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Monetary Policy in Pakistan

Confronting Fiscal Dominance and Imperfect Credibility

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Abstract

Monetary policy in Pakistan is currently operating in an environment in which fiscal deficits and government debt are increasing, the government is continuously borrowing from State Bank of Pakistan, and there is concern that inflation and debt growth would not be controlled. To explore feasible monetary policy options in such an environment, the paper uses a DSGE model that allows for imperfect credibility, and distinguishes between two regimes that are relevant for Pakistan: weak monetary independence (fiscal policy determines the inflation target, but undertakes fiscal measures to stabilize government debt) and fiscal dominance (monetary policy is constrained to use interest rates to stabilize both inflation and government debt). In the weak monetary independence regime, imperfect credibility amplifies the inflation response to different shocks and leads to greater variability of Inflation. However, increased inflation variability is not too large if monetary policy pursues a sufficiently strong anti-inflation policy. Inflationary consequences of fiscal dominance are much more serious. Shocks, such as an increase in government expenditures, lead to much larger inflation rates under fiscal dominance even if there is full credibility. Inflation is much more variable under fiscal dominance. An important implication of our analysis is that inflation volatility can be avoided if fiscal authority takes the responsibility for stabilizing debt and leaves monetary policy free to focus on stabilizing inflation.

1. Introduction

Monetary policy in Pakistan currently faces major challenges in formulating an appropriate response to adverse macroeconomic conditions. CPI inflation has been high and persistent while GDP growth has fallen to low levels (see Figure 1). Inflation and growth performance since 2005, moreover, has generally been worse than the target levels. The Government has not been successful in controlling its budget position. While the current account deficit has improved recently, the fiscal deficit has been rising consistently since 2006 and has contributed to a significant increase in government debt (see Figure 2). The government has continuously financed a significant portion of the deficit by borrowing from State Bank of Pakistan (SBP), although borrowing from the scheduled banks has also increased sharply in the recent years (Figure 3).

Monetary policy options available to the State Bank in these difficult circumstances depend on how fiscal policy behaves and interacts with the monetary policy. Two macro policy regimes have been contrasted in the literature. In the first regime, monetary authorities have the independence to choose an inflation goal and implement policies to achieve this objective. In this case, monetary policy determines the revenue from money creation (seignorage), and given this revenue, fiscal policy adjusts its primary surplus to balance its (intertemporal) budget constraint and stabilize debt. Central banks in most developed countries follow an inflation targeting policy within such an environment. In the second regime, fiscal policy chooses a path of primary surplus and seignorage, and does not attempt to stabilize debt. This regime is generally referred to as "fiscal dominance" since monetary policy in this case is subordinated to the seignorage requirements of the fiscal authority.[1] Difficulties in controlling government expenditures and increasing tax revenues have lead to the emergence of fiscal dominance in many developing countries. We can also distinguish an intermediate policy regime in which the central bank is not free to choose the inflation target (which is determined by the long-term seignorage requirements of fiscal policy), but fiscal authorities assume responsibility to stabilize debt via an adjustment of the primary surplus. We refer to this intermediate regime as weak monetary independence (in contrast to the first regime of strong monetary independence).

SBP has not enjoyed full independence in determining monetary policy. Indeed, before 1993, SBP had neither the authority nor instruments at its disposal to conduct an independent monetary policy. Financial sector reforms of 1990s empowered SBP to formulate and implement monetary policy and regulate the financial sector. SBP Act (1956, amended 2003, Section 9A) gives the SBP (its Central Board of Directors) the authority to formulate and conduct monetary and credit policies in accordance with the targets of inflation and growth set by the Government. However, creation of Monetary and Fiscal Policy Coordination Board (MFPCB) diluted the authority of SBP's Central Board to determine and limit government borrowing.[2] To reduce fiscal dominance and enhance operational independence, SBP proposed amendment to the Act. Recently (March 2012) National Assembly has passed a modified version of the amendments, which allow the government to borrow from SBP with a requirement to retire such borrowings by the end of each quarter of each fiscal year and reduce the outstanding stock of borrowings

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[1] Policy implications of the two environments were first discussed by Sargent and Wallace (1981), who calls the first regime "Ricardian" and the second "non-Ricardian". Also see Leeper (1991), who refers to the regimes as active and passive monetary policies.

[2] Section 9B of the SBP Act includes the following condition: "…ensure that Bank conduct monetary and credit policy in a manner consistent with these targets and the recommendations of the MFPCB with respect to macro-economic policy objectives."

within eight years. In case of non-compliance, Minister of Finance is required to provide a rational in the parliament. The government, however, does not appear to have taken steps to meet these requirements.

As the behavior of fiscal policy, especially with regard to the use of fiscal instruments to control debt, is not clear, we consider two possibilities. One possibility is that fiscal authorities require certain seignorage, but take action (in accordance with the SBP Act) to adjust primary surplus to stabilize debt. In this case, although the long-term inflation rate is determined by the seignorage needs, SBP can follow an interest rate rule to control inflation (around the seignorage-determined long-term rate) without a responsibility to control debt. The policy regime for SBP under these conditions can be described as weak monetary independence. Alternatively, if fiscal policy ignores the need to control debt (as reflected in its recent behavior), SBP faces fiscal dominance.

In the presence of fiscal dominance, an important issue is whether it would be feasible for the monetary policy to control inflation. Benigno and Woodford (2006) argue that monetary policy can play a role in controlling inflation if inflation expectations are anchored. Kumhof et al. (2008) develop an implementable interest rate rule that includes fiscal variables, and show that monetary policy facing fiscal dominance can use this rule to stabilize both inflation and debt under certain conditions. The optimal interest rate rule under fiscal dominance, however, involves greater losses than the optimal rule under monetary independence.

Credibility issues arise under both policy regimes. In the case of weak monetary independence, government commitment to stabilizing debt may not be credible. There may be a concern that the government would let primary surplus and debt increase permanently, which would require larger seignorage and inflation in the long run. Under fiscal dominance, there may be doubts about the central bank's ability to keep both long term debt and inflation at target levels. In this situation, monetary policy cannot take it for granted that inflationary expectation would be anchored by the announced inflation target and needs to build credibility by delivering inflation rates that are consistent with the target.

In this paper, we evaluate monetary policy rules for SBP in a model that allows for fiscal dominance and imperfect credibility. To explore the influence of imperfect credibility on inflationary expectations, we use a model of endogenous credibility based on Isard et al. (2001).[3] In this model, public's inflationary expectations allow for the possibility that inflation will converge to a rate that is higher than the target rate announced by monetary policy. The weight assigned to this possibility depends on the credibility stock (which varies between no credibility to full credibility). Monetary policy can gradually improve the credibility stock by an inflation performance that is consistent with the target.

Section 2 describes the model. The response of inflation to various shocks under different regimes is discussed in Section 3. Section 4 compares the performance of alternative monetary policy rules and Section 5 concludes the paper.

2. The Model

We use the model developed in Choudhri and Malik (2012) and extend it to incorporate an endogenous model of credibility. There is one composite good (consisting of differentiated home and foreign varieties), which is used for consumption, investment and government expenditures. There are two types of households: high-income households denoted by H and

[3] Also see Alichi et al., 2009, for incorporating this model of endogenous credibility in a simple linearized version of a DSGE model for an open economy.

low-income households denoted by L. Households of type H supply skilled labor, own firms and participate in financial markets: buy government bonds, hold bank deposits and take bank loans to finance fixed expenditures on nondurables. Households of type L supply unskilled labor, are liquidity constrained, and do not transact in the financial markets (hold no assets except currency). Capital goods producers undertake investment decisions subject to adjustment costs and supply (installed) capital to capital leasing firms who finance the additions to capital by loans from banks. Banks require cash reserves and government bonds to provide convertibility services for deposits and use labor to monitor loans. Government uses lump-sum taxes to raise revenue.[4] Domestic financial markets are not integrated with global financial markets, and households and banks are assumed not to hold foreign bonds. Finally, nominal rigidities are introduced by assuming that there are adjustment costs for both prices and wages as in Rotemberg (1982). We first briefly discuss the basic model under forward-looking (model-consistent) expectations and then modify it to allow inflationary expectations to be determined by an endogenous credibility stock.

