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Macroeconomic Implications of the Transition to Inflation Targeting and Capital Account Liberalization in Romania

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Abstract

In the near future, Romania will introduce inflation targeting and fully liberalize its capital account. This paper aims to analyze, in a dynamic general-equilibrium model with sticky prices and monopolistic competition, how these two profound changes will affect the ability of monetary policy to pursue its objective of price stability. In particular, the resilience of the current and future monetary policy regimes to shocks is evaluated against two welfare criteria: a standard central bank loss function containing the deviations of inflation, output, and the real exchange rate from their equilibrium values, and the compensating variation measure of Lucas (1987).

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[1] Large parts of this paper were written when Ms. Berkmen was a summer intern at the IMF. Mr. Gueorguiev is an economist in the European Department.

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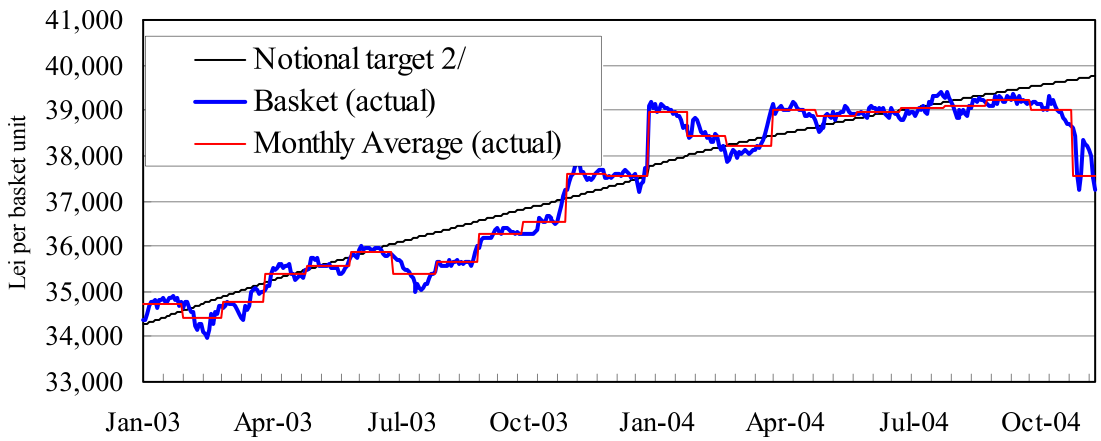
I. INTRODUCTION

Until recently, the National Bank of Romania (NBR) operated in a de facto exchange-rate-based framework. Relying on the exchange rate as an implicit nominal anchor, the central bank guided it broadly in line with the annual disinflation target and moderate real effective appreciation (Figure 1). The existing restrictions on nonresident purchases of treasury bills and bank deposits afforded the NBR a degree of autonomy in setting its policy interest rate, which it used mainly to support the targeted exchange rate dynamics and reserve accumulation. By avoiding both disruptive exchange rate fluctuations and unsustainable appreciation, this monetary framework enabled the NBR to strike a balance between successfully anchoring inflation expectations and preserving competitiveness. Improved macroeconomic conditions, the prospects for European Union accession, and the large yield differential between lei and foreign currency-denominated assets (given the increasing credibility of the NBR's exchange rate management) resulted in sustained capital inflows, mostly in the form of bank borrowing and foreign direct investment (FDI), and substantial reserve accumulation.

Figure 1. Exchange Rate Path of the Leu Versus an EUR-US$ Basket 1/



Sources: National Bank of Romania and authors' calculations.
1/ The EUR-US$ weights are 60-40 for 2003 and 75-25 for 2004.
2/ Based on announced annual targets for inflation and real exchange rate appreciation.

However, the NBR has long considered inflation targeting (IT) to be the appropriate medium-term monetary policy framework and intends to adopt it in 2005. The central bank wants to credibly commit itself to controlling inflation, while shifting the responsibility for the external current account to fiscal and income policies. Moreover, IT is seen as conducive to further strengthening the NBR's independence. The NBR also considers that an explicitly fixed exchange rate regime would encourage expansionary fiscal and wage policies, thus exposing Romania to the risks of developing an unsustainable current account position and losing reserves. This makes IT the preferred framework. To facilitate the transition to the new

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framework, the NBR recently stopped announcing real appreciation targets and limited its interventions in the foreign currency market.

In addition, the capital account will be fully liberalized in the process of Romania's accession to the European Union (EU). According to the agreed schedule, all restrictions on financial flows would be abolished by 2007 at the latest, and some of them would have to be dropped earlier. The NBR is naturally reluctant to deviate too much from this schedule, although it did decide to postpone the lifting of the restriction on nonresidents' opening bank accounts (originally scheduled for January 2004). Moreover, capital account liberalization is a necessary condition for Romania to fully integrate into the European and world economies and rapidly catch up with EU income levels.

This paper analyzes how these two profound monetary regime changes will affect the ability of monetary policy to pursue its objective of price stability. The analysis employs a dynamic general-equilibrium model with sticky prices and monopolistic competition, in which the main macroeconomic relations are explicitly derived from microeconomic foundations. These relations are combined with monetary policy rules specific to the old regime (characterized by partial capital mobility and an exchange rate anchor) and the emerging one (free capital mobility plus IT). Within the latter regime, we also distinguish between flexible IT (in which monetary policy responds to deviations of expected inflation, output, and the exchange rate from their steady-state values) and a stricter version (in which the exchange rate is allowed to float freely). Then we evaluate the performance of the three frameworks in terms of their ability to stabilize inflation and against two welfare criteria: (i) a standard central bank loss function containing the deviations of inflation, output, and the real exchange rate from their equilibrium values; and (ii) the compensating variation measure of Lucas (1987) that provides the fraction by which consumers' original consumption basket has to be increased for them to enjoy the same lifetime utility under each regime.

We find that both variations of the forthcoming monetary policy regime are superior in welfare terms to the framework used until recently, mostly because the capital account opening leads to lower interest rates and permanently higher output and consumption. These gains come despite increased inflation volatility under the IT regimes.

Specifically, the exchange-rate-based framework is best at stabilizing inflation at the expense of higher real exchange rate volatility. This is because the nominal exchange rate—the policy instrument—has direct influence over the CPI inflation and moves in the opposite direction from it in response to shocks. A flexible IT framework is best in stabilizing the real exchange rate, since inflation and the nominal exchange rate generally move together, while stricter IT is by far superior in stabilizing output, as the free-floating exchange rate absorbs a larger part of the shocks than the other two frameworks. This feature allows the stricter IT to minimize the central bank loss for the three real and exogenous shocks we experiment with. It underperforms the flexible IT regime, however, on nominal shocks in terms of that welfare criterion, since these shocks create excessive inflation and real exchange rate volatility under the stricter IT regime. Nevertheless, in terms of the compensating variation—our preferred welfare measure—

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the stricter IT framework shines again, owing to both the permanent increase in steady-state consumption and its superior stabilizing properties.

The analysis proceeds as follows. Section II introduces the model and derives the aggregate demand and aggregate supply relations. Section III simplifies these relations by log linearizing them around the steady state and discusses the alternative environment and monetary policy rules under each regime.[2] Section IV defines the welfare criteria used for evaluating the models' performance. Section V calibrates the model, presents the results, and conducts a sensitivity analysis over various parameter configurations. Section VI concludes.

II. The Model

A. Households

A continuum of identical infinitely lived households indexed by $j \in [0,1]$ specializes in the production of a single differentiated good. Each household maximizes a lifetime utility function:

$$E_t \left\{ \sum_{t=0}^{\infty} \beta^t \left[u\left(C_t(j), \frac{M_t(j)}{P_t} \right) - \int_0^1 \upsilon\left(h_t(j)\right) dj \right] \right\}, \tag{1}$$

where u is an increasing concave function and υ is an increasing convex function representing disutility of labor. The discount factor β is between 0 and 1, while $h_t(j)$ is the quantity of labor supply of type j. The contribution of consumption and real money balances to utility is additively separable.

Consumption C_t is a composite index given by

$$C_t = \frac{C_{h,t}^{(1-\gamma)} C_{f,t}^{\gamma}}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}, \tag{2}$$

where $C_{h,t}$ and $C_{f,t}$ are indices of consumption of domestic and foreign goods, respectively, with unitary elasticity of substitution between themselves. Each consumption index is a Dixit-Stiglitz (1977) aggregate, defined as

$$C_{h,t} = \left[\left(\frac{1}{1-\gamma} \right)^{\frac{1}{\theta}} \int_0^1 C_{h,t}(j)^{(\theta-1)/\theta} \, d_j \right]^{\theta/(\theta-1)}, \quad C_{f,t} = \left[\left(\frac{1}{\gamma} \right)^{\frac{1}{\theta}} \int_0^1 C_{f,t}(j)^{(\theta-1)/\theta} \, d_j \right]^{\theta/(\theta-1)}, \tag{3}$$

where $\theta > 1$ is the constant price elasticity of demand faced by each monopolist producer.

[2] A detailed technical appendix is available from the authors upon request.

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The flow budget constraint of the household can be represented as

$$\int_0^1 \left[P_{h,t}(j)C_{h,t}(j) + P_{f,t}(j)C_{f,t}(j) \right] d_j + M_t(j) + E_t\left[F_{t,t+1}B_{t+1}(j) \right]$$
$$\leq W_t(j) + \int_0^1 w_t(j)h_t(j)d_j + \int_0^1 \Pi_t(j)d_j + TR_t \quad . \tag{4}$$

$B_{t+1}(j)$ denotes the nominal value at date t+1 of the bond portfolio that the household holds at the end of period t. In the free capital mobility case, this will represent a complete set of state-contingent claims, as in Cole and Obstfeld (1991), Gali and Monacelli (2002), and Parrado (2004). In the partial capital mobility model, this represents the portfolio available to domestic households. TR_t stands for lump-sum fiscal transfers, net of lump-sum taxes. The wage received by the household is denoted by w_t . $W_t(j)$ denotes the nominal value of the household's financial wealth at the beginning of period t. Therefore, beginning-of-period wealth for the next period is given by

$$W_{t+1}(j) = (1+i_t)B_t(j) + M_t(j) = B_{t+1}(j) + M_t(j), \tag{5}$$

where M_t denotes household's end of period nominal money balances.

