

A Model for Monetary Policy Analysis in Pakistan: The Role of Foreign Exchange and Credit Markets

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Non-Technical Summary

IGC has supported an ongoing program to develop and use a Dynamic Stochastic General Equilibrium (DSGE) model for monetary policy analysis in Pakistan. Previous projects have designed a DSGE model suitable for Pakistan, used it to examine important monetary policy issues, and made the model ready for operation at the State Bank of Pakistan (SBP). The present project undertakes important extensions of the model to explore the role of foreign exchange and credit markets in determining the macroeconomic effects of monetary policy. Monetary policy plays an important role in advanced countries in controlling inflation and stabilizing economic activity. Foreign exchange and credit markets in these countries represent important channels for the transmission of monetary policy effects. In Pakistan, credit markets are less developed and international capital flows are less dominant in the foreign exchange market. The project incorporates these differences in the model and explores how they influence the effectiveness of monetary policy.

Most central banks use control over interest rates as the key instrument of monetary policy. A lower policy interest rate leads to a decrease in a variety of interest rates. As costs and prices adjust slowly, lower policy interest rate also leads to a decline in the expected real interest rates (nominal interest rates minus expected inflation). This decline increases aggregate demand and thus output and inflation through three important effects. First, the expected real return on saving is reduced, which increases consumption by discouraging savings. Second, the expected real cost of borrowing is reduced, which induces more investment. Third, the real value of home currency depreciates (as capital outflows are stimulated by lower expected real interest rates), which improves the trade balance.

In Pakistan, credit markets do not operate smoothly and the lending rates do not fall quickly and adequately in response to lower policy interest rates. This feature can weaken the effect of monetary policy on investment. Also, the financial markets in Pakistan are not well integrated with global financial markets. One consequence of this lack of integration is that SBP can intervene in the foreign exchange market to stabilize the exchange rate without causing significant international capital flows. Although this policy reduces exchange rate fluctuations, it weakens the monetary policy effect on trade balance operating via the exchange rate adjustment.

We incorporate these features of the credit and foreign exchange market in the DSGE model for monetary policy analysis in Pakistan (MPAP model) calibrated to Pakistan's economy. We introduce inertia in the setting of the interest rate on bank loans. The degree of this friction is chosen to allow a low pass-through from the policy interest rate to the bank lending rate, which

is consistent with the evidence. We add transaction costs in international borrowing and lending and these costs are assumed to rise as the volume of borrowing or lending increases. This friction is assumed to be sufficiently large to explain the small effect of exchange market intervention by SBP on international capital flows. The model also allows for inertia in the formation of inflation expectations. We undertake simulations of the MPAP model with the above frictions to examine the dynamic effects of monetary policy (with exchange rate stabilization) on inflation and the output gap (between actual and potential GDP). We also derive the dynamic effects from a standard model without these frictions and flexible exchange rates to explore the extent to which monetary policy effectiveness in Pakistan is weakened by the frictions and exchange rate stabilization. We find that these factors make a significant difference and the impact of monetary policy on inflation and the output gap in the MPAP model is roughly one-half of that in the standard model.

One important monetary policy issue in Pakistan is how the policy interest rate should respond to inflation. Estimates based on historical data suggest that the interest rate response to inflation has been weak in Pakistan. Since monetary policy effectiveness is diminished because of credit and foreign exchange market frictions, there may be a need for a more vigorous interest rate response to inflation to effectively control inflation and reduce output variability. To explore this issue, we use the model to evaluate the macroeconomic performance of different monetary policies with different degrees of interest rate response, and with or without exchange rate stabilization. To evaluate the performance of each policy, we use stochastic simulation of the model (where the economy is subjected to demand and supply and internal and external shocks) to generate artificial series on key macroeconomic variables. These series are used to calculate indexes of variability of inflation, output gap and real depreciation as three key indicators of macroeconomic performance. The results of our simulations suggest that using moderate rather than weak response to inflation would significantly lower inflation variability and would also make output more stable. Strong response would further reduce inflation and output variability, although the improvement from moderate to strong response would not be as large as that from weak to moderate response. Our results also show that if monetary policy also attempts to stabilize real exchange rate movements (via intervention in the foreign exchange market), it would achieve this goal at a cost of much higher inflation and output variability for each type of inflation response.

Our model simulations assume that fiscal authorities adjust taxes and/or expenditures to control debt levels. Without fiscal adjustment to control debt, the rate of borrowing would keep on increasing, making it infeasible to control inflation. If government does not control debt, central bank could attempt to stabilize it. In a previous paper, we explored a policy rule where SBP adjusts interest rates to control debt as well as inflation. This policy was found to lead to high and volatile inflation and cause large welfare losses. Concerns regarding fiscal policy could also lead to credibility problems which would worsen economic conditions. An important policy

implication is that macroeconomic performance and the ability of SBP to control inflation can be improved considerably if fiscal policy takes the responsibility to stabilize debt.

1. Introduction

This paper discusses the results of a project supported by IGC, which is part of an ongoing program to develop and use a DSGE model for monetary policy analysis in Pakistan. Previous projects have designed a DSGE model suitable for Pakistan, used it to examine important monetary policy issues, and made the model ready for operation at the State Bank of Pakistan (SBP). The present project undertakes two important extensions of the model needed to address pressing monetary policy issues.¹ One extension is the modelling of international capital flows and SBP intervention in the foreign exchange market. The dynamics of international capital flows have always played a significant role in influencing the balance of payments position in Pakistan and, as a consequence, SBP's exchange rate and interest rate policy. There is a need to examine the interaction of SBP's foreign exchange market intervention with the interest rate policy in the context of intervention-induced foreign exchange losses. Another extension is the modelling of the credit market to better understand the impact of the policy interest rate on the bank loan rate and, in turn, on the behaviour of credit availed to the private sector. This extension also allows us to examine the implications of excessive fiscal borrowing for the private credit market.

In adding the two extensions in the model, we take into account two features of the financial and credit markets in Pakistan. First, the financial markets in Pakistan are not well integrated with global financial markets and there are important departures from the interest parity relation. To incorporate this feature, we introduce a friction in the form of transaction costs in international borrowing or lending. Large transaction costs would allow exchange market intervention to have significant impact on the exchange rate and stabilize exchange rate

¹ These extensions were identified in meetings with SBP staff for consultation about the development, use and application of the model.

movements. Second, the credit market in Pakistan are less developed than advanced countries and the lending rates do not adjust quickly and adequately to change in the policy interest rate. We capture this feature by introducing adjustment costs in the setting of the interest rate on bank loans. Large adjustment costs can account for low pass-through from the policy rate to the bank loan rate observed in low income countries (Mishra et al., 2010).

Frictions in the credit and exchange markets and exchange rate stabilization weaken the effect of monetary policy on inflation and output. To explore the role that these factors play in reducing the effectiveness of monetary policy, we compare the extended model with a standard model with flexible exchange rates and without the credit and exchange market frictions. We find that the output and inflation effects of an interest rate change in the extended model are much weaker than the standard model. One implication of these results is that the SBP may need to respond to inflation more strongly to effectively control inflation. We undertake stochastic simulations of the extended model to explore the appropriate interest rate rule.

Section 2 discusses the extensions of the model and derives the new relations for the extended model. Effectiveness of monetary policy in the extended model is examined in Section 3 . Section 4 evaluates the performance of alternative interest rate rules.

2. Extended Model

Our previous research developed a dynamic stochastic general equilibrium model designed for monetary policy analysis in Pakistan (MPAP). The model has a modular structure: it starts with a basic version and then adds various extensions and modifications.² The basic version of the model (MPAP0) is based on the conventional New-Keynesian framework and

²² For a discussion of the basic version and its extensions, see Choudhri and Malik (2013).

represents a fairly standard model of a small open economy with one household, two differentiated goods (home and foreign goods) and two inputs (labor and capital). A second version (MPAP1) allows for two types of households: high-income (H type) household who can borrow or lend and low-income (L type) households who are liquidity constrained. The third version (MPAP2) also introduces a competitive banking sector that transforms deposits (by high-income households) into loans (to firms) for financing investment.³

The current project extends the model further in two directions. First, international capital flows are determined endogenously. Frictions in the form of transactions costs are introduced to account for a lack of financial integration between Pakistan and advanced countries. Second, the banking sector is assumed to operate under monopolistic competition. This setup allows the introduction of inertia in the determination of the interest rate on bank loans, which can explain low pass-through from the policy rate to the bank loan rate. In the remainder of this section, we explain the relations based on the two extensions. The complete model, which incorporates the new relations in the model version MPAP2 is described in Appendix 1.

