Financial Frictions and Optimal Policy Response to Shocks

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Summary

Financial shocks are important source of business cycle fluctuations. Financial frictions help transmission of financial shocks to the real economy. They may also significantly amplify the effects of real and nominal shocks to the economy. This study aims to investigate three issues regarding the role of financial frictions for Pakistan. First, the study examines that whether the standard New Keynesian DSGE model augmented with financial frictions matches the behavior of macroeconomic variables better than one where financial-structure irrelevance is assumed. Second, the study investigates whether the magnitude and propagation of various demand side and supply side shocks differ when financial frictions are taken into account. Third, optimal policy implications of various shocks are ascertained. The New Keynesian DSGE model with external finance premium is calibrated for Pakistan economy to cater for financial frictions in a variety of model environment. The results of the study showed that a DSGE model with financial friction matches the behavior and relationship of major macroeconomic variables better. Financial frictions interact with supply side shocks to generate this outcome. With respect to the second objective, the study showed that observed policy practices tend to propagate, amplify and persist the effect of shock owing to financial frictions. Observed policy contains useful information regarding inflation, output and consumption but fail to address the instability arising from monetary and financial shocks. Optimal policy analysis revealed when monetary policy with aggressive inflation stabilization is coordinated with fiscal policy stabilization more than what has been implied by observed data, macroeconomic fluctuations are better regulated.

1. Introduction

The last decade and a half has seen the phenomenal growth in the theoretical and empirical investigation of the importance of financial frictions for macroeconomic fluctuations. Embedding different features of financial sector in contemporaneous mainstream macroeconomic modelling (New Keynesian Dynamic Stochastic General Equilibrium-NK DSGE) and exploring the wide variety of propagation mechanisms of financial and non-financial interventions to real economy have been the pivotal constituents of this research (Curdia & Woodford, 2016; Gertler & Karadi, 2011; Gertler & Kiyotaki, 2010, 2015; Gertler et al., 2012). The origin of financial-NK DSGE models dates back to the seminal work of Bernanke et al. (1999) (BGG, hereafter). Built upon costly state verification model of Townsend (1979), BGG framework features nominal rigidities with agency problem vis-à-vis lenders and borrowers and argues that endogenous development in credit market are capable of transforming sudden and short-lived failures of financial markets into sharp and protracted real economic fluctuations through financial accelerator mechanism. Agency problem - owing to asymmetric information - is resolved with appropriate borrowing contract, which in turn introduces a role for leverage, risk and spreads.

The core of financial accelerator mechanism lies at the relationship between firm's leverage, financial composition of the firm and agency costs of borrowing from financial markets. This cost, known as external finance premium (EFP) depicts the difference between the cost of external funding and the opportunity cost of using internal resources for financing capital expenditures. The EFP is negatively related to firm's balance sheet i.e. net worth and to macroeconomic conditions, hence, is counter-cyclical. Following adverse shocks, firms with low leverage, hence liable of higher EFP, face further deterioration in their creditworthiness and are refused for external finance for future. EFP, therefore, effects the economy via price of loans extended and its counter-cyclical nature accelerates and amplify the effects and persistence of shocks through balance channel.[3]

Since its formulation, external finance premium has been used extensively to integrate financial frictions in DSGE models in a variety of model environments. The implications of these financial-NK DSGE models are critical not only for descriptive ability of DSGE models but also for macro-financial linkages and conduct of macroeconomic policy. Nonetheless, the application of DSGE models with external finance premium remained confined to developed countries. There have been sparse attempts to analyze the role of financial frictions for developing country with a handful of exceptions of those which faced financial-led turbulence followed by global financial crises. This leaves us with limited knowledge of the role of financial frictions for business cycle fluctuations in these countries.

Nevertheless, it is imperative to examine the issue for the developing countries for a multitude of forthright reasons. First, the very reason for introducing the financial frictions in DSGE models of developed country, i.e. dissatisfaction with financial- structure irrelevance theorem, is equally relatable to developing countries. Moreover, the change in the dynamic interactions of economic variable due to financial conditions demonstrated by leverage, credit spreads and risks, is as a prevalent economic phenomenon for developing countries as for developed countries. The former, in his regard, require more concerted scrutiny owing to the evolving credit markets.

Second, underpenetrated capital markets specifically corporate bond market in developing countries, for long, have not only inhibited entrepreneur prospects of alternative external finance and higher probability of survival but has also relegated central bank's ability to prompt

[3] An unexpected decrease in the nominal interest rate, for example, raises the net worth of borrowers, which in BGG's financial accelerator framework lowers the external finance premium faced by borrowers. Hence, relative to models without credit market imperfections, the financial accelerator model yields a greater investment and thus output response to nominal interest rate shocks.

and/or to stabilize business activities. After financial crises developing countries have become increasingly aware of the importance of deep and liquid corporate bond markets. Intensive efforts in this regards has not only resulted in significant increase in the share of developing countries' bond market -that is projected to rise above 30 from 11 percent in 2007 percent of world bond market by 2030[4] - but also has manifested considerable volatility (Mizen and Tsoukas, 2012). This evolution is envisaged to have substantial bearings for macro-financial linkages. In this backdrop, exploring the nature and extent of financial penetration of macroeconomy in an enriched environment offered by DSGE models is expected to provide insights to develop stable macro-financial linkages.

Third, a weak or nonexistent firm's balance sheet channel of monetary transmission mechanism in developing countries is widely reported in previous literature. It rears no surprise owing to underdeveloped capital markets that lack both breadth and depth. However, with changing financial conditions it becomes imperious to revisit this channel as it does not host only monetary shocks but may happen an important catalyst for other shocks which effect firm's balance sheet directly or indirectly.

Against this background, the present study attempts to quantify the role of the financial accelerator *a la* BGG (1999) for macroeconomic fluctuations in Pakistan. The rationales for analyzing the role of financial frictions for developing countries (mentioned above) are well-suited for Pakistan also. Widespread presence of information asymmetries between lenders and borrowers renders financial- structure irrelevance theorem inapposite giving rise to the role of financial rigidities. Moreover, corporate debt (TFC) market is in its primitive stage and its evolution is erratic, on one hand, and on the other, wide credit spread continue to prevail owing to weak competition faced by banking sector as a source of external financing. Exploring the

[4] See, report by iosco (2012)

transmission mechanism of monetary and other shocks through balance sheet channel in a DSGE framework is also less ventured area of research for Pakistan.

The objectives of the study are threefold. First, since NK-DSGE have become standard tool for macroeconomic policy analysis, it is important to know how well a standard NK-DSGE model explains the macroeconomic behavior. In this regard, the study compares the descriptive performance of a standard DSGE model developed by Smets and Wouters (2007) (SW, herafter) with the model augmented with BGG-type financial accelerator, an approach closely related to the work of Gilchrist et al. (2009).

Existing empirical literature documents mixed results in this regard. For instance, BGG (1999), Christiano et al. (2003), Christensen and Dib (2008) and De Graeve (2008) documented that allowance of external finance premium, thus a more substantiated transmission of shocks delivers the better description of the US economy.[5] Gilchrist and Zakrajsek (2011) showed that a reasonably calibrated version of the benchmark SW (2007) model augmented with the BGG financial accelerator can fully account for the overall drop in consumption, investment, hours, and output that was observed during the crisis period in the US economy. Contrary to it, Meier and Muller (2006) and Gelain (2010) argued that for European countries financial accelerator seems less important than capital adjustment cost and other standard features of model than what has been conjectured theoretically. Similarly, Brzoza-Brzezina and Kolasa (2013) and Curdia and Woodford (2015) showed that a clear-cut improvement with respect to the benchmark NK DSGE model cannot be observed when models are extended to cater for financial frictions.

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[5] BGG (1999) showed that empirical relevance of models increases significantly if EFP is accompanied with other frictions like investment lags, firm's heterogeneity in access to credit market. Similarly, De Graeve (2008) showed that investment adjustment costs along with EFP enhance empirical performance of model to match observed macroeconomics behavior

Second objective of the study is related to the investigation of the existence of financial accelerator mechanism in the propagation, amplification and persistence of nominal and real shocks to the economy. The study compares the models with and without financial friction for different kinds of shocks. The property of the model economy that is fundamental for financial accelerator mechanism to exist is the counter-cyclicality of EFP. A strand of empirical research reports EFP to be counter-cyclical and inferred that EFP accounts for the depth and protractedness of various shocks channelized to the real economy through borrower's net worth (BGG, 1999) and through household liquidity preferences (Christiano et al., 2003). Second strand of literature renders financial accelerator empirically insignificant as opposed to that has been theoretically conjectured for the propagation of shocks. Furthermore, considerable volume of research on financial friction *a la* BGG ascribes the incidence of financial acceleration to specific shocks, variables and other frictions in the model. For instance, the existence of financial attenuation as opposed to accelerator mechanism is documented by De Greave (2008) and Zhu (2017) for monetary policy shock and is ascribed to the interaction of financial frictions with other frictions and shocks.