$F_{t,T}$ denotes the stochastic discount factor, such that the market price at date t of a portfolio yielding a random nominal value X_T at a subsequent day T is given by $E_t[F_{t,T}X_T]$. Thus the riskless short-term (one-period) nominal interest rate i_t is given by

$$\frac{1}{1+i_t} = E_t\left[F_{t,t+1} \right]. \tag{6}$$

We assume that each household owns an equal share of the firms. Their income from the sale of the goods is thus represented by the profit Π_t which incorporates the proportional sales tax. The detailed derivation of this function can be found in subsection C.

Along with optimal allocation of consumption and the no-Ponzi condition, the flow budget constraint is equivalent to the following intertemporal budget constraint:

$$\sum_{s=t}^{\infty} E_t \left\{ F_{t,s} \left[P_t C_t + \frac{i_t}{1+i_t} M_t \right] \right\}$$
$$\leq \sum_{s=t}^{\infty} E_t \left\{ F_{t,s} \left[\int_0^1 w_t(j)h_t(j)d_j + \int_0^1 \Pi_t(j)d_j + TR_t \right] \right\} + W_t . \tag{7}$$

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Therefore, households maximize utility (1) subject to the intertemporal budget constraint (7). The first-order conditions are

$$E_t\left[\frac{u_c(C_{t+1})}{u_c(C_t)}\frac{P_t}{P_{t+1}}\right]\beta = E_t\left[F_{t,t+1}\right] \tag{8}$$

and

$$\frac{u_m(m_t)}{u_c(C_t)} = \frac{i_t}{1+i_t}, \tag{9}$$

and the intertemporal budget constraint holding with equality.

Using(6), (8) can be written in terms of a condition that the short-term nominal interest rate must satisfy:

$$1+i_t = \beta^{-1}\left\{E_t\left[\frac{u_c(C_{t+1})}{u_c(C_t)}\frac{P_t}{P_{t+1}}\right]\right\}^{-1}. \tag{10}$$

Equation (9) can be rewritten in terms of the familiar money demand equation

$$\frac{M_t}{P_t} = L\left(C_t, i_t\right). \tag{11}$$

Equation (10) can be interpreted as an intertemporal aggregate demand equation. Equation (11) is the traditional LM equation, where money demand is a function of absorption and the interest rate. We assume that the central bank controls the riskless one-period nominal interest rate. In this case, money supply passively follows money demand at the interest rate set by monetary policy. Therefore, the LM equation will not be essential for the rest of the model.

Finally, households must choose the optimal quantity of each kind of labor to supply, given the wages they face and their valuation of additional income:

$$\frac{\upsilon_h(h_t(j))}{u_c(C_t, m_t)} = \frac{w_t(j)}{P_t}. \tag{12}$$

The rest of the world (ROW) is treated as exogenous. The consumer's problem in the ROW is the same as the home country's problem. Assuming that the share of home-country products in world production is small, the Euler equation for the rest of the world takes the form

$$E_t\left[\frac{u^*{}_c(C_{t+1})}{u^*{}_c(C_t)}\frac{P^*{}_t}{P^*{}_{t+1}}\right]\beta = E_t\left[F^*{}_{t,t+1}\right], \tag{13}$$

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where $F^{*}_{t,t+1}$ is the stochastic discount factor for one-period-ahead nominal payoffs relevant to foreign households. In the open capital account model (with complete financial markets), this condition takes the form[3]

$$E_t\left[\frac{u^{*}{}_c(C_{t+1})}{u^{*}{}_c(C_t)}\frac{P^{*}{}_t}{P^{*}{}_{t+1}}\frac{S_t}{S_{t+1}}\right]\beta = E_t\left[F_{t,t+1}\right], \tag{14}$$

Combining (8) and (14), when the financial markets are complete, home-country consumption will be linked to the world consumption through

$$u_c(C_t) = cu^{*}{}_c(C_t)Q_t, \tag{15}$$

where c is a constant depending on the initial conditions and Q_t is the real exchange rate defined by $Q_t = \frac{S_t P^{*}_t}{P_t}$. As long as world consumption is stationary, home consumption will be stationary as well, so we can log linearize the model around the unique steady state.

When capital controls are present, the stochastic discount factors do not have to be equalized as the portfolio available to domestic and foreign households would be different. We will assume that they will differ by the degree of capital control, which we represent by $Z_t > 0$. When $Z_t = 1$, we are back to the free capital mobility case. As Romania's current capital controls are mostly on inflows, domestic interest rates are higher than the foreign ones, which implies that $Z_t > 1$. Therefore, the Euler equation takes the form

$$E_t\left[\frac{u^{*}{}_c(C_{t+1})}{u^{*}{}_c(C_t)}\frac{P^{*}{}_t}{P^{*}{}_{t+1}}\frac{S_t}{S_{t+1}}\right]\beta = E_t\left[F_{t,t+1}\right]Z_t. \tag{16}$$

We further assume that the logarithm of Z_t follows an autoregressive process with a drift, to represent the reduction in the degree of capital controls over time in Romania:[4]

$$Z_t = \tilde{Z}Z_{t-1}^{\rho^z}e^{\varepsilon_t^z} \text{ or } \log Z_t = \log\tilde{Z} + \rho_z \log Z_{t-1} + \varepsilon^{z}{}_t. \tag{17}$$

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[3] Throughout the paper we use the terms "open capital account", "financial opening", and "free capital mobility" interchangeably. The same convention applies to the terms "partial capital mobility" and "capital controls".

[4] The speed and sequencing of the capital account liberalization have already been agreed with the European Commission (EC) as part of Romania's EU accession process and are thus somewhat exogenous to the short-term macroeconomic developments.

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$\tilde{Z} > 1$ guarantees that, in this model, we never reach free capital mobility. this will be introduced in the second model, along with the IT regime.

As we assume that the elasticity of substitution between domestic and foreign goods is one and initial holdings of international bonds are zero, the current account in the home economy is always balanced, independent of the availability of access to international financial markets. This allows us to use a unique steady state in this case as well. However, the steady state consumption levels are different in each of these models. In particular, the steady state consumption is lower in the case with capital controls.

B. Government

The government balances its budget in each period. Therefore, its budget constraint is represented by

$$\tau(P_t Y_t) - TR_t + M_t - M_{t-1} = 0, \qquad (18)$$

where τ represents the proportional sales tax. We will assume that (1-τ)=μ, that is, the government sets the tax rate so as to offset the market distortion caused by monopolistic competition, where μ represents the markup imposed by monopolistic firms. This implies that price rigidity is the only source of distortion in the economy.

C. Producers

The production function is

$$Y_t(j) = A_t h_t(j)^{\eta} I_t(j)^{1-\eta}, \qquad (19)$$

where A_t is a time-varying exogenous technology factor and I_t stands for imported inputs.[5] Accordingly, each firm will minimize the cost

$$w_t h_t(j) + P_t^* S_t I_t(j), \qquad (20)$$

where P_t^* is the foreign price and S_t is the nominal exchange rate, subject to the production function.

[5] Intermediate inputs constituted approximately 65 percent of total imports in 2003 (National Institute of Statistics of Romania, 2004).

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Given demand functions for labor and imported inputs obtained from cost minimization and by imposing market equilibrium, the nominal marginal cost is

$$MC_t = k^* Y_t(j)^{\omega} (P_t^* S_t)^{(1-\eta)(1+\omega)} \left[\frac{P_t}{C_t^{\sigma^{-1}}} \right]^{\omega/\nu} A_t^{1+\omega}, \tag{21}$$

where k^* is an unimportant constant and ω is the elasticity of marginal cost with respect to the firm's own output.

Finally, we need to specify the pricing mechanism in this economy. We are assuming staggered prices, à la Calvo (1983). Producers have only random and exogenous opportunities to change their prices. In each period, a fraction, α, of the prices in the economy remain unchanged, and a fraction (1-α) are updated. Note that the probability of a price change in any period is independent of its previous adjustments. Accordingly, the domestic price index boils down to

$$P_{h,t} = \left[(1-\alpha) p(j)_{h,t}^{1-\theta} + \alpha P_{h,t-1}^{1-\theta} \right]^{\frac{1}{1-\theta}}. \tag{22}$$

Producers maximize the following profit function:

$$E_t \left\{ \sum_{T=t}^{\infty} \alpha^{T-t} F_{t,T} \left[\Pi(P_{h,t}(j), P_{h,T}^I, P_{h,T}; Y_T, S_T) \right] \right\} \quad , \tag{23}$$

where the profit function for any firm supplying good j is given by

$$\begin{aligned} \Pi_t(j) &= (1-\tau) P_{h,t}(j) Y_t\ (j) - w_t h_t\ (j) - P_t^* S_t I_t(j) \\ &= (1-\tau) P_{h,t}(j) Y_t\ (j) - \frac{k\left(P_t^* S_t\right)^{1-\eta} (w_t)^{\eta}}{A_t} y_t(j). \end{aligned}$$

By using the demand equation and substituting out wages, the profit function takes the form

$$\Pi_t = (1-\tau) p_{h,t}(j) \left(\frac{P_{h,t}(j)}{P_{h,t}} \right)^{-\theta} C_{h,t}^d$$

$$- \frac{ -k\left(P_t^* S_t\right)^{1-\eta} \left(P_t \upsilon_h \left(\frac{ \left(\frac{P^I{}_{h,t}(j)}{P_{h,t}} \right)^{-\theta/\eta} }{ A_t^{1/\eta} I_t(j)^{1-\eta/\eta} } \right) \Big/ u_c(C_t) \right)^{\eta} }{A_t} \left(\frac{p_{h,t}(j)}{P_{h,t}} \right)^{-\theta} C_{h,t}^d, \tag{24}$$

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where we assume that the wages depend on the industry price level.