2.1 Endogenous international capital flows

To add this extension to the version with two households, we assume that high-income households can also borrow and lend internationally by holding foreign assets or liabilities. We also assume that international borrowing or lending involves a significant transaction cost that increases in net foreign assets. Assuming a continuum of H type households indexed by $h \in (0,1)$, express the utility function and the budget constraint for a household of this type as

³ We also consider a variation that incorporates imperfect credibility of monetary and fiscal policy rules and adds a model in which inflationary expectations depend on credibility stock that is determined endogenously

$$U_{H,t}(h) = E_t \sum_{s=t}^{\infty} \beta^{s-t} \left(\frac{c_{H,s}(h)^{1-\theta}}{1-\theta} + \frac{\xi_{HC} c_{H,s}(h)^{1-\chi}}{1-\chi} + \frac{\xi_{HD} d_{H,s}(h)^{1-\kappa}}{1-\kappa} - \frac{\xi_{HN} n_{H,s}(h)^{1+\nu}}{1+\nu} \right),$$

$$c_{H,t}(h) + \tau_{H,t}(h) + cu_{H,t}(h) + d_{H,t}(h) + b_t(h) + s_t b_t^*(h) = cu_{H,t-1}(h) / \Pi_t + (1 + r_{D,t-1}) d_{H,t-1}(h) + (1 + r_{t-1}) (b_{t-1}(h) + s_t (1 + r_{t-1}^*) b_{t-1}^*(h) (1 - TC_{t-1}) + w_{H,t} n_{H,t}(h) (1 - AC_{WH,t}(h)) - q_t i_t(h) - r_{L,t-1} \bar{l}_H(h) + re_t k_{t-1}(h) + pr_t(h).$$

where, , in period t , $c_{H,t}(h)$ and $n_{H,t}(h)$ are the household's consumption and labor supply;

$cu_{H,t}(h)$ and $d_{H,t}(h)$ are the (end of period) holding of real currency and bank deposits (in terms of the composite good); $\tau_t(h)$ represents (lump sum) real taxes; $b_t(h)$ and $b_t^*(h)$ are the real stocks of domestic and foreign bonds and $k_t(h)$ is the stock of capital (at the end of the period); $i_t(h) [= k_t(h) - k_{t-1}(h)]$ is real investment while $\bar{l}_H(h)$ is the (fixed) real value of household loans from banks; s_t is the real exchange rate; q_t is the price of installed capital, $\Pi_t = P_t / P_{t-1}$ where P_t is the price of a unit of the composite good; $r_{D,t}$, r_t and $r_{L,t}$ are the real interest rates on bank deposits, government bonds and bank loans; re_t is the real rental rate for installed capital; $w_{H,t}(h)$ is the real wage rate; and AC_{Wt} is the wage adjustment cost; $pr_t(h)$ represents the household's share of real profits and TC_t is the transaction cost for foreign bonds defined as⁴

$$TC_t = \frac{e^{\mu b^*} - 1}{e^{\mu b^*} + 1}, \quad \mu > 0.$$

Note that that TC_t is zero in the absence of international borrowing or lending ($b_t^* = 0$). If b_t^* is positive (negative), TC_t is greater (smaller) than zero and increases (decreases) as lending (borrowing) abroad increases. In this case home residents receive (pay) an interest rate lower

⁴ This form of the transaction cost function is based on Laxton and Pesenti (2003)

(higher) than the foreign rate. Parameter μ determines the slope of the transaction cost function and an increase in μ makes the function steeper.

In the presence of net foreign assets in the household portfolio, optimization by the household implies the following new condition

$$(1 + r_t) = \frac{s_t^e (1 + r_t^*) (1 - TC_t)}{s_t},$$

where s_t^e is the expected value of s_{t+1} at time t . To allow for inertia in the formation of exchange rate expectations, we assume that $s_t^e = \Lambda E_t s_{t+1} + (1 - \Lambda) s_{t-1}$, $0 < \Lambda \leq 1$.

Combining the budget constraint of both high- and low-income households with the government's flow budget and the State Bank's balance sheet relations, we can derive the following relation determining the accumulation of foreign assets:

$$b_t^* = (1 + r_{t-1}^*) (1 - TC_{t-1}) b_{t-1}^* + (ni_t - c_{H,t}) / s_t$$

where ni_t represents net income of H households and is defined as .

$ni_t \equiv p_{X,t} z_{X,t} + p_{D,t} z_{D,t} + s_t rm_t^* + s_t dir_t^* - i_t - g_t - c_{L,t} - AC_t$. In this definition, $p_{X,t}$ and $p_{D,t}$ are the real prices of the bundles exported and supplied to the domestic market; $z_{X,t}$ and $z_{D,t}$ represent the demand for the two bundles; rm_t^* is the amount of foreign remittances in dollars (assumed to be received by L households); dir_t^* is the change in State Bank's holding of international reserves; $c_{L,t}$ is the consumption of L households; and AC_t represents the total adjustment costs.

The relation determining the consumption of H households can be derived as follows.

First, assume, for simplicity, that $r_t^* = r^*$, move the above foreign asset relation forward on period and then use it repeatedly to substitute for future values of b_t^* to obtain⁵

$$b_t^* = \frac{1}{(1+r^*)(1-TC_t)} \left(\frac{c_{t+1} - ni_{t+1}}{s_{t+1}} \right) + \frac{1}{(1+r^*)^2(1-TC_t)(1-TC_{t+1})} \left(\frac{c_{t+2} - ni_{t+2}}{s_{t+2}} \right) + \dots$$

Next, use this relation to substitute for b_t^* in the foreign asset relation, make use of the Euler condition (implied by the household optimization) that $c_{H,t+1}^\theta = c_{H,t}^\theta \beta(1+r_t)$ to eliminate future values of $c_{H,t}$, and derive

$$c_t = \frac{sumni_t + b_{t-1}^*}{sumr_t},$$

where $sumni_t = \frac{1}{s_t(1+r^*)(1-TC_{t-1})} ni_t + \frac{1}{s_{t+1}(1+r^*)^2(1-TC_{t-1})(1-TC_t)} ni_{t+1} + \dots$, and

$$sumr_t \equiv \frac{1}{s_t(1+r^*)(1-TC_{t-1})} + \frac{[\beta(1+r_t)]^{1/\theta}}{s_{t+1}(1+r^*)^2(1-TC_{t-1})(1-TC_t)} + \frac{[\beta(1+r_t)]^{1/\theta} [\beta(1+r_{t+1})]^{1/\theta}}{s_{t+2}(1+r^*)^3(1-TC_{t-1})(1-TC_t)(1-TC_{t+1})} + \dots$$

Variable $sumni_t$ represents the discounted value of H household's net income stream while $sumr_t$ is a conversion factor that makes the product of c_t and $sumr_t$ equal to the discounted value of H household's consumption stream. These above expressions are simplified as

$$sumni_t = \frac{1}{s_t(1+r^*)(1-TC_{t-1})} ni_t + \frac{1}{(1+r^*)(1-TC_{t-1})} sumni_{t+1},$$

⁵ In deriving this series we use the transversality condition that

$$\lim_{n \rightarrow \infty} \prod_{s=t}^{t+n-1} \frac{1}{(1-TC_s)} \left[\frac{1}{(1+r^*)^n} b_{t+n}^* \right] = 0.$$

$$sumr_t = \frac{1}{s_t(1+r^*)(1-TC_{t-1})} + \frac{[\beta(1+r_t)]^{1/\theta}}{(1+r^*)(1-TC_{t-1})} sumr_{t+1}.$$

2.2 Monopolistically competitive banking sector

Assume that there is a continuum of banks indexed by $b \in (0,1)$. Each bank faces a demand function for its loans, $l_{B,t}(b) = l_{B,t} (r_{L,t}(b) / r_{L,t})^{-\sigma_B}$, where $l_{B,t} = \left[\int_0^1 l_{B,t}(b)^{(\sigma_B-1)/\sigma_B} db \right]^{\sigma_B/(\sigma_B-1)}$, and $r_{L,t}(b)$ is the interest rate on loans set by the bank. A friction in the banking sector is introduced by the assumption that banks face adjustment costs in setting the loan rate, which are given by

$$AC_{B,t}(h) = \frac{\omega_B}{2} \left(\frac{[1+r_{L,t}(b)]}{[1+r_{L,t-1}(b)]} - 1 \right)^2.$$