2.1 Basic Model

Households

There be a continuum of households of type H and L, indexed by $h \in (0,1)$ and $l \in (0,1)$, respectively. The Utility function and the budget constraint for household h of type H are:

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

[4] As our focus is on monetary policy issues and not on the efficiency costs of distortionary taxes, such taxes are not included in the model to simplify the analysis..

$$c_{H,t}(h)+\tau_{H,t}(h)+cu_{H,t}(h)+d_{H,t}(h)+b_{H,t}(h)=cu_{H,t-1}(h)/\Pi_t+(1+r_{D,t-1})d_{H,t-1}(h)$$
$$+(1+r_{t-1})b_{H,t-1}(h)-(1+r_{L,t-1})\bar{l}_H(h)+pr_t(h)+w_{H,t}n_{H,t}(h)(1-AC_{WH,t}(h)) \quad ,$$

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 $\mathrm{d}_{H,t}(h)$ are the (end of period) holdings of real stocks of currency and bank deposits (in terms of the composite good); $\tau_{H,t}(h)$ represents (lump sum) real taxes; $b_{H,t}(h)$ is the real stock of government bonds (at the end of the period); $\Pi_t = P_t / P_{t-1}$ 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; $\bar{l}_H(h)$ is the fixed real value of bank loans; $pr_t(h)$ represents the household's share of profits; $w_{H,t}(h)$ is the real wage rate; and

$AC_{WH,t} = \frac{\omega_H}{2}\left(\frac{w_{H,t}(h)\Pi_t}{w_{H,t-1}(h)\Pi_{t-1}}-1\right)^2$ is the wage adjustment cost expressed in terms of real wages.[5]

The household chooses $c_{H,t}(h), cu_{H,t}(h), d_{H,t}(h),$ and $\mathrm{w}_{H,t}(h)$ to maximize utility subject to the budget constraint and the demand for its labor service given by $n_{H,t}(h) = n_{H,t}(w_{H,t}(h)/w_{H,t})^{-\varepsilon}$ with $w_{H,t}$ representing the real wage of the H type labor supply bundle (defined below). Optimization by the household implies the following conditions:

$$c_{H,t}^{-\theta} = \beta(1+r_t)E_t c_{H,t+1}^{-\theta}, \tag{1}$$

$$cu_{H,t}{}^{-\chi} = \frac{c_{H,t}^{-\theta}}{\xi_{HC,t}}\left(\frac{1+r_t-1/\Pi_t^e}{1+r_t}\right), \tag{2}$$

[5] This adjustment cost function is based on the extension of the basic Rotemberg model by Laxton and Pesenti (2003) and accounts for the presence of inflation. We use a similar function below for price adjustment costs.

$$d_{H,t}{}^{-\kappa} = \frac{c_{H,t}^{-\theta}}{\xi_{HD,t}}\left(\frac{r_t - r_{D,t}}{1+r_t}\right), \tag{3}$$

$$\begin{aligned}(1-AC_{WH,t})(\varepsilon-1)w_{H,t}(h) &= \varepsilon\xi_{HN}(n_{H,t}(h))^{\nu}(c_{H,t}(h))^{\theta} - (w_{H,t}(h))^2\frac{\partial AC_{WH,t}}{\partial w_{H,t}(h)} \\ &-\frac{1}{1+r_t}\frac{n_{H,t+1}}{n_{H,t}}\frac{w_{H,t}(h)w_{H,t+1}(h)}{\Pi_t^e}\frac{\partial AC_{WH,t+1}}{\partial w_{H,t}(h)},\end{aligned} \tag{4}$$

where Π_t^e is the expected inflation rate, which is defined in the basic model (for all agents) as

$$\Pi_t^e = E_t\Pi_{t+1}. \tag{5}$$

Note that in steady state, $AC_{WH}(h) = \frac{\partial AC_{WH,t}}{\partial w_{H,t}} = \frac{\partial AC_{WH,t+1}}{\partial w_{H,t+1}} = 0$, and the expression for the real wage simplifies to $w_{H,t}(h) = \frac{\varepsilon\xi_{HN}n_{H,t}^{\nu}(h)c_{H,t}^{\theta}(h)}{(\varepsilon-1)}$.

The corresponding utility function for household l is

$U_{L,t}(l) = E_t\sum_{s=t}^{\infty}\beta^{s-t}\left(\frac{c_{L,s}^{1-\theta}(l)}{1-\theta} + \frac{\xi_{LC}(cu_{L,s}(l))^{1-\chi}}{1-\chi} - \frac{\xi_{LN}n_{L,s}^{1+\nu}(l)}{1+\nu}\right)$. As household l cannot borrow or lend, l's budget constraint (that excludes holding of bank deposits and bonds) determines the household's consumption as

$$c_{L,t} = w_{L,t}n_{L,t}(1-AC_{WL,t}(l)) + cu_{L,t-1}/\Pi_t - cu_{L,t} - \tau_{L,t}, \tag{6}$$

where $AC_{WL,t} = \frac{\omega_L}{2}\left(\frac{w_{L,t}(l)\Pi_t}{w_{L,t-1}(l)\Pi_{t-1}} - 1\right)^2$. Utility maximization by the household subject to the budget constraint and labor demand equal to $n_{L,t}(l) = n_{L,t}(w_{H,t}(l)/w_{L,t})^{-\varepsilon}$ with $w_{L,t}$ representing the real wage of the L type labor supply bundle (also defined below) implies that

$$cu_{L,t}^{-\chi} = \frac{c_{L,t}^{-\theta}}{\xi_{LC,t}}\left(1 - \frac{\beta E_t c_{L,t+1}^{-\theta}}{E_t \Pi_{t+1} c_{L,t}^{-\theta}}\right), \tag{7}$$

$$\begin{aligned}(1 - AC_{WL,t})(\varepsilon - 1)w_{L,t}(l) &= \varepsilon \xi_{LN}(n_{L,t}(l))^{\nu}(c_{L,t}(l))^{\theta} - (w_{L,t}(l))^2 \frac{\partial AC_{WL,t}}{\partial w_{L,t}(l)} \\ &- \frac{1}{1+r_t}\frac{n_{L,t+1}(l)}{n_{L,t}(l)}\frac{w_{L,t}(l) w_{L,t+1}(l)}{\Pi_{t+1}^e}\frac{\partial AC_{WL,t+1}}{\partial w_{L,t}(l)}.\end{aligned} \tag{8}$$

The expression for l's real wage also simplifies in steady state as

$$w_{L,t}(l) = \frac{\varepsilon \xi_{LN}(n_{L,t}(l))^{\nu}(c_{L,t}(l))^{\theta}}{(\varepsilon - 1)}.$$

Banks

Deposit creation and production of loans by a bank is determined by the following liquidity and monitoring functions:[6]

$$d_{H,t} = \xi_{BD}(cr_t)^{\gamma}(b_{B,t})^{1-\gamma}, \tag{9}$$

$$l_{B,t} = \xi_{BL} n_{HB,t}, \tag{10}$$

where cr_t , $b_{B,t}$ and $l_{B,t}$ are real values of cash reserves, government bonds held by banks, and bank loans while $n_{HB,t}$ is a bundle of labor services of H type households defined as $n_{HB,t} = \left[\int_0^1 n_{HB,t}(h)^{(\varepsilon-1)/\varepsilon} dh\right]^{\varepsilon/(\varepsilon-1)}$. We assume, for simplicity, that banks employ only H type households. The balance sheet of the banking sector is given by

$$cr_t + b_{B,t} + l_{B,t} = d_{H,t}. \tag{11}$$

[6] The specification of the banking sector is based on Canzoneri et al. (2008). In their paper, bank loans finance a fixed amount of loans to households. We assume that bank loans are also used to finance investment.

Banks choose the ratios, $b_{B,t}/d_{H,t}$ and $\mathrm{cr}_t/d_{H,t}$, to maximize the discounted value of profits subject to the balance-sheet constraint, and the liquidity and monitoring relations.[7] The optimal choice by banks implies that

$$\frac{cr_t}{d_{H,t}}=\gamma\left[\frac{(r_{L,t}-r_{D,t})-w_{H,t}\xi_{BL,t}}{(1+r_{L,t}-1/E_t\Pi_{t+1})-w_{H,t}/\xi_{BL,t}}\right], \tag{12}$$

$$\frac{b_{B,t}}{d_{H,t}}=(1-\gamma)\left[\frac{(r_{L,t}-r_{D,t})-w_{H,t}/\xi_{BL,t}}{(r_{L,t}-r_t)-w_{H,t}/\xi_{BL,t}}\right], \tag{13}$$

where $w_{H,t}/\xi_{BL,t}$ represents the marginal cost of making a loan (in real value).