Producers will maximize the above profit function with respect to $P_{h,t}(j)$. Then the resulting first order condition is

$$E_t\left\{\sum_{T=t}^{\infty}(\alpha)^{T-t}\,F_{t,T}\Pi_1\left(P_{h,t}^{new},P_{h,t}^{I},P_{h,T};Y_T,S_T\right)\right\}=0\,, \tag{25}$$

where $P_{h,t}^{new}$ represents the new optimal price level.

The stochastic discount factor is substituted out by using the first-order condition to the consumer's problem:

$$E_t\left\{\sum_{T=t}^{\infty}(\alpha\beta)^{T-t}\,u_c(C_T)\Pi_1\right\}=0\,,$$

where

$$\begin{aligned}\Pi_1&=\frac{(1-\tau)(1-\theta)}{\theta}\left(\frac{P_{h,t}(j)}{P_{h,t}}\right)^{-\theta}C_{h,t}^{d}-MC_t\left(\frac{P_{h,t}(j)}{P_{h,t}}\right)^{-\theta}\frac{1}{p_{h,t}(j)}C_{h,t}^{d}\\&=\left[P_{h,t}(j)-MC_t\right]\left(\frac{P_{h,t}(j)}{P_{h,t}}\right)^{-\theta}C_{h,t}^{d}\end{aligned} \tag{26}$$

where in the second line of equation (26) we used the fact that $\dfrac{(1-\tau)(1-\theta)}{\theta}=\dfrac{(1-\tau)}{\mu}=1$. ${C_{h,t}}^{d}$ is total demand for domestically produced goods. The first-order condition then becomes

$$E_t\left\{\sum_{T=t}^{\infty}(\alpha\beta)^{T-t}\,u_c(C_T)\left[\frac{P^{new}{}_{h,t}}{P_{h,T}}-mc_T\right]\left(\frac{P^{new}{}_{h,t}}{P_{h,T}}\right)^{-\theta}C_{h,T}^{d}\right\}=0\,. \tag{27}$$

We define the real marginal cost as $mc_t=\dfrac{MC_t}{P_{h,t}}$. This and the evolution of $P_{h,t}$, given in (22), together provide the aggregate supply (AS) relation in the economy.

III. The Log-Linearized Model

All terms appearing in this section are percentage deviations from their respective steady state values, as indicated by lower-case letters.

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A. Aggregate Demand

The log linearization of equation (10) produces the following standard open economy IS curve:

$$\begin{aligned} x_t &= E_t x_{t+1} - \sigma i_t + \varphi_\pi E_t \pi_{h,t+1} + \gamma({y^*}_t - E_t {y^*}_{t+1}) + \varphi_s \left(s_t - E_t s_{t+1}\right) \\ &\quad -\varphi_a (a_t - E_t a_{t+1}), \end{aligned} \tag{28}$$

where x_t is the output gap defined as the difference between output and its natural level. In addition to the standard closed economy relation, the current output gap depends on the current and expected future nominal exchange rate. Accordingly, a depreciation at present time shifts demand from foreign products to domestic ones and raises output.

Similarly, the log linearization of (11) gives a traditional money demand representation:

$$m_t = \varphi_y c_t - \varphi_i i_t, \tag{29}$$

where φ_i is the interest rate sensitivity of the money demand and φ_y is the income elasticity.

B. Aggregate Supply

The log linear approximation of the domestic price index (22) can be written as

$$p_{h,t} = (1-\alpha) p_{h,t}^{new} + \alpha p_{h,t-1}. \tag{30}$$

When we add and subtract $(1-\alpha) p_{h,t}$ and rearrange the terms we obtain

$$\pi_{h,t} = \frac{1-\alpha}{\alpha}\left({p_{h,t}}^{new} - p_{h,t}\right). \tag{31}$$

Aggregate supply then takes the following form:

$$\pi_{h,t} = \beta E_t \pi_{h,t+1} + \kappa_x x_t + \kappa_q (p_t^* + s_t - p_{h,t}) - \kappa_y y_t^*. \tag{32}$$

Finally, assuming zero deviation from the steady state for foreign inflation, consumer price index (CPI) inflation can be written as

$$\pi_t = \gamma(s_t - s_{t-1}) + (1-\gamma)(\pi_{h,t}). \tag{33}$$

C. Capital Controls Versus Uncovered Interest Parity

While there are capital controls in the first model, we will assume complete international financial markets after the switch to IT and the capital account liberalization. Without some form of perfect risk sharing, consumption may not be stationary – a situation that prevents log

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linearization around a unique steady state. In order to avoid these complications in the case with capital controls, we assume that the elasticity between domestic and foreign goods is one, as mentioned above. Given the Cobb-Douglas preferences for traded goods (equation (2)) and the small economy assumption, the structure of financial markets would then not affect equilibrium allocations. As a result, the current account is always in balance.[6] We also assume that the domestic financial markets are sufficiently complete, so that diversification opportunities allow consumption smoothing in case of sector-specific shocks.

Before the removal of capital controls, log linearization of the Euler equations (8) and (16) for the home and the foreign country imply that

$$i_t = i_t^* + E_t s_{t+1} - s_t + \zeta_t, \tag{34}$$

where ζ_t represents the interest rate wedge stemming from capital controls. In this context, the nominal exchange rate is the policy instrument.

However, with perfect capital mobility, uncovered interest parity holds:

$$i_t - i_t^* = E_t s_{t+1} - s_t. \tag{35}$$

In this case, log linearization of (15) and the market-clearing condition[7]

$$c_t = \frac{1}{1-\gamma} y_t - \frac{\gamma}{1-\gamma} y_t^* - \frac{\gamma}{1-\gamma}\frac{2-\gamma}{1-\gamma} q_t \tag{36}$$

imply that

$$y_t = y_t^* + \mu q_t, \quad \text{where } \mu = (1-\gamma)\sigma + \frac{\gamma(2-\gamma)}{(1-\gamma)}. \tag{37}$$

[6] This is a common assumption in papers on large open economies, such as Obstfeld and Rogoff (2000), Corsetti and Pesenti (2001), and Benigno and Benigno (2001). The intuition is as follows: when the relative price of foreign goods rises, the increase in demand for domestic goods (and the nominal income) is exactly offset by the proportional decline in the residents' purchasing power. Therefore, no need for international asset movements arises. Parado and Velasco (2002) examine this condition for a small open economy (SOE) and show that with the extreme size asymmetry between the SOE and the ROW, the ROW would behave as a closed economy and its current account would always be zero, implying that the SOE's current account is also zero.

[7] Derived in the technical appendix, which is available from the authors upon request.

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D. Monetary Policy Rules

In the presence of partial capital controls, the central bank's instrument is the exchange rate. Therefore, monetary policy takes the following form:

$$s_t = \rho_s s_{t-1} + (1-\rho_s)\overline{s}_t + \varepsilon_t^s,$$
where (38)
$$\overline{s}_t = \chi_\pi (E_t \pi_{t+1} - \overline{\pi}) + \chi_x x_t$$

and where $\chi_\pi < 0, \chi_x < 0$ and $\overline{\pi}$ is the implicit inflation target.

We assume exchange rate smoothing, in order to reflect the concern of the monetary authorities about excessive exchange rate volatility. This is in line with the NBR's practice in 2003 – 2004 (Figure 1). Moreover, the analysis in Gueorguiev (2004) shows that while the pass-through from the exchange rate to prices remains significant, exchange rate volatility explains only a small fraction of inflation variability over the period 2001-04, indicating a relatively smooth exchange rate. Furthermore, in the current model, exchange rate volatility is undesirable because it brings about volatility in marginal costs, which, in turn, adversely affects production. Whenever expected inflation exceeds its target, the central bank appreciates the currency to offset the effect on the CPI. The emphasis on the output gap is minor and only comes because of its implications for future inflation. The stochastic term in the exchange rate rule allows occasional deviations from the rule in the form of shocks ε^s to the exchange rate, which are assumed to be zero-mean, independently and identically distributed (i.i.d.). The interest rate is then determined through (34).

With free capital mobility, monetary policy reduces to

$$i_t = (1-\rho_i)\overline{i}_t + \rho_i i_{t-1}$$
where (39)
$$\overline{i}_t = \phi_\pi (E_t \pi_{t+k} - \overline{\pi}) + \phi_x x_t + \phi_s s_t + \varepsilon^i{}_t$$

is the interest rate target, $\overline{\pi}$ is the inflation target, and $\phi_\pi > 1, \phi_x > 0, \phi_s > 0$. We assume interest rate smoothing, as interest rate volatility has information costs that reduce investment, trade and growth. We also allow for zero mean i.i.d. interest rate shocks, which can be interpreted as either temporary deviations from the interest rate rule or monetary policy mistakes. The coefficient of the exchange rate reflects the central bank's concern for the exchange rate owing to its impact on inflation. A higher value implies a higher degree of managed floating, as in Parrado (2004). The level of the exchange rate is determined through the uncovered interest parity condition (35). We also allow for a zero-mean, i.i.d. exchange rate shock in order to analyze the effect of unexpected exchange rate changes caused by external factors (e.g., contagion) under an open capital account.

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E. Stochastic Processes

The four exogenous stochastic processes evolve as follows:

$$y_t^* = \rho^{y*} y_{t-1}^* + \varepsilon_t^{y^*} \tag{40}$$

$$i_t^* = \rho^{i^*} i_{t-1}^* + \varepsilon_t^{i^*} \tag{41}$$

$$a_t = \rho^a a_{t-1} + \varepsilon_t^a \tag{42}$$

$$\zeta_t = \tilde{\zeta} + \rho^{\zeta} \zeta_{t-1} + \varepsilon_t^z . \tag{43}$$

All error terms are i.i.d. with zero mean.

