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Fiscal and Monetary Policy Interactions in Pakistan Using a Dynamic Stochastic General Equilibrium Framework

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Currently Pakistan's economy is under stress and registered a sluggish growth for many years in a row. The performance of major economic indicators is not satisfactory. Low investment, double digit inflation, fiscal imbalances and low external capital inflows indicates the severity of the grave economic situation. This paper investigates fiscal and monetary policy interaction in Pakistan using dynamic stochastic general equilibrium model. Finding of the paper reveals that fiscal and monetary policy interacts with each other and with other macroeconomic variables. Inflation responds to fiscal policy shocks in the form of government spending, revenue and borrowing shocks. Monetary authority's decisions are also affecting fiscal policy variables. It is also evident that fiscal discipline is critical for the effective formulation and execution of monetary policy.

JEL Classifications: E32, E37, E52, E61, E63,
Keywords: Monetary Policy, Fiscal Dominance, DSGE, Pakistan

1. INTRODUCTION

Currently Pakistan's economy is under stress and registered a sluggish growth for many years in a row. Economy is passing through the difficult time of its history. Outlook is bleak and gloomy. The performance of major economic indicators is not satisfactory. Low investment, persistent and high inflation, fiscal imbalances and low external capital inflows indicates the severity of the grave economic situation. Another important issue is the persistent and continuous budget deficit which is the bone of contention between fiscal authority and state bank of Pakistan. Persistence budget deficits

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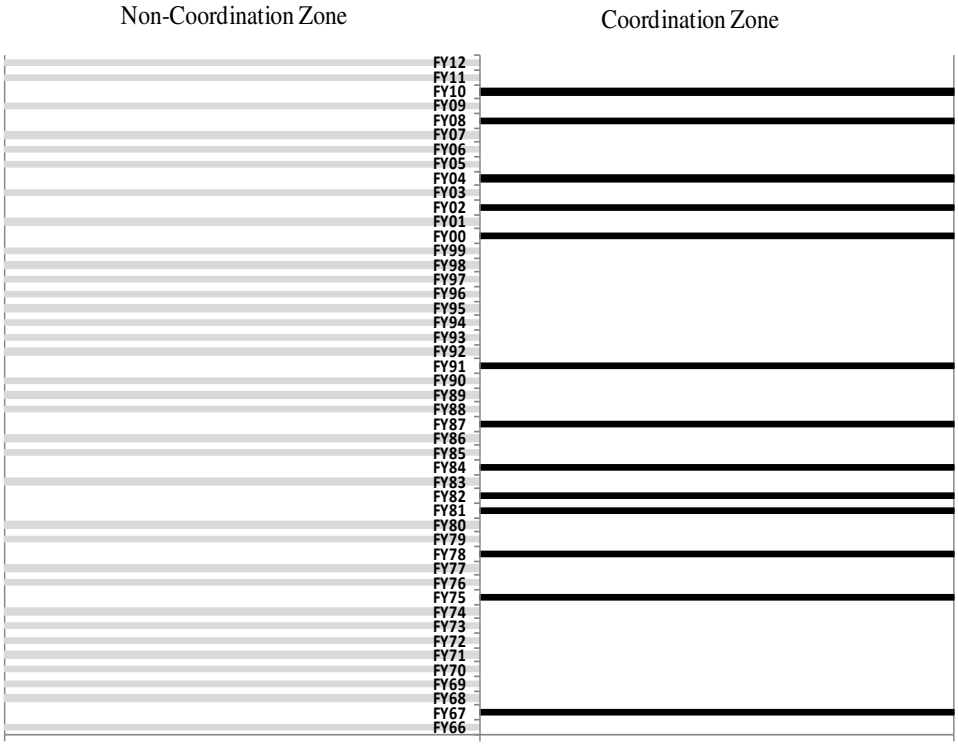
and government borrowing deters the formulation and execution of an independent monetary policy.

State Bank of Pakistan is adopting tight monetary policy in order to discourage government borrowing from the domestic banking system and non-bank financial institutions, particularly from the state bank of Pakistan. But even the higher interest rate is not working as preventive arms to stop the federal government's borrowing. There are many reasons, the first and at the forefront is the friendly attitude of the State bank of Pakistan. State bank acts amicably and never decline Federal government's demands for fund to bridge the fiscal gap. SBP always extends a helping hand by providing the demanded seigniorage to the government. Another issue is the non-serious attitude of the Federal government. Fiscal authority and politicians failed to stop fiscal slippages and is not serious in ensuring fiscal consolidation and adjustments. Third, politicians and treasury benches never allowed SBP to act and operate independently. Numerous institutional arrangements are made and number of legislations passed from the parliament for the independency and autonomy of State Bank of Pakistan. In 1994 monetary and fiscal policy coordination board was formulated for greater cooperation between fiscal and monetary policy. But significant lack of coordination has been observed over the years. From 1966 to 2012, these authorities coordinated effectively only 13 times to achieve broad macroeconomic goals (see, Figure 1 for self explanatory visual representation).

Fig. 1. Years of Monetary/Fiscal Policy Coordination in Pakistan



Source: Arby and Hanif (2010) and Authors' Calculations up-to Fiscal Year 2012.

However, over the periods, State Bank of Pakistan is trying to implement various policy reforms to overcome coordination failure. For example, in 2005, fiscal responsibility and debt limitation act was introduced in order to stop budget deficits and to reduce public debt gradually. Again On 10 March 2012 president of Pakistan signed and endorsed state bank of Pakistan amendment Bill 2012. The objective of the amended draft is to reduce the powers of the politicians and treasury to influence monetary authority. The bill also aims to put brakes on federal government or other public agencies borrowing from state bank of Pakistan. New bill seeks the formulation and execution of monetary policy more independently. Government of Pakistan passed legislation time and again to stop federal government from running excessive budget deficits, discourage the accumulation of huge public debt and to provide autonomy to the state bank of Pakistan. Unfortunately legislations are not implemented in its true spirit and the objectives of these institutional arrangements are not being materialised. Figure 2 shows a gradual increase of budget deficit as percent of GDP especially after FY03. In order to finance fiscal gap, government mainly rely on borrowing from domestic sources. This figure also shows a massive increase in total public sector borrowing as percent of GDP. Figure 3, on the other hand shows the process of monetisation mainly through government borrowing and its likely consequences on consumer price index (CPI) inflation. The continuous increasing trend in both CPI inflation and borrowing behaviour pushes central bank to increase its policy discount rate. Hence, a war between fiscal and monetary authority over budget deficits and borrowing from State Bank of Pakistan drive the debate on the interactions of fiscal and monetary policy.

Fig. 2. Public Sector Borrowing, Budget Deficit and Policy Discount Rate

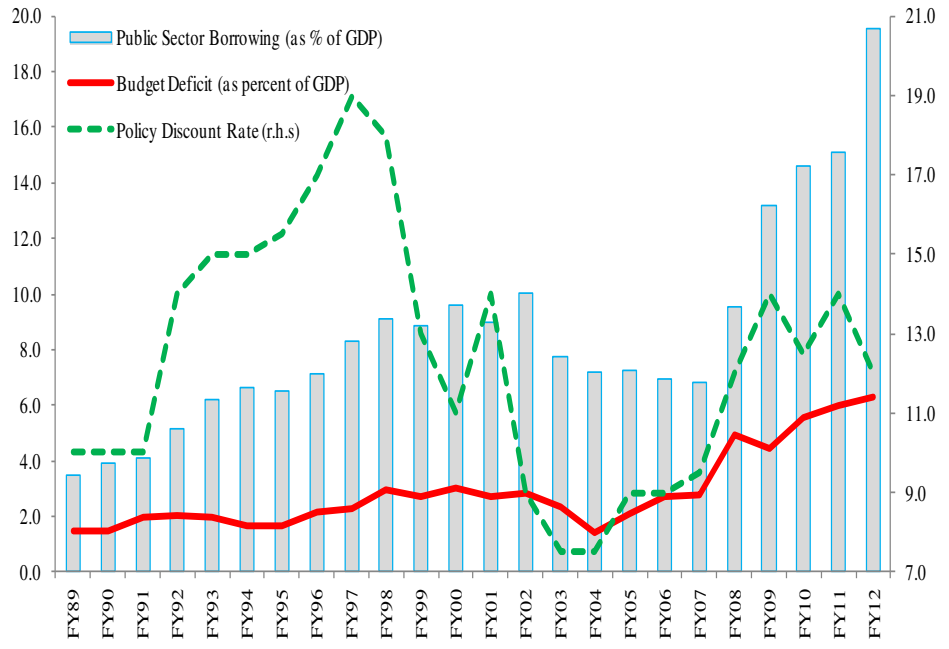
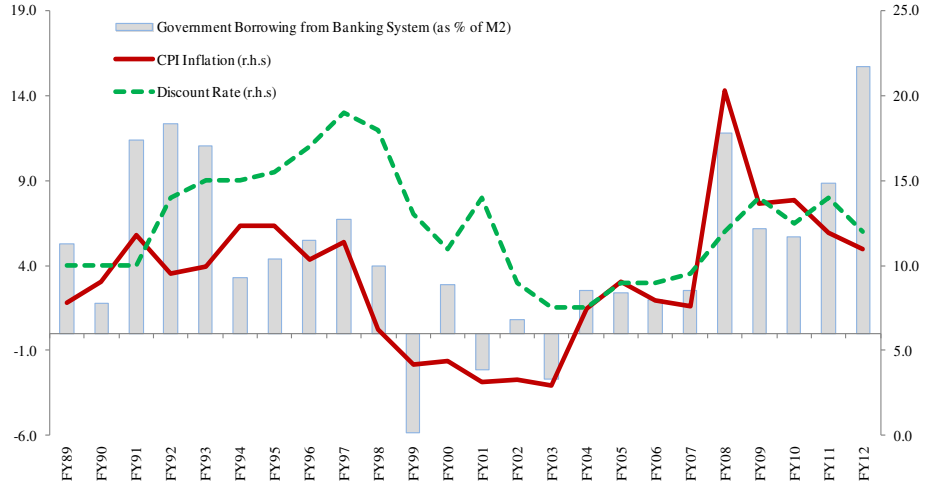