Deposit creation and production of loans by a bank is determined by the following liquidity and monitoring functions:

$$d_{H,t}(b) = \xi_{BD} (cr_t(b))^\gamma (b_{B,t}(b))^{1-\gamma},$$

$$l_{B,t}(b) = \xi_{BL} n_{HB,t}(b)$$

where $cr_t(b)$ and $b_{B,t}(b)$ represent real values of cash reserves and government bonds held by banks, and $n_{HB,t}(b)$ is the employment of H type labor (banks are assumed to employ only this type of labor). The balance sheet of the banks is given by

$$cr_t(b) + b_{B,t}(b) + l_{B,t}(b) = d_{H,t}(b).$$

The discounted value of bank profits is

$$E_t \sum_{s=t}^{\infty} \beta^{s-t} \lambda_{H,s} \left(\begin{array}{l} cr_s(b) / \Pi_{s+1} + (1+r_s)b_{B,s}(b) + (1+r_{L,s}(b))l_{B,s}(b)(1-AC_{B,s}) \\ -(1+r_{D,s})d_{H,s}(b) - w_{H,s}n_{HB,s}(b) \end{array} \right),$$

where $\lambda_{H,s}$ denotes the marginal value of wealth for H households (the Lagrange multiplier associated with their budget constraint) and $w_{H,t}$ represents the real wage rate for the H type labor bundle. Banks maximize this value subject to the liquidity and monitoring relations and the balance-sheet constraint. The optimal conditions in symmetric equilibrium are⁶

$$cr_t = \gamma \left[\frac{\lambda_{B,t} - (1+r_{D,t})}{\lambda_{B,t} - 1 / E_t \Pi_{t+1}} \right] d_{H,t},$$

$$b_{B,t} = (1-\gamma) \left[\frac{\lambda_{B,t} - (1+r_{D,t})}{\lambda_{B,t} - (1+r_t)} \right] d_{H,t},$$

$$\begin{aligned} \lambda_{B,t} = & (1-AC_{B,t})[1+r_{L,t}(1-1/\sigma)] + (1+r_{L,t})(r_{L,t}/\sigma)(\partial AC_{B,t} / \partial r_{L,t}) - (w_{H,t} / \xi_{BL,t}) \\ & + \beta(c_{H,t+1}^{-\theta} / c_{H,t}^{-\theta}) \left[(1+r_{L,t+1})(l_{B,t+1} / l_{B,t})(r_{L,t} / \sigma)(\partial AC_{B,t+1} / \partial r_{L,t}) \right], \end{aligned}$$

where $\lambda_{B,t}$ is the shadow price associated with the balance sheet constraint, and we have made

use of the condition (implied by household optimization) that $\lambda_{H,t} = c_{H,t}^{-\theta}$. Note that the

adjustment cost parameter, ω_B , influences the shadow price and thus affects the response of $r_{L,t}$

to r_t .

⁶ To derive these conditions we use the following Lagrange expression:

$$Z_B = E_t \sum_{s=t}^{\infty} \beta^{s-t} \lambda_{H,s} \left(\begin{array}{l} cr_s(b) / \Pi_{s+1} + \tilde{r}_s b_{B,s}(b) + \tilde{r}_{L,s}(b) l_{B,s}(b) (1-AC_{B,s}) - \tilde{r}_{D,s} \xi_{BD,s} (cr_s(b))^\gamma (b_{B,s}(b))^{1-\gamma} \\ - \frac{w_{H,s} l_{B,s}(b)}{\xi_{BL,s}} + \lambda_{B,s} \left\{ \xi_{BD,s} (cr_s(b))^\gamma (b_{B,s}(b))^{1-\gamma} - cr_s(b) - b_{B,s}(b) - l_{B,s}(b) \right\} \end{array} \right)$$

3. Effectiveness of Monetary Policy

We first use the extended model to explore how frictions in the credit and foreign exchange market influence the effectiveness of monetary policy. Frictions in the credit market are represented by adjustment costs in setting the bank loan rate. The adjustment cost parameter, ω_B , determines how the lending rate responds to the policy rate. We assume that this parameter equals 1200. This value makes the short run effect of the policy rate on the bank lending rate in the model consistent with the evidence for low income countries (Mishra et al., 2010). In the foreign exchange market, frictions arise from transaction costs in international borrowing or lending. We assume that the transaction cost parameter, μ , equals 20. This value is sufficiently large to allow SBP intervention in the foreign exchange market (purchase or sale of international reserves) to have a substantial effect on the exchange rate. We also introduce inertia in the formation of exchange rate and inflation expectations by letting Λ (the weight on forward looking component) equal to 0.5.

Monetary policy is assumed to operate in an environment that we call “weak monetary independence”. The inflation target is not chosen by SBP, but is determined by the government (through the fiscal authority) and depends on its needs to generate sufficient revenue from money creation. SBP, however, is free to choose a policy for implementing the inflation target. We assume that the SBP policy can be represented by an interest rate rule of the following general form:

$$\ln(1 + R_t) = \phi_{rr} \ln(1 + R_{t-1}) + (1 - \phi_{rr}) \{ \ln(1 + \bar{R}) + (1 + \phi_{r\pi}) \ln(E_t \Pi_{t+1} / \bar{\Pi}) + \phi_{ry} \ln(y_t / \bar{y}) \} + \ln \xi_{R,t},$$

where R_t is the nominal interest rate set by SBP, $\bar{\Pi}$ is the inflation target (determined by the fiscal authority), \bar{R} is long-run nominal interest rate consistent with the steady state real rate, \bar{y} is the steady state output, and $\xi_{R,t}$ is the shock to the monetary policy rule. The government is assumed to take responsibility for stabilizing its debt at a target level and uses a tax rule which adjust taxes (slowly) in response to debt growth.⁷ Finally, SBP is also assumed to follow a policy of stabilizing the real exchange rate by buying or selling international reserves. We describe this policy by an intervention rule of the following simple form:

$$d\text{irs}_t^* = \phi_{ir}(s_t - \bar{s}), \quad \phi_{ir} < 0,$$

where \bar{s} is the real exchange rate in the steady state.

The key channel for the transmission of the monetary policy effects in the model is the real interest rate. The real interest rate equals the nominal interest rate minus the expected inflation rate. A policy induced reduction in the nominal interest rate lowers the real interest rate directly as well as indirectly by raising the expected inflation rate. The lower real interest rate increases three components of aggregate demand. First, as the real return to savings is less, households increase consumption.⁸ Second, a decrease in the bank loan rate in response to lower policy rate reduces the real cost of borrowing and thus increases investment. Third, the real exchange rate appreciates (the real value of home currency depreciates) in response to a decrease in the real interest rate (via the interest parity relation). The exchange rate appreciation increases trade balance. The frictions introduced in the model make monetary policy less effective by

⁷ Choudhri and Malik (2013) consider an alternative policy environment of “fiscal dominance” where the government does not follow the tax rule, and SBP has to follow an interest rate rule which also targets debt. This policy is shown to cause higher and more volatile inflation.

⁸ In our model L household are liquidity constrained and do not save. However, their consumption would also increase via an increase in income brought about by higher aggregate demand.

impeding these effects. Expectation inertia dampens the effect on the expected inflation rate and the real interest rate falls less (for a given reduction in the nominal interest rate). Credit frictions make the bank lending rate less responsive to changes in the policy rate. Exchange rate stabilization policy (made possible by frictions in international capital flows) blocks the effect operating via the real exchange rate policy.

To explore the effectiveness of monetary policy, we examine the response of output and inflation to a temporary decrease in the interest rate. In the interest rate rule, the temporary rate decrease is represented by a negative shock to monetary policy rule for one quarter equal to a 1% decrease in the annualized interest rate. Estimates of the interest rate rule for Pakistan suggest that the response to inflation is weak and we set the inflation coefficient ($\phi_{r\pi}$) equal to 0.15. We assume no response to output ($\phi_{ry} = 0$) and moderate interest rate smoothing ($\phi_{rr} = 0.5$). To illustrate the role of various frictions and exchange rate stabilization in influencing monetary policy effectiveness, we compare the extended MPAP model with a standard model without frictions and fully flexible exchange rate. In the standard model, we assume no adjustment costs in the bank loan rate ($\omega_B = 0$) and negligible transaction costs in international borrowing or lending ($\mu = 0.01$).⁹ We also assume no exchange market intervention ($\phi_r = 0$) in this model.