IV. Welfare Criteria

The ideal welfare criterion is the one obtained from a second-order Taylor approximation to the utility function. However, in a small open economy model, it is very difficult to eliminate the linear terms in the Taylor approximation. In addition, in our model the presence of intermediate inputs affects demand for labor, complicating the approximation of the disutility from work. Another hurdle stems from the difference in the steady states in the two models that we consider.

Given this caveat, we will use two welfare criteria to evaluate the welfare implications of our models:

- For comparability with most of the literature, we will evaluate the stabilizing performance of the frameworks under a standard loss function:

$$E\left[L_t\right] = \lambda_\pi Var\left[\pi_{h,t}\right] + \lambda_x Var\left[x_t\right] + \lambda_q Var\left[q_t\right]. \tag{44}$$

- Our preferred measure is, however, the compensating variation introduced by Lucas (1987). The net welfare gain under the new policy regime, compared with the old one, is computed as the fraction by which consumers' original steady state consumption basket would have to be increased to deliver the same lifetime utility as under the new regime.

We would tend to give less weight to the welfare comparisons based on the loss function for the following reason. Kim and Kim (2003) have shown that a first-order log linearization of the model's structural equations, coupled with a welfare function derived from a first-order linearization of the utility function, distorts welfare analysis, and as a result financial opening may spuriously appear to be welfare-reducing. In our analysis, we minimize this bias by explicitly calculating the shift in steady state consumption, as well as the consumption path in response to shocks. Nevertheless, we are forced to use ad-hoc weights in the loss function, as their derivation from model parameters would require a second-order Taylor series approximation, which is difficult for small open economy with an explicit production side and a

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shift in the steady state consumption.[8] We compensate for the ad-hoc weights by subjecting them to sensitivity analysis.

The first two terms of the loss function are standard in all models and come from the sticky prices. What matters for utility is domestic inflation, not the CPI inflation, because only domestic prices are sticky. Sticky prices distort the consumption/leisure choice, and, through the disutility of work, affect welfare. In an open economy, real exchange rate variations are also costly. In particular, in our model the real exchange rate affects the firm's choice of intermediate input and labor, generating an additional impact on the disutility of work. To see that, consider the log linear approximation of the labor demand equation:[9]

$$h_t(j) = y_t(j) + (1-\eta)\left(p_t^* + s_t - w_t\right) - a_t .$$

Solving this for the wage rate and substituting in the log-linearized version of the labor supply (12) will bring about the effect of the exchange rate on the marginal disutility of the work. In addition, when we use the market-clearing condition (36) to represent consumption in terms of output, the real exchange rate will be one of the terms that appears in the utility function.[10]

V. Model Parameterization and Results

The selected parameter values and their explanations are provided in Table 1. A discount factor of β = 0.99 implies a steady state real interest rate of 4 percent per annum. A price elasticity of demand of θ = 4.33 translates into an average markup of 30 percent, not unusual for an emerging market with attractive conditions for capital. As part of the sensitivity analysis, we analyze the range 4.33-20, which implies markup between 30 percent and 5 percent. The size of the intertemporal elasticity of substitution is more controversial and has an important effect on the results.[11] Therefore, we have tried the range 0.5-2. The values of the monetary policy parameters are set such that there is a high degree of interest rate and exchange rate smoothing. In the model with free capital mobility, ϕ_s is chosen to reflect a mild degree of managed float. Moreover, the central bank values its performance on inflation higher than stabilizing the output gap or the exchange rate and thus responds to inflation deviations more aggressively. The weights in the loss function reflect the inflation's priority; as for the output gap and the real exchange rate, we present some sensitivity analysis in Table 4. For certain monetary policy parameter combinations, the model is not determinate. Therefore, parameters are also chosen such that the model is determinate.

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[8] In the literature, second-order approximations for small open economies have been derived only with a simpler production side and single period (Senay and Sutherland, 2004).

[9] Derived in the technical appendix, which is available from the authors upon request.

[10] Obstfeld and Rogoff (2000) and Senay and Sutherland (2004) have a similar term.

[11] Hall (1988) and Barsky et al. (1997) estimate values smaller than 1.

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Table 1. List of Parameter Values

Parameter	Explanation	Value
β	Discount factor	0.99
γ	Share of foreign goods in domestic consumption (Approximated by the share of imports in GDP)	0.37
θ	Price elasticity of demand faced by each monopolist	4.33
η	Share of labor in production	0.60
α	Probability that a firm does not change its price (Frequency of price adjustments is once in four quarters)	0.75
1/υ	Labor supply elasticity	0.50
σ	Intertemporal elasticity of substitution	1.10
	Derived Parameters	
	IS equation	
φ_π	The coefficient of the expected inflation	1.296
φ_s	The coefficient of the nominal exchange rate	0.196
φ_a	The coefficient of the technology shock	1.452
	AS equation	
κ_x	The coefficient of the output gap	0.0254
κ_q	The coefficient of the real exchange rate	0.0175
κ_{y^*}	The coefficient of foreign output	0.0039
	Interest Rate Rule (Model with free capital mobility)	
$(1-\rho_i)\phi_\pi$	The coefficient of expected inflation deviation from the target	1.5
$(1-\rho_i)\phi_x$	The coefficient of the output gap	0.1
$(1-\rho_i)\phi_s$	The coefficient of the exchange rate	0.8
ρ_i	The degree of interest rate smoothing	0.8
	Exchange Rate Rule (Model with capital controls)	
$(1-\rho_s)\chi_x$	The coefficient of the output gap	-0.1
$(1-\rho_s)\chi_\pi$	The coefficient of expected inflation deviation from the target	-1.5
ρ_s	The degree of exchange rate smoothing	0.8
	Shock persistence	
ρ_a	Serial correlation of technology shock	0.9
ρ_{y^*}	Serial correlation of shock to foreign output	0.9
ρ_{i^*}	Serial correlation of shock to foreign interest rate	0.9
	Central Bank Loss Function	
λ_π	The weight of inflation variation	1.5
λ_x	The weight of output gap variation	0.5
λ_q	The weight of real exchange rate variation	0.5

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A. Impulse Responses

Capital Controls

We examine the model variables' response to five shocks: (i) a temporary halt in the process of relaxing capital controls, which creates a 50-basis-point interest rate rise relative to the baseline; (ii) a 10 percent nominal exchange rate depreciation, which reflects an one-off deviation from the systematic policy rule; (iii) a 25-basis-point foreign interest rate (i^*) increase; (iv) a 1 percent increase in foreign output (y^*); and (v) a productivity shock, expressed as 1 percent increase in the technology factor (a).

When the foreign interest rate increases, foreign output will be affected as well. According to the European Central Bank's (ECB) Area wide Model of the Euro Area (Fagan et al., 2001), a 25-basis-point ECB interest rate increase causes Euro-area output (our proxy for foreign output) to decline by about 0.25 percent. The impulse responses reflect these two changes together. Figure 2 present the response of the main economic variables to these five shocks.

A temporary intensification of capital controls raises the domestic interest rate and reduces output and domestic inflation on impact. The monetary policy rule implies an exchange rate depreciation. The overall impact on the CPI is then negligible. Interestingly, a shock of the sort did occur in January 2004 with the postponement of the liberalization of nonresident access to local bank accounts. While many other factors were in play, commercial bank interest rates stayed high until midyear, and the NBR actively resisted strong appreciation pressures to keep the CPI from undershooting the targeted path.

A one-off exchange rate depreciation generates a significant output increase through expenditure switching toward domestically produced goods. The initial impact on CPI inflation is offset by the ensuing exchange rate appreciation, after the first-period depreciation.

A foreign interest rate shock raises the domestic interest rate on impact, which, in turn, lowers output and domestic inflation. The monetary policy rule then implies an exchange rate depreciation. However, as the central bank smoothes the exchange rate, this depreciation is not fully realized on impact, which creates expectations for further depreciation. These expectations produce a further increase in the interest rate through the interest rate parity condition, which reduces output even more. After a while, the effect of the shock begins to dissipate and the exchange rate begins appreciating. Its "hump" trajectory helps to stabilize the CPI inflation. During the initial few periods when domestic inflation is lower, the exchange rate depreciates, which keeps the CPI more or less constant.

An increase in foreign output raises domestic output and inflation, which implies an exchange rate appreciation through the monetary policy rule. The hump in the exchange rate again creates expectations for appreciation, which induce lower interest rate and higher output. The appreciation of the currency outweighs the increase in domestic inflation and lowers the CPI inflation.

