MONETARY POLICY IN A SMALL EMERGING ECONOMY: EXPLORING DESIRABLE INTEREST RATE RULES

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ABSTRACT

There is a considerable recent literature that examines what interest rate rules work best for industrial countries. Relatively little research, however, has been undertaken to investigate the suitability of different rules for emerging countries that confront a different mix of shocks and face greater dangers from both inflation and exchange rate targeting. This paper explores desirable monetary policy rules for a small emerging economy like Pakistan, which is fairly well integrated with the global financial market, and has reasonably well-developed institutions to implement monetary policy rules. A stochastic dynamic general equilibrium model representative of such an economy is used to compare and evaluate the performance of alternative interest rate rules in response to different shocks. The relative performance of the rules is shown to depend on the criterion used for evaluation and on the type of shocks that the economy experiences. The paper also identifies conditions under which a vigorous inflation targeting policy is desirable even in the presence of concerns about exchange rate variability (fear of floating).

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1. Introduction

Over the past three decades, there have been significant developments in the monetary policy pursued by industrial countries. After experiencing high inflation rates in the 1970's, industrial economies followed a policy of reducing inflation rates in the 1980's and maintaining low rates afterwards. Many European countries used fixed exchange rates to control inflation. Other industrial countries followed a policy of flexible exchange rates backed by an explicit or implicit targeting of inflation. This policy was implemented by the use of the short-term interest rate as the key instrument.

There has been much research on how the interest rate should respond to inflation and other macroeconomic variables. This research has been stimulated by the recent development of new Keynesian models that introduce nominal rigidities and imperfect competition in a dynamic general equilibrium framework with strong theoretical foundations. In these models, monetary policy can be represented by simple rules that specify the reaction of the interest rate as a function of a few macroeconomic variables.[1] There is an extensive and growing literature that explores the optimal form of the interest rate rule.[2] The precise form of the optimal rule depends on the specification of the macroeconomic environment. It is generally agreed, however, that a rule in which the interest rate responds sufficiently strongly to deviations of the inflation rate from its target level and reacts to other macro variables (such as output gap) works well, and such policy has contributed to improved macroeconomic performance of industrial countries.[3]

[1] See Svensson (2002), however, for a criticism of such instrument rules.
[2] See, for example, Gali and Monacelli (2002), Kollmann (2002), Smets and Wouters (2002), Laxton and Pesenti (2003), and Ambler, Dib and Rebei (2004).
[3] The evidence for the United States is discussed by Clarida, Gali and Gertler (2000).

There is less agreement on what monetary policy is appropriate for emerging economies that have liberalized capital flows and have become increasingly integrated with the global financial market. These economies do not have as well-developed financial institutions as industrial countries. They are also subject to more volatile shocks, especially external financial shocks that affect capital flows. These features make fixed exchange rates unattractive for emerging countries since vulnerability of financial institutions and exposure to large external financial shocks can make them prone to currency crises. Emerging countries may also fear floating exchange rates because large exchange rate swings can cause loss of credibility in international capital markets and lead to disruption of capital flows.[4]

There has not been much discussion about what kind of interest rate rule is desirable for emerging economies in the presence of fear of floating considerations. An important issue is how the response of the interest rate to inflation and output gap affects exchange rate variability and whether a weaker interest rate reaction to these variables would reduce exchange rate fluctuations. A related question is whether monetary policy should smooth exchange rates by adjusting interest rates directly in response to exchange rate changes.

This paper explores these issues using a stylized stochastic general equilibrium model for an emerging economy like Pakistan. The model incorporates key features of the new open economy macroeconomic models and allows for nominal rigidities in both goods and labor markets.[5] Quantitative analysis of the model is used to assess the performance of several interest rate rules, which differ in their response to inflation,

[4] See Calvo and Reinhart (2000, 2002).
[5] Stickiness in both prices and wages leads to a tradeoff between inflation and output. See Erceg, Henderson and Levin (2000)

output gap and exchange rate change. In evaluating these rules, we consider a number of indicators of macroeconomic performance including an index of representative agent's welfare. We examine how well a rule performs in response to different shocks. The theoretical framework is described in Section 2. Section 3 performs the quantitative analysis and Section 4 concludes the paper.

2. Theoretical Framework

2.1 Basic Setup

This section develops a simple dynamic general equilibrium model for a small emerging economy. To keep the analysis simple, the model assumes that there is no capital accumulation and no intermediate goods. Monetary policy is assumed to use the short term interest rate as its instrument, and money is not introduced explicitly in the model. As the paper does not address fiscal policy issues, government expenditures and taxes are not explicitly modeled.

There are two countries, a small home country (representing an emerging economy) and a large foreign country. An asterisk is used to denote foreign variables. One variable input, labor, is used in each country to produce a traded and a nontraded good. There are many households and firms in both economies. To introduce nominal rigidities in both labor and goods markets, it is assumed that each household supplies a differentiated labor service and each firm a differentiated product variety under monopolistic competition, and that both wages and prices are subject to adjustment costs.

Households trade a short-term foreign bond denominated in foreign currency to borrow or lend internationally. International borrowing or lending is unrestricted but

subject to a transaction cost that increases in foreign debt.[6] This cost could also be considered a function of exchange rate volatility. Although we do not model this relation explicitly, it could potentially provide a motivation for fear of floating.

2.2 Consumption and Production

The household's aggregate consumption basket is given by

$$C_t = \left[\chi_N^{1/\gamma} C_{N,t}^{(\gamma-1)/\gamma} + \chi_T^{1/\gamma} C_{T,t}^{(\gamma-1)/\gamma} \right]^{\gamma/(\gamma-1)}, \tag{1}$$

where $C_{N,t}$ and $C_{T,t}$ are consumption indexes for the differentiated nontraded and traded goods, $\chi_N + \chi_T = 1$, and γ is the elasticity of substitution between the traded and nontraded goods. The consumption index for the differentiated traded good is

$$C_{T,t} = \left[\chi_{TH}^{1/\eta} C_{TH,t}^{(\eta-1)/\eta} + \chi_{TF}^{1/\eta} C_{TF,t}^{(\eta-1)/\eta} \right]^{\eta/(\eta-1)}, \tag{2}$$

where $C_{TH,t}$ and $C_{TF,t}$ are consumption bundles of home and foreign varieties of the traded good, and $\chi_{TH} + \chi_{TF} = 1$, and η represents the elasticity of substitution between the two bundles.