Figures 1 and 2 show the dynamic effects (over 12 quarters) of the temporary interest rate decrease on the output gap (percent change in output relative to steady state output) and inflation (percent annual rate). The effectiveness of monetary policy in the MPAP model is significantly weaker than in the standard model. Indeed, first-quarter impact of the interest rate reduction on output and inflation in the MPAP model is roughly half of that in the standard model.

⁹ A very small cost ensures convergence to a unique steady state, but has a negligible effect on the dynamics.

Differences between the two models are further explored in Figures 3 through 5. Figure 3 illustrates the effect of inertia in inflation expectations and shows that the real rate does not initially fall as much in the MPAP model as in the standard model. The effect of adjustment cost on the spread between real bank loan rate and the real interest rate is shown in Figure 4. In the MPAP model, the spread rises sharply as the bank loan rate does not initially fall as much as the interest rate. The role of exchange rate stabilization is highlighted in Figure 5. In the standard model, the monetary policy shock causes a temporary real depreciation of the rupee, but these effects are offset by the stabilization policy in the MPAP model.

4. Model Dynamics

This section examines the dynamic adjustment of key macro variables to various shocks (other than the monetary policy shock). Our model focuses on shocks to four variables: government expenditures, total factor productivity (TFP), foreign import prices, and foreign remittances. All four variables are assumed to follow an AR (1) process (in logs), expressed as

$$\ln g_t = (1 - \rho_G) \ln \bar{g} + \rho_G \ln g_{t-1} + x_{G,t},$$

$$\ln \xi_{Y,t} = (1 - \rho_Y) \ln \bar{\xi}_Y + \rho_Y \ln \xi_{Y,t-1} + x_{Y,t},$$

$$\ln rm_t^* = (1 - \rho_{RM}) \ln \bar{rm}^* + \rho_{RM} \ln rm_{t-1}^* + x_{RM,t},$$

$$\ln(p_{M,t}^*) = (1 - \rho_M) \ln(\bar{p}_M^*) + \rho_M \ln(p_{M,t-1}^*) + x_{M,t},$$

where $\xi_{Y,t}$ represents TFP, and a bar over the variable denotes steady state value, and

$x_{G,t}, x_{Y,t}, x_{RM,t}$ and $x_{M,t}$ are white noise shocks. We use the data since 2000 to estimate the

autoregressive coefficient and the standard deviation of the shock.¹⁰ The values of these parameters are shown in Table 1.

Figures 6 through 9 examine the effect of a one standard deviation shock to each variable (in quarter 1) on output gap, inflation, real interest rate and real (rupee) depreciation (over 12 quarters). In this analysis, the real exchange rate is not stabilized ($\phi_{ir} = 0$), and the coefficients of the interest rate rule are assumed to be the same as in section 2. A positive shock to government expenditures increases aggregate demand, and brings about a temporary increase in both output and inflation and causes a temporary real depreciation (see Figure 6). A positive shock to TFP represents an increase in aggregate supply, and while it also increases output and causes real depreciation in the short run, it reduces inflation temporarily (see Figure 7). A positive shock to foreign remittances causes a temporary real appreciation by increasing capital inflows, which leads to lower output and inflation in the short run (see Figure 8). Finally, a positive import prices shock diverts demand from more expensive foreign goods to home goods, which increases both output and inflation in the short run although there is a temporary real appreciation (see Figure 9).

5. Appropriate Interest Rate Rule

In this section, we examine how different interest rate rules would affect macroeconomic performance. As mentioned above, estimates of interest rate rules suggest that the response of the interest rate to inflation is weak. Our analysis of the extended MPAP model also shows that the effect of interest rate changes on inflation and output is smaller than in the standard model, and

¹⁰ Only annual series are available for government expenditures and TFP. These series were converted to quarterly series using a conversion procedure. Data on TFP are preliminary. All series were detrended using the Hodrick-Prescott filter.

monetary policy in Pakistan may have been less effective in controlling inflation and stabilizing output. We now explore the potential for reducing inflation and output variability through the use a more vigorous response to inflation in the interest rate rule. We examine interest rate rules with and without intervention in the foreign exchange market to stabilize the exchange rate.

To evaluate the performance of each rule, we use stochastic simulation of the model (with the four shocks discussed above) to generate artificial series on key macroeconomic variables. These series are used to calculate standard deviations of inflation, output gap and real depreciation as three key indicators of macroeconomic performance. The results are summarized in Table 2 for three types of reaction to inflation: weak, moderate and strong. The weak response with inflation coefficient equal to 0.15 represents the current practice as suggested by the empirical estimates. The moderate response with inflation coefficient equal to 0.50 conforms to the value used in the standard Taylor rule. For the strong response, we let the inflation coefficient equal to 1.0.

The table shows that using the moderate rather than the weak response to inflation would significantly lower inflation variability (by about 20%), and would also make output more stable. Strong response would further reduce inflation and output variability, although the improvement from moderate to strong response would not be as large as that from weak to moderate response. The table also shows that if monetary policy also attempts to stabilize real exchange rate movements (via intervention in the foreign exchange market), it would achieve this goal at a cost of much higher inflation and output variability for each type of inflation response. This result can be explained by noting that exchange rate stabilization makes interest rate changes less effective, and thus inflation and output would be less stable under this policy for a given inflation response.

6. Concluding Remarks

The present paper discusses the extensions of the MPAP model to incorporate endogenous international capital flows and an imperfectly competitive banking sector. We have introduced significant frictions in the foreign exchange and credit markets to capture key features of Pakistan's financial sectors. We also introduced inertia in the formation of price expectations. Our analysis shows that these frictions weaken the impact of interest rate changes on inflation and output gap, and thus make monetary policy in Pakistan less effective.

We undertake stochastic simulations to explore what would be an appropriate interest rate response to inflation in the presence of frictions discussed above. Estimates of the interest rate rule in Pakistan suggest that the inflation coefficient in the rule is low (it is around 0.15). The results of our simulations suggest that a stronger response (a significantly higher inflation coefficient) would be desirable to stabilize inflation and output. SBP generally intervenes in the foreign exchange market to stabilize the exchange rate. Our simulation results show that exchange rate stability is achieved at the cost of greater variability of inflation and output: inflation and output would be more stable if the exchange rate is allowed to fluctuate freely.

Our analysis in this paper assumes that fiscal authorities adjust taxes and/or expenditures to control debt levels. Without fiscal adjustment to control debt, the rate of borrowing would keep on increasing, making it infeasible to control inflation. If government does not control debt, central bank could attempt to stabilize it. (Benigno and Woodford, 2006, Kumhof et al. , 2008). In a previous paper (Choudhri and Malik, 2012), we explored a policy rule where SBP adjusts interest rates to control debt. This policy was found to lead to high and volatile inflation and cause large welfare losses.

Concerns regarding fiscal policy could lead to credibility problems which would worsen economic conditions. For instance, government commitment to stabilizing debt may not be credible; there may be a concern that the government would raise primary deficit permanently leading to higher long-run seignorage and inflation; there may be doubts about the central bank's ability to keep both long term debt and inflation at target levels. These considerations suggest that macroeconomic performance and the ability of SBP to control inflation can be improved considerably if fiscal policy takes the responsibility to stabilize debt.

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Appendix 1. Complete Model

H households

$$c_{H,t} = \frac{sumni_t + b_{t-1}^*}{sumr_t} \quad (1)$$

$$sumni_t = \frac{1}{s_t(1+r^*)(1-TC_{t-1})} ni_t + \frac{1}{(1+r^*)(1-TC_{t-1})} sumni_{t+1} \quad (2)$$

$$sumr_t = \frac{1}{s_t(1+r^*)(1-TC_{t-1})} + \frac{[\beta(1+r_t)]^{1/\theta}}{(1+r^*)(1-TC_{t-1})} sumr_{t+1} \quad (3)$$

$$ni_t = p_{X,t}z_{X,t} + p_{D,t}z_{D,t} + s_t rm_t^* - i_t - g_t - c_{L,t} - AC_t \quad (4)$$

$$b_t^* = (1+r^*)(1-TC_{t-1})b_{t-1}^* + (ni_t - c_t) / s_t \quad (5)$$

$$(1+r_t) = \frac{E_t s_{t+1} (1+r_t^*) (1-TC_t)}{s_t} \quad (6)$$

$$TC_t = \frac{e^{\mu b^*} - 1}{e^{\mu b^*} + 1} \quad (7)$$

$$cu_{H,t}^{-\chi} = \frac{c_{H,t}^{-\theta}}{\xi_{HC}} \left(\frac{1+r_t - 1/\Pi_t^e}{1+r_t} \right) \quad (8)$$

$$d_{H,t}^{-\kappa} = \frac{c_{H,t}^{-\theta}}{\xi_{HD}} \left(\frac{r_t - r_{D,t}}{1+r_t} \right) \quad (9)$$

$$(1 - AC_{WH,t})(\varepsilon - 1)w_{H,t} = \varepsilon \xi_{HN} (n_t)^v (c_{H,t})^\theta - (w_{H,t})^2 \frac{\partial AC_{WH,t}}{\partial w_{H,t}} \quad (10)$$

$$- \frac{1}{1+r_t} \frac{n_{H,t+1}}{n_{H,t}} \frac{w_{H,t} w_{H,t+1}}{\Pi_t^e} \frac{\partial AC_{WH,t+1}}{\partial w_{H,t}}$$

$$\Pi_t^e = (E_t \Pi_{t+1})^\Lambda (\Pi_{t-1})^{1-\Lambda}, \quad 0 < \Lambda \leq 1 \quad (11)$$

$$AC_{WH,t} = \frac{\omega_{WH}}{2} \left(\frac{w_{H,t} \Pi_t}{w_{H,t-1} \Pi_{t-1}} - 1 \right)^2 \quad (12)$$