Last but not least, the study aims to enquire the policy implications of various shocks for the standard New Keynesian DSGE model augmented with financial frictions and compare it with the model where financial-structure irrelevance is assumed. The literature has probed this issue by assigning different weights to feed-back variables in simple and/or augmented Taylor rule and advocated that rigorous output stabilization, smaller counter cyclical movements in interest rate and response to financial variables like credit growth and money supply shock result in financial attenuation. The study approaches this objective differently by deriving optimal policy parameters for different shocks under varying model environment.

The empirical exercise of the present study closely follows De Greave (2008), Christensen and Dib (2008) and Gilchrist et al. (2009) in the way financial friction *a la* BGG is introduced.

However, the study differs from the literature in a couple of ways. First, the study assesses the role of financial accelerator mechanism in a variety of model environments. For instance, the following six models are considered.

1. The state-of-art DSGE model without financial frictions but with optimal policy setup (Model 1)
2. The state-of-art DSGE model with financial frictions and optimal policy setup but with simple Taylor rule (Model 2).
3. The state-of-art DSGE model with financial frictions, optimal policy setup and financial sector augmented Taylor rule (Model 3).
4. The state-of-art DSGE model without financial frictions and without optimal policy setup (Model 4).
5. The state-of-art DSGE model with financial frictions, without optimal policy setup but with simple Taylor rule (Model 5).
6. The state-of-art DSGE model with financial frictions without optimal policy setup and financial sector augmented Taylor rule (Model 6).

Second, along with monetary policy, automatic stabilizing rule of fiscal policy is also included in each setup for which little evidence can be found in contemporary literature. Moreover, the shock specific optimal monetary and fiscal policy rules are also estimated. This is essentially important for a developing country like Pakistan where the research in framework of NK DSGE modelling is at its embryonic stage and policy response to various types of shocks is yet to discern.

The rest of the study is organized as follows. Section 2 presents the methodology. Section 3 presents results and discussion and section 4 concludes.

2. The Model

The basic model of the study is a closed economy DSGE model similar to that of Gilchrist et al. (2009). They extended SW (2007) DSGE model to account for financial frictions *a la* BGG (1999). The model economy consists of households, final and intermediate good producers, and a monetary and fiscal authority. The model incorporates a variety of nominal and real rigidities, such as habit persistence on the part of households, investment adjustment costs, variable capital utilization and Calvo-style price and wage rigidities along with incomplete indexation. Fiscal policy is assumed to be automatic stabilizing where government expenditures adjust counter-cyclically to output deviations. Monetary policy in the model is conducted under two alternative rules; a) Taylor rule where interest rate responds to inflation and output deviation and ; b)Taylor augmented rule where financial indicator in the form of deviation of credit growth from its steady state level has been included in the rule. The model is standard, hence, we refrain from a detailed exposition of first principles and present the log linearized version of model. We first outline the basic model without financial frictions and then describe the extension of the model that includes the financial accelerator mechanism.[6]

2.1. A SW Model without Financial Frictions

Households' maximization problem is characterized with separable consumption $(C_t)$and labor (N_t) preferences. Households maximize utility through intertemporal substitution in consumption and intra-temporal trade-off between consumption and labor. Evolution of aggregate consumption takes place around past (C_{t-1}) and future consumption (C_{t+1}), real interest rate $(r_t - \pi_{t+1})$ and is subject to preference shock (ϵ_t^b). The interest elasticity of

[6] For full-blown exposition of model, we refer the readers to Smets and Wouters (2003) and Christiano et al. (2005).

consumption depends on intertemporal elasticity of substitution θ_c and habit persistence (h).[7] The Euler equation for consumption is given as follows.

$$C_t = \frac{h}{1+h}C_{t-1} + \frac{1}{1+h}C_{t+1} - \frac{1-h}{1+h\theta_c}(r_t - \pi_{t+1}) + \frac{1-h}{1+h\theta_c}(\epsilon_t^b - \epsilon_{t+1}^b) \quad \dots \quad \dots \quad (1)$$

Along with consumption, demand side of the economy constitutes of optimal investment trajectory specified in a dynamic Euler equation for investment. It is derived under the assumption that capital producer produce new capital stock K_t in the competitive market and rent it out entrepreneurs/ intermediate goods producers at a given rental rate of r^k. Supply of capital rental services K_t^s is determined as a result of maximization problem of capital producer either by investing in additional capital I_t or by changing the utilization rate z_t of already installed capital. Capital goods producer incur quadratic capital adjustment cost φ for both of their actions. Investment equation is given as follows.

$$I_t = \frac{1}{1+\beta}I_{t-1} + \frac{\beta}{1+\beta}I_{t+1} + \frac{\varphi}{1+\beta}q_t + \beta\epsilon_{t+1}^I - \epsilon_t^I \quad \dots \quad \dots \quad (2)$$

Similar to consumption, current investment I_t is weighted average of past I_{t-1} and future investment I_{t+1}, and value of installed capital q_t. Investment is also subject to shock to the capital adjustment cost which reduces investment temporarily.

Given the log-linearized standard capital accumulation equation

$$K_t = (1-\delta)K_{t-1} + \delta I_t \quad \dots \quad \dots \quad (3)$$

[7] Habit persistence determines the degree of consumption persistence and preference shock is a shock to discount factor that effects intertemporal substitution decisions.

the corresponding arbitrage condition for the value of installed capital q_t expresses the current q_t as a positive function of its own expected future value and expected future marginal product of capital mpk_{t+1} and negative function of ex-ante real interest rate $(r_t - \pi_{t+1})$.

$$q_t = -(r_t - \pi_{t+1}) + \frac{1-\delta}{1-\delta+\overline{r^k}} q_{t+1} + \frac{\overline{r^k}}{1-\delta+\overline{r^k}} mpk_{t+1} + \epsilon_t^q \quad \dots \quad \dots \quad (4)$$

Where δ is depreciation rate and $\overline{r^k}$ is the rate of return on capital in steady state. ϵ_t^q is a shock to rate of return on equity investment that may arise due to fluctuations in equity premium.[8]

Households supply differentiated labor to intermediate good producer and set wages under staggered contracts with constant (Calvo) probability $(1 - \xi_w)$ of renegotiation in each period. A fraction of households that optimize, set wages a mark-up μ_t^w over marginal rate of substitution between leisure and consumption mrs_t. Symbolically,

$$\mu_t^w = w_t - mrs_t \quad \dots \quad \dots \quad (5)$$

The wages for the remaining households are partially indexed with inflation parameterized through ι_w. The combination of non-reoptimized wages and partial indexation results in the following wage equation.

$$w_t = \frac{\beta}{1+\beta} w_{t+1} + \frac{1}{1+\beta} w_{t-1} + \frac{\beta}{1+\beta} \pi_{t+1} - \frac{1+\beta\iota_w}{1+\beta} \pi_t + \frac{\iota_w}{1+\beta} \pi_{t-1} - \frac{1}{1+\beta\iota_w} \frac{1-\beta\xi_w(1-\xi_w)}{\xi_w(\phi_w - 1)\varepsilon_w + 1} \mu_t^w + \epsilon_t^w \quad \dots \quad \dots \quad (6)$$

Equation (6) shows that real wage is a weighted average of past and expected future wages and past, current and expected inflation rate along with wage mark-up and a cost-push shock to

[8] In a model with financial frictions, by modelling capital good production in a sector separate from households, this shock arises as a shock to external finance premium. It is presented in next section where financial frictions are explicitly modelled.

wages ϵ_t^w. The indexation of non-reoptimized wages ι_w determines the strength of relationship between current wages and current and past inflation whereas ϕ_w is the deviation of actual wages from wages that would have prevailed given the fully flexible labor market.[9]

The production sector consists of monopolistically competitive firms that produce intermediate goods and perfectly competitive final goods producers that combine the intermediate goods and produce homogeneous final goods. Aggregate output y_t is subject to Cobb-Douglas technology augmented with fixed cost ϕ_p and exogenous level of technology ϵ_t^a.

$$y_t = \phi_p(\alpha K_t^s + (1-\alpha)N_t + \epsilon_t^a) \quad \dots \quad \dots \quad (7)$$

Where α captures the share of capital in production. Capital service K_t^s is the aggregation of existing capital stock and capital utilization rate z_t and is given in equation below.

$$K_t^s = K_{t-1} + z_t \quad \dots \quad \dots \quad (8)$$

Moreover, equating the cost of higher utilization of capital with the rental price of capital services results in optimal capital utilization rate.

$$z_t = \frac{1-\psi}{\psi} mpk_t \quad \dots \quad \dots \quad (9)$$

where ψ is elasticity of utilization cost with respect to capital inputs and mpk_t is marginal product of capital which under cost-minimization problem takes the following form

$$mpk_t = -(K_t^s - N_t) + w_t \quad \dots \quad \dots \quad (10)$$

[9] The parameter determines the degree of wage rigidity in labor market. Higher the value of parameter lower is the difference.