Assume that there is a continuum of varieties in the unit interval for each good. The consumption bundle for the nontraded good is an aggregate of its varieties, indexed by $n \in [0,1]$, and is defined as

$$C_{N,t} = \left[\int_0^1 C_{N,t}(n)^{(\sigma-1/\sigma} dn \right]^{\sigma/(\sigma-1)}, \tag{3}$$

where σ is the elasticity of substitution between any pair of varieties. Similarly, the consumption aggregates of home and foreign varieties of the traded good, indexed by $h,\ f \in [0,1]$, are

[6] Such a cost ensures that the model converges to a deterministic steady state with zero net foreign assets.

$$C_{TH,t} = \left[\int_0^1 C_{TH,t}(h)^{(\sigma-1/\sigma} dh \right]^{\sigma/(\sigma-1)}, C_{TF,t} = \left[\int_0^1 C_{TF,t}(f)^{(\sigma-1/\sigma} df \right]^{\sigma/(\sigma-1)} \quad . \tag{4}$$

Optimal allocation of consumption expenditure between the nontraded and traded goods, between the home and foreign bundles of traded goods, and among different varieties of each product category leads to the following demand functions:

$$C_{N,t} = \chi_N C_t (P_{N,t} / P_t)^{-\gamma}, \quad C_{T,t} = \chi_T C_t (P_{T,t} / P_t)^{-\gamma}, \tag{5}$$

$$C_{TH,t} = \chi_{TH} C_{T,t} (P_{TH,t} / P_{T,t})^{-\eta}, \quad C_{TF,t} = \chi_{TF} C_{T,t} (P_{TF,t} / P_{T,t})^{-\eta}, \tag{6}$$

$$C_{N,t}(n) = C_{N,t}(P_{N,t}(n) / P_{N,t})^{-\sigma}, \tag{7}$$

$$C_{TH,t}(h) = C_{TH,t}(P_{TH,t}(h) / P_{TH,t})^{-\sigma}, \quad C_{TF,t}(f) = C_{TF,t}(P_{T,t}(f) / P_{TF,t})^{-\sigma}, \tag{8}$$

where $P_{N,t}(n)$, $P_{TH,t}(h)$, and $P_{TF,t}(f)$ are the prices of a variety of nontraded, home traded and foreign traded goods; P_t and $P_{T,t}$ are the cost-minimizing price indexes for the aggregate basket (1) and the traded goods consumption bundle (2) ; and $P_{N,t}$, $P_{TH,t}$ and $P_{TF,t}$ are the corresponding price indexes for nontraded and traded goods categories defined in (3) and (4). Similarly, foreign optimal allocation between different categories of consumption goods yields the following foreign demand function for home goods:

$$C^*_{TH,t} = \chi^*_{TH} C^*_{T,t} (P^*_{TH,t} / P^*_{T,t})^{-\eta}, \quad C^*_{TH,t}(h) = C^*_{TH,t}(P^*_{TH,t}(h) / P^*_{TH,t})^{-\sigma}. \tag{9}$$

The home price indexes are defined as

$$P_t = \left[\chi_N P_{N.t}^{1-\gamma} + \chi_T P_{T,t}^{1-\gamma} \right]^{1/(1-\gamma)}, \quad P_{T,t} = \left[\chi_{TH} P_{TH,t}^{1-\eta} + \chi_{TF} P_{TF,t}^{1-\eta} \right]^{1/(1-\eta)}, \tag{10}$$

$$P_{N,t} = \left[\int_0^1 P_{N,t}(n)^{1-\sigma} dn \right]^{1/(1-\sigma)}, \tag{11}$$

$$P_{TH,t} = \left[\int_0^1 P_{TH,t}(h)^{1-\sigma} dh \right]^{1/(1-\sigma)}, \quad P_{TF,t} = \left[\int_0^1 P_{TF,t}(f)^{1-\sigma} df \right]^{1/(1-\sigma)}. \tag{12}$$

For home firms producing the nontaded and traded goods, the technology is given by the following production functions:

$$Y_{N,t} = A_N L_{N,t}, \quad Y_{T,t} = A_T L_{T,t}, \tag{13}$$

where $Y_{N,t}$, $L_{N,t}$ and A_N represent output, a bundle of labor inputs and an index of labor productivity for the nontraded good, and $Y_{T,t}$, $L_{T,t}$ and A_T are the corresponding variables for the home traded good. The labor input bundle is an aggregate of differentiated services supplied by a continuum of households in the unit interval. The aggregate index of labor services, indexed by $l \in [0,1]$, in each sector is defined as

$$L_{N,t} = \left[\int_0^1 L_{N,t}(l)^{(\varepsilon-1/\varepsilon}\, dl\right]^{\varepsilon/(\varepsilon-1)}, \quad L_{T,t} = \left[\int_0^1 L_{T,t}(l)^{(\varepsilon-1/\varepsilon}\, dl\right]^{\varepsilon/(\varepsilon-1)}, \tag{14}$$

where ε is the substitution elasticity for labor services. The optimal allocation of the aggregate labor input among different services in the two sectors gives the total demand for each household's service, $L_t(l) = L_{N,t}(l) + L_{T,t}(l)$, as

$$L_t(l) = L_t(W_t(l)/W_t)^{-\varepsilon}, \tag{15}$$

where $L_t = L_{N,t} + L_{T,t}$, and W_t represents a wage index defined as

$$W_t = \left[\int_0^1 W_t(l)^{1-\varepsilon}\, dl\right]^{1/(1-\varepsilon)}. \tag{16}$$