Investment

We assume a standard model of investment where capital producers make additions to installed capital in the presence of adjustment costs. However, to relate investment to bank loans, we introduce capital leasing firms who require bank loans to finance purchases of additional installed capital from capital producers. Let k_t represent the installed capital stock at the beginning of period t, and i_t investment in the period. In each period, capital goods producers buy previously installed capital (after depreciation), k_t, from capital leasing firms, produce and sell new installed capital, $k_{t+1}=k_t+i_t$. Investment is subject to adjustment costs given by

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[7] The discounted value of their profits equals $E_t\sum_{s=t}^{\infty}\Delta_{t,s}\left(cr_s/E_t\Pi_{s+1}+(1+r_s)b_{B,s}+(1+r_{L,s})l_{B,s}-(1+r_{D,s})d_{H,s}-w_{H,s}n_{HB,s}\right)$, where $\Delta_{t,s}$ denotes the discount factor and $w_{H,t}$ represents the real wage rate for the H type labor bundle (defined below).

$AC_{I,t} = \frac{\omega_I}{2}\left(\frac{i_t}{k_t} - \delta\right)^2 k_t$, where δ is the depreciation rate. Let q_t denote the real price of a unit of installed capital. Maximization of the discounted value of profits by the capital goods producers implies that[8]

$$q_t = 1 + \omega_I \left(\frac{i_t}{k_t} - \delta\right). \tag{14}$$

Capital leasing firms rent installed capital to firms producing the final good. In each period, they distribute income from previously installed capital to H households, and finance the real cost of additional installed capital [$q_t(k_{t+1} - k_t)$] by a loan from banks. Their real profit from the acquisition of additional installed capital in period $t+1$ is $[E_t re_{t+1} + (1-\delta)E_t q_{t+1}]i_t - (1 + r_{L.t})q_t i_t$, where re_t denoted the real rental rate for a unit of capital. The optimal choice for investment satisfies

$$1 + r_{L.t} = \frac{E_t re_{t+1} + (1-\delta)E_t q_{t+1}}{q_t}. \tag{15}$$

Capital accumulates as

$$k_{t+1} = i_t + (1-\delta)k_t, \tag{16}$$

and investment is linked to bank loans as

$$q_t i_t = l_{B,t} - \bar{l}_H, \tag{17}$$

where $\bar{l}_H$ is the aggregate amount of fixed loans to households of type H.

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[8] The discounted value of profits equals $E_t \sum_{s=t}^{\infty} \Delta_{t,s}\left[q_s(k_{s+1} - k_s) - (i_s - AC_{I,s})\right]$, where $\Delta_{t,s}$ is the discount factor.

Composite good

The composite good is a CES bundle of home and foreign varieties produced by a continuum of home firms indexed by $f \in (0,1)$ and foreign firms indexed by $f^* \in (0,1)$. Letting z_t represent the amount of the composite good, we have

$$z_t = c_{H,t} + c_{L,t} + i_t + g_t \,, \tag{18}$$

where $z_t = \left[(1-\psi)^{1/\eta}(z_{D,t})^{(\eta-1)/\eta} + \psi^{1/\eta}(z_{M,t})^{(\eta-1)/\eta}\right]^{\eta/(\eta-1)}$, $z_{D,t} = \left(\int_0^1 z_{D,t}(f)^{(\sigma-1)/\sigma} df\right)^{\sigma/(\sigma-1)}$, $z_{M,t} = \left(\int_0^1 z_{M,t}(f^*)^{(\sigma-1)/\sigma} df^*\right)^{\sigma/(\sigma-1)}$, $z_{D,t}(f)$ is the amount of the home variety sold at home, and $z_{M,t}(f^*)$ is the imported amount of the foreign variety.

It follows that the home demand for the bundles of domestic and foreign varieties is given by

$$z_{D,t} = (1-\psi) z_t p_{D,t}{}^{-\eta}, \tag{19}$$

$$z_{M,t} = \psi z_t p_{M,t}{}^{-\eta}, \tag{20}$$

$$1 = \left[\psi p_{M,t}{}^{1-\eta} + (1-\psi) p_{D,t}{}^{1-\eta}\right]^{\frac{1}{1-\eta}}. \tag{21}$$

where $p_{D,t}$ and $p_{M,t}$ are the real prices of the domestic and foreign bundles.

Similarly, the foreign demand for the bundle of home varieties is given by

$$z_{X,t} = \psi^* z_t^* (p^*_{X,t})^{-\eta} \,, \tag{22}$$

where $z_{X,t} = \left(\int_0^1 z_{X,t}(f)^{(\sigma-1)/\sigma} df\right)^{\sigma/(\sigma-1)}$, $z_{x,t}(f)$ represents the exported amount of a home variety, and an asterisk denotes parameters and variables in the foreign economy.

The home variety of the composite good is produced according to the following production function:

$$y_t(f) = \xi_{y,t} n_{HY,t}(f)^{\alpha_H} n_{L,t}(f)^{\alpha_L} k_t(f)^{1-\alpha_H-\alpha_L} \tag{23}$$

where $n_{HY,t}$ and $n_{L,t}$ are bundles of labor services defined as $n_{HY,t} = \left[\int_0^1 n_{HY,t}(h)^{(\varepsilon-1)/\varepsilon} dh\right]^{\varepsilon/(\varepsilon-1)}$, and $n_{L,t} = \left[\int_0^1 n_{L,t}(l)^{(\varepsilon-1)/\varepsilon} dl\right]^{\varepsilon/(\varepsilon-1)}$. The optimal choice of inputs implies the following demand functions:

$$n_{HY,t}(f) = \alpha_H y_t(f) mc_t / w_{H,t}, \tag{24}$$

$$n_{L,t}(f) = \alpha_L y_t(f) mc_t / w_{L,t}, \tag{25}$$

$$k_t(f) = (1-\alpha_H-\alpha_L) y_t(f) mc_t / re_t, \tag{26}$$

where $w_{L,t} = \left[\int_0^1 w_{L,t}(l)^{1-\varepsilon} dl\right]^{1/(1-\varepsilon)}$ and $w_{H,t} = \left[\int_0^1 w_{H,t}(h)^{1-\varepsilon} dh\right]^{1/(1-\varepsilon)}$ are the real wage rates for the L and H type labor bundles, and mc_t is the real marginal cost of producing the home variety. Aggregate labor supply of H type household equals the household's supply to final producers and banks, so that

$$n_{H,t}(h) = n_{HY,t}(h) + n_{HB,t}(h). \tag{27}$$

Output of the home variety equals

$$y_t(f) = z_{D,t}(f) + z_{X,t}(f). \tag{28}$$

Firms choose real domestic and export prices, $p_{D,t}(f)$ and $p_{X,t}(f)$ to maximize the discounted value of the profits,

$$\sum_{s=t}^{\infty}\Delta_{t,s}\left[(p_{D,s}(f)-mc_s)z_{D,s}(f)(1-AC_{PD,s}(f))+(p_{X,s}(f)-mc_s)z_{X,s}(f)(1-AC_{PX,s}(f))\right],$$

subject to domestic and export demand functions, $z_{D,t}(f)=z_{D,t}(p_{D,t}(f)/p_{D,t})^{-\sigma}$, $z_{X,t}(f)=z_{X,t}(p_{X,t}(f)/p_{X,t})^{-\sigma}$, and adjustment costs assumed to equal $AC_{PD,t}(f)=\frac{\omega_P}{2}\left(\frac{p_{D,t}(f)\Pi_t}{p_{D,t-1}(f)\Pi_{t-1}}-1\right)^2$ and $AC_{PX,t}(f)=\frac{\omega_P}{2}\left(\frac{p_{X,t}(f)\Pi_t}{p_{X,t-1}(f)\Pi_{t-1}}-1\right)^2$.Noting that $\Delta_{t,t}=1, \Delta_{t,t+1}=1/(1+r_t)E_t\Pi_{t+1}$, the optimal prices are

$$\begin{aligned}(1-AC_{PD,t}(f))\left[(\sigma-1)p_{D,t}(f)-\sigma mc_t\right]&=-p_{D,t}(f)(p_{D,t}(f)-mc_t)\frac{\partial AC_{PD,t}(f)}{\partial p_{D,t}(f)}\\ &-\frac{z_{D,t+1}(f)}{(1+r_t)z_{D,t}(f)}p_{D,t}(f)(p_{D,t+1}(f)-mc_{t+1})\frac{\partial AC_{PD,t+1}(f)}{\partial p_{D,t}(f)},\end{aligned} \tag{29}$$

$$\begin{aligned}(1-AC_{PX,t}(f))\left[(\sigma-1)p_{X,t}(f)-\sigma mc_t\right]&=-p_{X,t}(f)(p_{X,t}(f)-mc_t)\frac{\partial AC_{PX,t}(f)}{\partial p_{X,t}(f)}\\ &-\frac{z_{X,t+1}(f)}{(1+r_t)z_{X,t}(f)}p_{X,t}(f)(p_{X,t+1}(f)-mc_{t+1})\frac{\partial AC_{PX,t+1}(f)}{\partial p_{X,t}(f)}.\end{aligned} \tag{30}$$