L households

$$c_{L,t} = w_{L,t} n_{L,t} (1 - AC_{WL,t}(l)) + s_t r m_t^* + c u_{L,t-1} / \Pi_t - c u_{L,t} - \tau_{L,t} \quad (13)$$

$$c u_{L,t}^{-\chi} = \frac{c_{L,t}^{-\theta}}{\xi_{LC}} \left(1 - \frac{\beta E_t c_{L,t+1}^{-\theta}}{\Pi_t^e c_{L,t}^{-\theta}} \right) \quad (14)$$

$$(1 - AC_{WL,t})(\varepsilon - 1) w_{L,t} = \varepsilon \xi_{LN} n_{L,t}^\nu c_{L,t}^\theta - w_{L,t}^2 \frac{\partial AC_{WL,t}}{\partial w_{L,t}} - \frac{1}{1+r_t} \frac{n_{L,t+1}}{n_{L,t}} \frac{w_{L,t} w_{L,t+1}}{\Pi_{t+1}^e} \frac{\partial AC_{WL,t+1}}{\partial w_{L,t}}. \quad (15)$$

$$AC_{WL,t} = \frac{\omega_{WL}}{2} \left(\frac{w_{L,t} \Pi_t}{w_{L,t-1} \Pi_{t-1}} - 1 \right)^2 \quad (16)$$

Banks

$$d_{H,t} = \xi_{BD} (c r_t)^\gamma (b_{B,t})^{1-\gamma} \quad (17)$$

$$l_{B,t} = \xi_{BL} n_{HB,t}, \quad (18)$$

$$c r_t + b_{B,t} + l_{B,t} = d_{H,t} \quad (19)$$

$$c r_t = \gamma \left[\frac{\lambda_{B,t} - (1 + r_{D,t})}{\lambda_{B,t} - 1 / \Pi_t^e} \right] d_{H,t} \quad (20)$$

$$b_{B,t} = (1 - \gamma) \left[\frac{\lambda_{B,t} - (1 + r_{D,t})}{\lambda_{B,t} - (1 + r_t)} \right] d_{H,t} \quad (21)$$

$$\begin{aligned} \lambda_{B,t} = & (1 - AC_{B,t})[1 + r_{L,t}(1 - 1/\sigma)] + (1 + r_{L,t})(r_{L,t}/\sigma)(\partial AC_{B,t}/\partial r_{L,t}) - (w_{H,t}/\xi_{BL,t}) \\ & + \beta(c_{H,t+1}^{-\theta}/c_{H,t}^{-\theta})[(1 + r_{L,t+1})(l_{B,t+1}/l_{B,t})(r_{L,t}/\sigma)(\partial AC_{B,t+1}/\partial r_{L,t})] \end{aligned} \quad (22)$$

$$AC_{B,t} = \frac{\omega_B}{2} \left(\frac{[1 + r_{L,t}(b)]}{[1 + r_{L,t-1}(b)]} - 1 \right)^2 \quad (23)$$

Investment

$$q_t = 1 + \omega_I \left(\frac{i_t}{k_t} - \delta \right). \quad (24)$$

$$1 + r_{L,t} = \frac{E_t r e_{t+1} + (1 - \delta) E_t q_{t+1}}{q_t} \quad (25)$$

$$k_{t+1} = i_t + (1 - \delta)k_t \quad (26)$$

$$i_t = l_{B,t} - \bar{l}_H \quad (27)$$

Demand

$$z_t = c_{H,t} + c_{L,t} + i_t + g_t - AC_t \quad (28)$$

$$AC_t = (p_{D,t} - mc_t)z_{D,t}AC_{PD,t} + (p_{X,t} - mc_t)z_{X,t}AC_{PX,t} + AC_{WH,t}w_{H,t}n_{H,t} + AC_{WL,t}w_{L,t}n_{L,t} + AC_{I,t} \quad (29)$$

$$z_{D,t} = (1 - \psi)z_t p_{D,t}^{-\eta} \quad (30)$$

$$z_{M,t} = \psi z_t p_{M,t}^{-\eta} \quad (31)$$

$$1 = \left[\psi p_{M,t}^{1-\eta} + (1 - \psi) p_{D,t}^{1-\eta} \right]^{\frac{1}{1-\eta}} \quad (32)$$

$$z_{X,t} = \psi^* z_t^* (p_{X,t}^*)^{-\eta} \quad (33)$$

Firms

$$y_t = \xi_{Y,t} n_{HY,t}^{\alpha_H} n_{L,t}^{\alpha_L} k_t^{1-\alpha_H-\alpha_L} \quad (34)$$

$$n_{HY,t} = \alpha_H y_t mc_t / w_{H,t}, \quad (35)$$

$$n_{L,t} = \alpha_L y_t mc_t / w_{L,t} \quad (36)$$

$$n_{H,t} = n_{HY,t} + n_{HB,t} \quad (37)$$

$$k_t = (1 - \alpha_H - \alpha_L) y_t mc_t / re_t \quad (38)$$

$$y_t(f) = z_{D,t}(f) + z_{X,t}(f). \quad (39)$$

$$AC_{PD,t}(f) = \frac{\omega_P}{2} \left(\frac{p_{D,t}(f)\Pi_t}{p_{D,t-1}(f)\Pi_{t-1}} - 1 \right)^2 \quad (40)$$

$$AC_{PX,t}(f) = \frac{\omega_P}{2} \left(\frac{p_{X,t}(f)\Pi_t}{p_{X,t-1}(f)\Pi_{t-1}} - 1 \right)^2 \quad (41)$$

$$(1 - AC_{PD,t}) [(\sigma - 1)p_{D,t} - \sigma mc_t] = -p_{D,t}(p_{D,t} - mc_t) \frac{\partial AC_{PD,t}}{\partial p_{D,t}} \\ - \frac{z_{D,t+1}}{(1 + r_t)z_{D,t}} p_{D,t}(p_{D,t+1} - mc_{t+1}) \frac{\partial AC_{PD,t+1}}{\partial p_{D,t}} \quad (42)$$

$$(1 - AC_{PX,t}) [(\sigma - 1)p_{X,t} - \sigma mc_t] = -p_{X,t}(p_{X,t} - mc_t) \frac{\partial AC_{PX,t}}{\partial p_{X,t}} \\ - \frac{z_{X,t+1}}{(1 + r_t)z_{X,t}} p_{X,t}(p_{X,t+1} - mc_{t+1}) \frac{\partial AC_{PX,t+1}}{\partial p_{X,t}} \quad (43)$$

$$p_{M,t} = s_t p_{M,t}^* \quad (44)$$

$$p_{X,t} = s_t p_{X,t}^* \quad (45)$$

$$b_t = g_t - \tau_{H,t} - \tau_{L,t} - (mb_t - mb_{t-1} / \Pi_t) + (1 + r_{t-1})b_{t-1} \quad (46)$$

$$\tau_{H,t} = \bar{\tau}_H + \phi_{tb} (b_{t-1} - \bar{b}) \quad (47)$$

$$m\bar{b}(1 - 1/\bar{\Pi}) = \bar{g} - \bar{\tau}_H - \bar{\tau}_L + \bar{r}\bar{b} \quad (48)$$