Marginal product of labor that also results from firm's cost minimization problem is given below

$$mpn_t = \alpha(K_t^s - N_t) + \epsilon_t^a \qquad \ldots \qquad \ldots \qquad (11)$$

Similar to wages, price setting by monopolistically competitive firms also takes the form of staggered contracts. A fraction of firms find the opportunity to revise prices with constant Calvo probability $(1-\xi_p)$ and sets prices a murk-up μ_t^p over wages. Non-reoptimized prices are partially indexed ι_p to past inflation. Consequently inflation π_t dynamics assume the following process.

$$\pi_t = \frac{\beta}{1+\beta\iota_p}\pi_{t+1} + \frac{\iota_p}{1+\beta\iota_p}\pi_{t-1} + \frac{1}{1+\beta\iota_p}\frac{1-\beta\xi_p(1-\xi_p)}{\xi_p(\phi_p-1)\varepsilon_p+1}\mu_t^p + \epsilon_t^p \qquad \ldots \qquad \ldots \qquad (12)$$

Equation (12) in a hybrid NK price Philips curve, where forward-looking behavior is depicted by expected future inflation term π_{t+1} and backward-looking part succeeds from partial indexation. A price mark-up shock ϵ_t^p also determines the evolution of current inflation process.

The resource constraint decomposes aggregate output in consumption, investment good, government expenditure and resource lost owing to variable capital utilization.

$$y_t = c_y C_t + i_y I_t + z_y z_y + g_y G_t \qquad \ldots \qquad \ldots \qquad (13)$$

Fiscal policy is modelled through a government spending rule that includes government expenditure smoothing and responds to lagged difference output [10] and exogenous government spending disturbance

$$G_t = \rho_G G_{t-1} + (1-\rho_G)\rho_{yG}(y_{t-1} - y_{t-2}) + \epsilon_t^G \qquad \dots \qquad \dots \qquad (14)$$

Monetary policy follows rule in setting short-term nominal interest rate where interest rate responds to its lag, current inflation, difference output and exogenous policy disturbance.

$$r_t = \rho_r r_{t-1} + (1-\rho_r)\rho_\pi \pi_t + (1-\rho_r)\rho_y(y_t - y_{t-1}) + \epsilon_t^r \qquad \dots \qquad \dots \qquad (15)$$

2.2. A SW model with Financial Accelerator

The existence of financial frictions alters the modeling setup for entrepreneurs as compared to the SW (2003) model. Entrepreneurs finance their capital expenditure $q_t K_t$ using internal resources (Net Worth, n_t) and bank loans b_t. Costly state verification problem between entrepreneur and financial intermediary implies that entrepreneurs face external finance premium s_t that derives a wedge between the expected return on ${r^k}_{t+1}$ capital and risk free rate r_t. The capital arbitrage conditions for entrepreneur under financial friction and resultant equation for external finance premium are given as follows.

$${r^k}_{t+1} = \left[\frac{1-\delta}{1-\delta+\overline{r^k}}\right] q_{t+1} + \left[\frac{\overline{r^k}}{1-\delta+\overline{r^k}}\right] mpk_{t+1} - q_t \qquad \dots \qquad \dots \qquad (16)$$

$$s_t = {r^k}_{t+1} - (r_t - \pi_{t+1}) \qquad \dots \qquad \dots \qquad (17)$$

[10] Similar rule for taxes can also be assumed, nonetheless, Schmitt-Grohé and Uribe (1988) showed that cyclical changes in tax rates are unrealistic, may lead to sunspot equilibria and may add instability to the economy. The postulate is also verified by a number of empirical studies.

The cyclicality of EFP implies that EFP is negatively related to the strength of entrepreneurial balance sheet.

$$s_t = -\chi(n_t - q_t - K_t) + \epsilon_t^{fd} \qquad \dots \qquad \dots \qquad (18)$$

Where parameter χ measures the elasticity of EFP to variation in entrepreneurial balance sheet, measured by net worth relative to capital expenditures.[11] The EFP is also subject to exogenous financial disturbance ϵ_t^{fd}, that may be considered a supply side shock originating from financial market.

Entrepreneurs are risk neutral and discounts future more heavily than households, their net worth accumulate according to following process.

$$n_t = \frac{K}{N}\left(r_t^k - \quad {}_{t-1}r_t^k\right) + \quad {}_{t-1}r_t^k + \theta n_t + \epsilon_t^{nw} \qquad \dots \qquad \dots \qquad (19)$$

Where $\frac{K}{N}$ is the steady state ratio of capital expenditures to entrepreneurial net worth and is survival rate. The entrepreneurs that do not survive are supposed to consume their net worth

$$c_t^e = n_t \qquad \dots \qquad \dots \qquad (20)$$

The resource constraint modified in the following manner

$$y_t = c_y C_t + c_y^e c_t^e + i_y I_t + z_y z_t + g_y G_t \qquad \dots \qquad \dots \qquad (21)$$

Finally, after inclusion of financial friction in the model, along with equation (15) an alternative monetary policy rule is also considered that takes into account the deviation of credit growth

[11] Higher the value of entrepreneurial balance sheet, higher the entrepreneurs stake in project, lower the moral hazard problem. Moreover, in case of financial sufficiency of entrepreneurs, agency problem does not materialize, risk free rate and rate of return on capital coincide and model collapses to state-of-art DSGE model by SW (2003).

from its steady state level to take into account the financial stability in the conduct of monetary policy.

$$r_t = \rho_r r_{t-1} + (1-\rho_r)\rho_\pi \pi_t + (1-\rho_r)\rho_y(y_t - y_{t-1}) + (1-\rho_r)\rho_{cg}(CG_t - \overline{CG}) + \epsilon_t^r \quad (22)$$

All the exogenous process are assumed to follow autoregressive scheme (1) process with i.i.d innovations.

To summarize, the canonical representation of model is given in table 1 and table 2 in Appendix A. Models presented in both tables are calibrated for both optimal policy and current policy setup. This gives rise to six versions of the model as mentioned in section 1 of this study.

2.3. Calibration

We set parameters values to calibrate the model to quarterly data of Pakistan economy. The value of some parameters - for which data is available - are estimated using relevant estimation techniques. The rest of parameters are obtained from existing literature in DSGE framework preferably for Pakistan and other developing countries. Table 3 in Appendix A presents the parameters of model equations.

The discount factor has been computed by taking the inverse of long term average quarterly interest rate. The value of discount factor is 0.998 that is consistent with steady state annualized real interest rate of 4 percent. Annual data on depreciation rate is taken from Penn World Table and is adjusted to correspond to quarterly frequency of the model. The average value of depreciation rate is 0.025 which is in line with literature to produce an annual depreciation rate of 10 percent. The annual balance sheet analysis of non-financial corporation listed at Karachi Stock Exchange also revealed that depreciation rate has remained closer to 10 percent per annum since 2001 to 2015.

For the households' block we estimated the value of habit persistence to be 0.86 by applying generalized method of moment using quarterly data obtained from Arby (2013). The value of elasticity of substitution or alternatively risk aversion parameter is assumed to be closer to one in a number of DSGE models for emerging economies. Following Choudhri and Malik (2012) it is value is set at 1.01. Similarly the Frisch elasticity of labor supply is repeatedly reported around 2 for emerging economies. Degree of wage stickiness is set to be 0.75 which implies that firms change wages annually in Pakistan, a time period closer to one reported by Ahmed et al. (2012). Similarly, the parameters for wage indexation has been taken from Ahmed et al. (2012) who report that 36 percent of the firms index their wages. Elasticity of substitution between differentiated labors is set at 6 which ensures a mark-up of 20 percent –a value commonly used in DSGE literature.

The share of capital in production is set at 0.49 which is obtained by estimating production function using cointegration technique. Approximately the same value has been used by Ahmad et al. (2012) and is also reported reasonable for developing countries by Liu (2008). Prices are reported less sticky than wages for Pakistan, hence firms are assumed to change prices every third quarter. Accordingly the degree of price stickiness is set at 0.70. Price indexation is assumed to be zero as valuable information on the indexation of prices with past prices is not available. By doing so we are not deviating from conventional literature as a number of DSGE models are calibrated assuming this parameter to be 0. Elasticity of substitution between different varieties of intermediate good is also set as 6 which ensures a price mark-up rate of 20 percent.

In the extension to financial sector set-up, we find no evidence from DSGE class of models to calibrate elasticity of substitution between external finance premium and leverage for developing countries. We analyzed the data on net worth of the firms and their interest expenses from the balance sheet of non-financial corporation and roughly calculated it be 17 percent annually. Mizen and Soukas (2012) calculated this elasticity for Asian corporate bond markets to be 16 percent annually which is closer to the value obtained from data on Pakistan. The value is then adjusted to match with quarterly frequency of the model. The survival rate for entrepreneur is set to 0.99 percent which implies an entrepreneur lives on average for more than 24 quarters or 6 years.

Parameters pertaining to the policy block of the model are estimated using Fully Modified Ordinary Least Square (FMOLS). Government spending smoothing parameter turned out to be -0.1 while government response to lagged difference output in - 0.22. For simple Taylor rule response of interest rate to inflation is estimated to be 0.18 while for augmented Taylor rule it reduces to 0.14. The response of interest rate to credit growth is 0.05 percent. The interest rate smoothing parameter and response to difference output remained at 0.93 and 0.10 in both monetary policy rules.