Fig. 3. CPI Inflation, Government Borrowing and Policy Discount Rate



Therefore, we investigate in this paper the degree of interaction between fiscal and monetary policy. Following Cebi (2012), we modify DSGE model by incorporating public sector borrowing in the central bank reaction function. The unrestrained federal government's borrowing from the banking system in general and from State Bank of Pakistan in particular forces us to include it in the model. In a recent work, Choudhari and Malik (2012) while analysing the objectives of monetary policy in Pakistan termed government borrowing as a constraint on monetary policy. Monetary authority's choice of policy instrument and the level of inflation are greatly affected by fiscal deficits and it's financing. This is the main reason that forced State Bank to give weight to public finances especially Federal government borrowing while formulating and executing monetary policy.

Economies are changing momentarily. And it is very much difficult to capture all the dynamism, features and attributes of these changing economies. But the use of different models enables and helps us to get closer to the real picture of the shift in economic environment. Tracking the dynamics of fiscal and monetary policy interaction in Pakistan is important because fiscal dominancy has important implications and state bank of Pakistan is prone to the significant political pressure. Active fiscal policy plays a critical role in the determination of many macroeconomic variables. Furthermore, government spending and its revenues decisions and frequent intervention from the treasury benches undermine the effectiveness of monetary policy. Keeping in perspective the deteriorated fiscal position of the federal government, we modified the DSGE model with fiscal and monetary policy constraints. The objective of using DSGE model for the interaction of fiscal and monetary policy in Pakistan is to explore avenues for the effective formulation and execution of these policies.

The paper is designed in such a manner that Section 2 describes the relevant literature review. Section 3 illustrates dynamic stochastic general equilibrium model for the interaction of fiscal and monetary policies. In Section 4 discuss calibration results and Section 5 presents some policy prescription in perspective of these findings and wrapping up remarks.

2. LITERATURE REVIEW

Researchers, policy makers and economic managers are increasingly interested in the use of Dynamic Stochastic General Equilibrium Models (DSGE) for macroeconomic analysis. Dynamic Stochastic General Equilibrium is relatively complex as compared with earlier models for macroeconomic analysis. This paper uses small scale open economy DSGE model followed the one used by Lubik and Schorfheide (2007), Haider and Khan (2008) and Cebi (2012). The model is modified by incorporating fiscal authority and especially the federal government borrowing. The main drawback of the previous models used for macroeconomic analysis like real business cycles is the absence of room for policy intervention. Because RBC suggests that business cycles respond to shocks optimally and there is no role of policy makers to play and intervene through its policy instrument. On the other hand consensus exists among researcher and academicians that DSGE model is very effective in analysing the relationships and has the immunity against the famous Lucas critique.

The field is new but quite enough literature is available on DSGE models due to the increased interest of policy maker and academicians in this area. The importance of DSGE models have forced the central bankers around the world to adopt these models for policy making and bring it out from the contours of academic discussion. In the last several years there is surprising developments in DSGE modelling. Following the famous Real Business Cycle theory, Kydland and Prescott (1982) have started work on DSGE modelling. Dynamic Stochastic general equilibrium model heavily based on the new Keynesian set up. New Keynesians school of thought provides greater room by assigning an important role to fiscal and monetary policy for stabilisation. The inclusion of different assumptions largely contributed in the development of DSGE model.

DSGE is frequently used by the central bankers for analysing the effectiveness of monetary policy while the role of fiscal policy is largely ignored. Similarly much of the attention has been given to the monetary policy rules. The earlier version of the new Keynesians dynamic stochastic general equilibrium models have limited role for the fiscal policy. For example, Gali (2003) presents a symbolic and narrow role for the fiscal policy. Ratto, *et al.* (2009) also identified that less attention has been given to the public sector and to the interaction of fiscal and monetary policy interaction in DSGE models. Muscatelli, *et al.* (2004) investigate the issue of fiscal and monetary policy interaction and modified the model by including the extended version of fiscal policy transmission channels. They estimated the model instead of calibration. Literature also discussed the two policies as strategic substitutes versus strategic complements. Charles (1999) explores that fiscal and monetary policy behaves as a strategic substitutes. Hagen, *et al.* (2001) termed the relationship between fiscal and monetary authority as an asymmetric. This implies that expansionary fiscal policy is accompanied by tight monetary policy stance. Muscatelli and Mundschenk (2001) probe that the strategic substitutability of fiscal and monetary policy does not applied to the all economies. Melitz (1997) also looked into the matter of fiscal and monetary policy but the results are largely ambiguous. It is not clear from his findings that the relationship between the policy instruments of the two authorities over the period depends on policy or some structural shocks.

Strand of literatures also available on the fiscal and monetary policy interaction in a dynamic stochastic general equilibrium model focusing a greater role for the fiscal authority. Coenen and Straub (2005) realised the active role played by treasury in policy making and its impact on the economy. They incorporate active and dominant fiscal policy along non-Ricardian consumer into the DSGE model. Keeping the permanent income hypothesis, considerable number of economic agents are non-Ricardian in nature against the standard IS curve which heavily relied on the assumption of Ricardian equivalence. They investigate consequences of active and dominant fiscal policy and find considerable influence of fiscal policy over macroeconomic variables. They termed the micro-foundation and optimising agents based model very effective for assessing outcomes of different economic policies. Central bankers in developed and developing economies have modified DSGE model according to the prevailing situation in their respective economies. Tovar (2009) suggests that DSGE model is useful in exploring the basis of instability, remarkable in the identification of structural changes, estimate and anticipate the effects of alternate policy regime. Considerable portion of the existing literature is contributed to the panel date but over the years, remarkable contribution by researchers has been made to the DSGE modelling and they termed these models equally useful for time series data. Smets and Wouters (2003) allowed for different structural shocks. They reveal that beside panel data, DSGE models are able to calculate and predict time series data as well. Bernanke *et al* (1999) also include time series data of financial fractions into DSGE models. Cespedes, *et al*. (2004) also investigated DSGE models while incorporating the financial sector. They investigated the impact of firm's balances on the investment. Choi and Cook (2004) have incorporated banking sector and examine the performance while using DSGE model. Milani (2004) contributed differently by comparing learning and the mechanical source of persistence like rational expectation in habit formation or inflation indexation. Davereux and Saito (2005) developed an alternate approach that allowed for time-varying portfolio in the DSGE models. Engel and Matsumto (2005) kept the centre of attention on complete market and included assets markets plus portfolio choice in the DSGE model. Devereux and Sutherland (2006) further investigated the issue and present a general formula for entire range of assets that is compatible with DSGE models. Fabio and Sala (2006) have added to the literature by investigating DSGE model particularly the identifiability and its repercussions for parameter estimations. An and Schorfheide (2007) revisited the related literature with DSGE and discuss at length the empirical implications of the model. Christiano, *et al*. (2007) extending the model into a small open economy framework and modified the model to include financial friction and fraction in the labour market. Adolfson, *et al.* (2008) studied DSGE with various assumptions while analysing the impact of monetary policy and transmission of shocks in the economy. They also investigate the trade-off between inflation stabilisation as well as output gap stabilisation with the help of DSGE framework.

Keeping in perspective the advantages of Dynamic Stochastic General Equilibrium models, both developed and developing economies are formulating DSGE models for their economies. The central banks around the world are frequently using these models for analysis and diagnosing economic problems and policy formulation. The robustness of the DSGE models has derived the debate on the use of these models in emerging economies for policy

analysis. Following the seminal work of Christiano, *et al.* (2005), Coenen and Straub (2005) and Cebi (2012), model used in this thesis is an open economy DSGE model with some modification. We modified the model by incorporating federal government borrowing from state bank of Pakistan. We investigate the response of domestic output, taxes, inflation, monetary policy instrument and other variables to government borrowing shock. We estimate the parameters for the economy of Pakistan while using DSGE model in order to be consistent with the micro-foundation of our economy.

We take two policy environments. In the first specification, we calibrate the original DSGE model used by Cebi (2012) excluding government borrowing. In the second specification some modification has been made while incorporate fiscal policy, particularly federal government borrowing from state bank of Pakistan. Recognising its significance, we check technology as well as foreign output shocks, besides fiscal and monetary policy variables shocks.