$$mb_t = cu_{H,t} + cu_{L,t} + cr_t \quad (49)$$

$$\ln(1 + R_t) = \phi_{rr} \ln(1 + R_{t-1}) + (1 - \phi_{rr}) \{ \ln(1 + \bar{R}) + (1 + \phi_{rx}) \ln(E_t \Pi_{t+1} / \bar{\Pi}) + \phi_{ry} \ln(y_t / \bar{y}) \} + \ln \xi_{R,t} \quad (50)$$

$$1 + r_t = (1 + R_t) / \Pi_t^e \quad (51)$$

$$1 + \bar{R} = (1 + \bar{r})\bar{\Pi} \quad (52)$$

$$dirs_t^* = \phi_{ir} (s_t - \bar{s}) \quad (53)$$

Shocks

$$\ln g_t = (1 - \rho_G) \ln \bar{g} + \rho_G \ln g_{t-1} + x_{G,t} \quad (54)$$

$$\ln \xi_{Y,t} = (1 - \rho_Y) \ln \bar{\xi}_Y + \rho_Y \ln \xi_{Y,t-1} + x_{Y,t} \quad (55)$$

$$\ln rm_t^* = (1 - \rho_{RM}) \ln \bar{rm}^* + \rho_{RM} \ln rm_{t-1}^* + x_{RM,t} \quad (56)$$

$$\ln(p_{M,t}^*) = (1 - \rho_M) \ln(\bar{p}_M^*) + \rho_M \ln(p_{M,t-1}^*) + x_{M,t} \quad (57)$$

Endogenous variables:

$AC_t, AC_{B,t}, AC_{PD,t}, AC_{PX,t}, AC_{WH,t}, AC_{WL,t}, b_t, b_t^*, b_{B,t}, c_{H,t}, c_{L,t}, cr_t, cu_{H,t}, cu_{L,t}, d_{H,t}, dirs_t^*, g_t, i_t, k_t, l_{B,t}, mb_t, mc_t, n_{H,t}, n_{HB,t}, n_{HY,t}, n_{L,t}, ni_t, p_{D,t}, p_{M,t}, p_{M,t}^*, p_{X,t}, p_{X,t}^*, r_t, r_{D,t}, r_{L,t}, re_t, q_t, R_t, \bar{R}, w_{H,t}, w_{L,t}, y_t, s_t, sumni_t, sumr_t, TC_t, z_t, z_{D,t}, z_{M,t}, z_{X,t}, \lambda_{B,t}, \tau_{H,t}, \bar{\tau}_H, \Pi_t, \Pi_t^e, \xi_{Y,t}, \xi_{R,t}.$

Exogenous variables:

$$\bar{b}, \bar{g}, \bar{m}\bar{b}, \bar{l}_H, r_i^*, \bar{r}m_i^*, x_{G,t}, x_{Y,t}, x_{RM,t}, x_{M,t}, \bar{\tau}_L.$$

Parameters:

$$\alpha_H, \alpha_L, \beta, \chi, \delta, \varepsilon, \phi_{rr}, \phi_{r\pi}, \phi_{ry}, \phi_{rb}, \gamma, \eta, \mu, \nu, \theta, \rho_G, \rho_M, \rho_R, \rho_Y, \sigma, \omega_I, \omega_{WH}, \omega_{WL}, \omega_P, \\ \xi_{BL}, \xi_{HC}, \xi_{HD}, \xi_{LC}, \xi_{HN}, \xi_{LN}, \xi_Y, \psi, \Lambda, \bar{\Pi}, \bar{b}, \bar{c}\bar{f}, \bar{g}, \bar{p}_M^*, \tilde{z}^* (= \psi^* z_i^*).$$

Figure 1

Dynamic Response of Output Gap (%) to a Temporary Interest Rate Decrease

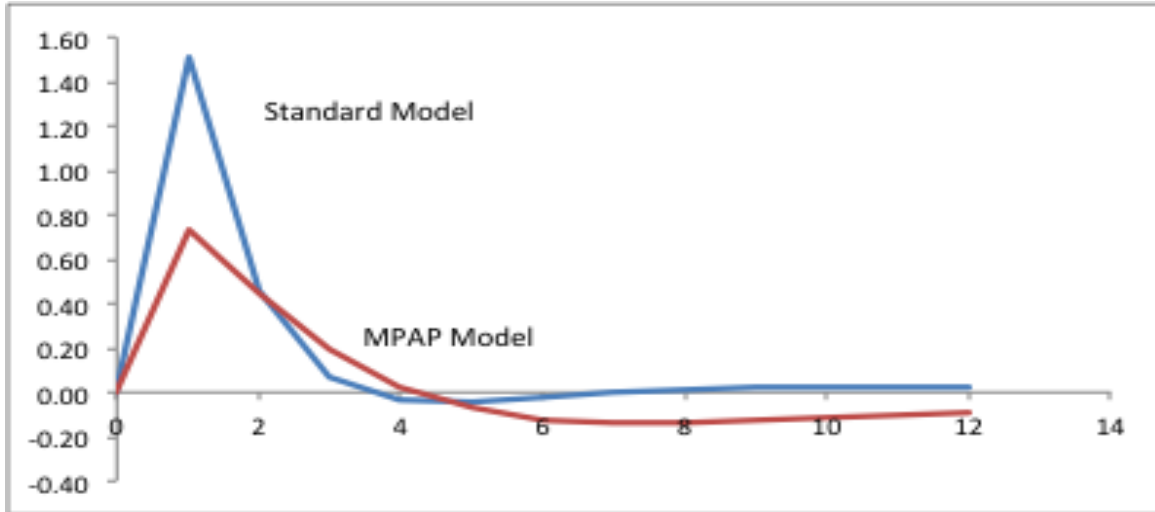


Figure 2

Dynamic Response of Inflation (annual %) to a Temporary Interest Rate Decrease

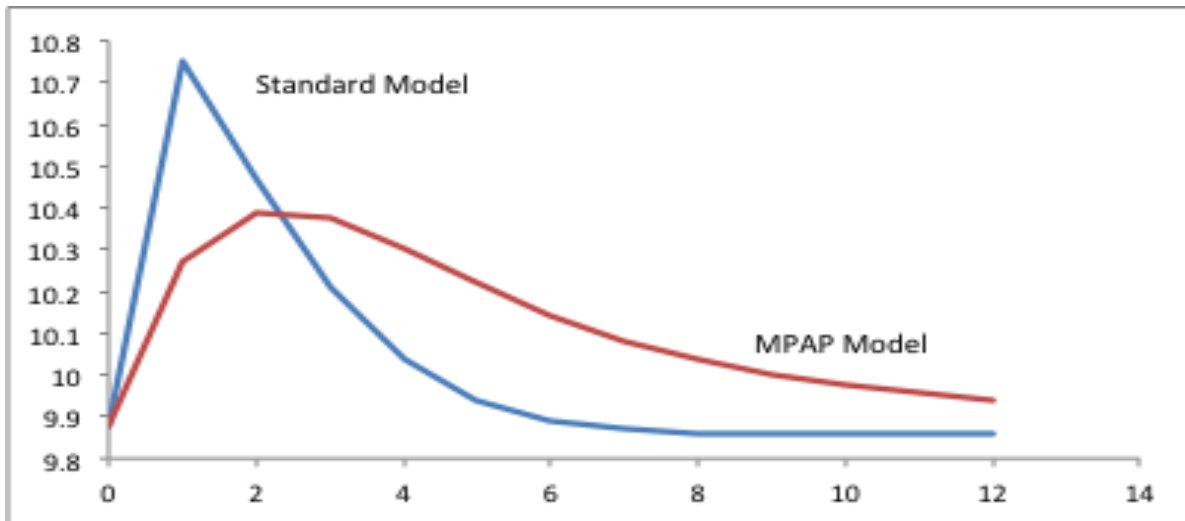


Figure 3

Dynamic Response of the Real Interest Rate (annual %) to a Temporary Interest Rate Decrease