In steady state, both prices are the same and equal marginal cost multiplied by a markup factor: $p_{D,t}(f)=p_{X,t}(f)=\frac{\sigma}{\sigma-1}mc_t$. Let s_t denote the real exchange rate. The real prices of imported and exported varieties in the home and foreign markets are linked as

$$p_{M.t}(f^*)=s_t p^*_{M,t}(f^*), \tag{31}$$

$$p_{X,t}(f) = s_t p^*_{X,t}(f). \tag{32}$$

In symmetric equilibrium, $z_{M,t}(f^*) = z_{M,t}$, $z_{D,t}(f) = z_{D,t}$, $z_{X,t}(f) = z_{X,t}$, $y_t(f) = y_t$; $p_{M,t}(f^*) = p_{M,t}$, $p_{D,t}(f) = p_{D,t}$, $p_{X,t}(f) = p_{X,t}$; $n_{H,t}(h) = n_{H,t} = n_{HY,t} + n_{HB,t}$, $n_{L,t}(l) = n_{L,t}$; and $w_{H,t}(h) = w_{H,t}$, $w_{L,t}(l) = w_{L,t}$. The current account balance condition is

$$p_{M,t} z_{M,t} = p_{X,t} z_{X,t} + cf_t, \tag{33}$$

where cf_t is an exogenous net capital inflow (including remittances). Assuming that the home economy is small, foreign variables z_t^* and $p_{M,t}{}^*$ are exogenous.

Define $b_{s,t}$ and $b_{P,t} = b_{H,t} + b_{B,t}$ as the real stocks of government bonds held by SBP and the private sector. Also define $cu_t = cu_{H,t} + cu_{L,t}$ as real currency held by public, and $mb_t = cu_t + cr_t$ as the real monetary base. Assuming that the government does not pay interest to SBP (i.e., interest on $b_{s,t}$ is transferred to the government), the government's flow budget constraint is

$$b_{Pt} = g_t - \tau_{H,t} - \tau_{L,t} - (mb_t - mb_{t-1} / \Pi_t) + (1 + r_{t-1}) b_{P,t-1}, \tag{34}$$

where real primary deficit equals $g_t - \tau_{H,t} - \tau_{L,t}$ and real seignorage equals $mb_t - mb_{t-1} / \Pi_t$. The balance sheet of SBP can be expressed as

$$mb_t = b_{s,t} + s_t ir_t^*, \tag{35}$$

where ir_t^* represents real foreign value of SBP's international reserves.

Monetary and Fiscal policy

We distinguish two policy regimes. In this regime (weak monetary independence) fiscal policy chooses real seignorage in the long run, but adjusts primary deficit to stabilize debt at some target level. Monetary policy uses a Taylor-type rule with an inflation target determined by long-run real seignorage. Assume that fiscal policy uses taxes on H type households, $\tau_{H,t}$, to adjust primary deficit (g_t and $\tau_{L,t}$ are determined exogenously). Let a bar over a variable denote the steady state value of the variable. The first regime's tax rule is expressed as

$$\tau_{H,t} = \bar{\tau}_H + \phi_{\tau b}\left(b_{P,t-1} - \bar{b}_P\right), \quad \phi_{\tau b} > 0. \tag{36}$$

The steady-state seignorage satisfies the budget constraint (34) as

$$\overline{mb}(1 - 1/\bar{\Pi}) = \bar{g} - \bar{\tau}_H - \bar{\tau}_L + \bar{r}\bar{b}_P \tag{37}$$

The steady-state inflation rate, $\bar{\Pi}$, is given by (37) since $\overline{mb}$ and $\bar{r}$ are determined by the model, and $\bar{g} - \bar{\tau}_H - \bar{\tau}_L$ and $\bar{b}_P$ are determined by fiscal policy. Using this inflation rate as the target rate, we express a general form of the SBP's interest rate rule as

$$\ln(1+R_t) = \phi_{rr}\ln(1+R_{t-1}) + (1-\phi_{rr})\{\ln(1+\bar{R}) + (1+\phi_{r\pi})\ln(E_t\Pi_{t+1}/\bar{\Pi}) + \phi_{ry}\ln(y_t/\bar{y})\} + \ln\xi_{r,t}, \tag{38}$$

where $1+R_t$ is the gross nominal interest rate, which is related to the gross real rate as $1+r_t = (1+R_t)/\Pi_t^e$); $1+\bar{R} = (1+\bar{r})\bar{\Pi}$, $\xi_{r,t}$ is a monetary policy shock, $0 \le \phi_{rr} < 1$, $\phi_{r\pi} > 0$ and $\phi_{ry} > 0$.

In the second regime (fiscal dominance), fiscal policy does not adjust taxes in response to debt growth and monetary policy attempts to stabilize debt. In this regime, the interest-rate rule is modified to include reaction to debt growth as follows:

$$\begin{aligned}\ln(1+R_t) = \phi_{rr}\ln(1+R_{t-1}) + (1-\phi_{rr})\{\ln(1+\bar{R}) + (1+\phi_{r\pi})\ln(E_t\Pi_{t+1}/\bar{\Pi}) + \phi_{ry}\ln(y_t/\bar{y}) \\ + \phi_{rb}(b_{P,t-1} - b_{P,t})\} + \ln\xi_{r,t}.\end{aligned} \quad (39)$$

Note that the signs of the coefficients in (43) are not restricted to be positive as this restriction may no longer be feasible under fiscal dominance.

Shocks

We consider four shocks in the model: three internal and one external shock. The internal shocks include shocks to real government expenditures (g_t), total factor productivity ($\xi_{y,t}$) and to monetary policy rule ($\xi_{r,t}$). The external shock is a shock to real foreign price of imports ($p^*_{M,t}$). Each shock is assumed to follow an AR (1) process, and the equations for the variables subject to shocks are given by

$$\ln g_t = (1-\rho_g)\ln\bar{g} + \rho_g \ln g_{t-1} + x_{g,t}, \quad (40)$$

$$\ln\xi_{y,t} = (1-\rho_y)\ln\bar{\xi}_y + \rho_y \ln\xi_{y,t-1} + x_{y,t}, \quad (41)$$

$$\ln\xi_{r,t} = (1-\rho_r)\ln\bar{\xi}_r + \rho_r \ln\xi_{r,t-1} + x_{r,t}, \quad (42)$$

$$\ln(p^*_{M,t}) = (1-\rho_{PM})\ln(\bar{p}^*_M) + \rho_{PM}\ln(p^*_{M,t-1}) + x_{pm,t}, \quad (43)$$

where $x_{g,t}, x_{y,t}, x_{r,t}$, and $x_{pm,t}$ are white-noise shocks.