Parameters governing the process of preference, productivity, price, fiscal and monetary policy shocks are estimated and their values are presented in table 3. Resultantly, their innovations constitute the respective standard deviations. Moreover, the empirical data is used to calibrate the models for different steady state values. The steady-state values for entrepreneurial consumption to GDP ratio and ratio of resource lost to GDP is taken from literature.

3. Results and Discussion

3.1. Assessing the Simulation Performance of DSGE Models

Conventionally, the performance of the business cycle models is evaluated by comparing the second moments of simulated series with the empirical moments obtained from the observed data. To assess the contribution of financial accelerator model, we follow this convention and compare the model implied volatilities, relative volatilities and autocorrelation with the one generated from data for the main variable of interest. The theoretical moments from optimal policy set-up are not reported as current dynamics of actual data are not determined by the optimal policy rather follow observed policy practices. Quarterly data for output, inflation, interest rate and consumption is used for calculating observed volatility while for investment, working hours and government expenditures data is at annual frequency. The data is adjusted at quarterly frequency and volatility is calculated. All the variables are seasonally adjusted. Table 4 summarizes the second moments of key variables from data and compares them with standard deviation generated by models. Part B of table 4 reports relative volatilities and part C presents the comparison in autocorrelation for 5-quarter horizon. First and second simulation exercise is carried out for different combinations of shocks ; a) where all shocks are included; b) all shocks except financial; c) only demand side shocks; d) only supply side shocks; e) financial and supply side shocks, and ; f) financial and demand side shocks.

Simulation result for all of the shocks show that model 5 -with financial accelerator and simple Taylor rule, outperforms other models in matching observed output growth volatility. It explains approximately 70 percent of observed volatility in output growth and overestimate the volatility in government expenditures, investment and working hour’s growth. One of the plausible reasons for this outcome may be the difference in frequency at which data is collected and model is calibrated. Model 6 delivers better description of nominal variables of the economy particularly inflation and interest rate. It also overestimates the government expenditure, working hours and investment growth but to a lesser extent. All models fail to match consumption growth volatility commending for the better presentation of household sector in DSGE modelling for Pakistan.

Model 5 performs better than its respective counterparts for all combination of shocks. When financial shocks are excluded model's ability to explain output volatility reduces to 65 percent. No notable difference is observed for other variables. Comparison among different combination of shocks reveal that moments implied by model when only supply side shocks are active, match the observed volatilities better than one with only demand side shocks. Moreover, financial accelerator interact more with supply side shock.

Relative volatilities reveal that model 4, with financial accelerator turned off, better match the inflation and completely explain the interest rate behavior while model 6 seconds it when financial accelerator interacts with demand side shock. Investment and working hours are overestimated and consumption is understated in all of the models. Part C of table 4 presents autocorrelation of selected variables and compare it with model implied autocorrelation. In general, model 5 does a better job in matching the autocorrelation of nominal variables like inflation, interest rate and government spending. The model with financial frictions turned off generates autocorrelation of real side variables closer to observed data.

Though overall performance of models is not extremely appealing, still models augmented with financial frictions performed better. However, as financial frictions have contributed only marginally for the descriptive ability of model, our study lies closer to that strand of literature (see, for instance, Meir and Muller, 2006) which concludes that mere allowance of financial frictions does not guarantee the overwhelming performance of model rather it is conditional on a number of other features of model. The impulse response and variance decomposition analysis carried out below is expected to elaborate this conclusion further.

3.2. Impulse Response and Optimal Policy

To better capture the contribution of financial friction to DSGE model we proceed to transmission mechanism and policy analysis. Figure 1 to Figure 10 in Appendix C presents the response of key macroeconomic aggregate to various shocks. Table 5 in Appendix C contains the optimal policy response against each shock for three alternative models. Basic purpose of this exercise is to meet the second and third objectives of the study which confer the investigation of financial accelerator mechanism and resultant optimal policy response.

Preference Shock

Figure 1 contains the response of macroeconomic variables to one standard deviation preference shock. A preference shock induces individuals to discount future more heavily, hence increase working hours and reduce consumption. This leads to an increase in output, investment and inflation. Conducive economic environment upsurges entrepreneurial net worth. There is diminutive amplification of output, investment and working hours and also a dampening effect on consumption when financial frictions are present.

Optimal and observed policy rules in absence of financial frictions produce different responses to feedback variables, nonetheless for the transmission mechanism of preference shock the difference seems inconsequential. It also holds in presence of financial frictions, where optimal policy with augmented Taylor rule coincides with observed policy practices irrespective of rule adopted. Moreover, for all the models incorporating financial frictions, response of EFP to preference shock is negligible except model 2 which features a pro-cyclical external finance premium.

Productivity Shock

Productivity shock induces a slight hump shaped response in output and investment, and pushes consumption and inflation only slightly away from steady state in absence of financial frictions. Financial frictions inhibit the favorability of positive productivity shock and turned out to be decelerating for output, investment and working hours for a few quarters. For inflation and consumption, influence of financial frictions is conditional to model settings. Credit market tightening displayed in decline of net worth and high EFP elucidates dampening of real economy in models with financial frictions.

Contrary to preference shock, effect of productivity shock and resulting accelerator (or decelerator) mechanism is contingent to the variables under consideration and characteristics of model economy. Observed and optimal policy practices in absence of financial frictions results in rapid mitigation of shock for all variables even though observed practices are more oriented towards interest rate smoothing while optimal policy does this job with more aggressive output stabilization in monetary policy and less in fiscal policy. With financial frictions, observed practices depicted in model 5 and model 6 yield parallel responses for all variables except inflation and consumption. Amplification and persistence of shock in model 2 is uniform across all the variables. A look at the optimal parameters reveal that productivity shock can be destabilizing if encountered with a mix of contractionary monetary and expansionary fiscal policies. Apart from inflation and consumption, in model 3 with an oscillatory response to interest rate and rigorous inflation and credit growth stabilization combined with a fiscal policy more contractionary than observed one, variables make their way back to steady state. Inflation and consumption are better dealt by observed policy rules.

Fiscal Policy Shock

Figure 3 shows the impulse responses to an exogenous government spending shock. In an economy with financial-irrelevance, Ricardian equivalence is ubiquitous in face of an exogenous fiscal expansion. Financial rigidities lead to the emergence of fiscal multipliers for the real side of the economy and also expand financial market by improving firms' balance sheet and lowering premium.

The difference between observed and optimal policy for regulating fiscal shocks offers an interesting account. Fiscal multiplier for output is active only when economy operates under model 5 which is characterized with observed policy with simple Taylor rule. For other variables economy under augmented Taylor rule shows similar dynamics. Optimal policy with excess fiscal smoothing and low output stabilization coupled with monetary policy with no remarkable change from observed policy seems better than other policy option to stabilize the economy.

Price Mark-up Shock

Reponses of macroeconomic variables to a price mark-up shock is portrayed in figure 4. Financial frictions adds to the severity of adverse price mark-up shock and lead to a significant decline in output and working hours when shock is not countered by optimal policy responses as depicted in model 5 and 6. Amplification can also be observed for investment which is complemented with persistence of shock for consumption. Accelerator mechanism is also active for inflation and results in both amplification and persistence of mark-up shocks in model with augmented Taylor rule. Net worth is generally pro-cyclical and EFP is counter-cyclical in face of price mark-up shocks but are also sensitive to economic structure characterized in model economy. The optimal policy rule derived by model 2 and model 3 results in equally strong adjustments to cater for adverse price shock for output, investment, working hours, net worth and EFP. Economy in Model 2 requires a mix of contractionary monetary and expansionary fiscal policy with an expansionary response of interest rate to output deviations. However, this sign inconsistency is not present for model 3 where economy resumes its original equilibrium with inflation and financial market stabilization and marginal role for fiscal policy to intervene. For inflation however, model 2 coincides with current policy practices under simply Taylor rule and regulates the price instability. The current policy options and optimal policies for consumption from the models with financial frictions depict certain trade-offs. For instance, an economy depicted by model 6 with observed augmented Taylor rule is capable of keeping consumption above its steady state level for 4 quarters but pushes it beyond the steady state for a protracted period of time. However, model 2 does not offer an increase in consumption, remains negative but closer to steady state, nonetheless, causes shock to persist.

Cost-push Shock

Given the current parameterization of model, a positive cost push shock is completely dampened by rigorous output stabilization by both fiscal and monetary policy as depicted in figure 5. In the absence of financial friction and optimal policy set up, the shock generates a moderate humped effect for output. However, magnitude and destabilizing effect of shock is evident in models with financial frictions. The optimal policy adhered by augmented Taylor rule curbed the immediate negative consequences of shock for output but couldn't reduce the persistence of shock. Neither the observed policy practices nor the optimal policy derived from concurrent structure of economy addresses the macroeconomic fluctuations arising from an adverse cost push shock despite the aggressiveness derived in monetary policy under model 6. This situation along with persistence of shock in optimal policy set-up lead us to assume that it may be the result of expansionary fiscal policy as depicted in table 5.