The marginal costs in the two sectors are given by

$$MC_{N,t} = W_t / A_N, \quad MC_{T,t} = W_t / A_T. \tag{17}$$

2.3 Households

The utility of an infinitely-lived household is assumed to be

$$U_t = E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} \left(\frac{C_\tau^{1-\theta}(l)}{1-\theta} - \frac{\psi L_\tau^{1+\mu}(l)}{1+\mu} \right), \tag{18}$$

where $C_\tau(l)$ is the household's aggregate consumption. Households hold domestic and foreign bonds. Domestic bonds are denominated in home currency while foreign bonds are denominated in foreign currency. Only foreign bonds are use for international borrowing or lending and their holding is subject to a transaction cost. There are also adjustment costs associated with wage changes. Household budget constraint is given by

$$\begin{aligned} &B_{t+1}(l) + S_t B^*_{t+1}(l) = (1+R_{t-1})B_t(l) + S_t(1+R^*_{t-1})(1-TC_{t-1})B^*_t(l) \\ &+ W_t(l)L_t(l)(1-AC_{W,t}(l)) + PF_t(l) - P_t C_t(l), \end{aligned} \tag{19}$$

where $B_t(l)$ and $B^*_t(l)$ are home and foreign bonds held by households at the beginning of period *t*; S_t is the exchange rate; R_{t-1} and R^*_{t-1} are the home and foreign interest rates for a loan in period $t-1$ (paid at the beginning of period t); TC_{t-1} is the transaction cost for foreign borrowing or lending in period $t-1$; $PF_t(l)$ is the household's share of profits; and $AC_{W,t}(l)$ is the household's cost of adjusting wages. The wage adjustment costs (as a proportion of wage income) are assumed to be given by the following quadratic function:

$$AC_{W,t}(l) = \frac{\omega_W}{2}\left(\frac{W_{L,t}(l)}{W_{L,t-1}(l)} - 1\right)^2. \tag{20}$$

Each household chooses consumption and sets the wage rate to maximize lifetime utility (18) subject to the budget constraint (19) and labor demand (15). The household optimization yields the following first order conditions:

$$\frac{\beta C_t(l)^\theta P_t}{C_{t+1}(l)^\theta P_{t+1}} = \frac{1}{1+R_t}, \tag{21}$$

$$\frac{S_t}{S_{t+1}} = \frac{(1+R^*_t)(1-TC_t)}{1+R_t}, \tag{22}$$

$$(\varepsilon-1)(1-AC_{w,t}(l))W_t(l)=\varepsilon\psi L_t^{\mu}P_t/C_t^{-\theta}-W_t^2(l)\partial AC_{W,t}(l)/\partial W_t(l)$$
$$-[(W_t(l)W_{t+1}(l)L_{t+1})/((1+R_t)L_t)]\partial AC_{W,t+1}(l)/\partial W_t(l). \tag{23}$$

2.4 Firms

Each firm takes the demand for its variety as given and sets prices to maximize the present discounted value of profits. Price changes are subject to adjustment costs. Price adjustment costs (as a proportion of profits) for nontraded and traded goods are of the same form as wage adjustment costs, and are given by the following quadratic functions:

$$AC_{N,t}(n)=\frac{\omega_P}{2}\left(\frac{P_{N,t}(n)}{P_{N,t-1}(n)}-1\right)^2,\quad AC_{T,t}(h)=\frac{\omega_P}{2}\left(\frac{P_{TH,t}(h)}{P_{TH,t-1}(h)}-1\right)^2, \tag{24}$$

where the adjustment cost parameter, ω_P, is assumed to be same for both sectors.

For a firm producing the nontraded good and facing the demand function given in (7), profits in each period equal

$$PF_{N,t}(n)=(P_{N,t}(n)-MC_{N,t})C_{N,t}(P_{N,t}(n)/P_{N,t})^{-\varepsilon}(1-AC_{N,t}(n)). \tag{25}$$

Let $D_{t,\tau}$ denote the rate used to discount τ-period values at period t. The firm chooses $P_{N,\tau}(n)$ to maximize $\sum_{\tau=t}^{\infty}D_{t,\tau}PR_{N,\tau}(n)$. The optimal price at t satisfies the following first-order condition:

$$(1-AC_{N,t}(n))[(\sigma-1)P_{N,t}(n)-\sigma MC_{N,t}]=-P_{N,t}(n)(P_{N,t}(n)-MC_{N,t})\partial AC_{N,t}(n)/\partial P_{N,t}(n)$$
$$-[P_{N,t}(n)(P_{N,t+1}(n)-MC_{N,t+1})C_{N,t+1})/((1+R_t)C_{N,t})]\partial AC_{N,t+1}(n)/\partial P_{N,t}(n). \tag{26}$$

Firms producing the traded good are able to price discriminate between the home and foreign markets. For simplicity, we assume that prices in both markets are set in

terms of the home currency. Let $P'_{TH,t}(h) = S_t P^*_{TH,t}(h)$ denote the price of a home variety set for the foreign market. Profits of a firm in the traded good sector are then given by

$$\begin{aligned} PF_{T,t}(h) &= (P_{TH,t}(h) - MC_{T,t})C_{TH,t}(P_{TH,t}(h)/P_{TH,t})^{-\varepsilon}(1 - AC_{P,t}(h)) \\ &+ (P'_{TH,t}(h) - MC_{TH,t})C^*_{TH,t}(P'_{TH,t}(h)/P'_{TH,t})^{-\varepsilon}(1 - AC'_{P,t}(h)), \end{aligned} \tag{27}$$

where $AC'_{P,t}$ is the adjustment cost for the foreign-market price analogous to (24) and $P'_{TH,t}$ is the price index for the bundle of home varieties sold abroad. The first-order conditions for the firm's choice of optimal prices are similar to (26) and imply that $P'_{TH,t}(h) = P_{TH,t}(h)$.