2.2 Endogenous Credibility

To introduce endogenous credibility in the above setup, we use a model based on Isard et al. (2001). We modify the standard specification of inflationary expectations (5) as follows:

$$\ln \Pi_t^e = \lambda_t E_t \ln \Pi_{t+1} + (1-\lambda_t)\ln \Pi_{t-1} + \mathrm{B}_t + \ln \xi_{\pi^e,t}\,, \tag{44}$$

which assumes that inflationary expectations are a weighted average of forward and backward looking components, and may also be subject to a possible bias, B_t, and an expectation shock, $\xi_{\pi^e,t}$. The weight on the forward looking component, λ_t, represents a measure of the credibility stock and varies between zero (no credibility) and one (full credibility). The credibility stock evolves according to the following autoregressive form:

$$\lambda_t = \rho_\lambda \lambda_{t-1} + (1-\rho_\lambda)\Gamma_{t-1}, \quad 0 < \rho_\lambda < 1\,, \tag{45}$$

where Γ_{t-1} is a credibility coefficient that is determined by public's initial beliefs and inflation performance as discussed below.

Assume that the public supposes that inflation rate is determined by either a low inflation or a high inflation regime. The inflation rate in the low inflation regime $(\ln \Pi_t^{LO})$ converges to the target rate ($\ln \bar{\Pi}$) while the inflation rate in the high inflation regime $(\ln \Pi_t^{HI})$ converges to a higher rate ($\ln \tilde{\Pi}$). The behavior of the inflation rate in two regimes is determined as

$$\ln \Pi_t^{LO} = \zeta_L \ln \Pi_{t-1} + (1-\zeta_L)\ln \bar{\Pi} + \ln \xi_{\pi^{LO},t}, \quad 0 < \zeta_L < 1\,, \tag{46}$$

$$\ln \Pi_t^{HI} = \zeta_H \ln \Pi_{t-1} + (1-\zeta_H)\ln \tilde{\Pi} + \ln \xi_{\pi^{HI},t}, \quad 0 < \zeta_H < 1\,, \tag{47}$$

where $\xi_{\pi^{LO},t}$ and $\xi_{\pi^{HI},t}$ are the shocks to the inflation rate in the two regimes. The credibility coefficient is determined by the following expression which is a measure of the extent to which actual inflation rate is consistent with the two regimes:

$$\Gamma_t = \frac{\left(\ln \Pi_t^{HI} - \ln \Pi_t\right)^2}{\left(\ln \Pi_t^{HI} - \ln \Pi_t\right)^2 + \left(\ln \Pi_t^{LO} - \ln \Pi_t\right)^2}. \tag{48}$$

The credibility coefficient also varies between 0 and 1. The coefficient approaches 0 as the actual inflation rate converges to the inflation rate predicted by the high inflation regime and 1 as the actual inflation rate converges to the inflation rate predicted by the low inflation regime.

Finally the bias is defined as a proportion of the difference between a weighted average of next-period inflation forecasts for the two inflation regimes and the target inflation rate as follows:

$$\mathrm{B}_t = \upsilon\left(\lambda_t E_t \ln \Pi_{t+1}^{LO} + (1-\lambda_t) E_t \ln \Pi_{t+1}^{HI} - \ln \bar{\Pi}\right), \quad 0 < \upsilon < 1. \tag{49}$$

In this formulation, as λ_t approaches 1 (full credibility), the bias will tend to 0 since $\ln \Pi_{t+1}^{LO}$ will converge to $\ln \bar{\Pi}$ according to (46). In this model, even if monetary policy initially faces less than full credibility, it can improve its credibility stock and eventually achieve full credibility by consistently following a rule that targets the inflation rate, $\ln \bar{\Pi}$. Under such policy, the convergence of inflation to the target rate would move the credibility coefficient to 1 via (48) and the credibility stock to 1 via (45). Also note that with λ_t approaching 1 and B_t approaching 0, $\ln \Pi_t^e$ would converge to $E_t \Pi_{t+1}$ according to (44).

3. Transmission of Shocks

In this section, we examine how the presence of endogenous credibility and fiscal dominance affect the transmission mechanism for different shocks. We calibrate the model to Pakistan's economy. Parameter values for the basic model are based on Choudhri and Malik (2012) and are summarized in Table 1.[9] The parameter values for the endogenous credibility model were initially set close to the values used in Alichi et al. (2009) and are also shown in Table 1. A sensitivity analysis was undertaken to explore the implications of varying these values.

An Increase in Government Expenditures

We first examine the dynamic effects of a temporary increase in government expenditures. This expenditure shock is of special interest as fiscal problems in Pakistan not only raise credibility issues but also could lead to fiscal dominance. We consider shocks to $\ln g_t$ $(x_{g,t})$ equal to 0.025 for 4 quarters. These shocks lead to a cumulative increase in real government expenditures (over 4 quarters) close to 1% of real GDP.

To explore the influence of imperfect credibility on inflation behavior, we compare the inflationary effect of fiscal shocks under: (1) weak monetary independence regime with model-consistent forward looking expectations (baseline case) and (2) weak monetary independence regime with expectations determined by the endogenous credibility model.[10] We assume that debt and inflation targets are close to current levels, and set the debt target ($\bar{b}_p$) equal to 60% of potential output ($\bar{y}$) and an inflation target of $\bar{\Pi} = 1.03$ which implies an annual inflation rate close to 12%. In the endogenous credibility case, the steady-state inflation rate in the high

[9] The values of a number of model parameters were chosen by calibrating the model to the data for Pakistan's economy while those of other parameters were selected from other studies. See Choudhri and Malik (2012) for further details.
[10] Next-period inflation forecast is given by (5) in the baseline case and (40)-(45) in the endogenous credibility case.

inflation regime is assumed to be twice as high ($\tilde{\Pi} = 1.06$). For illustrative purposes, we assume a simple monetary policy rule that does not smooth the interest rates and responds only to inflation with an inflation coefficient ($\phi_{r\pi}$) equal to 0.5, and a tax rule that responds weakly to deviations of debt from the target level.[11]

Figure 4 illustrates the dynamic response of the inflation rate (expressed as an annual percentage rate) over 15 quarters in the two cases. As compared to the baseline case, endogenous credibility raises the inflation rate in each period. The increase due to endogenous credibility is, however, not large: at its peak the inflation rate increases to about 12.5% (from 11.8%) in quarter 5 in the baseline case and about 12.7% under endogenous credibility. Our sensitivity analysis indicates that the credibility effect on inflation could be stronger for alternative parameter values, especially for a larger inflation bias (larger υ) or greater persistence of inflation rates in the low and high inflation regimes (larger ζ_L and ζ_H), but the effect does not tend to be very large.[12]

We next explore the inflationary consequences of fiscal dominance. To isolate the effect of fiscal dominance, we use the model without endogenous credibility. In this regime, fiscal policy does not follow the tax rule and monetary policy implements a modified interest rate rule which includes debt. Although the debt coefficient in this rule is negative, the inflation coefficient need not be positive. Indeed, we find that equilibrium determinacy is obtained under the modified rule for a wide range of positive and negative inflation coefficients (given a negative debt coefficient).[13]To examine the implications of positive versus negative response to

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[11] We let $\phi_{r\pi} = 0.5, \phi_{ry} = 0, \phi_{rr} = 0$ in the monetary policy rule and $\phi_{\tau b} = 0.025$ in the tax rule.

[12] For example, doubling the bias (increasing υ from 0.25 to 0.5) would increase the inflation rate by about a half of one percentage point in quarter 5.

[13] Another potential problem associated with such a rule is that the interest rate may violate the zero bond constraint (Kumhof et al., 2008). However, this problem does not arise in our case because of a high average value of the nominal interest rate.

inflation, we compare two simple rules with inflation coefficients equal to 0.5 and -0.5. In both cases, we assume no interest smoothing and no response to output gap.[14]The inflation and debt targets are the same as in the case of endogenous credibility discussed above.

The dynamic response of the inflation rate to the government expenditure increase under fiscal dominance is illustrated in Figure 5. Inflation initially increases more in the case of negative than a positive inflation response, but it also converges faster to the target rate. In both cases, the government expenditure increase leads to very high inflation rates (reaching peaks of 21.8% under negative inflation response and 19.5% under positive response) as compared to the baseline case. The behavior of real debt is also very different in the two cases. As illustrated in Figure 6, while the negative response to inflation quickly reduces real debt (by reducing the real cost debt servicing), the real debt continues to grow for a long period (for 13 quarters) if the inflation response is positive. Both types of reactions to inflation could also lead to major credibility issues, since inflation increases sharply under negative response and debt increases for a long period under positive response.