Financial friction decelerates the effect of cost push shock for inflation for Model 3 and Model 6 and accelerates it for Model 5. As far as inflation is concerned, current policy with simple Taylor rule and corresponding optimal policy are providing the environment where effects of cost-push shock are largely mitigated. The impact of cost push shock is negligible in models without financial frictions. In case optimal policy is pursued, financial frictions tend to intensify and retain the effect of shock while with consumption responding in an oscillatory pattern. Current practices under model 2 neither let financial amplification nor persistence in cost push shock whereas environment under model 6 is conducive for deceleration of the effect of cost push shock on consumption. Net worth and EFP both are highly volatile in response to shock and only current policy practice are expected to resume the steady state level of both variables.

Investment Related Shocks

A negative investment shock that materializes through increase in the adjustment cost of investment, decreases the marginal efficiency with which the consumer goods are converted into investment goods. Output, investment and hours decreases, net worth show reduction i, inflation and consumption remained fairly stable. The significant contribution of financial fritions may also be observed for models 5 and 6 that decelerates the effect of investment adjustment cost for output, investment and hours and accelerates it for EFP and net worth In model 5 and 6, a decrease in interest rate smoothing and increase in inflation and credit stabilization and no notable change in fiscal policy has resulted in both amplification and persistence of shock.

Same is the case with investment efficiency shock that materialize through price of capital where current policy boosts the strength of financial accelerator mechanism and intensify the shock.

Monetary Policy Shock

Figure 8 plots the responses to a one standard deviation monetary policy shock (monetary tightening). Economy under model 1 and model 3 is quite irresponsive to monetary policy shock attributed to optimal policy setting. For the economy with financial frictions and current policy practices, monetary policy shock is followed by a sharp decrease in output, investment and working hours. Declining returns to capital and increase in higher real interest cost of existing debt gives rise to debt deflation effect and results in reduction in net worth. Alternatively, balance sheet channel of monetary transmission also seems to exist. Tight monetary conditions, coupled with rising EFP erodes firms net worth and future prospects to avail external financing. Decrease in investment, working hours, output and increase in inflation is concomitant with deteriorated creditworthiness of borrowers. Response of consumption may be attributed to increase in entrepreneurial consumption.

The presence of financial accelerator mechanism implies a significant amplification and persistence of monetary policy shock particularly under economic framework not billeted by optimal policy rules. In the absence of financial frictions, observed and derived policy options yield contrary results where former inducing movements around the steady state, while later resuming the steady state immediately. The parametric weights show the excess smoothing of interest rate and marginal decrease in the responsiveness of monetary policy to inflation and output whereas keeping the weights in fiscal policy rule approximately same. In models with financial frictions, model 3 offsets the effect of shock downrightly, with lesser smoothing, relatively rigorous inflation and credit stabilization and marginal increase in response of fiscal policy to output as compared to observed policy setting. The consequent tightening of credit market as advocated by optimal monetary policy may rear some surprise at first place but is justifiable in the model where inflation has the tendency to soar-up following a monetary policy shock.

EFP and Net worth Shock

Impact of financial sector shocks, that is, shock to net worth and exogenous financial shock have immediate positive impact on output under current policy setup. Optimal policy under model 3 pursues financial stability rigorously and mitigates the impact of financial shocks to a larger extent. A positive net worth shock induces investment irrespective of features of models while a financial shock reduces investment up to varying degree dependent on policy set up of the model. An optimal monetary policy with simple Taylor rule as assumed in model 2 performs best to stabilize investment in face of financial shock. A financial shock pushes EFP high, makes financial condition stringent, default probability high and resultantly induces consumption. Current policy practices with augmented Taylor rule is assumed to mitigate the effect of financial repercussions.

3.3. Variance Decomposition Analysis

We next consider one quarter-ahead forecast error variance decomposition for the main variables of interest. Table 6 presents the one-quarter-ahead forecast error variance decomposition attributed to each shock across the models.

In model 1, with financial accelerator turned off and optimal policy defined by simple Taylor rule, cost-push shock accounts for bulk of fluctuations in real economic variables like output, investment and working hours. Its contribution is more than 50 percent for nominal variables like inflation and interest rate. Investment shock predominantly determines the consumption while fluctuations in government expenditure are attributed to combination of cost-push, price markup and preference shocks.

With financial accelerator present and simple Taylor rule, fluctuations in variables are distributed across cost-push and price mark-up shock. Financial shock explain considerable fluctuations in consumption. Productivity shock becomes another attributer to macroeconomic fluctuations particularly consumption when augmented Taylor rule is considered under optimal policy setup.

With observed policy practices and no financial accelerator, dynamics of economy change considerably particularly for policy variables like inflation, interest rate and government expenditure. Fluctuations in each policy variable attributes mostly to respective policy with changes in interest rate completely explained by interest rate shock. Even the presence of financial accelerator does not change the situation much for interest rate and inflation. However, switching to augmented Taylor rule brings us back to situation where cost push shock is the main contributor in forecasted variance of variable

4. Conclusion and Policy Recommendations

In this study, we have examined the financial accelerator mechanism and resultant optimal policy response for a variety of shocks in a NK DSGE model calibrated for Pakistan economy. The study underscores several implications regarding three very pertinent issues; 1) the usefulness of state-of the art DSGE models for policy analysis; 2) the role financial frictions play for economic fluctuations in Pakistan and; 3) the effectiveness of current policy practices along with highlighting the areas where policy revisions may be helpful.

Simulation exercise showed that models with financial accelerator are superior to the state-of-art DSGE models to match the observed macroeconomic fluctuations but only marginally. Considerable penetration of financial shocks occurs if concurred with supply side shocks. More striking results emerged from sensitivity analysis which depicts that reported parameters specifically either taken from different studies conducted for Pakistan or for which negligible information is available for Pakistan, are playing vital role in determining the size of simulated volatility. This substantiates the need for re-estimating these parameters encompassing the structural environment specific to Pakistan, most desirably under NK DSGE framework. Moreover, this study builds its analysis on the basis of one type of financial frictions. Including other frictions may improve the empirical properties of model.

The second noteworthy feature of the model is that though the premium is countercyclical yet the existence and strength of financial accelerator depends on the policy opted and variables considered. Broadly speaking, for supply side shock both amplification and persistence is more pronounced under optimal policy. Financial decelerator also occurred for some of the shocks. Specifically, we observed that cost-push and productivity shocks may be accelerating or decelerating for inflation and consumption depending on policy rule observed by central bank and stabilization weights placed in fiscal policy rule.

For policy implications, the results of study revealed some useful insights. For addressing some of the shocks for some variables current policy practices are extremely effective. For instance, for almost all types of demand and supply shocks except monetary and financial, the effect of shock for inflation and consumption is moderated by observed simple Taylor rule while for output observed augmented Taylor rule performs relatively better. This reveals the availability of important information with central bank to moderate inflation, output and consumption behavior. This is not true for financial and monetary policy shocks. Surprisingly, result show that monetary policy does not have appropriate mechanism to handle exogenous monetary and financial shocks. It may be due to the parameters' weights in policy rule which differ largely from one suggested for convergence. In the wake of evolving credit market, instituting a stable and robust macro-financial link is of utmost importance which Pakistan economy seems to despair of. In case of monetary policy shock optimal policy rule with credit growth while for financial shock simple rule is highly recommended for most of the macroeconomic variables.

Moreover, the augmented Taylor rule performs worst in face of most of the supply side shocks like cost-push and adjustment cost shock for stabilizing most of the macroeconomic variables.

Fiscal policy responses cannot be overlooked. Optimal fiscal policy is not only responsive to different types of shocks but also to rule followed by monetary policy. Thought it is hard to discern in given set-up that which policy leads other, it can be observed that stern fiscal stabilization in face of productivity, government spending and EFP shock reinforces the effectiveness of monetary policy for stabilizing the economy to a greater extent. More specifically, when monetary policy with aggressive inflation stabilization is coordinated with fiscal policy stabilization more than what has been implied by observed data, macroeconomic fluctuations are better regulated.

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Appendix A

Table 1: Canonical Presentation of Model Without Financial Friction.