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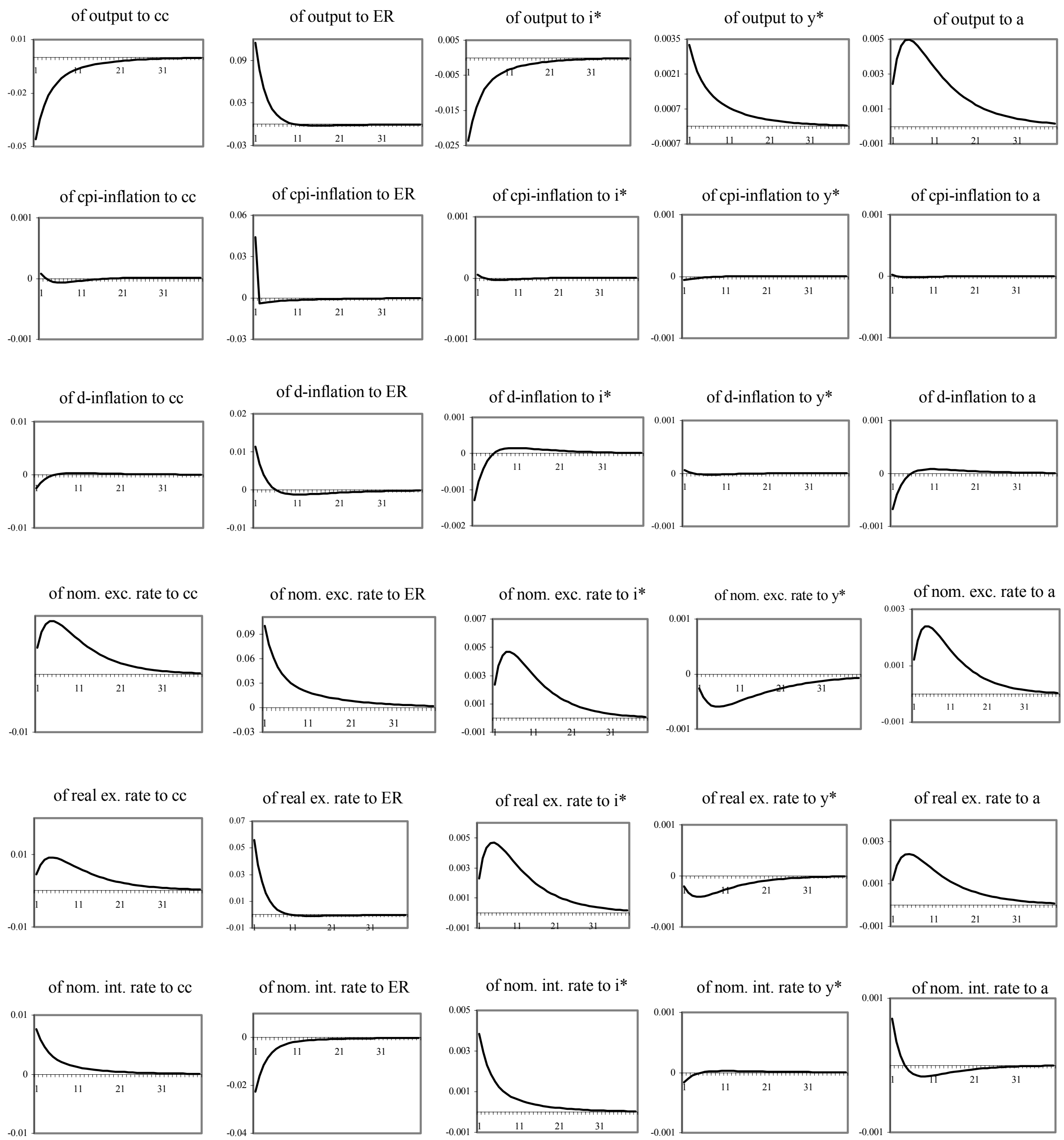
Figure 2. Capital Controls and an Exchange Rate Rule



Note: *cc* stands for capital controls; *d-inflation* is domestic-goods inflation.

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A positive productivity shock increases output and lowers domestic inflation. As monetary policy gives more weight to inflation stabilization, the exchange rate depreciates, which, in turn, raises the interest rate. The overall impact on the CPI inflation is again negligible.

To summarize, exchange rate smoothing is critical in stabilizing the CPI inflation, as it slows down the pass-through from exchange rate movements in response to shocks. The higher the degree of exchange rate smoothing, the higher the stability of CPI inflation, and the higher the volatility of other variables. This is because the exchange rate, being the policy instrument, moves opposite to inflation, which raises the volatility of the real exchange rate and output.

Free Capital Mobility

Within the free capital mobility model, we present three variations of the IT regime. Our baseline model involves flexible CPI inflation targeting, by which we mean that the central bank includes in its policy rule (39) not only expected CPI inflation, but also the output gap and the nominal exchange rate, with the coefficients provided in Table 1. This implies a certain degree of managed exchange rate floating. We will compare this baseline with a stricter IT version, where the policy (interest rate) rule includes only the expected inflation and output gap terms, while the exchange rate floats freely. In addition, we briefly analyze the case of domestic IT with a managed exchange rate.

Flexible CPI Inflation Targeting

Figure 3 shows the impulse responses for this case. A temporary increase in the interest rate and the resulting exchange rate appreciation reduces output on impact. In the next periods, the policy rule pulls down the interest rate as a result of the low output and inflation, which promotes quick convergence toward the steady state.

Similarly, an exchange rate shock in this model dies out immediately as a result of the uncovered interest parity. Managed floating implies an increase in the interest rate, which reduces output. If the exchange rate were free-floating, the interest rate would not have risen, and an exchange rate shock would have increased output instead (see the next subsection).

In a distinction from the capital controls model, an increase in the foreign interest rate raises the domestic interest rate less than proportionately, with the exchange rate also adjusting. The latter's initial increase is higher, the lower is the degree of exchange rate management.[12] This initial exchange rate jump, however, causes the CPI inflation to jump as well - a movement that is immediately reversed due to low domestic inflation and the appreciation of the currency afterwards.

[12] In this case, as the exchange rate adjusts, the decline in output is also smaller.

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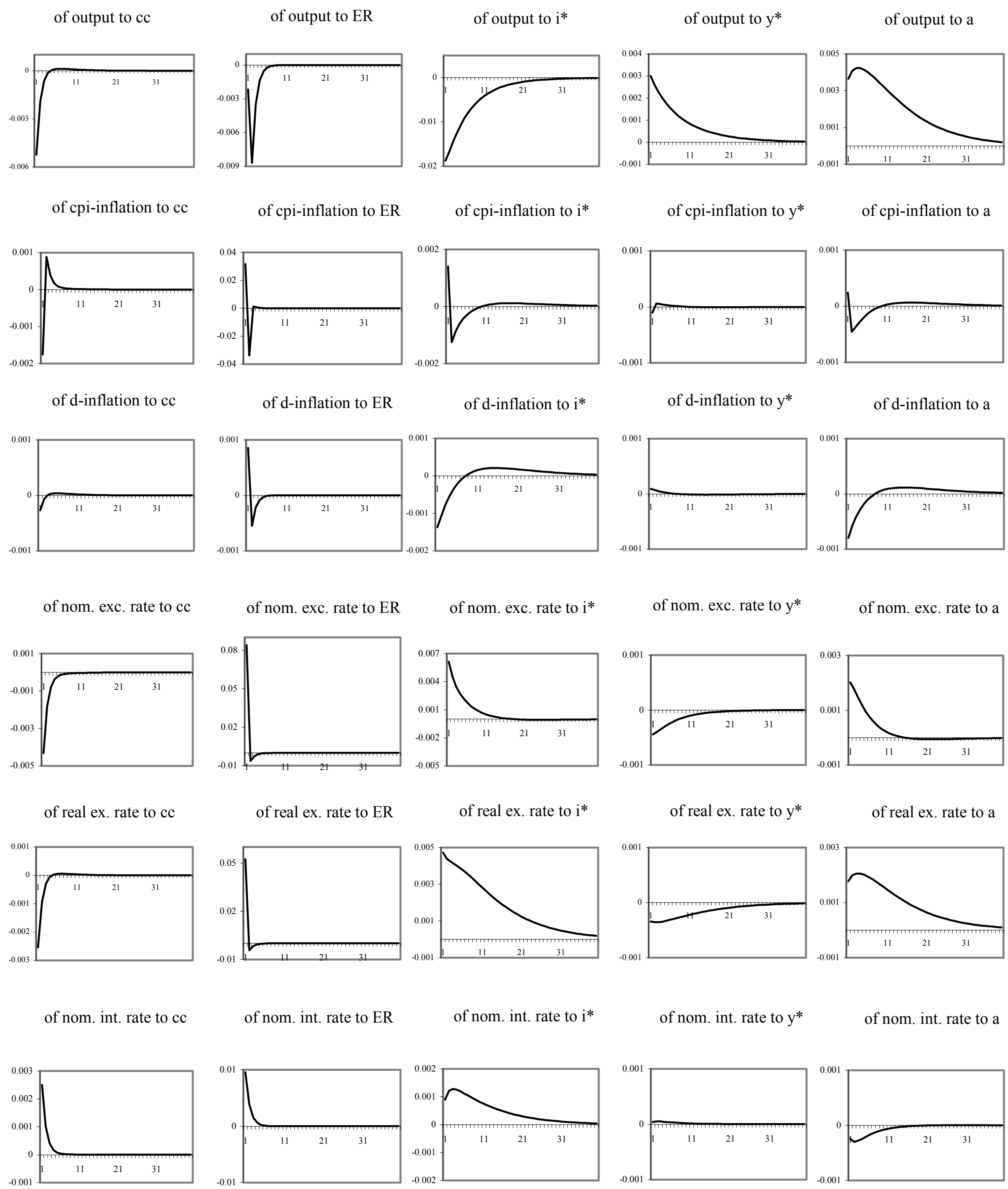
Figure 3. Free Capital Mobility and Flexible CPI Inflation Targeting



Note: *cc* stands for capital controls; *d-inflation* is domestic-goods inflation.

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A positive foreign output shock increases domestic output as well, but the impact is smaller than in the capital controls case, mainly because the monetary policy rule now implies an increase in the interest rate. The initial appreciation causes the CPI inflation to decline on impact; however, high domestic inflation combined with gradual depreciation pulls it back to positive levels.

Finally, a positive technology shock increases output and reduces domestic inflation. As monetary policy assigns a larger weight to inflation stabilization, the central bank cuts interest rates, which creates an additional increase in the output. The combined effect of low domestic inflation and the steady currency appreciation brings the CPI inflation below the steady state after its initial depreciation-induced jump.