Inflation generated by increases in government expenditures under fiscal dominance could produce significant welfare losses. Table 2 provides a compensating-variation measure of these losses for both types of households. The measure shows the proportion of steady-state consumption households would need to give up to be as well off in a state with government expenditure increases (over 4 quarters) as in a state without these increases. The losses are quite larger under fiscal dominance as compared to the endogenous credibility case; and under fiscal dominance, negative inflation response leads to much larger losses, especially for high-income household who hold government debt whose real value is reduced via rapid inflation. These

[14] In (39), we let $\phi_{rr} = 0, \phi_{ry} = 0, \phi_{rb} = 0.1$ and $\phi_{r\pi}$ equal to 0.5 or -0.5.

losses reflect the inefficiency that arises because of the use of one tool (interest rate) rather than two tools (interest rate and tax) to achieve two goals (stabilize inflation and debt).

Other Shocks

We also explored the response of inflation to other shocks. In particular, we examined the effect of a negative productivity shock, a positive import price shock and a negative shock to the interest rate rule. The results are very similar for the role of imperfect credibility. For each shock, the inflation response under endogenous credibility is higher than the baseline model, but the difference is not very large. The pattern of inflation response under fiscal dominance differs across shocks. In general, these shocks do not lead to much higher inflation rates under fiscal dominance. The reason for this result is that shocks to variables other than government expenditures do not have a significant direct affect on debt, and hence they do not induce an interest rate response (in the modified rule for fiscal dominance) that produces large inflation. It should be emphasized, however, that increases in government expenditures are a key source of fiscal dominance and expenditure shocks have a very strong inflationary effect.

4. Performance of Alternative Monetary Policy Rules

In this section we compare the performance of alternative rules. In evaluating the performance we use performance measures based on the traditional approach, in which losses arise from the variability of inflation and output around their target values. These measures are computed from stochastic simulations, in which the economy is subjected to shocks to government expenditures, productivity and import prices. Stochastic processes for these shocks are based on Choudhri and Malik (2012) and are shown in Table 1.[15]

We first consider the weak monetary policy independence regime described by fiscal and monetary policy rules (36) and (38). For selected variants of the monetary policy rule, Table 3 shows the standard deviations of inflation divergence from target and output gap for both the baseline and endogenous credibility models. First, comparing rules that respond only to inflation (do not react to output or smooth interest rates), there is a trade off between stabilizing inflation and output: less aggressive anti-inflation policy (smaller inflation coefficient) reduces output variability, but increases the variability of inflation. In the endogenous credibility model, output is more stable, but the variability of inflation increases substantially, especially when the anti-inflation stance is less aggressive. Indeed, ensuring a determinate solution under endogenous credibility requires that the inflation coefficient is not too low (less than 0.2). A rule that also reacts to output gap can bring about significant gains in output stability, but losses in terms of inflation variability are high. To achieve convergence under endogenous credibility, monetary policy is constrained not to use too high an output coefficient. Finally, interest rate smoothing also reduces output variability at the cost of larger inflation variability. This policy, however, also reduces the variability of interest rates and may confer additional benefits if interest rate stability is considered desirable.

We also examined the variability measures for the fiscal dominance regime. The modified basic rule for fiscal dominance (with inflation coefficient equal to 0.5 and debt coefficient equal to -0.1) generates much higher variability of inflation but slightly lower output

[15] For the evaluation of different monetary policy rules, the shock to the interest rate rule is assumed to be absent.

variability.[16] We explored a range of values for the inflation coefficient in this rule but inflation variability remained high over this range. Variations in the debt coefficient also did not appreciably affect inflation variability.

5. Concluding Remarks

Monetary policy in Pakistan is currently operating in an environment in which fiscal deficits and government debt are increasing, the government is continuously borrowing from SBP, and there is concern that inflation and debt growth would not be controlled. The paper uses a dynamic stochastic general equilibrium model to explore feasible monetary policy options in such an environment. In this model, we first allow for the possibility that there is lack of credibility that inflation will converge to the target rate and inflationary expectations incorporate the likelihood of inflation will approach a higher rate. Monetary policy can improve its credibility only by moving the inflation rate closer to the target rate. To introduce this mechanism, we use a model of endogenous credibility based on Isard et al. (2001). We also distinguish two policy regimes that are relevant for Pakistan. In the first regime (weak monetary independence), although fiscal policy determines the inflation target, it undertakes fiscal measures to stabilize government debt. Monetary policy in this regime is free to use an interest rate rule to stabilize inflation. In the second regime (fiscal dominance) taxes or expenditures are not adjusted to arrest debt growth. In this situation, monetary policy is constrained by the need to stabilize government debt. The constrained monetary policy is represented by an interest rate rule based on Kumhof et al. (2008) which includes both inflation and debt.

[16] The standard deviation of the inflation difference is equal to 0.1311 while that of the output gap equals 0.0814.

In the weak monetary independence regime, imperfect credibility amplifies the inflation response to different shocks. Inflationary shocks, such as increases in government expenditures, lead to higher inflation under imperfect credibility than full credibility. Variability of Inflation thus increases in the presence of imperfect credibility. However, increased inflation variability is not too large if monetary policy pursues a sufficiently strong anti-inflation policy.

Inflationary consequences of fiscal dominance are much more serious. Shocks that have an appreciable effect on government debt exert a strong impact on inflation as monetary policy has to also react to changes in the debt position. We find that an increase in government expenditures would lead to much larger inflation rates under fiscal dominance even if there is full credibility. Since budgetary shocks are likely to be important under conditions that lead to fiscal dominance, this regime will make inflation much more variable. An important implication of our analysis is that volatile inflation can be avoided if fiscal authority takes the responsibility for stabilizing debt and leaves monetary policy free to focus on stabilizing inflation. Recent amendments to the SBP Act require fiscal authorities to control government debt. Adherence to this requirement could significantly improve macroeconomic performance in Pakistan

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Figure 1. Inflation and Growth