2.5 Monetary Policy and Stochastic Environment

We assume that the monetary authority targets inflation and uses the interest rate as its instrument. We consider a simple case, in which the target rate of inflation equals zero and the monetary policy response is described by the following interest rate rule:

$$R_t = \bar{R} + \alpha_1 \log(P_t / P_{t-1}) + \alpha_2 \log(Y_t / \bar{Y}) + \alpha_3 \log(S_t / S_{t-1}), \tag{28}$$

where $\bar{R}$ and $\bar{Y}$ are the steady-state values of the interest rate and output. In addition to to inflation targeting, this rule also allows for output stabilization and exchange rate smoothing. Since the exchange rate depreciation and inflation rates are related, the response to depreciation also affects the reaction to the inflation. Letting Q_t $(\equiv S_t P^*_t / P_t)$ denote the real exchange rate and assuming that the foreign rate of inflation equals zero, we have: $\log(S_t / S_{t-1}) = \log(Q_t / Q_{t-1}) + \log(P_t / P_{t-1})$. Using this relation, we can express the rule (28) as

$$R_t = \bar{R} + (\alpha_1 + \alpha_3)(\log(P_t / P_{t-1}) + \alpha_2 \log(Y_t / \bar{Y}) + \alpha_3(\log(Q_t / Q_{t-1}). \tag{29}$$

As (29) shows, while α_3 captures the reaction to both depreciation and inflation, α_1 represents a response only to inflation.

A wide variety of external and internal stochastic shocks can be added to the model. Here we highlight three shocks that appear to be especially important for emerging economies. These shocks represent a financial shock to the uncovered interest rate parity (22), a real shock to productivity in the traded goods sector, and a real shock to demand for exports. The interest rate parity shock is introduced by defining the international financial transactions cost in (19) and (22) as

$$1 - TC_t = (1 - \overline{TC}_t) X_{1t}, \tag{30}$$

where X_{1t} represents a stochastic variable, and $\overline{TC}_t$ is a function of net foreign assets.[7] The other two shocks are included in the model by letting A_T in (13) and χ^*_{TH} in (9) be random variables as follows:

$$A_{T,t} = \overline{A}_T X_{2t}, \tag{31}$$

$$\chi^*_{TH,t} = \overline{\chi}^*_{TH} X_{3t}. \tag{32}$$

The three stochastic variables, X_{1t}, X_{2t} and X_{3t}, are assumed to follow an AR(1) process:

$$X_{it} = \rho_i X_{it-1} + u_{it}, \; i = 1, 2, 3. \tag{33}$$

[7] Following Laxton and Pesenti (2003), we assume that the transaction cost is the following function of the real value of net foreign assets:

$$\overline{TC}_t = \phi_1 \frac{\exp(\phi_2 S_t B_t^* / P_t) - 1}{\exp(\phi_2 S_t B_t^* / P_t + 1}$$

3. Quantitative Analysis

3.1 Parameter Values and Model Solution

Table 1 shows the values chosen for various parameters of the model. The steady-state values of consumption (C_t), labor supply (L_t), the wage rate (W_t), various home prices (P_t, $P_{N,t}$, $P_{T,t}$, $P_{TH,t}$ and $P_{TF,t}$), and the exchange rate (S_t) are all normalized to equal 1.0. Under this normalization, χ_N and χ_T represent the steady-state shares of nontraded and traded goods in aggregate consumption while χ_{TH} and χ_{TF} are the steady-state shares of home and foreign goods in traded goods. We assume that $\chi_N = 0.6$, $\chi_T = 0.4$, and $\chi_{TH} = \chi_{TF} = 0.5$.[8] Since aggregate expenditures equal GDP in steady state, these assumptions imply that in the long run, traded goods would account for 40% of GDP while imports (or exports) would equal 20% of GDP.[9] These values are representative of Pakistan's economy.[10]

The elasticity of substitution between traded and nontraded goods (γ) is generally considered to be close to one, and we assume that this value equals 1.1. The substitution elasticity between home and foreign traded goods (η) is set equal to 2.0, which represents the lower end of the range of estimates for this parameter in the literature. We choose a value of 5.0 for the substitution elasticity for varieties of each product category (σ). This value implies a mark up of 1.25, which is slightly above the estimates of mark

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[8] As there is balanced trade in steady state, the steady state value of $\chi^*_{TH} C^*_{T,t}$ equals 0.2.

[9] The real GDP in the model can be expressed as $G_t = (P_{N,t} Y_{N,t} + P_{TH,t} Y_{T,t}) / P_t$. In steady state, net foreign assets equal zero and $G_t = C_t$.

[10] Assuming that manufacturing and agriculture sectors proxy for traded goods, the average share of these sectors in GDP over the last two decades (from 1984 to 2004) for Pakistan is 41.88%. The average share of trade (defined as the average of imports and exports) in GDP over the same period is 20.7%. World Bank, *World Development Indicators* is the source of data for these calculations.

up reported for the OECD countries, but may be appropriate for emerging countries.[11] Substitution elasticity for labor services (ε) is also assumed to equal 5.0.

Letting a quarter represent a unit of time in the model, the discount rate is assumed to be 0.99, which implies an estimate of the annualized real rate of interest equal to 4%. There is a wide range of estimates for other parameters of the utility function. For the basic version, we choose values of 5.0 and 1.0, respectively, for the coefficient of relative risk aversion (θ) and the elasticity of labor supply ($1/\mu$). Experimentation with different values of these parameters indicated, however, that the results discussed below are not too sensitive to such variation. Given our normalization and the assumption that ε = 5.0, the steady-state version of (23) is used to calculate the value of ψ (the weight for the labor effort index in the utility function) as 0.64.

Parameters of the adjustment cost functions (ω_P and ω_W) are set equal to 400 each. These values generate plausible inertia in the behavior of wages and prices.[12] In the transaction cost function, values of both parameters (ϕ_1 and ϕ_2) are assumed to equal 0.01. These values lead to a slow convergence to a steady state with zero net foreign assets.