In a nutshell, CPI inflation is more volatile in response to shocks under flexible IT than under the previously analyzed exchange-rate-based policy rule. The main reason is that now the central bank smoothes the interest rate rather than the exchange rate. While the exchange rate directly affects the CPI inflation (see equation (33)), the interest rate works only indirectly through suppressing domestic inflation. The higher the responsiveness of the interest rate target to the exchange rate, the better is inflation stabilized. The real exchange rate volatility drops relative to the capital controls case, because the uncovered interest parity and the monetary policy rule make inflation and the exchange rate move largely together.

Free-Floating Exchange Rate

In this subsection, the central bank excludes the exchange rate from its policy rule. The steady state level of the exchange rate is determined purely by the PPP, and thus changes in response to shocks. The impulse responses are shown in Figure 4.

The main difference from the managed exchange rate case is that the exchange rate is much more volatile, which creates a larger jump in the CPI inflation on impact in response to the exchange rate, foreign interest rate, and technology shocks. However, CPI inflation is positively affected afterwards, as the exchange rate quickly reverts to its new steady state. Output is most sensitive to an exchange rate shock owing to the stimulus provided to demand for home goods (see equation (28)). As exchange rate volatility absorbs a larger part of the other shocks now compared to the previously analyzed regimes, output volatility is significantly lower than in the previous two regimes as shown in Table 2.

Flexible Domestic Inflation Targeting

In a small open economy with a large share of imported goods in the CPI and high exchange rate pass-through to prices, the central bank may have much higher influence on domestic inflation rather than on the CPI inflation, and thus may decide to target the former. In our model, however, this does not make much of a difference. When the exchange rate floats freely, impulse responses (Figure 5) are the same as under CPI IT, except for the exchange rate shock, which naturally makes the CPI inflation more volatile. When the central bank manages the exchange rate, even this difference tends to disappear, which can also be confirmed by the unconditional variances of the variables of interest (Table 2).

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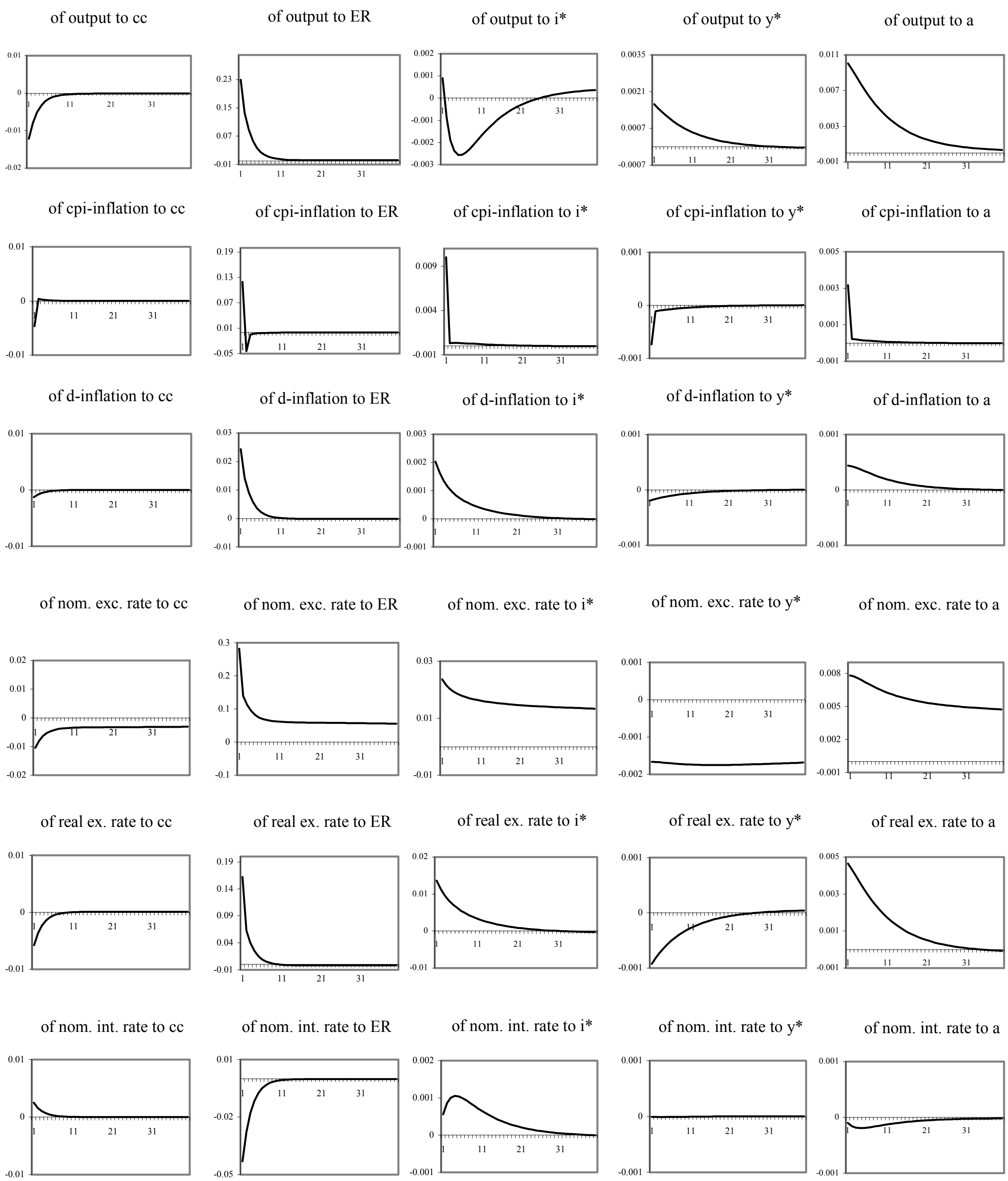
Figure 4. Free Capital Mobility and Stricter Inflation Targeting (Free-Floating Exchange Rate)



Note: *cc* stands for capital controls; *d-inflation* is domestic-goods inflation.

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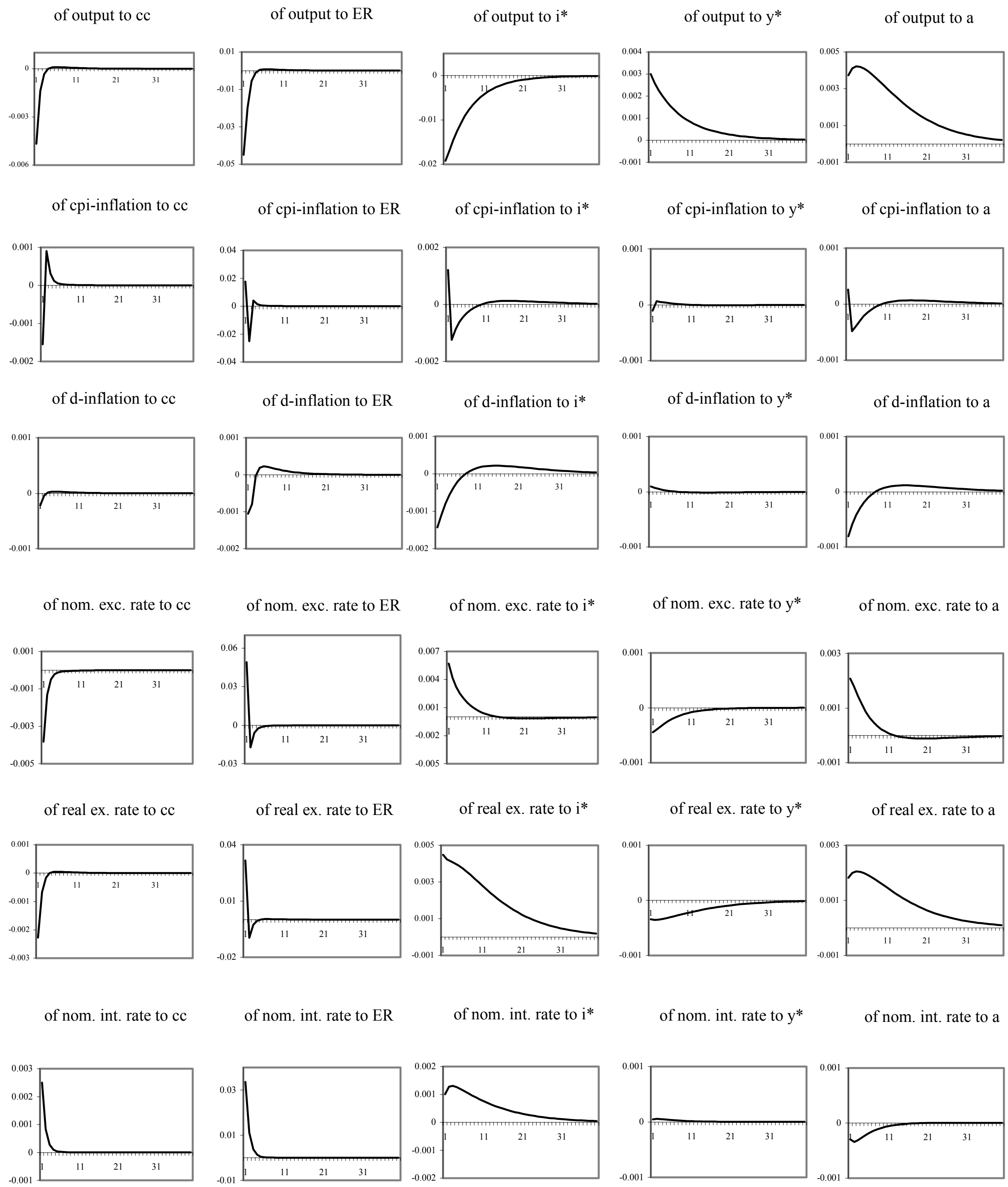
Figure 5. Free Capital Mobility and Flexible Domestic Inflation Targeting



Note: *cc* stands for capital controls; *d-inflation* is domestic-goods inflation.