3. MODEL SPECIFICATION

We use a small-scale open economy model for Pakistan. Following Cebi (2012), Fragetta and Kirsanova (2010), Ortiz, *et al.* (2009), Gali and Monacelli (2005), Fialho and Portugal (2005), the model set in motion with infinitely lived household who seeks to maximise the expected present discounted value of life time utility subject to inter temporal budget constraint:

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma_c}}{1-\sigma_c} + \chi \frac{C_t^{1-\sigma_g}}{1-\sigma_g} - \frac{N_t^{1+\phi_n}}{1+\phi_n} \right) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where $\beta=1(1+\rho)^t$ is the household discount factor and $\beta \in (0,1)$, σ is the inverse inters temporal elasticity of substitution in consumption, φ is inverse labour supply elasticity with respect to real wage and χ is relative weight on consumption of public goods. The aggregate variables in the utility function C_t, G_t and N_t are private consumption, government spending and labour supplied respectively.

Household Inter-temporal Budget Constraint

The household inter-temporal budget constraint is

$$P_t C_t + P_t G_t + E_t [Q_{t,t+1} D_{t+1}] + T \leq D_t + (1+\gamma_t) W_t N_t \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where $Q_{t,t+1}=1/(1+r_t)$ is one period ahead stochastic discount factor, r_t is nominal interest rate, T denote constant lump sum taxes and γ_t represent income tax rate. W_t is the nominal wage rate, D_t is nominal portfolio, P_t is consumer price index, C_t is composite consumption index which consist of index of domestically produced goods ($C_{H,t}$) and index of imported goods ($C_{F,t}$), and G_t is consumption index of public goods. These goods are produced by monopolistically competitive firms.

$$C_{H,t} = \left[\int_0^1 C_{H,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di \right]^{\frac{\varepsilon}{\varepsilon-1}} \quad \text{and} \quad C_{F,t} = \left[\int_0^1 C_{F,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di \right]^{\frac{\varepsilon}{\varepsilon-1}}$$

$$P_t C_t = \int_0^1 [P_{H,t}(i).C_{H,t}(i) + P_{F,t}(i).C_{F,t}(i)]di$$

A forwarding looking open economy IS curve by solving FOC,s simultaneously is:

$$\hat{y}_t = E_t(\hat{y}_{t+1}) - E_t(\Delta g_{t+1}) + \alpha(\varpi - 1)(\rho_{c^*} - 1)\hat{c}_t^* - \frac{1}{\sigma_\alpha}\left(\hat{r}_t - E_t\left[\hat{\pi}_{H,t+1}\right]\right) \quad \ldots \quad (3)$$

Where $\sigma_\alpha \equiv \dfrac{\sigma}{(1-\alpha)+\alpha\varpi}$

And $\varpi \equiv \sigma\gamma+(1-\alpha)(\sigma\eta-1)$

Parameter $\eta>0$ denotes elasticity of substitution between domestic and foreign goods, α measures the share of domestic consumption allocated to foreign goods (degree of openness) and γ reflects elasticity of substitution between the goods produced in different foreign countries. Endogenous variables are defined as follows:

Output $\hat{y}_t = \ln\left(\dfrac{Y_t}{\hat{Y}_t}\right) = y_t - \bar{y}$

Where $\bar{y}$ denote steady state value of y_t

Government spending $g_t = -\ln\left(1 - \dfrac{G_t}{Y_t}\right)$

Nominal interest rate r_t and domestic inflation $\pi_{H,t} = \ln\left(\dfrac{P_{H,t}}{P_{H,t-1}}\right)$

The forward looking open economy IS curve is given as:

$$\tilde{y}_t = E_t[y_{t+1}] - E_t[\Delta g_{t+1}] - \frac{1}{\sigma_\alpha}\left(r_t - E_t\left[\tilde{\pi}_{H,t+1}\right]\right) \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

Where $\tilde{y}_t = \hat{y}_t - \hat{y}_t^n$

and $\tilde{r}_t = \hat{r}_t - \hat{r}_t^n$

Finally $\hat{y}_t^n$ and $\hat{r}_t^n$ denote natural rate of output and nominal interest rate. These are the equilibrium level of output and interest rate in the absence of nominal rigidities which can be described as:

$$\hat{y}_t^n = \frac{(1+\phi)}{(\sigma_\alpha+\phi)}\hat{a}_t - \frac{(\sigma-\sigma_a)^{\wedge *}}{(\sigma_\alpha+\phi)}c_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

$$\hat{r}_t^n = \sigma_\alpha\left(E_t\left[\hat{y}_{t+1}^n\right] - \hat{y}_t^n\right) + \sigma_\alpha\alpha(\varpi-1)(\rho_{c^*}-1)\hat{c}_t^* \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

Where $\hat{a}_t$ is the log of technology process, A_t.

Behaviour of the Firm and Price Setting

Following, Haider and Khan (2008) and Cebi (2012), there is continuum of identical monopolistically firms in the economy. These firms produce differentiated products using linear technology:

$$Y_t(j) = A_t N_t(j) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

Following Calvo (1983), we assume that a fraction $1 - \theta$ of the firm can set a new price in each period and a fraction θ of them keeps its price unchanged. To take the inflation persistency in consideration, we also incorporate backward looking behaviour in price setting process by following Gali and Gertler (1999) and Cebi (2012):

$$P^b_{H,t} = P^*_{H,t-1}\frac{P_{H,t-1}}{P_{H,t-2}} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

Where, $P^*_{H,t-1} = \left(P^f_{h,t-1}\right)^{1-\zeta}\left(P^b_{H,t-1}\right)^{\zeta}$ is the aggregate prices chosen in period $t - 1$ by both optimising (forward looking, $P^f_{h,t-1}$) and rule of thumb (backward looking, $P^b_{H,t-1}$) price setters. Christiano, Eichenbaum, and Evans (2005) take into account lagged dynamics in the Phillips curve. Assuming that a fraction $1 - \theta$ of the firm can set a new price optimally in each period as in calvo model, the remaining part θ set their prices by using the previous period inflation rate. The rule of thumb price setter take into account the past period inflation rate $\pi_{H,t-1} = \frac{P_{H,t-1}}{P_{H,t-2}}$ as well as aggregate prices $P^*_{H,t-1}$ occurred in period $t - 1$, when they reset their prices in period t. the existence of backward looking firms besides forward looking firms allows us to obtain a log-linearised open economy hybrid Phillips curve in terms of deviation from steady state:

$$\hat{\pi}_{H,t} = \lambda^6\hat{\pi}_{H,t-1} + \lambda^f E_t\left[\hat{\pi}_{H,t+1}\right] + \kappa\hat{mc}_t + \varepsilon^{\pi}_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

$$\hat{mc}_t = \sigma_\alpha + \phi\left(\hat{y}_t - \hat{y}^n_t\right) - \sigma_\alpha\hat{g}_t + \hat{\tau}_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

Where $\lambda^b = \frac{\zeta}{\theta + \zeta(1-\theta(1-\beta))}$

$$\lambda^f = \frac{\beta\theta}{\theta + \zeta(1-\theta(1-\beta))}$$

$$\kappa = \frac{(1-\beta\theta)(1-\theta)(1-\zeta)}{\theta + \zeta(1-\theta(1-\beta))}$$

$\hat{mc}_t$ is the marginal cost and $\tau_t = -\ln\left(\frac{1-\gamma_t}{Y_t}\right)$ is a log-linearised tax rate. ε^{π}_t represent cost push shock which we include in Phillips curve by following, among others, Smet and

Wouters (2007) Beetsma and Jensen (2004), Ireland (2004), and Fragetta and Kirsanova (2010). Following Smets and Wouters (2003) and Fragetta and Kirsanova (2010).

According to equation (10) government spending and income tax as well as output gap directly affect inflation via Equation (9). The slope coefficient of Phillips curve κ shows sensitivity of domestic inflation with respect to real marginal cost.

Monetary Policy Rule

Following Cebi (2012), Haider and Khan (2008) and Smet and Wouters (2007), we define a simple Taylor type interest rate rule based on inflation and output gap (call it specification-I):

$$\hat{r}_t = \rho_r\left(\hat{r}_{t-1} - \hat{r}^n_{t-1}\right) + (1-\rho_r)[r_\pi \hat{\pi}_{H,t} + r_y\left(\hat{y}_t - \hat{y}^n_t\right)] + \hat{r}^n_t + \varepsilon^r_t \quad \ldots \quad \ldots(11\text{-A})$$

Where $\hat{r}^n_t$ represent the natural level of nominal interest rate. ρ_r is the interest rate smoothing coefficient and lies between zero and one. ε^r_t is interest rate shock and which can be interpreted as non systematic part of the monetary policy. Parameters r_π and r_y show the central bank preferences about inflation and output gap. Since the main aim of the central bank is price stability, the parameter r_π should be higher than r_y. This kind of monetary policy rule implies that Central Banks change nominal interest rates in response to deviation of inflation from its steady state value and deviation of output from its natural level. Additionally, Central Banks also take into account past value of nominal interest rates (when $\rho_r \neq 0$) when they reset their current nominal interest rates. The high value for the degree of interest rate smoothing reduces the contemporary responsiveness of the nominal interest rates to inflation and output gap.

Following, Choudhri and Malik (2012) and Kumhof, *et al*. (2008) we also augment Taylor Rule with a new variable, that is change in government borrowing. It is well defined in political macroeconomic literature, Chari, *et al.* (1991), Leeper (1991) and Sims (1994), in the presence of fiscal dominance, central bank also put some weight on change in government borrowing while setting policy interest rates. The modified version of Taylor rule (call it specification-II) is given as:

$$\hat{r}_t = \rho_r\left(\hat{r}_{t-1} - \hat{r}^n_{t-1}\right) + (1-\rho_r)\left[r_\pi \hat{\pi}_{H,t} + r_y\left(\hat{y}_t - \hat{y}^n_t\right) + r_b(b_t - b_{t-1})\right] + \hat{r}^n_t + \varepsilon^r_t \quad \ldots(11\text{-B})$$

Where, parameters r_π is relative weight assigned to change in government borrowing. This specification is also consistent with an empirical paper by Malik (2007) for Pakistan economy which also considers government borrowing as an important variable while extending simple Taylor type monetary policy rule.