We explored a number of variants of the interest rate rule (28). Differences among these variants are summarized in Table 2. For the baseline interest rate rule, we assume that the coefficient of the inflation variable (α_1) equals 1.1 while the other two coefficients equal zero. In this rule, monetary policy is concerned only with inflation and the inflation coefficient is close to the minimum value needed to provide a stable inflation

[11] Martins, Scarpetta and Pilat (1996), for example, estimate the average markup for manufacturing sectors in OECD countries at around 1.2 (implying an estimate of the substitution elasticity equal to about 6.0).
[12] Laxton and Pesenti (2003) assume these values for similar adjustment cost functions.

behavior.[13] We then consider three rules that change the policy response in some important respect. The first rule represents a stronger response to inflation than the baseline rule (the value of α_1 is raised to 2.1). In the second rule, the interest rate also reacts to output gap but the response to inflation is the same as in the baseline rule (α_2 equals 0.5 and α_1 remains equal to 1.1). The third rule maintains the baseline response to inflation, but allows the interest rate to respond to exchange rate movements in order to smooth exchange rate fluctuations (α_3 equals 1.0, and in view of (29), α_1 is lowered to 0.1 to keep $\alpha_1 + \alpha_3$ equal to 1.1).

DYNARE program is used to solve the model.[14] This program enabled us to obtain a deterministic steady-state solution to our nonlinear model and calculate the dynamic response of endogenous variables to different shocks. The program also provided estimates of the first and second moments of endogenous variables based on a stochastic simulation that uses second-order approximation of the model around its deterministic steady state. The second-order approximation is useful in examining the welfare effect of a policy change since it captures the effect that coefficients of the interest rate rule have on the stochastic means as well as variances of the arguments of the utility function.[15]

3.2 Dynamic Response of Key Macroeconomic Variables

We first illustrate how the effect of each shock is transmitted under the baseline rule. Figures 1-3 show the dynamic response of key macroeconomic variables over 20

[13] The response of the interest rate needs to be above unity to ensure a stable and unique solution.
[14] Since the price level has a unit root under inflation targeting, nominal variables in the model were transformed to first differences to obtain a stationary representation of the model needed for its solution.
[15] Ambler, Dib and Rebei (2004) show that parameters of the interest rate rule have a significant effect on stochastic means of variables entering the utility function. Also, see Kim and Kim (2003) who show that first-order approximations can be misleading for welfare comparisons.

quarters to a shock (u_{it}) in quarter 1.To facilitate comparisons, these shocks are scaled to have a similar effect on output in the first quarter.[16]

Figure 1 shows the responses to an interest rate parity shock. The home currency's depreciation rate ($\log S_t - \log S_{t-1}$) jumps up in the first quarter and this response reflects the need for the exchange rate to initially overshoot its value. The impact on the inflation rate ($\log P_t - \log P_{t-1}$) is smaller, but the pattern of response is similar to that of the depreciation rate. Given price and wage inertia, real GDP (G_t) and labor supply (L_t) increase temporarily in response to higher demand for goods and labor. Consumption (C_t) does not respond much because of intertemporal smoothing considerations. The current account thus registers a surplus for a certain period.[17]

The dynamic effect of a shock to traded goods productivity is exhibited in Figure 2. This shock causes the depreciation and inflation rates to move initially in opposite directions. Real GDP rises but labor supply initially falls (since less labor is needed to produce a given ouput because of higher productivity). The productivity shock leads first to a surplus and then a deficit in the current account. Figure 3 illustrates the dynamic effect of an export demand shock. In the presence of price and wage stickiness, the effect of this shock on prices and the exchange rate is small. Since there is little change in the rate of inflation and the interest rate (and hence in the real interest rate), consumption follows a stable path. There is, however, a significant effect on real GDP, labor supply and the current account.

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[16] The shocks are scaled as follows: u_{1t} = 0.01 for Figure1, u_{2t} = 0.15 for Figure 2, and u_{3t} = .05 for Figure 3. The persistence parameters in each case are assumed to be (as in the simulations reported below): ρ_1 = 0.5, ρ_2 = 0.8, and ρ_3 = 0.7.

[17] The current account is defined as $CA_t = Q_t(B_t^* - B_{t-1}^*)$.

3.3 Relative Performance of Alternative Interest Rate Rules

The traditional criterion for evaluating different monetary policy rules is based on a loss function that increases in measures of inflation variability and output gap. If there is fear of floating, the loss function would also be positively related to exchange rate variability. Variability of the interest rate may also be of concern, especially if financial institutions are vulnerable. The conventional loss function is not explicitly related to household welfare. The optimizing framework of new macroeconomic models makes it possible to assess monetary policy by the use of a welfare criterion based on household utility. We consider such a measure, but our model does not explicitly incorporate the externality associated with exchange rate volatility and thus, does not capture the effect of this factor on welfare.

Indicators based on both types of criteria are used in this paper to explore desirability of interest rate rules described in Table 2. The relative performance of different rules depends on what type of shocks affect the economy. To highlight this link, the paper presents results of simulations based on one shock at a time. For each simulation, we compare the performance of alternative policy rules using a number of indicators that include measures of variability for key macroeconomic variables as well as an index of household utility.

Table 3 presents results for simulations based on shocks to interest rate parity.[18] The effect of these shocks is transmitted to the economy via changes in the exchange rate. This effect can be offset directly by a policy of exchange rate smoothing or indirectly by an anti-inflation policy. Indeed, as the table shows, the stronger inflation targeting (SIT)

[18] These simulations assume that the standard error of u_{1t} equals 0.005 and ρ_1 = 0.5.

rule leads to lower standard errors of both the inflation rate and rate of exchange rate depreciation than the baseline rule. The output stabilization (OS) rule also reduces these standard errors. Interestingly, the exchange rate smoothing (ERS) rule is not as effective as the SIT and OS rules in reducing exchange rate variability. This policy also increases interest rate variability. Although differences in the effect on welfare among different rules are small, stronger inflation targeting achieves the highest welfare level.

Simulation results for shocks to traded goods productivity are displayed in Table 4.[19] The response to this shock involves tradeoffs between different goals. The SIT rule, for example, reduces the standard error of inflation in comparison with the baseline rule, but increases those of depreciation and output. The ERS rule lowers the standard errors of both depreciation and inflation but not that of output. If exchange rate volatility is a major concern, the ERS rule would be appealing in this case. The SIT rule, however, remains the best policy according to the welfare criterion.