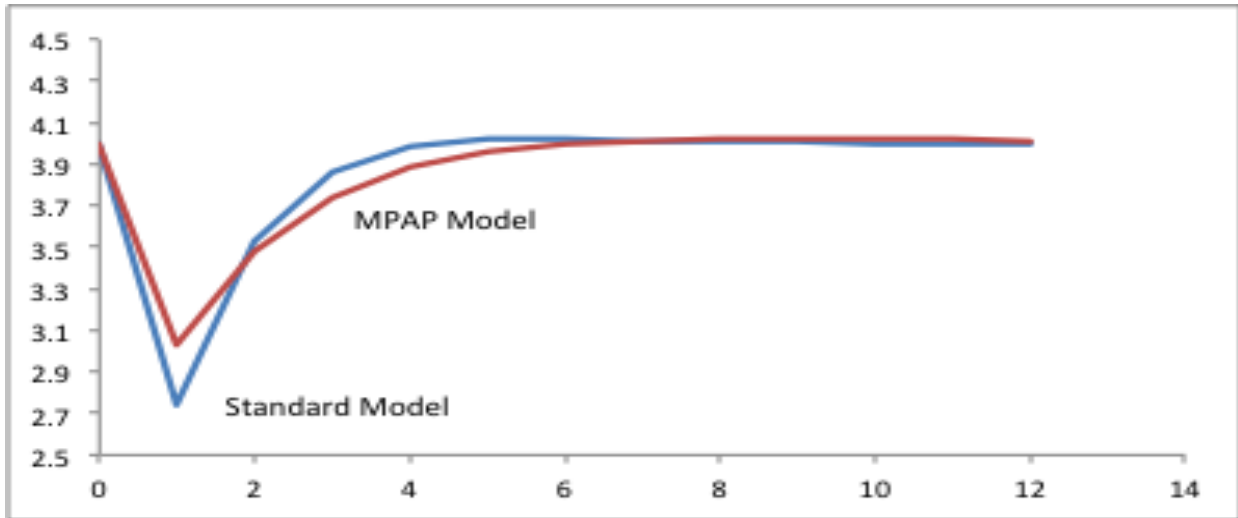


Figure 4

Dynamic Response of the Real Bank Loan Rate Spread (annual %) to a Temporary Interest Rate Decrease

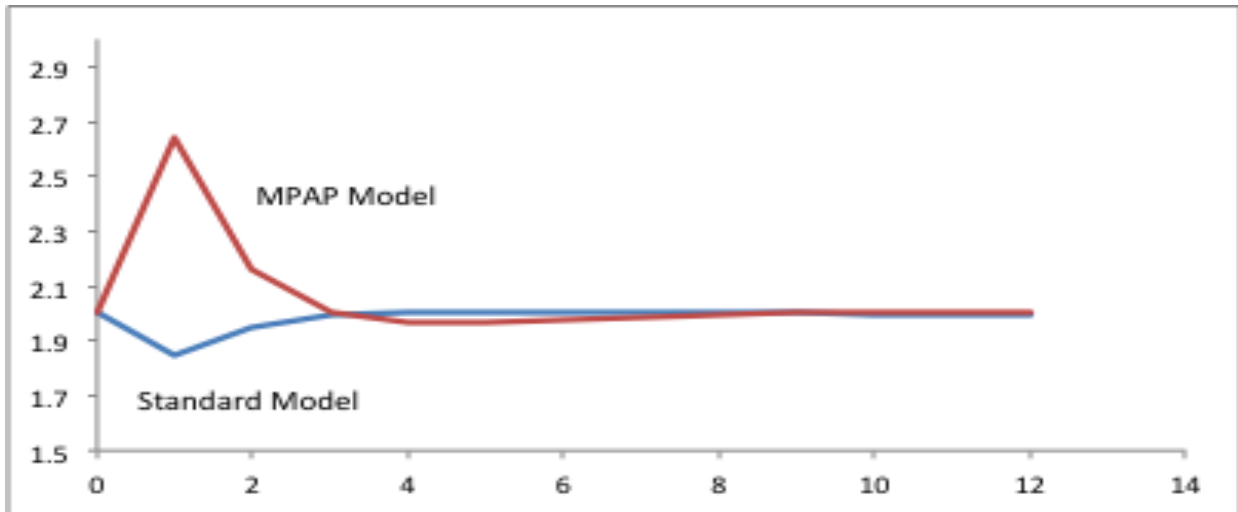


Figure 5

Dynamic Response of the Real Depreciation (%) to a Temporary Interest Rate Decrease