Fiscal Policy Rules

Following Cebi (2012) and Muscatelli and Tirelli (2005) we consider a backward looking form for the fiscal policy reaction function by taking into account lagged responses of fiscal policy to economic activity. We also assume smoothing of fiscal instruments, as Favero and Monacelli (2005) and Forni, Monetforte and Sessa (2009).

$$\hat{g}_t = \rho_g \hat{g}_{t-1} + (1-\rho_g)\left[g_y\left(\hat{y}_{t-1} - \hat{y}^n_{t-1}\right) + g_b \hat{b}_t\right] + \varepsilon^g_t \quad \ldots \quad \ldots \quad \ldots \quad (12)$$

$$\tau_t = \rho_\tau \tau_{t-1} + (1-\rho_t[\tau_y(y_{t-1} - y^n_{t-1}) + \tau_b b_t] + \varepsilon^\tau_t \quad \ldots \quad \ldots \quad \ldots \quad (13)$$

Parameters ρ_g and ρ_τ denote the degree of fiscal smoothing. Parameters g_y and τ_y demonstrate the sensitivities of government spending and tax to past value of output gap. Parameters g_b and τ_b correspond to feedback coefficient on unobservable debt stock. ε^g_t and ε^τ_t are government spending and tax shocks and which represent the non-systematic component of discretionary fiscal policy.

The Government Solvency Constraint

Finally the model is completed by fiscal constraint. As in Cebi (2012), Kirsonva, *et al.* (2007), and Fragetta and Kirsonva (2010) a log-linearised government solvency constraint or fiscal constraint can be expressed as:

$$\hat{b}_{t+1} = \hat{r}_t + \frac{1}{\beta}\left[\hat{b}_t - \hat{\pi}_{H,t} + (1-\beta)\left(\hat{\tau}_t - \hat{y}_t\right) + \frac{\overline{C}}{\overline{B}}\left(\hat{g}_t - \hat{\tau}_t\right)\right] \quad \ldots \quad \ldots \quad \ldots \quad (14)$$

Where, $b_t = \ln\left(\frac{B_t}{P_{H,t-1}}\right)$, B_t is nominal debt stock. $\overline{B}$ is the steady state debt to GDP ratio, and $\overline{C}$ steady state consumption to GDP ratio.

4. CALIBRATION RESULTS

In this section we estimate structural parameters values as well as shocks to the parameters. We do determine some of the values of parameters described in the model and while few are taken from other studies in this area particularly that of Haider and Khan (2008), Ahmad, *et al.* (2012), Ahmed, *et al.* (2012) and Choudhri and Malik (2012). Parameter's values are reported in Table A1. Based on these parameter values, we have calibrated model with two monetary policy rules specifications. The statistical result in terms of variance decompositions, cross correlations, and autocorrelations are reported in Table A2 to Table A4 and given in Appendix section. These results fairly replicate business cycle characteristics of Pakistan economy. Now, for policy related discussion, we would like to explain in the results of impulse responses to exogenous shocks and want to learn how monetary and fiscal policy interacts to each shock.

Impulse Response Analysis

Economic theories identified and recognised numerous shocks. These shocks have different implication for different macroeconomic variables. Some affect aggregate supply while others affect aggregate demand. Some shock affects both aggregate demand and aggregate supply simultaneously. There are also some sorts of shocks that affect

nominal characteristics of the economy. Figure A1 to A6 summarises Calibration and the resulting responses of different variable of interest to shocks.

Response of Domestic Output to Various Shocks

In Figure A1, the first schematic presentation outlines the response of domestic output to technology shock. The figure reveals that output follows the usual behaviour and has a positive response to technological shock. Level of domestic output deviates from the steady state as the technology shock hits the economy. In the beginning the output increase abruptly and formed a hum shaped. The response of domestic output also shows a high degree of persistence as it does not returns back to its steady state up to 16 quarters. We know that DSGE model is largely based on micro foundation and have the attributes of real business cycle. The response of domestic output to positive technological shocks is large and considerable. This is compatible with the existing literature as standard economic theory considers technological advancement as positive supply shock.

Second figure shows the response of domestic output to world output shocks. It is a well documented fact that no single country is cut off from the outside world in the current globalised world. Higher degree of financial integration and improved means of transportation and communication expose economies to external shocks. Mundell-Fleming model explores the vulnerability of domestic economy to shocks, especially world output and world interest rate shocks. These shocks are supposed to be transmitted from one economy to another. Our economy is also vulnerable and exposed to external shock in the world economy. Keeping in view the limitation of this thesis, we just incorporate world output shock. We employed a small open economy DSGE model. Figure shows that domestic output responds positively to world output shock. In the beginning domestic output rises sharply and remains above its steady state level for 6 quarters. Then it decline for a very short period and abruptly converges to its steady state.

The third graph shows the response of domestic output to inflation shock. High price level damages the macroeconomic performance of the country. When inflation hits the economy, output starts to decline and it remains below steady state for sufficiently long period of time. The decline in output is considerable up to three quarters and then it starts rising but never return to its steady state till 16 quarters. It implies that decline in output in response to inflationary shock is highly persistence in Pakistan. Our calibration follows the exact specification of Cebi. There are at least three major channels through which higher prices effect output level in the economy. First, an increase in the price level reduces consumer's wealth that discourages them to spend less. A decrease in consumer's purchasing power reduces demand in the economy resulting a fall in the output. Second, higher price in the economy induces the central bank to adopt tight monetary policy by increasing interest rate in the economy. Cost of doing business goes up as the capital gets expensive with the higher interest rate. This crowded private investment spending and reduces the overall level of output in the economy. There is another channel through which higher prices discourages domestic output. When there is inflationary pressure in the economy and the price level is rising, domestic currency appreciates which in turn discourage exports. Economic activities decrease with a fall in exports causes a decline in the domestic output. Furthermore, inflation causes the value of the currency to decrease. People start spending their savings in the presence of

inflationary pressure in the economy. Lower saving in the country also leads to a decrease in investment and discourages capital accumulation. The long term productivity falls that ultimately causes lower level of domestic output. So inflation has negative impacts and hinders economic growth.

In the next schematic presentation we investigate the response of domestic output to monetary policy. Interest rate is an important factor in the determination of output and economic growth. In our analysis the response of domestic output to monetary policy shock is negative. Domestic output falls with the tight monetary policy stance of the state bank of Pakistan. Output declines and remained below steady state up to 4 quarters. After 4 quarters domestic output starts rising but it again die out very quickly. The high responsiveness of output to monetary policy shock implies that nominal rigidity is not hold too much in Pakistan. Because if prices are sticky then output is not responsive too much to monetary policy shock. It means that prices are highly flexible in Pakistan. One policy implication of the flexible prices is that policy's role and effectiveness declines in a more volatile price environment. Second policy implication necessitates reforms in the behaviour of interest rate. Interest rate reforms are critical because the decision of the state bank of Pakistan regarding interest rate has critical implications for the investment and economic activities in the country. Higher interest rate increases the cost of doing business. Investors are unable to get cheap loans from the banking system in the presence of higher interest rate. This harms Capital accumulation and ultimately growth in the country.

Our analysis also uncovers a decline in output in response to positive fiscal shock in the form of higher taxes. Domestic output declines in the beginning and remain below its steady state for a short period. Output came back to its steady state and rises for two quarters and again die out very quickly. There are different transmission channels through which fiscal policy shocks, tax shocks, affect output. Imposition of higher tax has legitimate economic and business cost. Higher taxes increase price level. Higher prices and inflationary pressure in the economy discourage productive activities and causes output to fall. Higher taxes also discourage labour supply and employees have less incentive to work and earn more. Furthermore, tax shocks also distort price signals and compel rational agent to substitute goods bearing lower taxes. Similarly higher taxes discourage producers to invest and accumulate capital further. This implies that tax shocks slow the process of economic growth and cause the domestic output to decline. The findings are very much consistent with the standard economic literature.

We also investigate the response of domestic output to government spending shocks. Government spends money on the purchase of goods and services. Government also incurs expenditures on the development of infrastructures and carrying out public investments. Beside these expenditures, government also spends money on transfer payments. Transfer payments increases the availability of funds and purchasing power of the individuals. People spend more as they gets more money through transfer payments. So government spending promotes economic activity and influences growth. In the beginning domestic output expands in response to government spending shock. Output remains above its steady state level. It comes down to its steady state after 3 quarters and stayed there for seven quarters. Domestic output again converge to its steady state and remained there. We know that if the government has not enough resources, then its

continuous spending undermines growth. Government extracts resources from the more productive sectors of the economy to finance its spending on less productive activities. So in the beginning government spending maximises output but then it declines because expenditures are misallocated. This implies that fiscal shock, both higher spending and higher taxes, bring considerable volatility to domestic output. We know that volatility in the country reduces the impact of nominal variables on real variables. The impact of financial sector of the economy, monetary policy, has lesser impact on the real sector of the economy, fiscal policy. The impact of policy intervention reduces considerably in the presence of volatility. Government must rationalise its spending and its revenue behaviour in order to improve the policy environment.