Finally, Table 5 shows simulation results for shocks to export demand.[20] This shock contributes mainly to output variability because of slow adjustment of prices and wages. The standard errors for both inflation and depreciation are low even under the baseline rule. Relative to the baseline rule, the SIT rule lowers the standard error of inflation and the ERS rule decreases the standard errors of depreciation as well as inflation. These effects, however, are small and output variability remains high under both SIT and ERS rules. The OS rule does reduce output variability, but this policy also leads to increased variability of both inflation and depreciation. In terms of welfare, the

[19] Simulations for this table assume that the standard error of u_{2t} equals 0.05 and ρ_2 = 0.8. The productivity shock is assumed to have a more persistent effect than the interest parity shock.
[20] This table's simulations assume that the standard error of u_{3t} equals 0.05 and ρ_3 = 0.7.

SIT rule continues to be the best policy. In the presence of nominal rigidities based on adjustment costs, the SIT rule is able to improve welfare by stabilizing inflation, which avoids costly price and wage changes.

Before concluding, we briefly discuss implications of certain extensions of the model for monetary policy rules. The model assumes that there is a complete exchange rate pass-through to import prices. A number of factors such as intermediate imports, local distribution costs and local currency pricing could dampen the effect of exchange rate change on retail import prices.[21] Under these conditions, the connection between the exchange rate and CPI would be weaker, and inflation targeting would be less effective in offsetting exchange rate fluctuations in response to interest parity shocks.

The model also assumes that the effect of shocks to traded goods productivity is temporary and thus the real exchange rate is stationary. If productivity shocks exert a permanent effect, however, the real exchange rate would be nonstationary, and the interest rate response to exchange rate would need to account for permanent shifts in the real exchange rate.[22]

4. Conclusions

Flexible exchange rates and inflation targeting implemented by interest rate control has worked well for a number of industrial countries. It is not clear, however, whether such a policy is also suitable for emerging economies that are exposed to different shocks and have reasons to fear adverse effects from exchange rate fluctuations.

[21] For an analysis of the role of these factors for G-7 countries, see Choudhri, Hakura and Faruqee (2005).
[22] There is evidence for developing countries that productivity changes cause permanent shifts in the real exchange rate. See Choudhri and Khan (2005).

This paper addresses this issue using the framework of new open economy macroeconomic models.

The paper explores the desirability of several interest rate rules that have different responses to inflation, output and exchange rate change. The relative performance of the rules depends on the criterion used for evaluation and on the type of shocks that the economy confronts. The criterion based on the representative agent's welfare favors a rule which responds strongly to inflation and does not react to other variables. The differences in the level of welfare reached under different rules, however, are not large and a case can be made for considering other indicators of performance.

Avoiding excessive exchange rate fluctuations may be an important goal of emerging economies. Strong inflation response may be considered undesirable if this policy makes the exchange rate more volatile. The analysis of this paper shows that the effect of inflation response on exchange rate variability depends on what type of shocks affect the economy. Emerging economies are considered especially vulnerable to financial shocks to interest parity. Interestingly, such shocks do not create a tradeoff between inflation and exchange rate variability. As the paper shows, a strong anti-inflation policy also stabilizes the exchange rate in this case. Other shocks, such as real shocks to traded goods productivity do create a tradeoff: inflation variability is decreased at the cost of increased exchange rate variability. Facing such shocks, the interest rate may also need to respond to exchange rate movements to reduce their variability. These results suggest that determining the relative importance of different shocks would be an important topic for future research on appropriate monetary policy rules for emerging economies.

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Table 1
Values of Model Parameters

Parameters	Values	Parameters	Values
Shares		Utility Function	
χ_N	0.6	β	0.99
χ_T	0.4	θ	5.0
χ_{TH}	0.5	μ	1.0
χ_{TF}	0.5	ψ	0.64
Substitution Elasticities		Other Parameters	
γ	1.1	ω_P	400
η	2.0	ω_W	400
σ	5.0	ϕ_1	0.01
ε	5.0	ϕ_2	0.01

Table 2
Interest Rate Rules

	Coefficients		
	α_1	α_2	α_3
Baseline Rule	1.1	0.0	0.0
Stronger Inflation Targeting	2.1	0.0	0.0
Output Stabilization	1.1	0.5	0.0
Exchange Rate Smoothing	0.1	0.0	1.0

Table 3
The Relative Performance of Interest Rate Rules:
Shocks to Uncovered Interest Rate Parity

	Standard Deviation				Mean
	Inflation Rate	Exchange Rate Dep.	Output Gap	Interest Rate	Utility Index
Baseline Rule	0.00528	0.01042	0.00900	0.00581	-0.00163
Stronger Inflation Targeting	0.00363	0.00679	0.01077	0.00762	0.00708
Output Stabilization	0.00338	0.00644	0.00356	0.00463	0.00268
Exchange Rate Smoothing	0.00586	0.00960	0.01721	0.01017	0.00355

Note: Inflation rate and exchange rate depreciation represent quarterly log differences of CPI and the exchange rate; output gap is the log deviation of output from its deterministic steady-state value; interest rate represents the rate per quarter; and utility index is the difference of utility from its deterministic steady-state level.

Table 4
The Relative Performance of Interest Rate Rules:
Shocks to Traded Goods Productivity

	Standard Deviation				Mean
	Inflation Rate	Exchange Rate Dep.	Output Gap	Interest Rate	Utility Index
Baseline Rule	0.00670	0.00747	0.00777	0.00737	-0.00088
Stronger Inflation Targeting	0.00320	0.00996	0.02297	0.00672	0.00915
Output Stabilization	0.00683	0.00572	0.00383	0.00576	-0.01116
Exchange Rate Smoothing	0.00288	0.00075	0.00794	0.00069	-0.00198