Equation Title	Log-linearized Equation	Number
Consumption Euler Equation	$C_t = \frac{h}{1+h}C_{t-1} + \frac{1}{1+h}C_{t+1} - \frac{1-h}{(1+h)\theta_c}(r_t - \pi_{t+1}) + \frac{1-h}{(1+h)\theta_c}(\epsilon_t^b - \epsilon_{t+1}^b)$	(1)
Investment Euler Equation	$I_t = \frac{1}{1+\beta}I_{t-1} + \frac{\beta}{1+\beta}I_{t+1} + \frac{\varphi}{1+\beta}q_t + \beta\epsilon_{t+1}^I - \epsilon_t^I$	(2)
Capital Accumulation Equation	$K_t = (1-\delta)K_{t-1} + \delta I_t$	(3)
Tobin's q	$q_t = -(r_t - \pi_{t+1}) + \frac{1-\delta}{1-\delta+\overline{r^k}}q_{t+1} + \frac{\overline{r^k}}{1-\delta+\overline{r^k}}{r^k}_{t+1} + \epsilon_t^q$	(4)
Wage mark-up	$\mu_t^w = w_t - mrs_t$	(5)
Wage Philips Curve	$w_t = \frac{\beta}{1+\beta}w_{t+1} + \frac{1}{1+\beta}w_{t-1} + \frac{\beta}{1+\beta}\pi_{t+1} - \frac{1+\beta\iota_w}{1+\beta}\pi_t + \frac{\iota_w}{1+\beta}\pi_{t-1} - \frac{1}{1+\beta\iota_w}\frac{1-\beta\xi_w(1-\xi_w)}{\xi_w(\phi_w-1)\varepsilon_w+1}\mu_t^w + \epsilon_t^w$	(6)
Production Function	$y_t = \phi_p(\alpha K_t^s + (1-\alpha)N_t + \epsilon_t^a)$	(7)
Capital Services	$K_t^s = K_{t-1} + z_t$	(8)
Capital Utilization Rate	$z_t = \frac{1-\psi}{\psi}mpk_t$	(9)
Marginal Product of K	$mpk_t = -(K_t^s - N_t) + w_t$	(10)
Marginal Product of N	$mpn_t = \alpha(K_t^s - N_t) + \epsilon_t^a$	(11)
Price Philips Curve	$\pi_t = \frac{\beta}{1+\beta\iota_p}\pi_{t+1} + \frac{\iota_p}{1+\beta\iota_p}\pi_{t-1} + \frac{1}{1+\beta\iota_p}\frac{1-\beta\xi_p\left(1-\xi_p\right)}{\xi_p\left(\phi_p-1\right)\varepsilon_p+1}\mu_t^p + \epsilon_t^p$	(12)
Resource Constraint	$y_t = c_y C_t + i_y I_t + z_y z_y + g_y G_t$	(13)

Fiscal Policy	$G_t = \rho_G G_{t-1} + (1-\rho_G)\rho_{yG}(y_{t-1} - y_{t-2}) + \epsilon_t^G$	(14)
Monetary Policy	$r_t = \rho_r r_{t-1} + (1-\rho_r)\rho_\pi \pi_t + (1-\rho_r)\rho_y(y_t - y_{t-1}) + \epsilon_t^r$	(15)

Appendix A

Table 2: Canonical Presentation of Model With Financial Friction.

Equation Title	Log-linearized Equation	Number
Consumption Euler Equation	$C_t = \frac{h}{1+h}C_{t-1} + \frac{1}{1+h}C_{t+1} - \frac{1-h}{(1+h)\theta_c}(r_t - \pi_{t+1}) + \frac{1-h}{(1+h)\theta_c}(\epsilon_t^b - \epsilon_{t+1}^b)$	(1)
Investment Euler Equation	$I_t = \frac{1}{1+\beta}I_{t-1} + \frac{\beta}{1+\beta}I_{t+1} + \frac{\varphi}{1+\beta}q_t + \beta\epsilon_{t+1}^I - \epsilon_t^I$	(2)
Capital Accumulation Equation	$K_t = (1-\delta)K_{t-1} + \delta I_t$	(3)
Tobin's q	${r^k}_{t+1} = \left[\frac{1-\delta}{1-\delta+\overline{r^k}}\right]q_{t+1} + \left[\frac{\overline{r^k}}{1-\delta+\overline{r^k}}\right]mpk_{t+1} - q_t$	(16)
Wage mark-up	$\mu_t^w = w_t - mrs_t$	(5)
Wage Philips Curve	$w_t = \frac{\beta}{1+\beta}w_{t+1} + \frac{1}{1+\beta}w_{t-1} + \frac{\beta}{1+\beta}\pi_{t+1} - \frac{1+\beta\iota_w}{1+\beta}\pi_t + \frac{\iota_w}{1+\beta}\pi_{t-1} - \frac{1}{1+\beta\iota_w}\frac{1-\beta\xi_w(1-\xi_w)}{\xi_w(\phi_w - 1)\varepsilon_w + 1}\mu_t^w + \epsilon_t^w$	(6)
Production Function	$y_t = \phi_p(\alpha K_t^s + (1-\alpha)N_t + \epsilon_t^a)$	(7)
Capital Services	$K_t^s = K_{t-1} + z_t$	(8)
Capital Utilization Rate	$z_t = \frac{1-\psi}{\psi}mpk_t$	(9)
Marginal Product of K	$mpk_t = -(K_t^s - N_t) + w_t$	(10)
Marginal Product of N	$mpn_t = \alpha(K_t^s - N_t) + \epsilon_t^a$	(11)

Price Philips Curve	$\pi_t = \frac{\beta}{1+\beta\iota_p}\pi_{t+1} + \frac{\iota_p}{1+\beta\iota_p}\pi_{t-1} + \frac{1}{1+\beta\iota_p}\frac{1-\beta\xi_p\left(1-\xi_p\right)}{\xi_p\left(\phi_p-1\right)\varepsilon_p+1}\mu_t^p + \epsilon_t^p$	(12)
Resource Constraint	$y_t = c_y C_t + c_y^e c_t^e + i_y I_t + z_y z_t + g_y G_t$	(21)
Fiscal Policy	$G_t = \rho_G G_{t-1} + \left(1-\rho_G\right)\rho_{yG}\left(y_{t-1} - y_{t-2}\right) + \epsilon_t^G$	(14)
Monetary Policy	$r_t = \rho_r r_{t-1} + \left(1-\rho_r\right)\rho_\pi \pi_t + \left(1-\rho_r\right)\rho_y (y_t - y_{t-1}) + \epsilon_t^r$	(15)
External Finance Premium	$s_t = r^k{}_{t+1} - (r_t - \pi_{t+1})$	(17)
EFP elasticity to Net Worth	$s_t = -\chi\left(n_t - q_t - K_t\right) + \epsilon_t^{fd}$	(18)
Net Worth	$n_t = \frac{K}{N}(r_t^k - \quad {}_{t-1}r_t^k) + \quad {}_{t-1}r_t^k + \theta n_t + \epsilon_t^{nw}$	(19)
Entrepreneurial Consumption	$c_t^e = n_t$	(20)
Augmented Taylor Rule	$r_t = \rho_r r_{t-1} + \left(1-\rho_r\right)\rho_\pi \pi_t + \left(1-\rho_r\right)\rho_y (y_t - y_{t-1})$ $+ \left(1-\rho_r\right)\rho_{cg}(CG_t - \overline{CG}) + \epsilon_t^r$	(22)

Appendix A

Table 3: Parameters of the Models

Parameter	Description	Value	Estimation	Data/Reference
Fixed				
$\boldsymbol{\beta}$	*Discount factor*	0.998	Data	Quarterly Data/IMF
$\boldsymbol{\delta}$	*Depreciation Rate*	0.025	Data	Annual Data /SBP and Penn World Table. Parameters adjusted for quarterly response
Households				
$\boldsymbol{h}$	*Habit persistence*	0.86	GMM	Quarterly Data /Arby (2013)
$\boldsymbol{\theta_c}$	*Intertemporal elasticity of substitution*	1.01	Literature	Choudhri and Malik(2012); Gabriel et al. (2010); Castro et al.'s (2011)
$\boldsymbol{\theta_n}$	*Frisch Elasticity of labor supply*	2	Literature	
$\boldsymbol{\iota_w}$	*Degree of wage indexation*	0.36	Literature	Ahmed et al. (2013)
$\boldsymbol{\xi_w}$	*Degree of wage stickiness*	0.75	Literature	
$\boldsymbol{\phi_w}$	*Proportion of sticky wages*	0.15	Literature	
$\boldsymbol{\varepsilon_w}$	*Curvature of Dixit-Stigler Aggregator*	6	Literature	Choudhri and Malik(2012);
Producers				
$\boldsymbol{\alpha}$	*Share of Capital in Production*	0.49	Cointegration	Annual Data/ Coefficients adjust for quarterly response
$\boldsymbol{\phi_p}$	*share of fixed cost in production*	0.5	Literature	