If we compare the two specifications, it is visible that tax shocks and government spending shocks has a limited influence over output in the first specification. In Cebi's specification, he does not incorporate government borrowing from the central bank. Output remains tied to its steady state for almost 16 quarters and fiscal shock has a negligible influence over domestic output. This implies that federal government borrowing in Pakistan is critical variable that affect macroeconomic variables and the overall performance.

Response of Inflation to Various Shocks

In Figure A2, we trace the responsiveness of inflation to different shock, particularly shock to fiscal and monetary policy. In the first schematic presentation we report the response of inflation to technology shock. Technology advancement has a considerable impact on output and ultimately on inflation in the country. With a technology shock, inflation reduces because less units of effective inputs are needed to produce the same output. Inflation reduces considerably and remains below its steady state for very long period. It converges to its steady state almost after 15 quarters. We have very interesting findings. If we compare the two specifications, it is visible that when technology shock hits the economy, decline in inflation in Cebi specification is not as much robust as in our case. This may be due to the inclusion of government borrowing from state bank of Pakistan that is largely ignores by Cebi. Cebi's model does not consider government borrowing. This shows that technological shock has greater impact in the presence of government borrowing and fiscal policy is more effective. Inflation reduces to a greater extent in our scheme of things compare to the original model. This implies a greater role of fiscal policy in collecting the positive spillovers of the technological shocks.

Positive world output shock causes prices in the international market to rise. The increased economic and productivity activities leads to the rise in price of different commodity and especially oil prices. Pakistan imports a major share of oil from the international markets. Any increase in the world oil price has a consequential impact on the economy of Pakistan in general and inflation in particular. The figure shows that domestic price level in the economy is highly responsive. Inflation remains it steady state for a very long period and do not converges to its steady state up to 16 quarters. Any rise in the world output and commodity prices cause drive up the cost of factors of production. This has considerable impact on production and ultimately on inflation. World output shock also causes food prices to rise

Next we document the response of inflation to monetary policy shock. Impulse response function shows a significant decline in inflation in response to monetary policy shock. When monetary policy shock hits the economy, inflation declines and it remains below its steady state for sufficiently long period of time. The figure shows that inflation never returns to its steady state up to 16 quarters. This implies that tight monetary policy stance of state bank of Pakistan is effective in controlling inflation in the country. This also contradicts findings of the Javid and Munir (2010). there are many possible explanations. First, data covering period as well as the frequency of the data different. Second reason is the issue of Prize puzzle in DSGE model discussed by Rabanal (2007). the second interesting thing between the two specification is that in our case government has state bank of Pakistan has assigned weights to federal government from the central bank as well as from the domestic commercial banks. Cebi model has not includes government borrowing from the central bank and the response of inflation to tight monetary policy shock as not significant as that in our case. In our case monetary policy is more effective when it takes into accounts the government borrowing.

The next figure shows that a fiscal policy shocks, tax shocks, cause price level in the economy to rise. Inflation is highly responsive to tax shock and it remains above the steady state level. The response is also very persistent as remains there for sufficiently long time as positive government tax shock persist, and never return to its steady state up to 16 quarters. Tax rise increases the cost of production. Producers normally shift the incidents of taxation to the final consumers by including taxes in the prices thus resulting upward pressure in price level in the economy. When tax shocks hit the economy, price level rises in the economy. If we compare our findings with Cebi's findings, it is visible that elasticity of inflation with respect to price level in our economy is high. This implies that in our country producers largely add taxes to the prices of their commodity and bear less or no burden themselves.

In the next figure, we investigate response of inflation to government spending in the country. Price level stays above its steady state for very low period and comes to its steady state after 2 and half quarters. Then the price level start declines. One of the possible explanation for the falling prices after 8 months is the positive impact of government spending on output. Our results also reveals that output rises with the rise in government spending. Inflation level declines in the economy with the increased availability of goods and services.

From this figure we observed that contractionary or tight monetary policy reduces inflation while expansionary fiscal policy leads a price hike in the economy. This implies that fiscal and monetary policy works in the opposite direction and the situation demands for greater cooperation between fiscal and monetary authority in Pakistan.

Response of Interest Rate to Various Shocks

In Figure A3, we investigate monetary policy response to different shocks. In the first figure, we analyses the response of interest rate to technology shocks. A positive technological shock increase the interest rate in the beginning and remain above its steady state up to two quarters. After that it immediately decline and stayed below the steady state for sufficiently long period of time. Interest rate not come back to the steady

state even up to 16 quarters. This implies that monetary policy is expansionary in response to positive technology shock.

We also investigate the response of monetary policy to inflation shock in the economy. State bank of Pakistan response positively by increasing the interest rate to contain the inflationary pressure in the economy. Interest rate response actively and remain above its steady state and not comes to its steady state up to 16 quarters. Purchasing power of money erodes with price hike in the economy. So in order to control the erosion of purchasing power of domestic currency and to bring price stability in the country, state bank increase its policy instrument in response to inflation shock.

We further investigate the response of monetary policy to fiscal policy shock. We check both tax as well as government spending shock. Interest rate rises in response to tax shocks. Interest rate rise and it remains above its steady state for sufficiently long period of time. The response of monetary policy is significantly persistent. These are very interesting findings. If we compare the two specifications, it is clear that response of interest rate is not significant in Cebi's specification. His findings are more accurate and validate economic theory. According his findings central bank should not increase interest rate if government obtains revenue from taxes. Obtaining revenues from increased taxes means a contractionary fiscal policy. So it suggests an expansionary monetary policy in order to offset the negative spillovers of the contractionary fiscal policy. But in our case, state bank of Pakistan increases interest rate along higher tax rates. This implies that both fiscal and monetary authority follow contractionary policies and are making their policies independently. This should not be the case. If the fiscal branch is following tight fiscal policy then state bank of Pakistan must adopt loose monetary policy. There is a room for fiscal and monetary policy coordination because both higher interest rate and higher taxes badly effect the macroeconomic performance of the country.

Here it is also very important to compare the two specifications. In Cebi's specification, he does not assigned any weight to government borrowing. In his set up, the response of interest rate to technology shock is not considerable and it fell slightly. This also supports the finding of Clarida, *et al.* (1999) that central bank is not fully accommodative to technology and the monetary policy is not highly responsive. The response of interest rate remains flat for sufficiently long period of time. In our specification, we incorporate government sector and gave weight to federal government borrowing from state bank of Pakistan. In this case interest rate rises in the beginning, but it should not be the case. Because, according to Cebi's specification if government increases government taxes, then the central bank is supposed not to increase interest rate. But in our case it is increases which is not good for the economy.

Response of Government Borrowing to Various Shocks

In Figure A4, we investigate the response of government borrowing to different shocks. The response of government borrowing to inflation in positive. When there is inflation shock in the economy, government borrowing increases. It increases and remained above its steadiest rate up to 7 quarters. After 7 quarters the government borrowing comes to its steady rate and stayed there afterward till 16 quarters. The main

reason is that government is now paying more and incurred extra expenditure for the same goods and services.

Next we examine the response of government borrowing to monetary policy shocks. Government borrowing decreases in response of interest rate shock. Government borrowing lies below its steady state up to 5 quarters. Then it comes to its steady state and remained there up to 16 quarters. State bank of Pakistan knows that budget deficits and borrowing of the federal government from state bank creating many problems. In order to contain excessive government borrowing and the ruthless use of public exchequer. State bank of Pakistan keeps the discount rate high in order to avoid panic and stress and to force the federal government to adopt appropriate behaviour by rationalising its messy spending.

We also examine the response of government debt to tax shock. Government borrowing increases in response to a positive tax shock and remain above its steady state up to 6 quarters and then it joins its steady state level. There are many reasons for the positive response of government borrowing to tax shock. First tax erodes production activities and discourage capital accumulation. Low economic activities reduces government revenue from taxation and borrow from the banking system in order to finance its expenditure. Second, tax revenue is not enough to finance excessive federal government spending. If government expenditures are more than its revenues, then government borrowing increases along with higher taxes in the country.

We also investigate the response of government borrowing from state bank of Pakistan to fiscal shocks called government spending shock. Government borrowing decreases and stays below its steady state till 16 quarters. The response shows very persistent behaviour. There are many possible justifications for the negative response of government borrowing from state bank of Pakistan to government spending shock. For example, when the federal government increases its spending and the expenditure are greater than the revenue generated from taxes, then government resort state bank for providing money. State bank of Pakistan in return keeps the discount rate higher in order to restrict government borrowing from state bank of Pakistan. In this case it seems that monetary policy of state bank of Pakistan is effective in controlling federal government borrowing from the state bank. Another justification is that government borrows from external sources in order to finance its spending.

Response of Government Spending to Various Shocks

In Figure A5, we trace the response of government spending to different shocks in the economy. A rise in total factor productivity or technology shock causes domestic output to increase. In the first figure, response of government spending to technology shock is positive. Government spending deviates and remain above its steady state for many periods and never returned to steady state up to 16 quarters. This implies that there is a positive relationship between government spending and positive technology shocks. This shows a pro-cyclical fiscal policy behaviour in Pakistan. In earlier figure we noticed that output respond significantly to technology shocks. When economic activities stimulates in the country, government revenue also increases, enabling the government to spend more and more on the welfare of its public. Government may increase new projects and develop new infrastructures. All this will increase government spending.