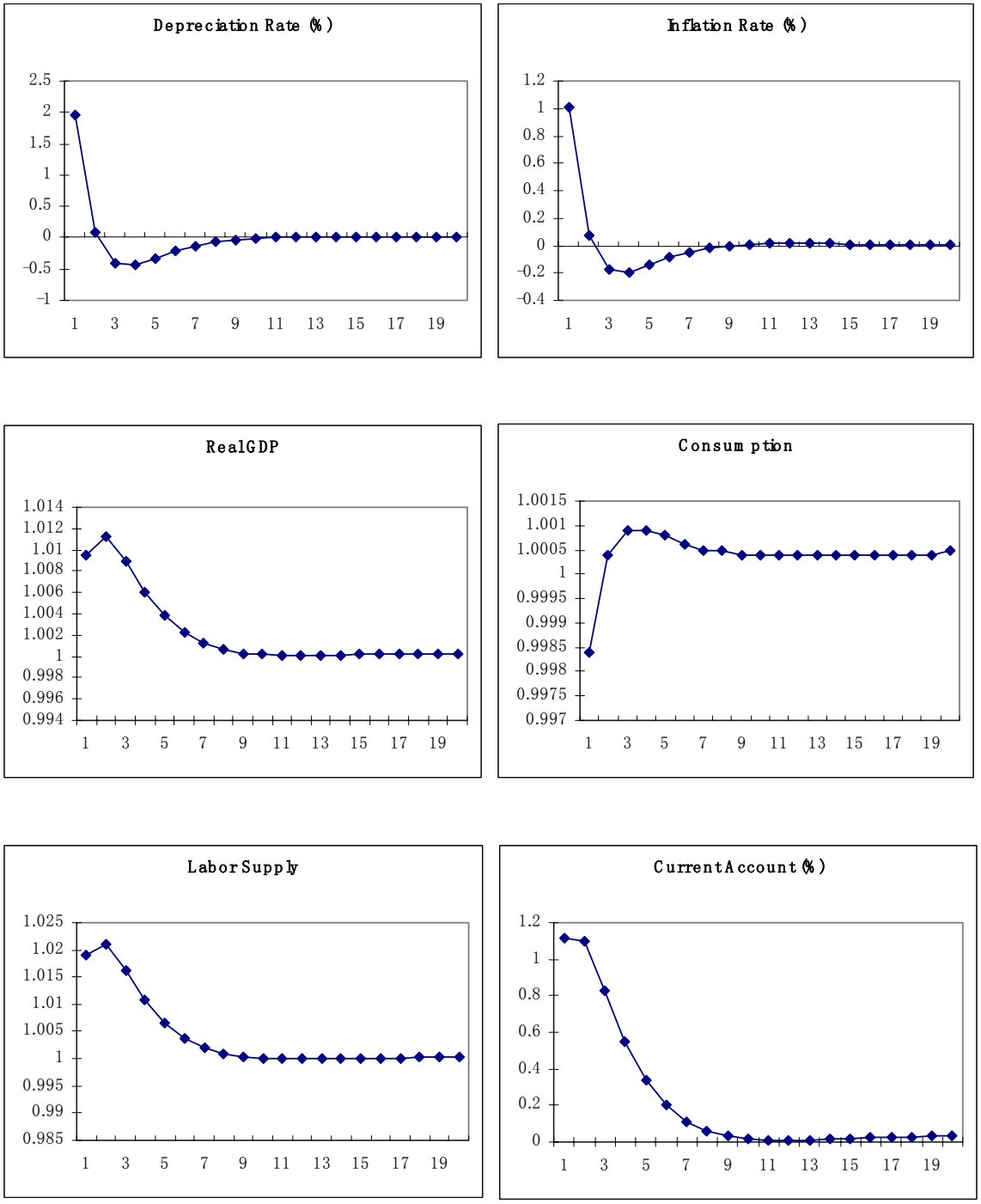
See notes to Table 3 for explanation of variables.

Table 5
The Relative Performance of Interest Rate Rules:
Shocks to Export Demand

	Standard Deviation				Mean
	Inflation Rate	Exchange Rate Dep.	Output Gap	Interest Rate	Utility Index
Baseline Rule	0.00017	0.00038	0.01235	0.00018	-0.00156
Stronger Inflation Targeting	0.00013	0.00037	0.01516	0.00027	0.00714
Output Stabilization	0.00447	0.00759	0.00734	0.00378	0.00370
Exchange Rate Smoothing	0.00008	0.00008	0.01202	0.00008	-0.00728

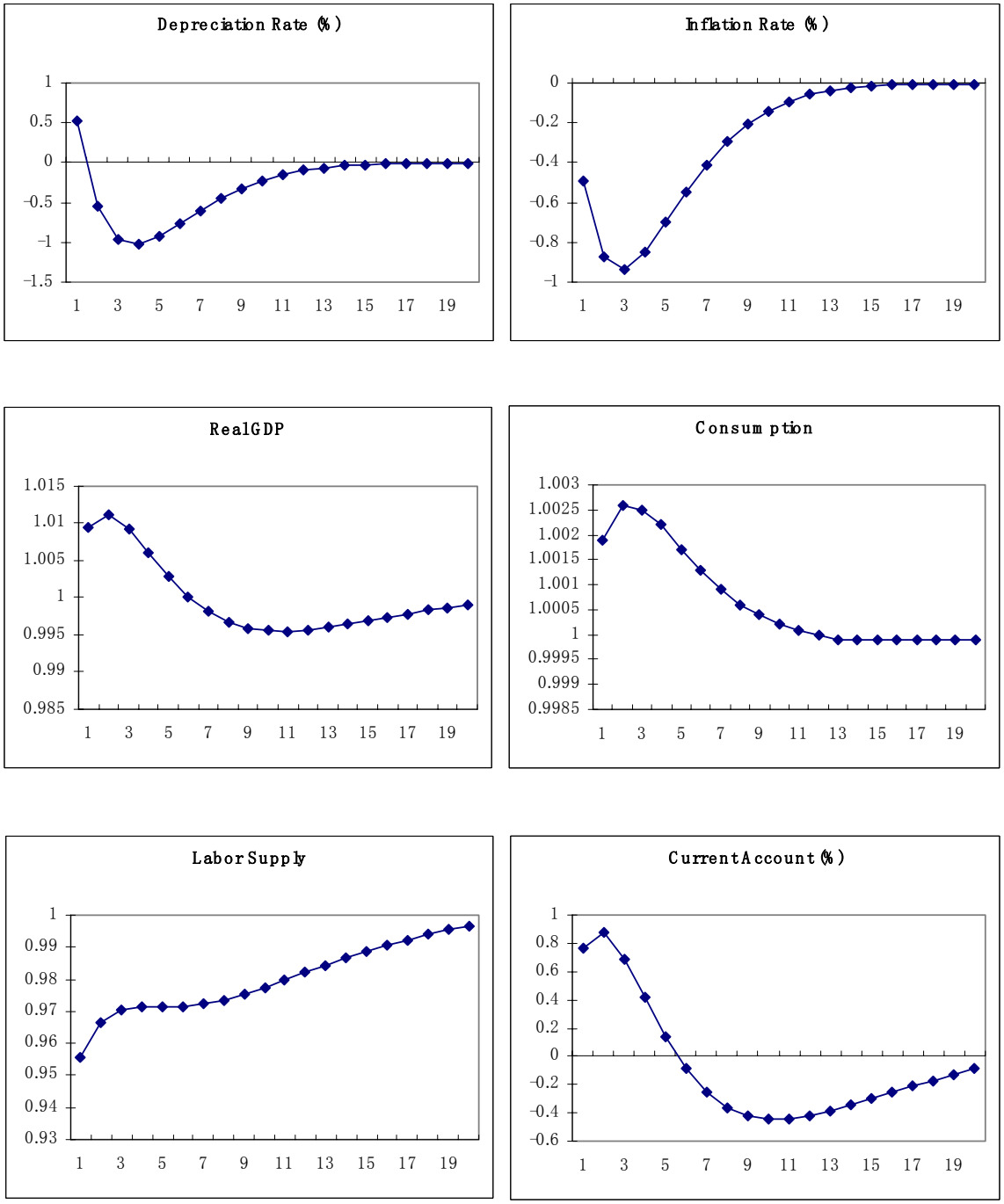
See notes to Table 3 for explanation of variables.