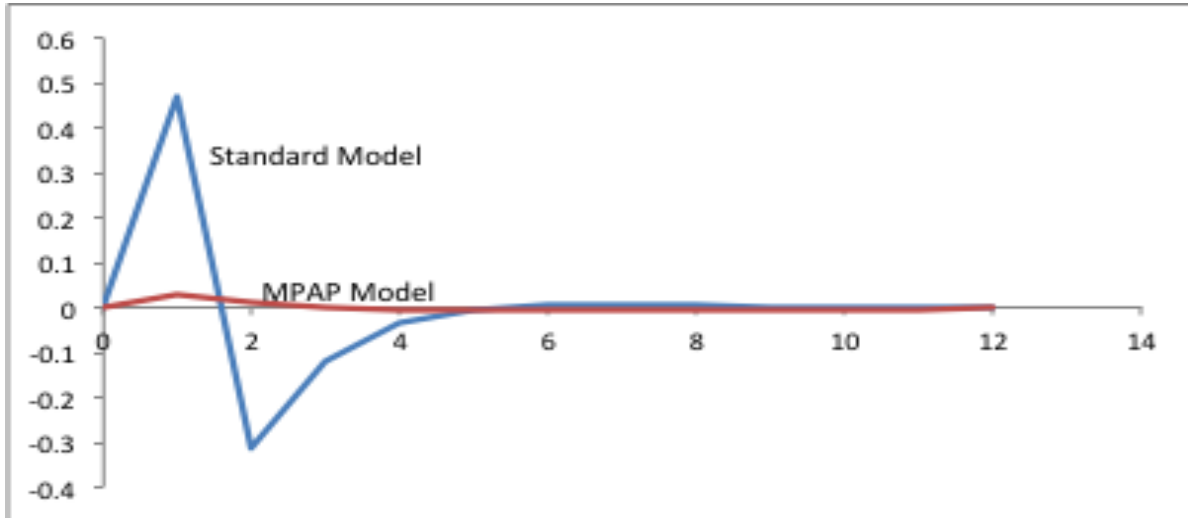


Figure 6

Dynamic Response to a (one s. d.) Shock to Government Expenditures

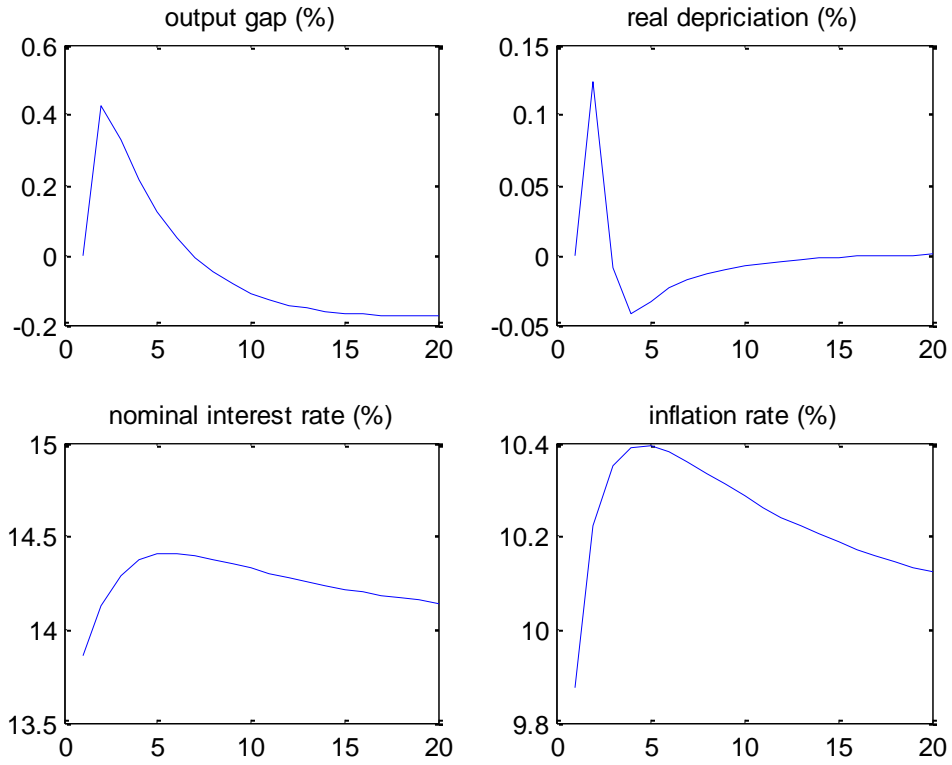


Figure 7

Dynamic Response to a (one s. d.) Shock to TFP

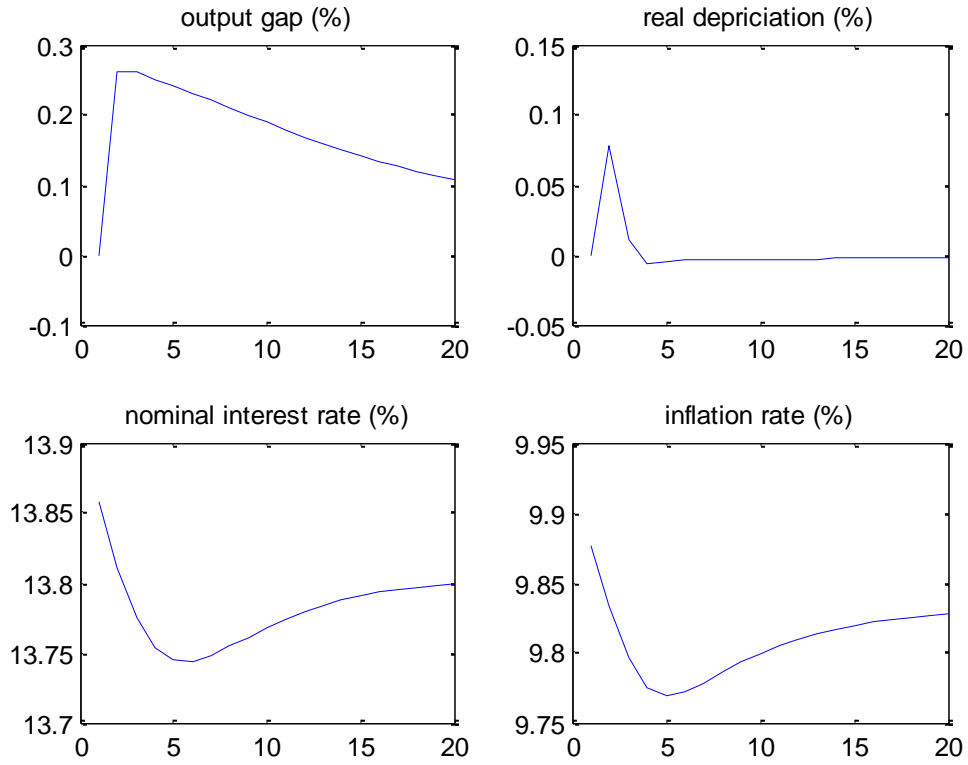


Figure 8

Dynamic Response to a (one s. d.) Shock to Foreign Remittances

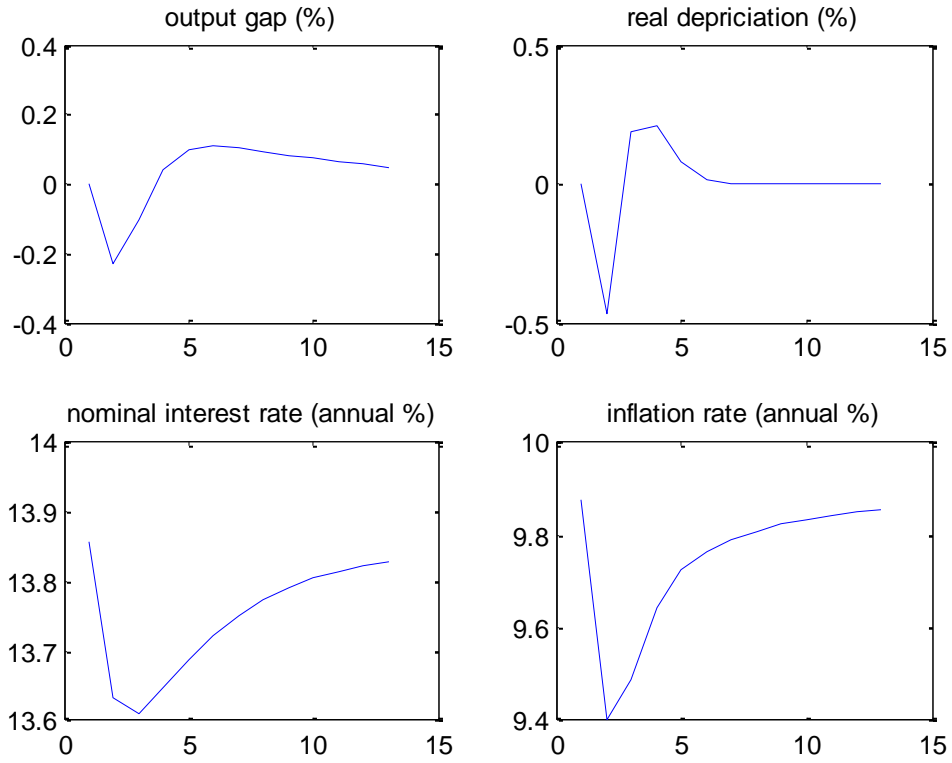


Figure 9

Dynamic Response to a (one s.d.) Shock to Foreign Import Price

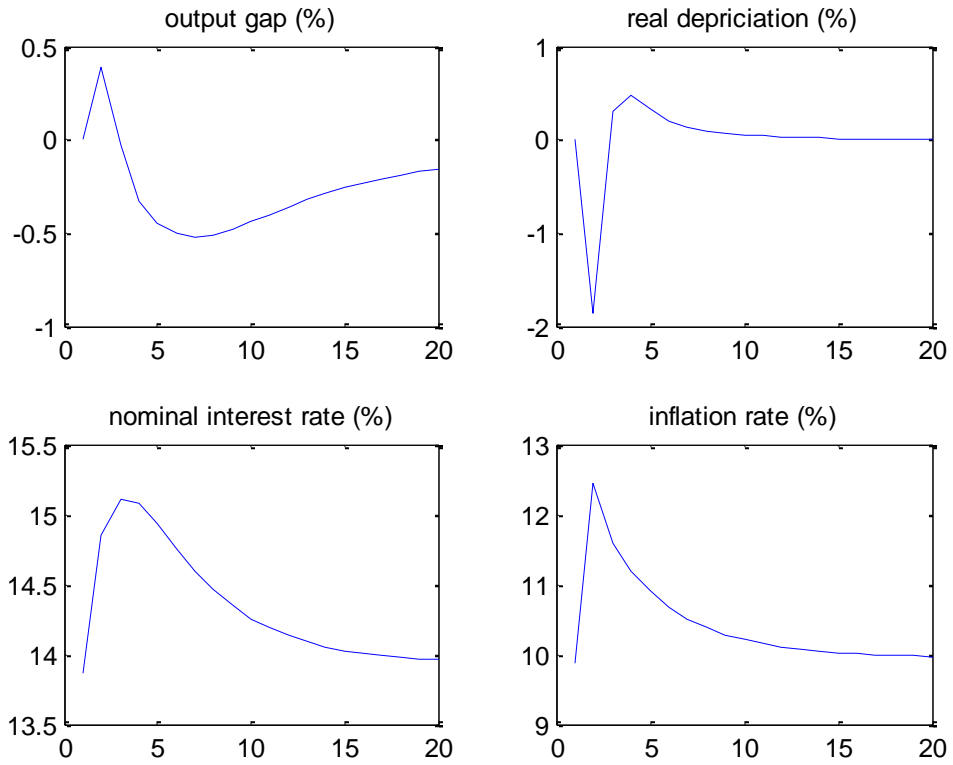


Table 1. Estimates of Autoregressive Coefficients and Standard Deviations

Variable	Autoregressive Coefficient	Standard Deviation
Government expenditures	0.92	0.04
TFP	0.93	0.002
Foreign Remittances	0.38	0.04
Foreign Import Price	0.66	0.05

Table 2. Macroeconomic Performance under Alternative Interest Rate Rules

	Standard Deviation		
	Inflation	Output Gap	Real Dep.
	(% per quarter)	(%)	(%)
<i>No Exchange Rate Stabilization</i>			
Weak Response ($\phi_{r\pi} = 0.15$)	0.832	1.795	1.881
Moderate Response ($\phi_{r\pi} = 0.5$)	0.662	1.636	1.980
Strong Response ($\phi_{r\pi} = 1.0$)	0.583	1.614	2.044
<i>Exchange Rate Stabilization</i>			
Weak Response ($\phi_{r\pi} = 0.15$)	1.509	3.213	0.233
Moderate Response ($\phi_{r\pi} = 0.5$)	1.160	2.700	0.275
Strong Response ($\phi_{r\pi} = 1.0$)	0.997	2.634	0.300