Government spending also increases in response to a positive world output shocks. Initially government spending remains above its steady state for almost 10 quarters. After 10 quarters, the shocks causes government spending to comes to its steady state and remain there up to 16 quarters.

In the next figure we investigate the response of government spending to inflation is positive. It means that in the presence of inflationary pressure in the economy, the government expenditure increases. Just like individual consumers, higher prices also hurt purchasing power of the government because rising prices means paying more for the same amount of goods and services. In the beginning, inflation shock stimulates government spending and is rising up to 3 quarters. After 3 quarters it started declining and reached to steady state after 12 quarters and stay there.

In the next figure we investigate the response of government spending to monetary policy shock.. state bank of Pakistan adopt tight monetary policy by keeping interest rate high in order to control the ruthless spending and government borrowing from the central and commercial banks. The analysis shows that state bank policy is effective to some extent in containing government spending. Monetary policy mainly influence aggregate demand and we know that government spending is an important element of aggregate demand equation. Government spending reduces to monetary policy shock and it declines up to 11 quarters and then it reaches to its steady state.

In the next figure we analysed the response of government spending to tax revenue shocks. It is visible from the figure that government increases public spending in response to a positive tax shock. Government spending rises till nine quarter and then it comes to its steady state and stayed there up to 16 quarters. When government's revenues increases from taxes, additional resources are now available making it easy and possible for the government to fund its project and exiting programs. This implies that a rise in tax revenue exert extra pressure on government to carry out additional public spending. It implies that government spending is elastic and respond to tax revenue shocks.

Response of Government Revenue to Various Shocks

Technology shocks play an important role and bring business fluctuation and economic volatility. Our analysis shows that government revenue responds to technology shocks (Figure A6). Total factor productivity and economic activities increase with a positive technology shock. Income level of the economy rises. Tax revenue also increases with the rise in income in the presence of any of the two tax system, constant or progressive tax system.

We also trace the response of tax revenue to inflation. Cost of production increase with inflation and discourages output. Aggregate supply shrinking. In the presence of high and volatile inflation in the economy, the producer increases the wages of the employee as the workers often demand for increased wages. Higher price means reduction in the purchasing power and discourage consumer spending. Agents are now paying more for goods and services. Higher prices restrict output and reduce production. This dampen economic growth and cause government revenue from taxes. In the start tax revenue increase with price shock. This validate economic theory. In the beginning, price shock maximises producer's profit and they respond to it by increasing production. This increase tax revenue in the short run. But this rise in the revenue persist for a short period

of two quarters and it die out very quickly. It remains below its steady state for sufficiently large period of time and never returned to steady state till 16 quarters.

The response of tax revenue to monetary policy shock is significant. Quantitative tightening in the form of reduced money supply or higher interest rate increase the cost of doing business and discourage economic activities. Higher interest rate also crowd out private investment. In order to control the inflationary pressure in the economy, state bank of Pakistan raises the interest rate and reduces the amount of lending. Business find it harder to get easy and cheap credit halting economic activities to stimulate. Cost of doing business goes up. Production activities declines and so government revenue. Higher interest rate also discourage consumers spending. People now spend less and increases their saving. Lower economic activities reduces government revenue from taxes. Tax revenue decreases up to 5 quarters. Tax revenue becomes to its steady state and remained there till 16 quarters.

We also investigate the response of tax revenues to government spending shock. Government spending increase budget deficit and interest rate. As government spending increases, borrowing from state bank and other commercial banks also rises. This drives up interest rate higher which increases the cost of capital. Investment crowded out and ultimately productivity activities decline with the rising interest rate. Tax revenue also decreases with slower economic activities. In our analysis response of tax revenue is considerable to government spending shocks. Tax revenues deviate from steady state and not return to steady state till 16 quarter.

5. CONCLUDING REMARKS

In this paper, we attempt to model the interaction of fiscal and monetary policy in Pakistan in a dynamic stochastic general equilibrium model. In this scheme of things, we permit and assign a bigger role to the fiscal policy and government borrowing. Our findings reveal that fiscal and monetary policy interacts in Pakistan.

The key findings of our analysis reveal that fiscal and monetary policy interacts with each others in response to shocks to different variables. We also include, government borrowing, technology as well as foreign output shock besides fiscal and monetary policy shocks. Briefly speaking the behaviour of domestic output follows the usual behaviour and has a positive response to technological shock. Level of domestic output deviates from the steady state as the technology shock hits the economy. Domestic output also shows a high degree of persistence. DSGE model is largely based on micro foundation and have the attributes of real business cycle. The response of domestic output to positive technological shocks is large and considerable and is compatible with the existing literature as standard economic theory considers technological advancement a positive supply shock. Our findings show that domestic output responds positively to world output shock. Our calibration goes and investigates the response of domestic output to inflationary shock. When inflation hits the economy, output starts to decline and it remains below steady state for sufficiently long period of time. The decline in output is considerable up to three quarters and then it starts rising but never return to its steady. Decline in output in response to inflationary shock is highly persistence in Pakistan.

Interest rate is an important factor in the determination of output and economic growth. In our analysis the response of domestic output to monetary policy shock is

negative and domestic output falls with the tight monetary policy stance of the state bank of Pakistan. The high responsiveness of output to monetary policy shock implies that nominal rigidity is not hold too much in Pakistan. This has very critical and important policy implications. First, role of economic policy declines in the absence of nominal rigidity and more volatile environment. Second policy implication necessitates reforms in the behaviour of interest rate. Interest rate reforms are critical because the decision of the state bank of Pakistan regarding interest rate has critical implications for the investment and economic activities in the country. Our analysis also uncovers a decline in output in response to fiscal shock in the form of higher taxes. We also investigate the response of domestic output to government spending shocks. Domestic output expands in response to government spending shock as increased government spending promotes economic activities and influences growth.

In Pakistan, technology advancement has a considerable impact on output and ultimately on inflation in the country. With a technology shock, inflation reduces because fewer units of effective inputs are needed to produce the same output. Inflation reduces considerably in response to technology shock. We also find that government spending responds positively and has increased with the introduction of new technology. This implies a greater role of fiscal policy in collecting the positive spillovers of the technological shocks. Inflation is also significantly responsive to monetary policy shock. When monetary policy shock hits the economy, inflation declines and it remains below its steady state for sufficiently long period of time. Tight monetary policy stance of state bank of Pakistan is effective in controlling inflation in the country. This contradicts findings of Javid and Munir (2010) where they find that phenomenon of price puzzle exists in Pakistan and monetary policy is not effective. Results also show that monetary policy is more effective when state bank gives weight to federal government borrowing. This means that state bank of Pakistan must give weight to fiscal policy in designing its objective function while formulating monetary policy. Inflation is also highly responsive to both the instruments of fiscal policy shocks. Price level in the economy rises with a surge in taxes. Elasticity of inflation with respect to taxes in Pakistan's economy is high. This implies that producers largely add taxes to the prices of their commodity and bear less or no burden themselves. Inflation is also responsive and deviates from its equilibrium state with increased government spending. Contractionary or tight monetary policy reduces inflation while expansionary fiscal policy leads a price hike in the economy indicating that both fiscal and monetary policy works in the opposite direction and the situation demands for greater cooperation between fiscal and monetary authority in Pakistan.

Inspecting the response of monetary policy to inflation shock in the economy unveil that state bank of Pakistan response positively by increasing the interest rate to contain the inflationary pressure in the economy. Examining monetary policy response to different shocks disclose that a positive technology shock increase the policy rate. Monetary policy also respond to fiscal policy shocks as state bank increases its policy rate to counter the negatives associated with excessive federal government spending. Fiscal policy also responds to monetary policy instruments. Government borrowing from state bank reduces with high policy rate. It means that monetary policy is effective in controlling fiscal profligacy. On the other hand federal government borrowing rises with

inflation. Government borrowing also increases in response to a positive tax shock. A rise in total factor productivity or technology shock causes government spending to deviates and remains above its steady state indicating the pro-cyclicality of fiscal policy in Pakistan. Government revenue rises with stimulating economic activities that enables the government to spend more and more on the welfare of its public. Government spending to inflation is highly elastic and increases in the presence of inflationary pressure in the economy. Preserving price stability is critical in order to reduce the burden on already squeesed treasury. Government expenditures are also elastic and public spending surge in response to a positive tax shock. Tax revenue also responds negatively to inflation. Tax is very important instrument of the fiscal policy and we report a significant response of tax to monetary policy shock. Quantitative tightening in the form of reduced money supply or higher interest rate increase the cost of doing business and discourage economic activities. Lower economic activities reduce government revenue from taxes. The response of tax revenues to government spending shock is negative.

Keeping the above discussion in perspective, we come to the conclusion that fiscal and monetary policy interacts with each other in Pakistan. So greater coordination between treasury benches and state bank of Pakistan is needed in order to increase the effectiveness of fiscal and monetary policy in the country.