Figure 1. The Dynamic Response to a Shock to Interest Rate Parity



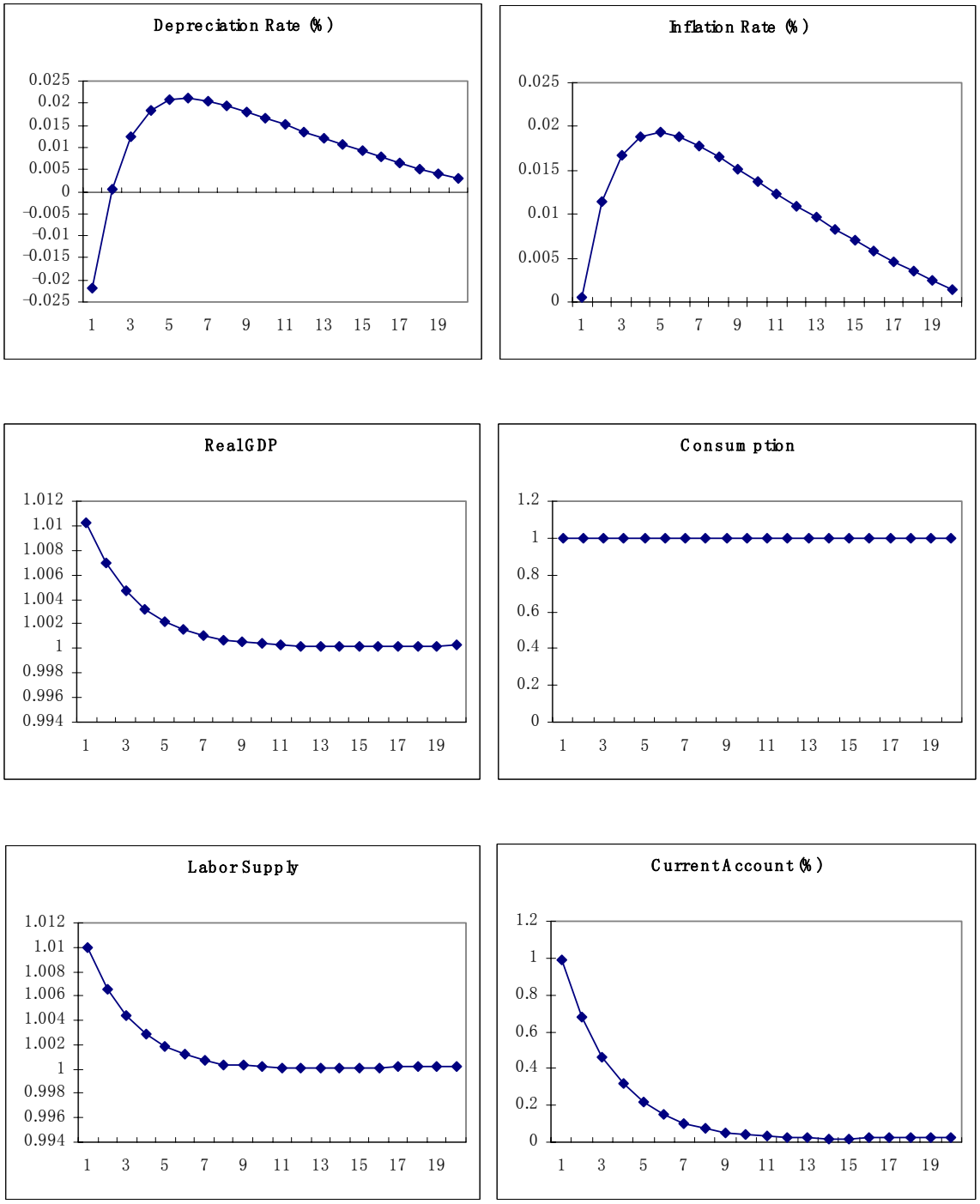
Note: The quarterly rates of depreciation and inflation, and the current account are multiplied by 100. The indexes of real GDP, consumption and labor supply equal 1 in steady state.

Figure 2. The Dynamic Response to a Shock to Traded Goods Productivity



See notes to Figure 1.

Figure 3. The Dynamic Response to a Shock to Export Demand



See notes to Figure 1.