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To summarize the impulse response results, restricted capital mobility and an exchange rate-based policy rule allow the central bank to stabilize the CPI inflation better than free capital mobility and an IT framework. However, this CPI stability comes at the cost of a more volatile real exchange rate, and, sometimes, output. Moreover, the maximum impact on output is larger in the model with capital controls for each of the three real and exogenous shocks (the foreign interest rate, the foreign output, and technology). As the degree of exchange rate smoothing declines in the capital controls model, the volatility of the output gap declines and the volatility of the CPI inflation increases. Under free capital mobility and IT, a floating exchange rate shoulders much of the adjustment and significantly reduces output volatility, at the cost of higher real exchange rate volatility relative to managed floating.

Table 2 . Unconditional Variances of the Main Variables
(In percent)

Capital controls and an exchange rate rule

	i* shock	Y* shock	Technology shock
Domestic inflation	0.00486	0.00001	0.00133
CPI	0.00002	0.00002	0.00001
Output	2.61790	0.06471	0.67441
Real exchange rate	0.37222	0.00276	0.09938

Free capital mobility and flexible CPI IT

	i* shock	Y* shock	Technology shock
Domestic inflation	0.00850	0.00004	0.00262
CPI	0.00857	0.00003	0.00103
Output	2.46656	0.06744	0.70708
Real exchange rate	0.33689	0.00216	0.08253

Free capital mobility and stricter CPI IT (free-floating exchange rate)

	i* shock	Y* shock	Technology shock
Domestic inflation	0.02549	0.00035	0.00242
CPI	0.18036	0.00110	0.01833
Output	0.17212	0.02648	0.14370
Real exchange rate	1.35005	0.00844	0.23433

Free capital mobility and flexible domestic IT

	i* shock	Y* shock	Technology shock
Domestic inflation	0.00891	0.00004	0.00266
CPI	0.00826	0.00004	0.00122
Output	2.50165	0.06750	0.69818
Real exchange rate	0.33117	0.00215	0.08274

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B. Welfare Analysis

Central Bank Loss Function

This subsection compares the policy regimes discussed in Section A in terms of the welfare loss they generate, as measured by the central bank loss function (44) - a weighted average of the variation in the domestic inflation, output gap, and real exchange rate. While the steady state is different under each regime, the loss function measures how well the central bank stabilizes domestic inflation, output gap, and the real exchange rate around the respective steady states.

As shocks to interest rates and the exchange rate have different interpretations[13] under each regime, only real and exogenous shocks (to the foreign interest rate, foreign output, and technology) are comparable across models. These three shocks are very important for a small open economy in transition, as they reflect changes in external demand and the transfer of technologies from abroad. Shocks to the interest rate and exchange rate are comparable between the variations of the IT regime.

Table 3 presents the welfare loss that stems from various shocks in all four models. The baseline model with free capital mobility and flexible IT performs about the same as the model with capital controls and an exchange rate rule. Once we let the exchange rate float freely, however, the welfare loss declines sharply for each of the three common shocks. The reverse holds if the economy is hit by domestic nominal (interest rate and exchange rate) shocks – managing the exchange rate pays off even under IT. Targeting domestic inflation rather than the CPI basically makes no difference.

Table 3. Welfare Results According to a Central Bank Loss Function

	Type of Shock				
Model	Interest Rate	Exchange Rate	Foreign Interest Rate	Foreign Output	Technology
Capital controls			0.01502	0.00034	0.00389
Free capital mobility (flexible CPI IT)	0.00033	0.02364	0.01415	0.00035	0.00399
Free capital mobility (floating exchange rate)	0.00281	1.06133	0.00799	0.00018	0.00193
Free capital mobility (flexible domestic IT)	0.00026	0.03153	0.01423	0.00035	0.00395

Figure 6 presents a sensitivity analysis with respect to the two parameters with the largest influence on the results - the price elasticity of demand faced by each monopolist, θ, and the

[13] Each of these variables is the instrument in one regime but determined by the interest parity condition in the other.

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intertemporal elasticity of substitution, σ.[14] Their values are placed on the horizontal axes, while the vertical axes reflect the respective welfare loss, other things being equal. For any value of θ and most values of σ, IT with a free-floating exchange rate is still superior for all shocks among the three regimes. For exceptionally low values of σ, however, it produces high real exchange rate volatility, which pulls up the welfare loss.

The model rankings are robust to changes in the loss function weights. Table 4 presents the results for two extreme cases. In the first case, zero weight is assigned to the real exchange rate, whereas in the second case a larger weight than in the baseline is assigned to the output gap term. In each case, the IT regime with a free-floating exchange rate retains its superiority, while the flexible IT regime performs broadly as the exchange-rate-based one, as under the baseline loss function weights.

Table 4. Sensitivity of Welfare Results to Loss-Function Weights

	λ_π=1.5, λ_x= 0.5, λ_q=0			λ_π=1.5, λ_x= 1, λ_q=0.5		
	Capital Controls, ER Rule,	Free Capital Mobility, Flexible IT	Free Capital Mobility, Floating ER	Capital Controls, ER Rule	Free Capital Mobility, Flexible IT	Free Capital Mobility, Floating ER
i* shock	0.01316	0.01246	0.00124	0.02811	0.02648	0.00885
Y* shock	0.00032	0.00034	0.00014	0.00066	0.00069	0.00031
Tech. shock	0.00339	0.00358	0.00078	0.00726	0.00752	0.00265

[14] The case of domestic IT is excluded because its responses to parameter variation are almost identical to those of the flexible IT case.

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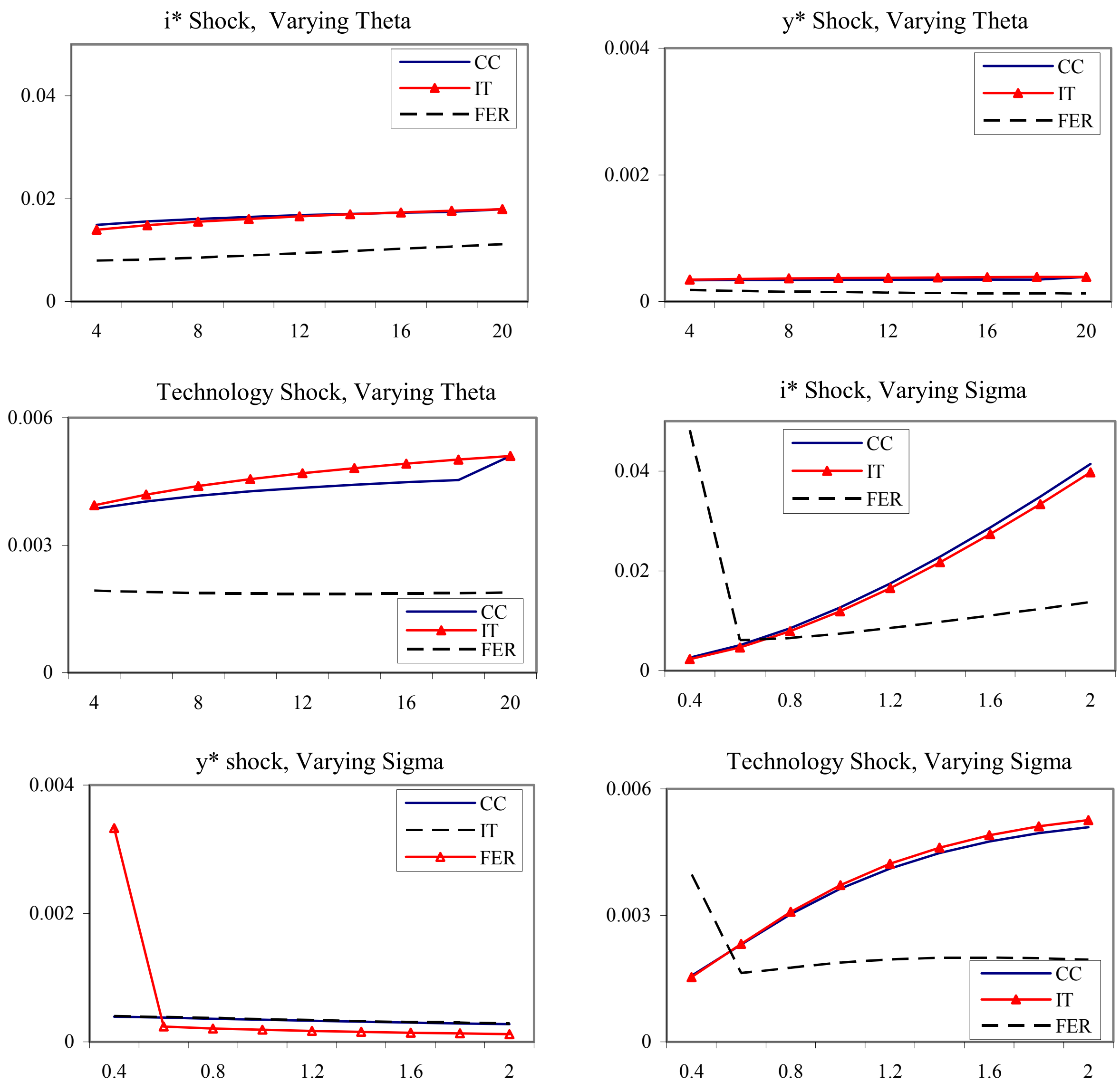
Figure 6. Sensitivity of Welfare Loss (Central Bank Loss Function) to Changes in Price Elasticity of Demand (Theta) and Intertemporal Elasticity of Substitution (Sigma)



Note: *CC* stands for capital controls, *IT* for flexible inflation targeting, and *FER* for inflation targeting with a freely floating exchange rate.

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Compensating Variation

In this section, we will compare welfare among different policy regimes by using the compensating variation measure introduced in Section IV.[15] For this purpose, we first express the labor effort in terms of consumption and the real exchange rate by using the equilibrium condition for the labor market. Then we calculate the fraction by which consumers' original steady state consumption basket (under the capital controls/exchange rate rule regime) would have to be increased to make them indifferent between their lifetime utility under that regime and the open capital account/IT one.[16] Table 5 presents the results for the first pair of models. A positive number indicates superiority of the IT regime.