RESULTS APPENDIX

Table A1

Selection of Parameter Values

Parameter	Description	Value	Reference
α	Degree of Openness	0.23	Haider and Khan (2008)
β	Subjective Discount Factor	0.99	Ahmed, *et al.* (2012)
θ	Degree of Price Stickiness	0.24	Haider and Khan (2008)
φ	Inverse Elasticity of Labour Supply	1.00	Haider and Khan (2008)
σ	Inverse Elasticity of Substitution in Consumption Supply	0.59	Ahmed, *et al.* (2012)
ρ_r	Degree of Interest Rate Smoothing	0.28	Ahmed, *et al.* (2012)
Y_π	Taylor Rule Coefficient on Inflation	1.48	Ahmed, *et al.* (2012)
γ_y	Taylor Rule Coefficient on Output Gap	0.52	Ahmed, *et al.* (2012)
ρ_g	Degree of Govt. Spending Smoothing	0.78	Ahmed, *et al.* (2012)
g_y	Spending Coefficient on Past Output Gap	0.01	Author's Calculations
ρ_τ	Degree of Tax Smoothing	0.22	Author's Calculations
τ_y	Tax Coefficient on Past Output Gap	0.01	Author's Calculations
g_b	Spending Coefficient on Debt	0.03	Author's Calculations
τ_b	Tax Coefficient on Debt	0.01	Author's Calculations
ζ	Degree of Backwardness	0.76	Haider and Khan (2008)
ρ_a	AR Coefficient of Technology	0.91	Ahmad, *et al*. (2012)
ρ_{y^*}	AR Coefficient of World Output	0.36	Ahmad, *et al*. (2012)
σ_a	SD of Technology Innovation	0.02	Ahmad, *et al*. (2012)
σ_π	SD of Inflation Innovation	0.05	Author's Calculations
σ_{y^*}	SD of World Consumption Innovation	0.02	Author's Calculations
σ_r	SD of Interest Rate Innovation	0.02	Ahmad, *et al*. (2012)

σ_g	SD of Govt. Spending Innovation	0.14	Ahmad, *et al*. (2012)
σ_τ	SD of Tax Innovation	0.06	Author's Calculations

Table A2

Variance Decomposition

Specification 1: Without Government Borrowing						
	μ_π	μ_r	μ_g	μ_τ	μ_a	μ_{c^*}
$\pi_{H,t}$	99.21	0.23	0.50	0.05	0.00	0.00
r_t	99.02	0.65	0.21	0.06	0.02	0.03
y_t	31.43	1.36	0.49	0.01	66.70	0.00
g_t	0.01	0.01	99.83	0.08	0.08	0.00
τ_t	0.46	0.03	3.01	96.50	0.01	0.00
b_t	0.08	0.10	98.42	1.01	0.38	0.00
Specification 2: With Government Borrowing						
	μ_π	μ_r	μ_g	μ_τ	μ_a	μ_{c^*}
$\pi_{H,t}$	81.43	0.29	17.98	0.31	0.00	0.00
r_t	64.91	0.14	33.37	1.56	0.01	0.01
y_t	25.14	0.93	19.03	0.50	54.41	0.00
g_t	0.01	0.01	99.82	0.09	0.08	0.00
τ_t	0.44	0.02	2.92	96.60	0.01	0.00
b_t	0.08	0.09	98.52	0.92	0.38	0.00

Table A3

Matrix of Correlation

Specification 1: Without Government Borrowing						
	μ_π	μ_r	μ_g	μ_τ	μ_a	μ_{c^*}
$\pi_{H,t}$	1.00	0.99	-0.55	-0.06	-0.03	0.08
r_t	0.99	1.00	-0.57	-0.03	-0.34	0.06
y_t	-0.55	-0.57	1.00	0.08	0.03	0.00
g_t	-0.06	-0.03	0.08	1.00	-0.15	-0.96
τ_t	-0.03	-0.03	0.03	-0.15	1.00	0.27
b_t	0.08	0.06	0.00	-0.96	0.27	1.00
Specification 2: With Government Borrowing						
	μ_π	μ_r	μ_g	μ_τ	μ_a	μ_{c^*}
$\pi_{H,t}$	1.00	0.86	-0.41	-0.24	0.02	0.27
r_t	0.86	1.00	-0.58	-0.46	0.15	0.51
y_t	-0.41	-0.58	1.00	0.08	0.01	-0.05
g_t	-0.24	-0.46	0.08	1.00	-0.14	-0.99

τ_t	0.02	0.15	0.01	-0.14	1.00	0.25
b_t	0.27	0.51	-0.05	-0.99	0.25	1.00

Table A4

Autocorrelations

Specification 1: Without Government Borrowing					
Order	1	2	3	4	5
$\pi_{H,t}$	0.922	0.792	0.655	0.530	0.424
r_t	0.925	0.796	0.660	0.535	0.429
y_t	0.967	0.919	0.868	0.822	0.780
g_t	0.931	0.810	0.678	0.554	0.446
τ_t	0.438	0.158	0.058	0.026	0.015
b_t	0.844	0.694	0.562	0.451	0.358
Specification 2: With Government Borrowing					
Order	1	2	3	4	5
$\pi_{H,t}$	0.933	0.816	0.690	0.572	0.468
r_t	0.814	0.688	0.589	0.504	0.430
y_t	0.824	0.730	0.676	0.640	0.614
g_t	0.923	0.793	0.655	0.530	0.422
τ_t	0.438	0.168	0.068	0.032	0.018
b_t	0.904	0.771	0.636	0.515	0.412

