ	Production elasticity between domestic and imported goods	5
$Q\left(\frac{IM}{Y}\right)$	Import share of GDP	0.20
δ	$\left(\frac{\theta}{\theta-1}\right)\cdot Q\left(\frac{IM}{Y}\right)$	0.222
s_c	Consumption share of GDP	0.786
η_q	Elasticity of exports to real exchange rate	0.538
η_{y^*}	Elasticity of exports to foreign income	1
λ	Weight on lagged and expected future π_t in Phillips Curve	0.5
ϕ	Slope of Phillips curve	0.086
χ	Import price component of Phillips Curve	0.79
ρ_a	AR(1) coefficient of productivity process, a_t	0.89
ρ_ν	AR(1) coefficient of preference process, ν_t	0.30
ρ_μ	AR(1) coefficient of cost-push inflation process, μ_t	0
ρ_κ	AR(1) coefficient of risk premium process, κ_t	0.50
ρ_{y^*}	AR(1) coefficient of foreign income process, y_t^*	0.81
σ_a	Standard deviation of productivity shock, ε_t^a	0.02
σ_ν	Standard deviation of preference shock, ε_t^ν	0.01
σ_μ	Standard deviation of cost-push inflation shock, ε_t^μ	0.0015
σ_κ	Standard deviation of risk premium shock, ε_t^κ	0.04
σ_{y^*}	Standard deviation of foreign output shock, $\varepsilon_t^{y^*}$	0.0075

to 0.015, as in Jensen (2002).

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