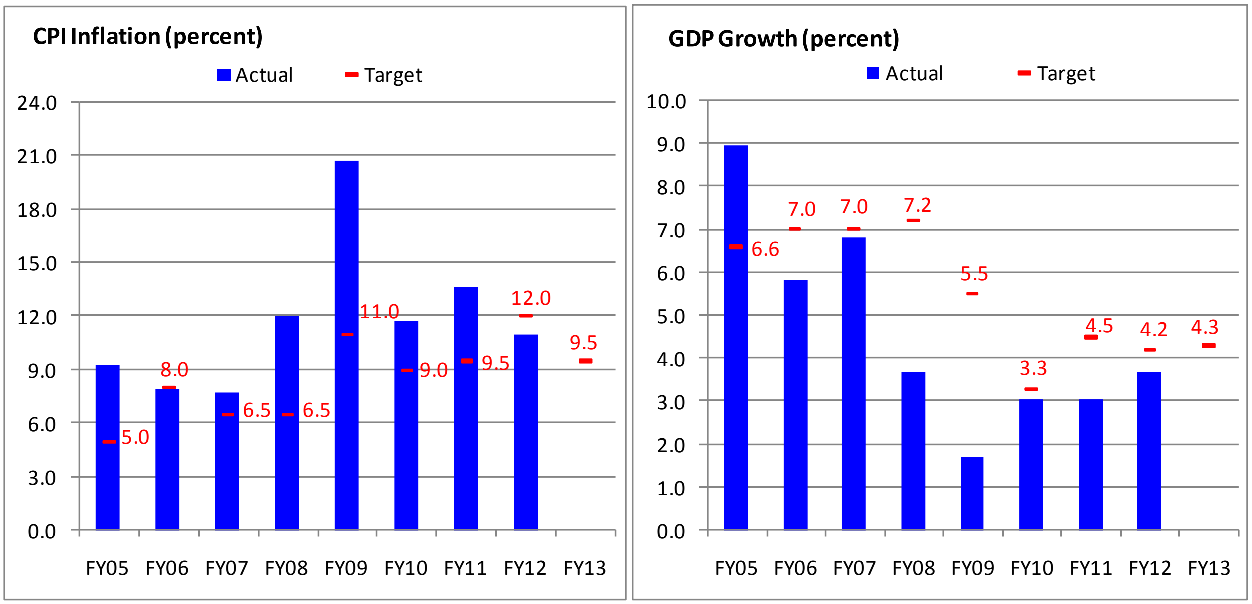


Figure 2. Rising Fiscal Deficit and Debt

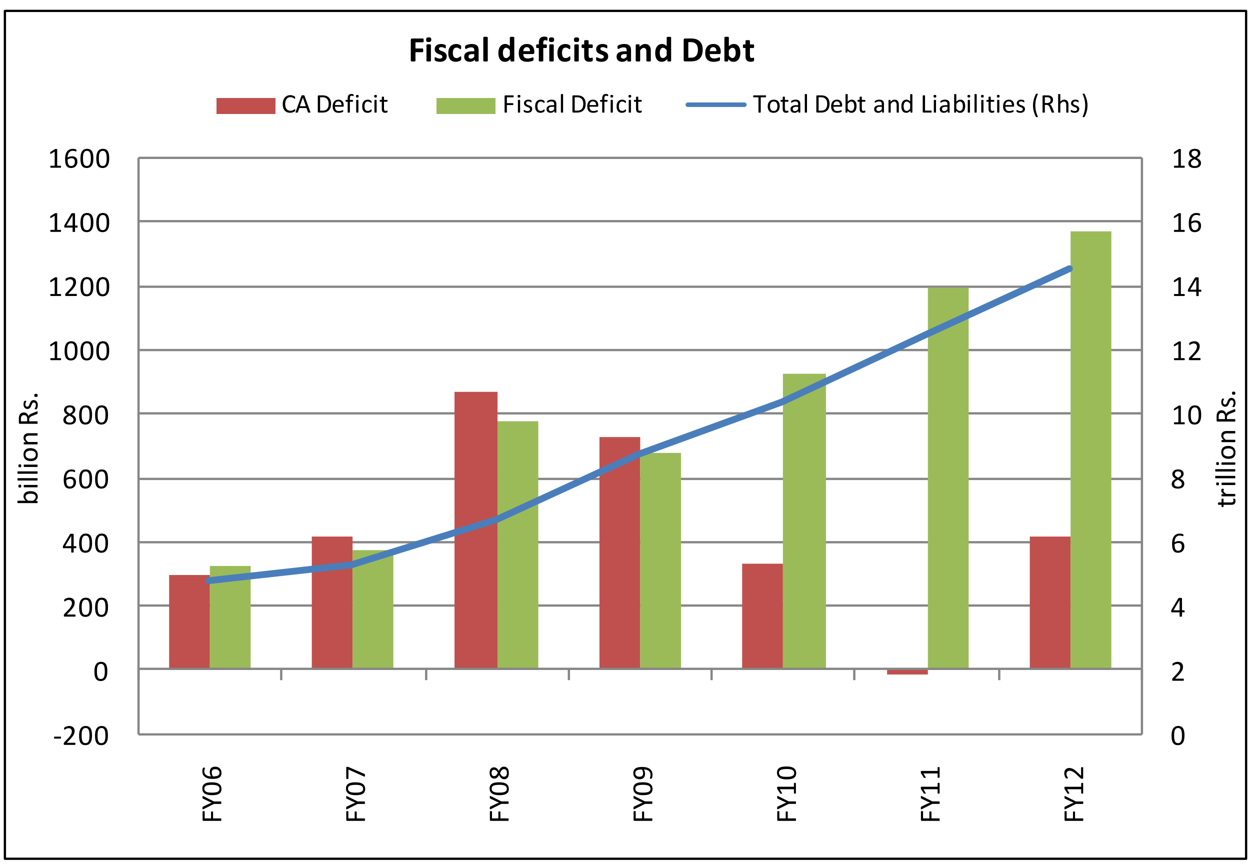


Figure 3. Government Borrowing

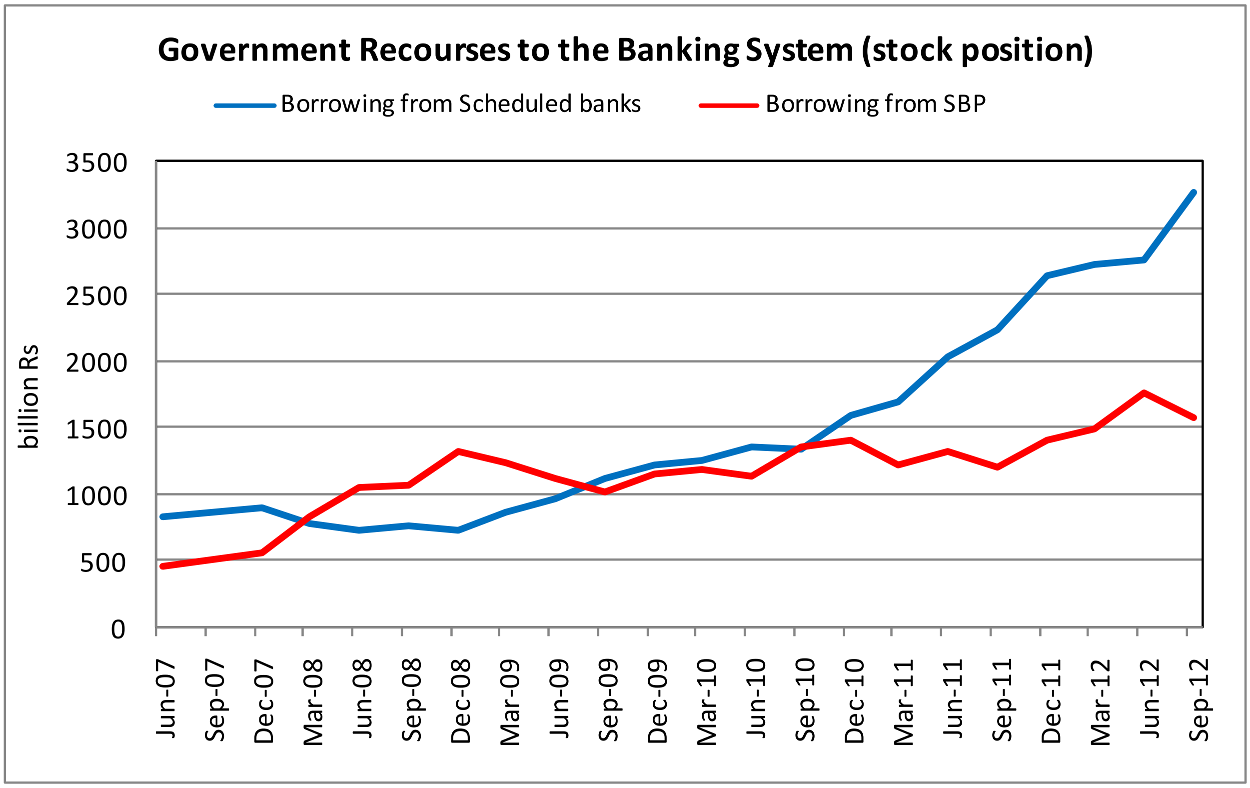
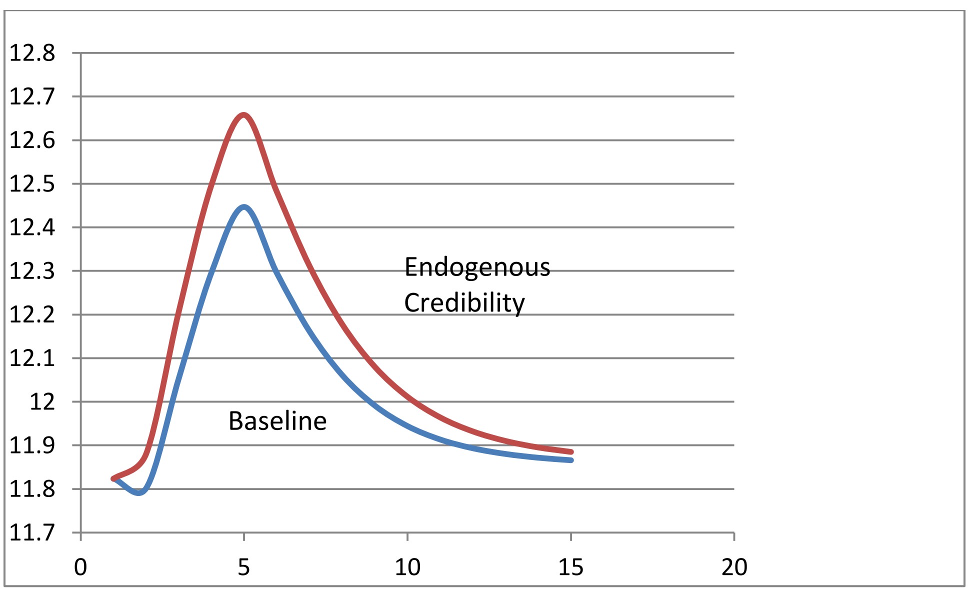
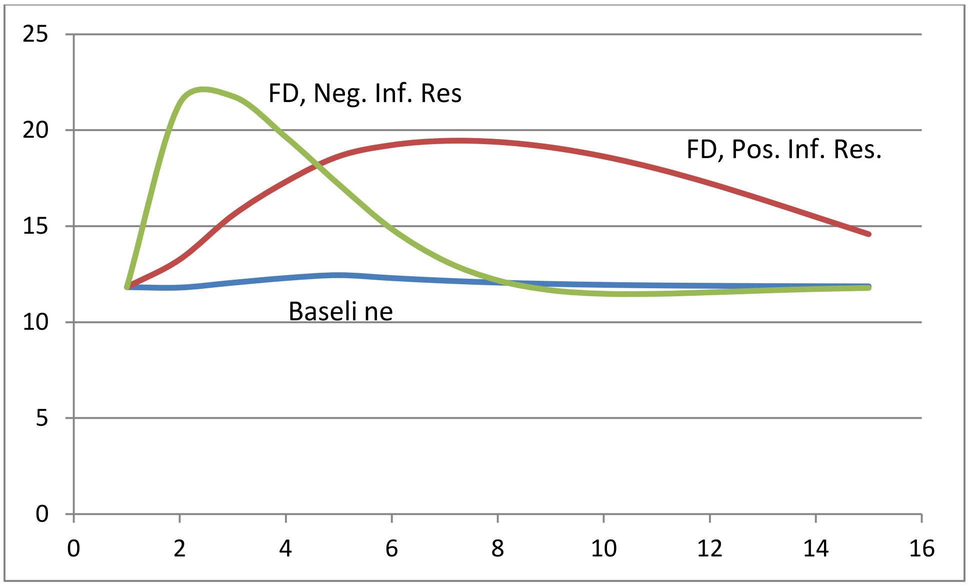