Table 5. Welfare Comparison According to Compensating Variation: Capital Controls/Exchange Rate Rule Versus Free Capital Mobility/Flexible CPI Inflation Targeting

Type of Shock	Overall Effect	Effect Stemming From Different Steady States	Effect Stemming From Different Dynamics in Response to Shocks
i^* shock	0.6582	0.6612	-0.0030
Y^* shock	0.6621	0.6612	0.0009
Technology shock	0.6575	0.6612	-0.0037

Overall, the free capital mobility/flexible IT regime results in a welfare improvement of 2/3 of a percentage point. This result can be split in two parts: the effect of the difference in steady state consumption (the second column) and the effect of the difference in the stabilizing properties of the two regimes (the last one). Predictably, the removal of capital controls lowers the steady state domestic interest rate and thus raises the steady state level of output and consumption. On the other hand, there is not much of a difference between the ability of both regimes to stabilize the economy. While the exchange-rate-based regime seems to perform marginally better for foreign interest and technology shocks, these gains pale in comparison with the improvement coming from the higher steady state consumption.

Table 6 compares the regime with capital controls/exchange rate rule and the regime with the free capital mobility/IT with a free-floating exchange rate. A positive number indicates superiority of the latter regime. The welfare increase stemming from a rise in the steady state consumption is still the same. The overall effect is now influenced by the different dynamics caused by the free-floating exchange rate. The latter absorbs a large part of the foreign interest rate shock through the uncovered interest parity, and some of the technology shock through the

[15] As this welfare measure can compare only two models at a time, we compare our three models in pairs. As replacing CPI inflation with domestic inflation as targeted measure seems to make no difference, we drop the domestic IT case.

[16] We ignore the utility from the money balances, as in Obstfeld and Rogoff (2000) and Corsetti and Pesenti (2001b).

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output gap. Thus, this variation of the IT regime outperforms the other one for foreign interest rate and technology shocks, and performs roughly the same for a foreign output shock.

Table 6. Welfare Comparison According to Compensating Variation: Capital Controls/Exchange Rate Rule Versus Free Capital Mobility/Stricter CPI Inflation Targeting (Free-Floating Exchange Rate)

Type of Shock	Overall Effect	Effect Stemming From Different Steady States	Effect Stemming from Different Dynamics in Response to Shocks
i^* shock	0.8692	0.6612	0.2080
Y^* shock	0.6406	0.6612	-0.0205
Technology shock	0.7285	0.6612	0.0673

Table 7 displays the results for the comparison of the two IT frameworks: with managed and free-floating exchange rate[17]. Again, a positive number indicates the superiority of the latter regime. As steady state consumption is the same, the only difference comes from the different monetary policy rules. The IT framework with free-floating exchange rate outperforms for technology and (especially) foreign interest rate shocks, and performs about the same for a foreign output shock.

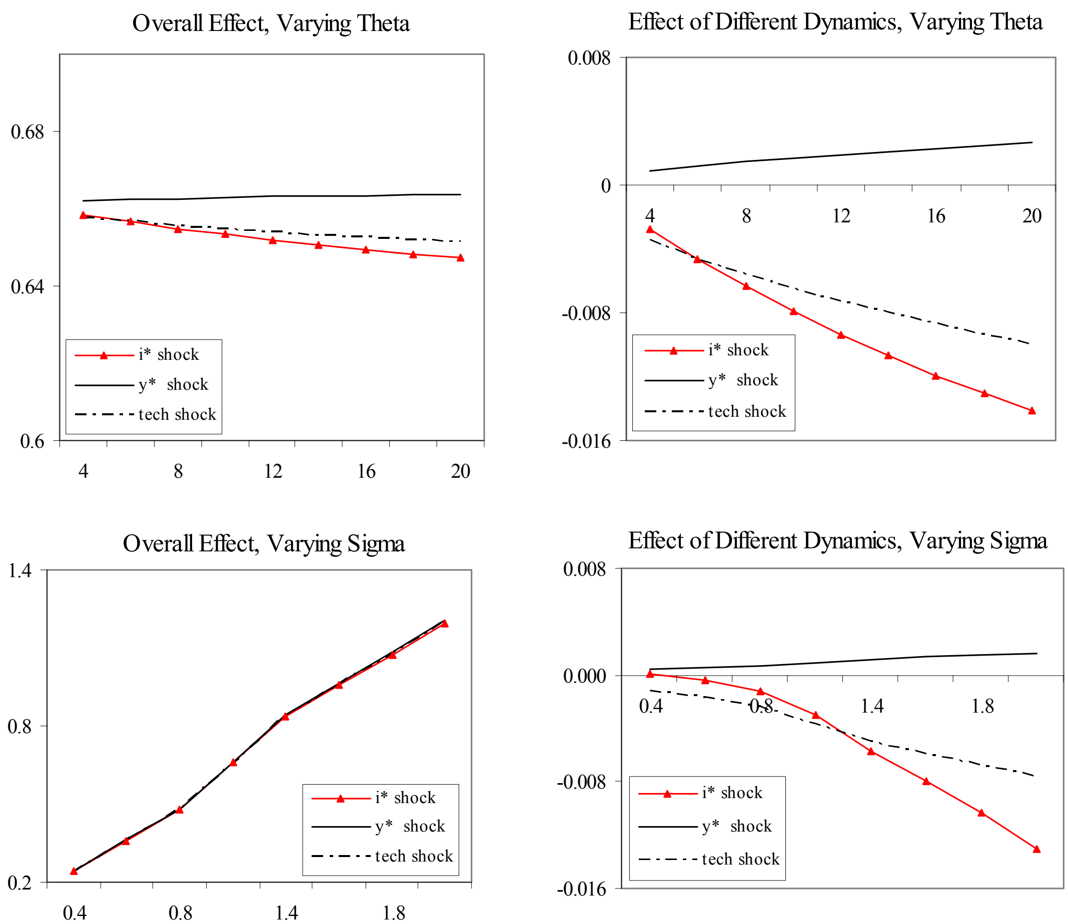
Table 7. Welfare Comparison According to Compensating Variation: Flexible Versus Stricter CPI Inflation Targeting (Free-Floating Exchange Rate)

Type of Shock	Effect Stemming From Different Dynamics in Response to Shocks
i^* shock	0.1970
Y^* shock	-0.0214
Technology shock	0.0707

These welfare results are robust to parameter changes. We present again in Figure 7 a sensitivity analysis for the two most important parameters: the price elasticity of demand faced by each monopolist, θ, and the intertemporal elasticity of substitution, σ . The only difference from the baseline is that, in the case of a low intertemporal elasticity of substitution, the welfare gains from capital account liberalization are smaller, as this parameter influences the steady state consumption.

[17] The targeted inflation measure is the CPI change. Replacing it with domestic inflation does not make a notable difference to the results in Table 7.

Figure 7. Sensitivity of Welfare Gains (Compensating-Variation Measure) to Changes in Price Elasticity of Demand (Theta) and Intertemporal Elasticity of Substitution (Sigma)



Notes: The entries show the welfare advantage/disadvantage of the policy regime of free capital mobility and flexible CPI inflation targeting over the regime of capital controls and an exchange rate rule, in percentage points. The two panels on the left show the overall welfare result, while the two panels on the right exclude the effect of the new steady state and thus compare only the welfare implications of the different stabilizing properties of the two regimes.

VI. Conclusions

This paper analyzes the macroeconomic implications of the forthcoming changes in Romania's monetary policy regime and external environment: from partial capital mobility and an exchange-rate-based policy rule to an open capital account coupled with an IT regime. A neo-Keynesian small open-economy model with explicit microeconomic foundations is developed and parameterized to reflect features of the Romanian economy.

The impulse responses show that a regime based on capital controls and an exchange rate rule would stabilize CPI inflation better than a flexible IT framework with open capital markets at

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the expense of higher real exchange rate volatility and larger maximum impact on output. This is not surprising, given the still-high exchange rate pass-through and Romania's high trade openness. In welfare terms, however, this regime's gains from less volatile inflation are offset by the losses from the more volatile real exchange rate, and, occasionally, output.

By lowering real interest rates, capital account liberalization would produce a permanent shift in steady-state consumption, thus increasing welfare by about 0.66 percent for the parameter configuration presented here.[18] Apart from this welfare gain, a flexible IT regime—which still reserves a place for the exchange rate in the monetary policy rule—has about the same stabilizing properties and welfare implications as the old regime, measured by the compensating variation. A stricter IT regime with free-floating exchange rate would be superior, mainly because it would allow the exchange rate to absorb more of the shocks hitting the economy and would thus stabilize output and consumption. Ironically, this regime implies higher inflation volatility than the other two.

The analysis based on an ad hoc central bank loss function produces somewhat different results. While the stricter IT regime still maintains its superiority for real and exogenous (productivity, foreign interest rate, and foreign output) shocks, it underperforms the flexible IT framework for domestic nominal (interest rate and exchange rate) shocks. The main reason is that managed floating better addresses the sources of these shocks and minimizes inflation and real exchange rate volatility. These results are somewhat sensitive to certain parameter values but not to the weights in the loss function.

These results are subject to two caveats. First, we measure the stabilizing properties of the various regimes against moderate-size shocks that change neither the underlying steady-state equilibrium of the economy, nor the transmission from shocks and instruments to the endogenous model variables. Second, both the gains from financial integration and the superior stabilizing properties of IT plus a free-floating exchange rate rest heavily on the assumption of a reasonably strong transmission between the policy interest rate and the real economy. Such a transmission still has room to improve in Romania. Thus, these results may be more applicable in the medium term, after the NBR has had a few years of practicing inflation targeting.

[18] The welfare gain depends on the initial degree of capital control and elasticity of substitution.

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