Fig. A1. Response of Domestic Output

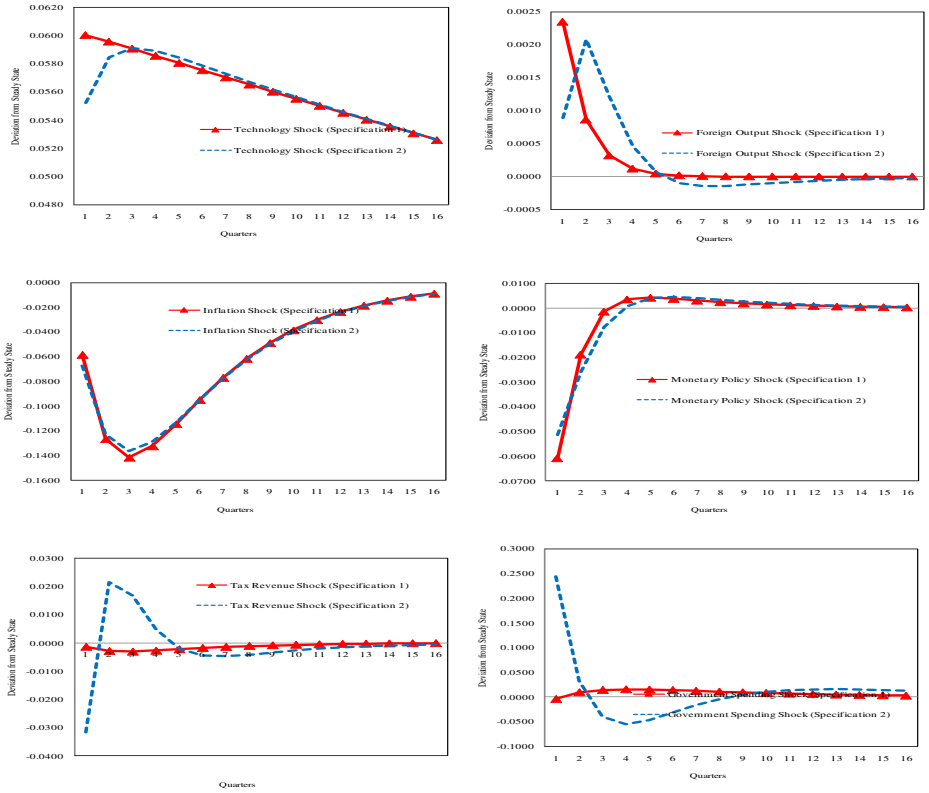


Fig. A2. Response of Domestic Inflation

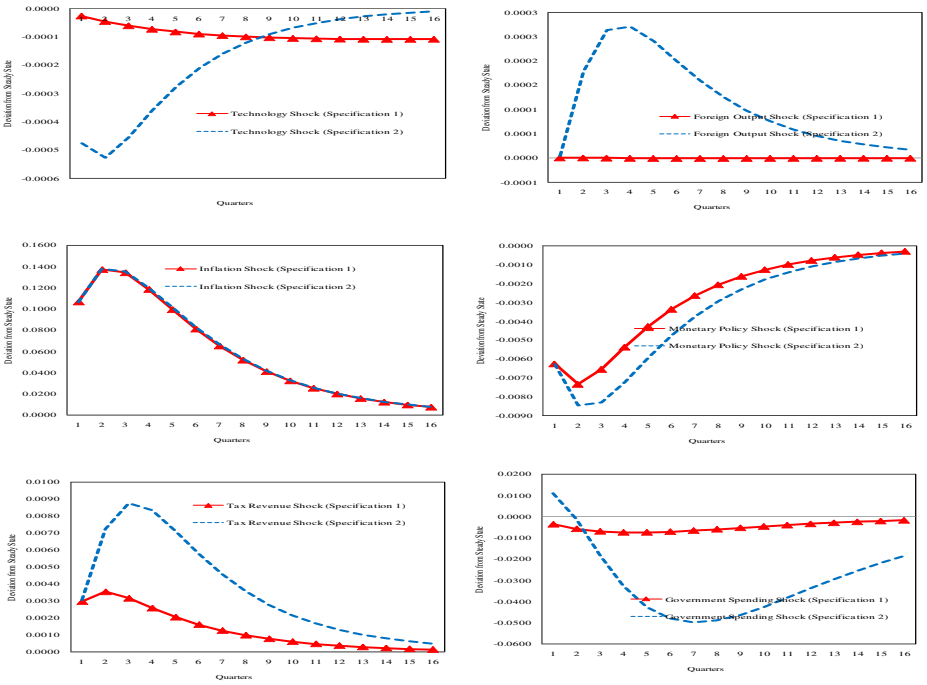


Fig. A3. Response of Interest Rate

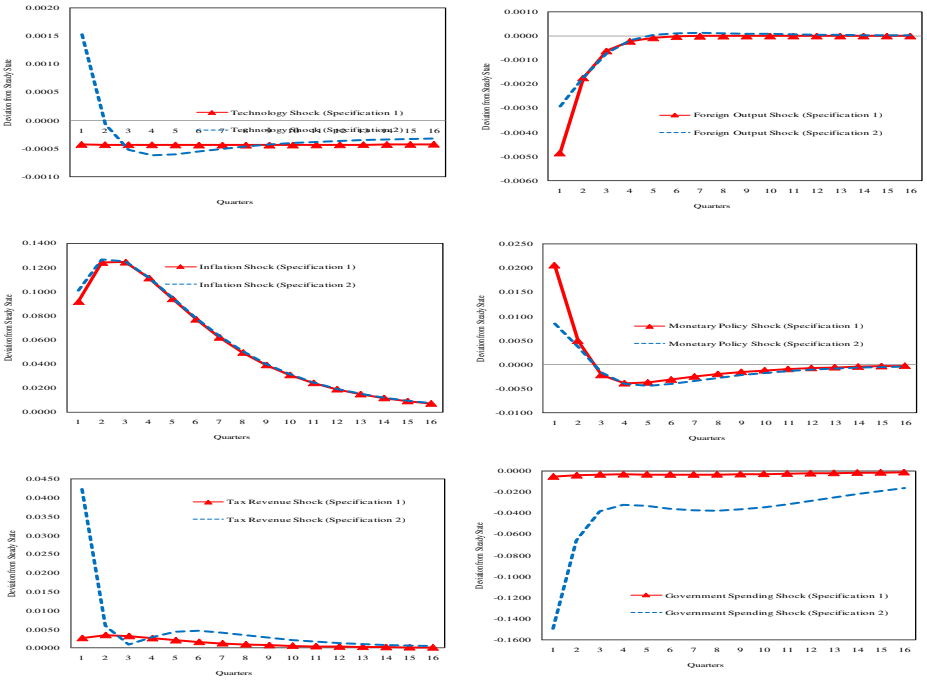


Fig. A4. Response of Government Borrowing

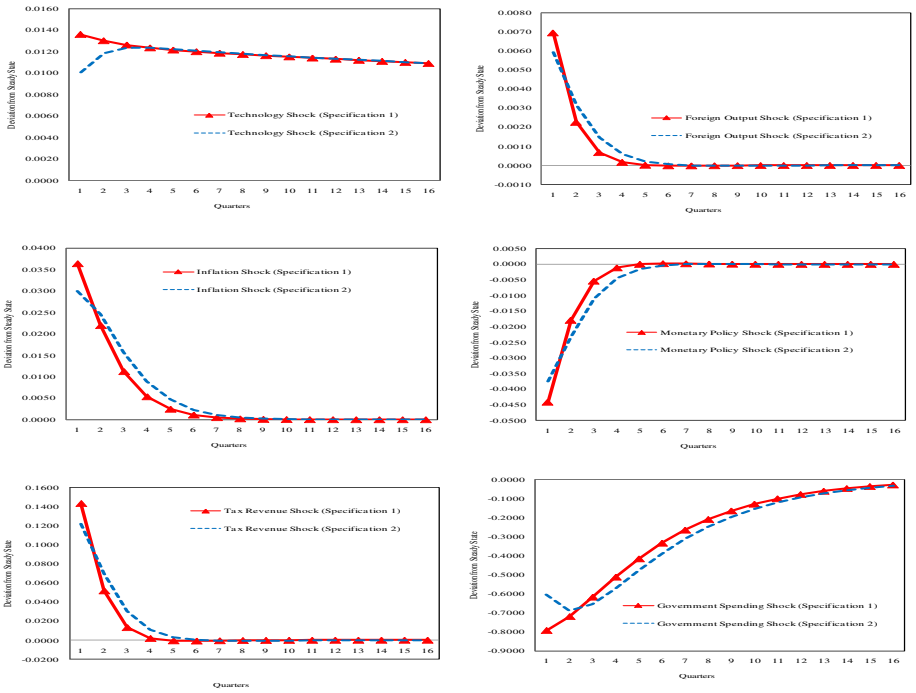


Fig. A5. Response of Government Spending

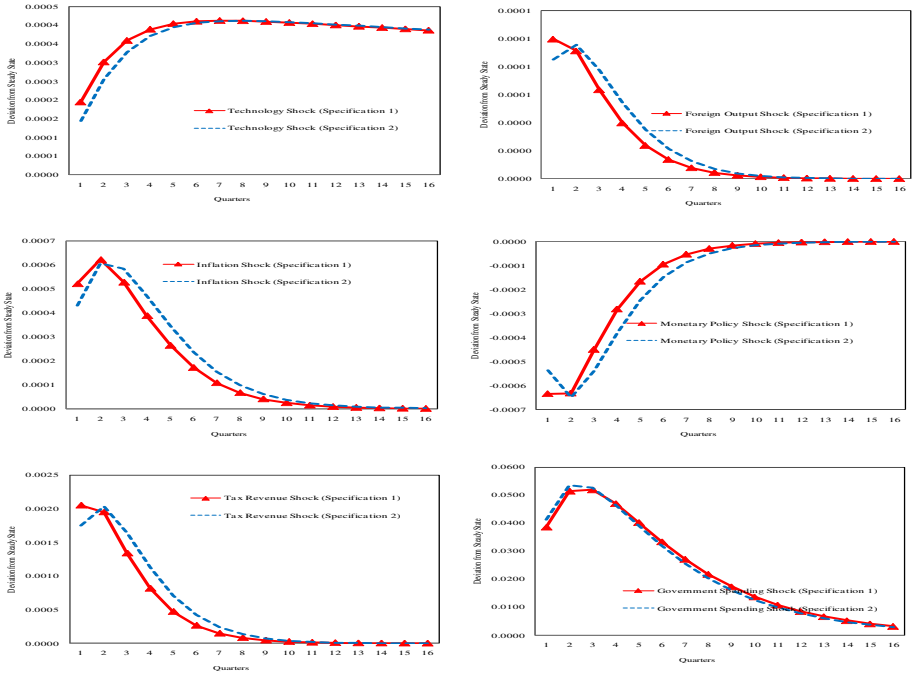
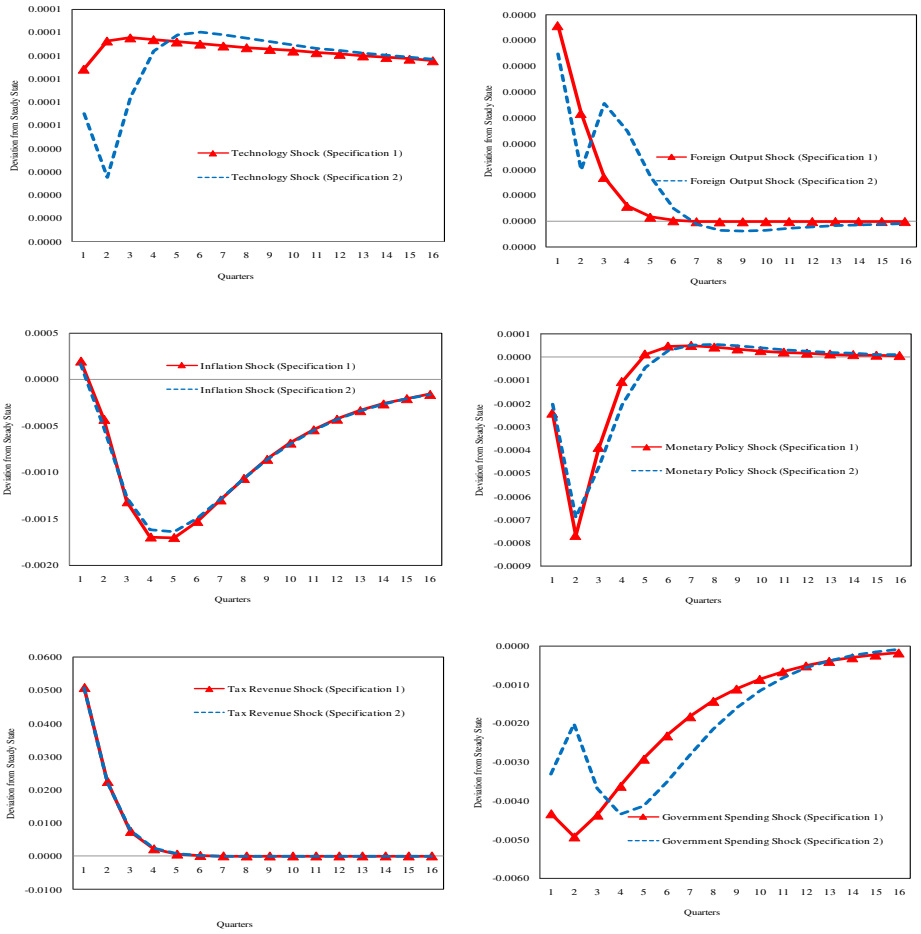


Fig. A6. Response of Tax Revenue



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