$\boldsymbol{\psi}$	*Elasticity of capital utilization*	0.54	Literature	
$\boldsymbol{\iota_p}$	*Degree of price indexation*	0	Literature	Choudhary et al. (2011)
$\boldsymbol{\xi_p}$	*Degree of price stickiness*	0.70	Literature	Choudhary et al. (2011)
$\boldsymbol{\phi_p}$	*Proportion of sticky prices*	0.08	Literature	Ahmed et al. (2013)
$\boldsymbol{\varepsilon_p}$	*Curvature of Dixit-Stigler Aggregator*	6	Literature	Choudhri and Malik(2012);
$\boldsymbol{\varphi}$	*Curvature of adjustment cost function*	4		
Policy Rule				
$\boldsymbol{\rho_G}$	*Government spending smoothing*	-0.1	FMOLS	Annual Data. Parameters adjusted for quarterly response
$\boldsymbol{\rho_{yG}}$	*Response to output change*	-0.22		
$\boldsymbol{\rho_r}$	*Interest rate smoothing*	0.93	FMOLS with and without financial indicator in Taylor rule	Quarterly Data/IMF
$\boldsymbol{\rho_\pi}$	*Response to inflation*	0.14/0.18		
$\boldsymbol{\rho_y}$	*Response to output*	0.10		
$\boldsymbol{\rho_{cg}}$	*Response to credit growth*	0.05		
Financial Frictions				
$\boldsymbol{\chi}$	*Elasticity of EFP with respect to leverage*	0.041	Literature	Mizen and Soukas (2012)
$\boldsymbol{\theta}$	*Entrepreneurial survival rate*	0.01	Literature	Bernanke et al. (1999)
Steady State Values in model Economy				
$\boldsymbol{c_y}$	*Consumption to GDP ratio*	0.66	Data	Handbook of statistics on Pakistan Economy

c_y^e	*Entrepreneurial consumption to GDP ratio*	0.01	Literature	
i_y	*Investment to GDP ratio*	0.08	Data	Handbook of statistics on Pakistan Economy
z_y	*Proportion of output lost due to capacity utilization*	0.01	Literature	
g_y	*Government Spending to GDP ratio*	0.24	Data	Handbook of statistics on Pakistan Economy

Appendix B

Table 4 : Standard Deviations and Relative Volatilities : Data and Models*

Variable	Data	All Shocks			No Financial Shocks			Demand Shocks Only			Supply Shocks Only			Demand and Financial Shocks			Supply and Financial Shocks		
		M 4	M 5	M 6	M 4	M 5	M 6	M 4	M 5	M 6	M 4	M 5	M 6	M 4	M 5	M 6	M 4	M 5	M 6
A. Standard Deviation																			
y_t	2.76	0.40	1.91	1.59	0.40	1.82	1.61	0.17	0.74	0.48	0.33	1.57	1.41	-	0.81	0.66	-	1.65	1.48
π_t	1.43	0.13	0.18	0.23	0.13	0.13	0.21	0.13	0.14	0.09	0.03	0.04	0.14	-	0.15	0.16	-	0.06	0.13
C_t	3.89	0.01	0.01	0.02	0.01	0.01	0.02	0.003	0.01	0.01	0.004	0.004	0.02	-	0.01	0.01	-	0.01	0.02
I_t	8.29	5.01	13.6	11.6	5.01	13.9	11.9	2.20	5.82	3.1	4.17	11.9	10.40	-	6.38	4.9	-	12.9	11.3
N_t	1.88	1.19	5.16	4.58	1.19	5.28	4.68	0.57	2.12	1.34	1.19	4.56	4.1	-	2.33	1.87	-	4.8	4.32
r_t	0.76	0.11	0.15	0.31	0.11	0.11	0.30	0.12	0.12	0.08	0.002	0.01	0.24	-	0.12	0.17	-	0.01	0.24
G_t	0.47	0.04	0.53	0.50	0.04	0.54	0.52	0.03	0.21	0.16	0.03	0.47	0.46	-	0.23	0.20	-	0.47	0.45
B. Relative Volatilities																			
y_t	1	1	1	1	1	1	1	1	1	1	1	1	1	-	1	1	-	1	1
π_t	0.51	0.32	0.15	0.14	0.32	0.07	0.13	0.76	0.18	0.18	0.09	0.20	0.09	-	0.18	0.24	-	0.03	0.08
C_t	1.40	0.025	0.005	0.01	0.025	0.005	0.01	0.01	0.01	0.02	0.01	0.002	0.01	-	0.01	0.01	-	0.006	0.01
I_t	3.00	12.52	7.12	7.29	12.52	7.63	7.39	12.94	7.86	6.45	12.63	7.57	7.37	-	7.87	7.42	-	7.81	7.63
N_t	0.68	2.97	2.70	2.88	2.97	2.90	2.90	3.35	2.86	2.79	3.60	2.90	2.90	-	2.87	2.83	-	2.90	2.91
r_t	0.27	0.275	0.07	0.19	0.27	0.06	0.18	0.70	0.70	0.16	0.006	0.006	0.17	-	0.14	0.25	-	0.006	0.16
G_t	0.17	0.1	0.27	0.31	0.1	0.29	0.32	0.17	0.28	0.33	0.09	0.29	0.32	-	0.28	0.30	-	0.17	0.30
C. Autocorrelations																			
	Data				M 4					M 5					M 6				
	1	2	3	4	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
y_t	0.84	0.83	0.80	0.9	0.94	0.81	0.63	0.42	0.21	0.32	0.26	0.04	-0.1	-0.14	0.22	0.17	-0.05	-0.17	-0.17
π_t	0.97	0.95	0.93	0.90	0.93	0.88	0.82	0.77	0.72	0.96	0.91	0.86	0.81	0.77	0.91	0.84	0.76	0.67	0.59
C_t	0.93	0.87	0.81	0.75	0.96	0.85	0.70	0.53	0.36	0.99	0.95	0.90	0.83	0.77	0.82	0.67	0.50	0.35	0.23
I_t	0.95	0.90	0.85	0.80	0.94	0.81	0.62	0.42	0.21	0.66	0.36	0.08	-0.15	-0.28	0.62	0.31	0.01	-0.21	-0.32
N_t	0.94	0.88	0.82	0.77	0.94	0.80	0.62	0.42	0.20	0.36	0.27	0.05	-0.11	-0.17	0.26	0.18	-0.1	-0.18	-0.21
r_t	0.83	0.73	0.668	0.61	0.99	0.97	0.94	0.91	0.87	0.98	0.97	0.95	0.92	0.89	0.19	0.25	0.22	0.18	0.22
G_t	-0.5	-0.01	0.1	-0.1	0.77	0.63	0.45	0.31	0.20	-0.51	0.15	-0.05	-0.06	0.04	-0.5	0.15	-0.1	-0.05	0.04

Source: Quarterly data has been taken from Arby (2013) and International Financial Statistics (various Issues)

***where M 4, M 5 and M 6 reefer to Model 4, 5 and 6, respectively**

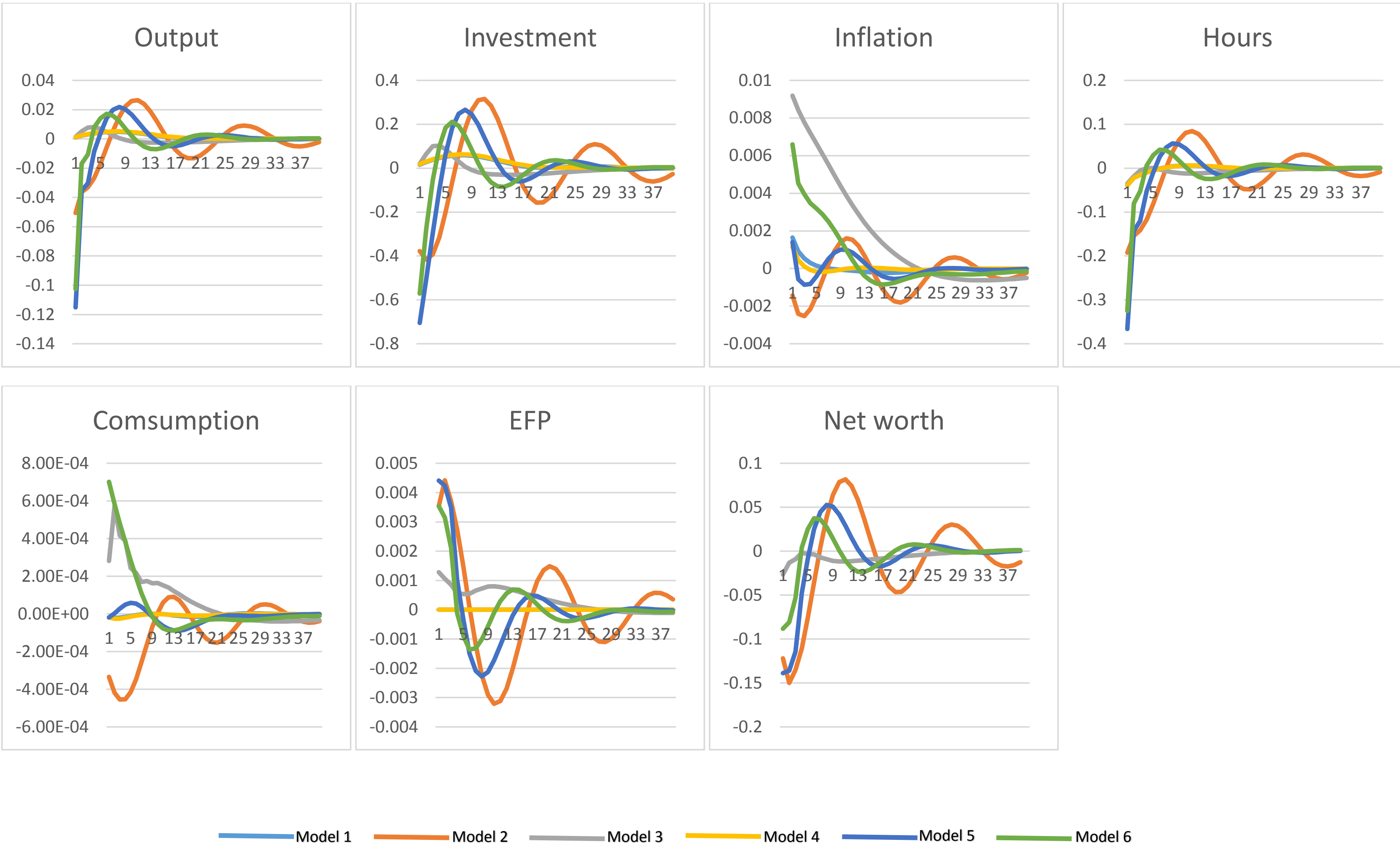
Appendix C

Figure 1: Preference Shock

Note: Responses are percentage deviation of a variable from its steady state value