Figure 4. Inflation Response under Endogenous Credibility



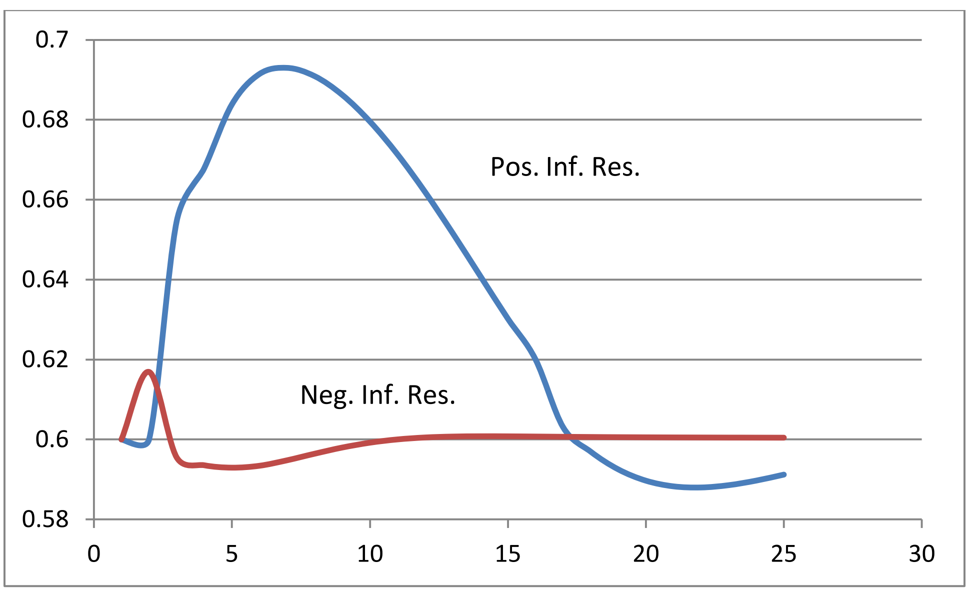
Note: The graphs show the response of inflation (as an annual percentage rate) to a 0.025 shock to $\ln g_t$ for 4 quarters.

Figure 5. Inflation Response under Fiscal Dominance



Note: The graphs show the response of inflation (as an annual percentage rate) to 0.025 a shock to $\ln g_t$ for 4 quarters.

Figure 6. Response of Real Debt under Fiscal Dominance



Note: The graphs show the response of real debt (as percentage of potential output) to 0.025 a shock to $\ln g_t$ for 4 quarters.

Table 1. Parameter Values for the Model

Households

$\beta = 1/1.01$, $\theta = 1.01$, $\chi = 2$, $\kappa = 2$, $\nu = 2$, $\xi_{HC} = 0.0056$, $\xi_{HD} = 0.0041$, $\xi_{HN} = 18.505$,

$\xi_{LC} = 0.0066$, $\xi_{LN} = 6.327$.

Banks, Investment

$\gamma = 0.85$, $\xi_{BL} = 204.8$, $l\overline{b} = 0.166$, $\omega_I = 4$, $\delta = 0.021$.

Composite Good

$\eta = 2$, $\sigma = 6$, $\psi = 0.161$, $\alpha_H = 0.363$, $\alpha_L = (2/3)\alpha_H$, $\overline{\xi}_y = 0.731$, $\varepsilon = 6$, $\psi^* z^* = 0.161$, $p_m^* = 1$.

Taxes, Targets

$\overline{\tau}_H = 0.1155$, $\tau_L = 0.075$, $\overline{b}_P = 0.6$, $\overline{\Pi} = 1.03$.

Adjustment Costs, Shocks

$\omega_H = 400$, $\omega_L = 400$, $\omega_L = 200$, $\rho_g = 0.5$, $\rho_y = 0.9$, $\rho_m = 0.7$, $stderr(x_{g,t}) = 0.05$,
$stderr(x_{y,t}) = 0.025$, $stderr(x_{pm,t}) = 0.05$.

Endogenous Credibility

$\rho_\lambda = 0.2$, $\tilde{\Pi} = 1.06$, $\zeta_L = 0.6$, $\zeta_H = 0.6$, $\upsilon = 0.25$.

Table 2. Welfare Losses for the Government Expenditure Increase

	Low-Income Households	High-Income Households
Endogenous Credibility	0.0019	0.0101
Fiscal Dominance (Neg. Res.)	0.0192	0.1297
Fiscal Dominance (Pos. Res.)	0.0135	0.0539

Note: Loss equals the proportion of steady-state consumption households would need to give up to be as well off in a state with 0.025 a shock to $\ln g_t$ for 4 quarters as in a state without these shocks.

Table 3. Performance of Different Monetary Rules

	Baseline Model		*Endogenous Credibility*	
	Inflation Diff. (Std. Dev.)	Output Gap (Std. Dev.)	Inflation Diff. (Std. Dev.)	Output Gap (Std. Dev.)
Basic Rule ($\rho_{rr} = 0, \phi_{r\pi} = 0.5, \phi_{ry} = 0$)	0.0316	0.0962	0.0408	0.0949
Less Anti-Inflation ($\rho_{rr} = 0, \phi_{r\pi} = 0.1, \phi_{ry} = 0)^a$	0.0896	0.0854	0.1555	0.0801
More Anti-Inflation ($\rho_{rr} = 0, \phi_{r\pi} = 0.9, \phi_{ry} = 0$)	0.0230	0.0984	0.0262	0.0981
React to Output ($\rho_{rr} = 0, \phi_{r\pi} = 0.5, \phi_{ry} = 0.5)^b$	0.2562	0.0615	0.3239	0.0606
Interest Smoothing ($\rho_{rr} = 0.9, \phi_{r\pi} = 0.5, \phi_{ry} = 0$)	0.0375	0.0863	0.0438	0.0856

Note: Inflation difference and output gap are defined as $\ln(\Pi_t / \bar{\Pi}) \times 400$ and $\ln(y_t / \bar{y}) \times 100$.

[a]For the endogenous credibility model , $\phi_{rp} = .2$ is used as a determinate solution is not obtained for a lower value.

[b]For the endogenous credibility model , $\phi_{ry} = .45$ is used as a determinate solution is not obtained for a higherer value.

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