Appendix C

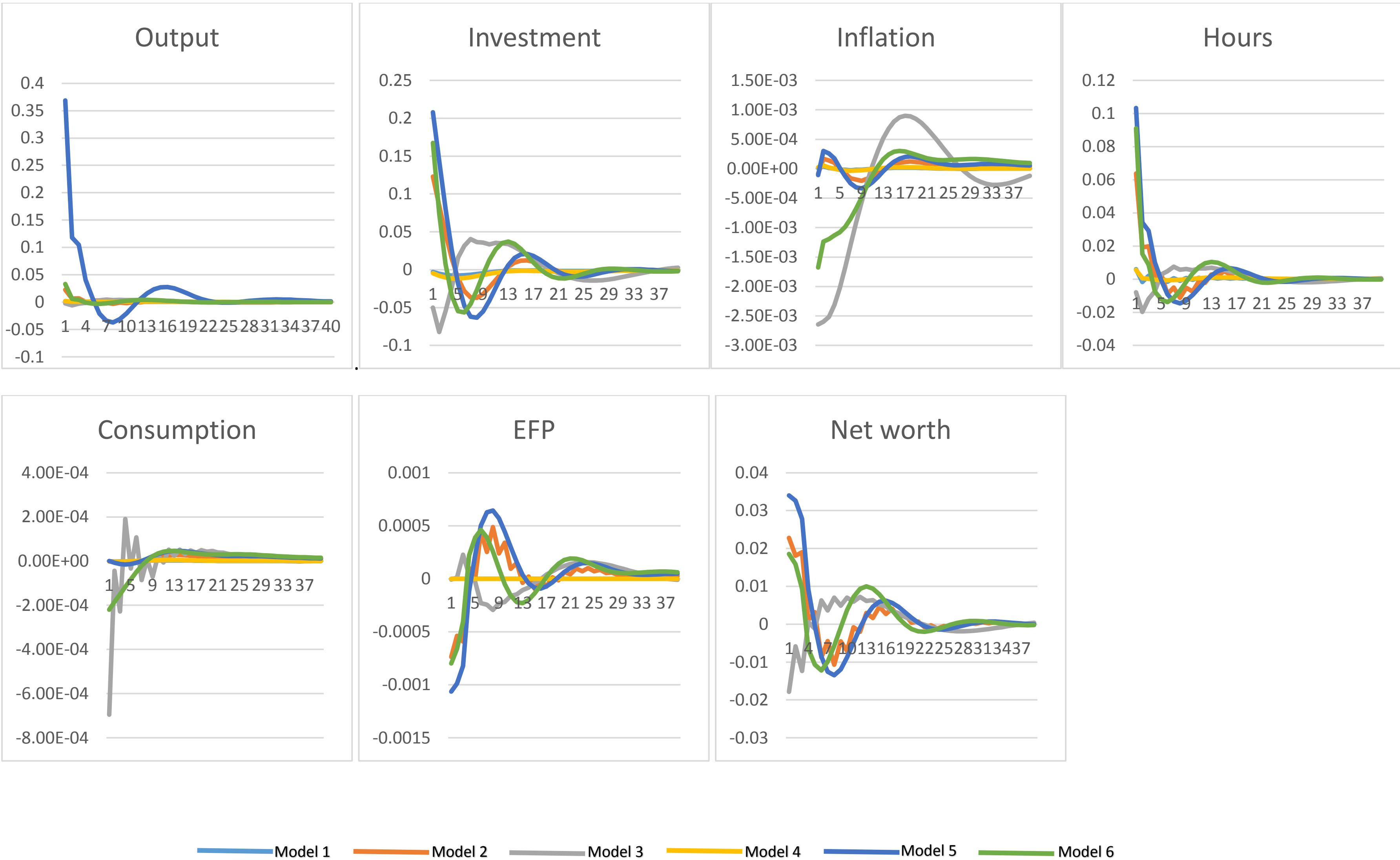
Figure 2: Productivity Shock



Note: Responses are percentage deviation of a variable from its steady state value

Appendix C

Figure 3: Fiscal Shock



Note: Responses are percentage deviation of a variable from its steady state value

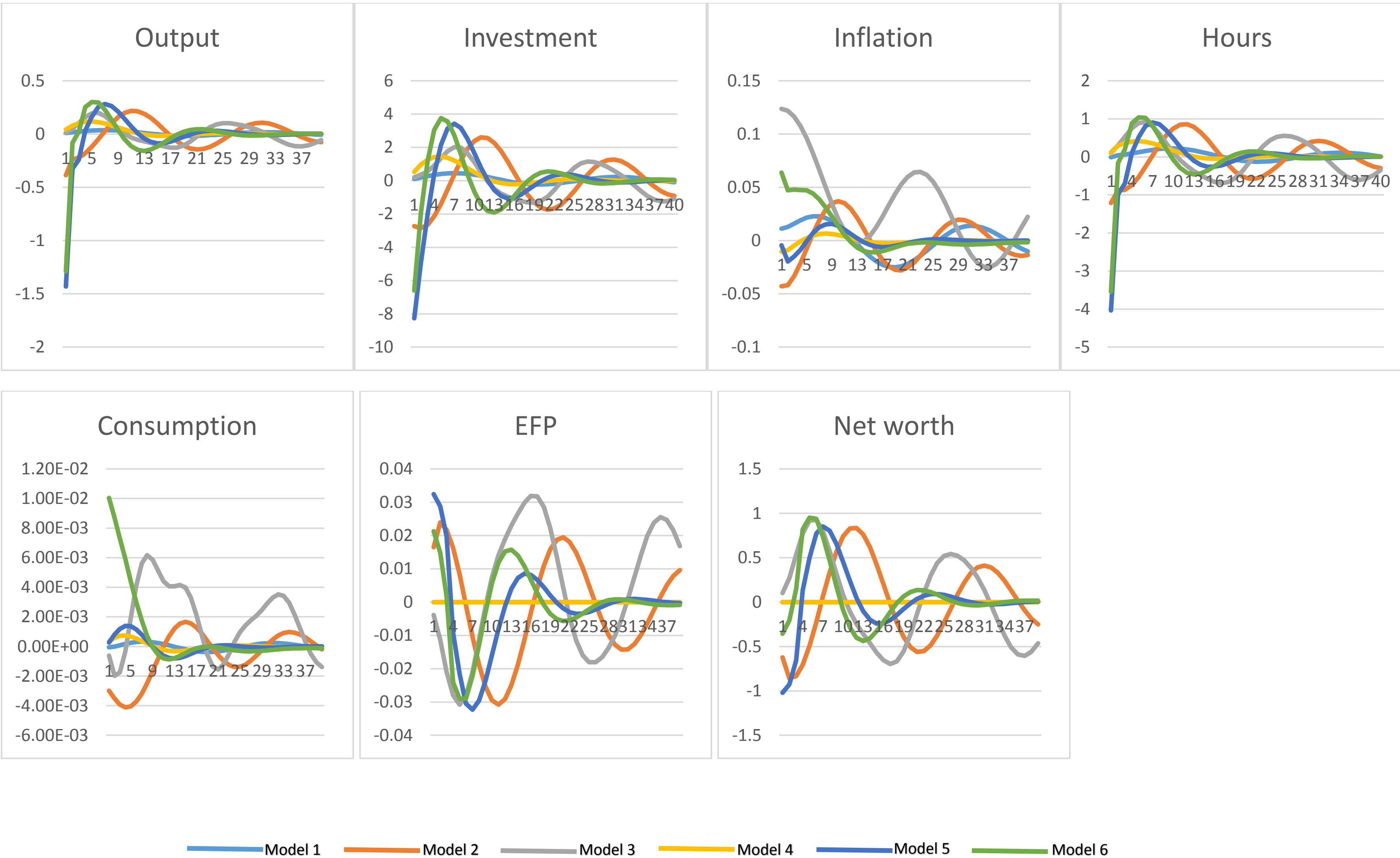
Appendix C

Figure 4: Price mark-up Shock

Note: Responses are percentage deviation of a variable from its steady state value

Appendix C

Figure 5: Cost-push Shock



Note: Responses are percentage deviation of a variable from its steady state value

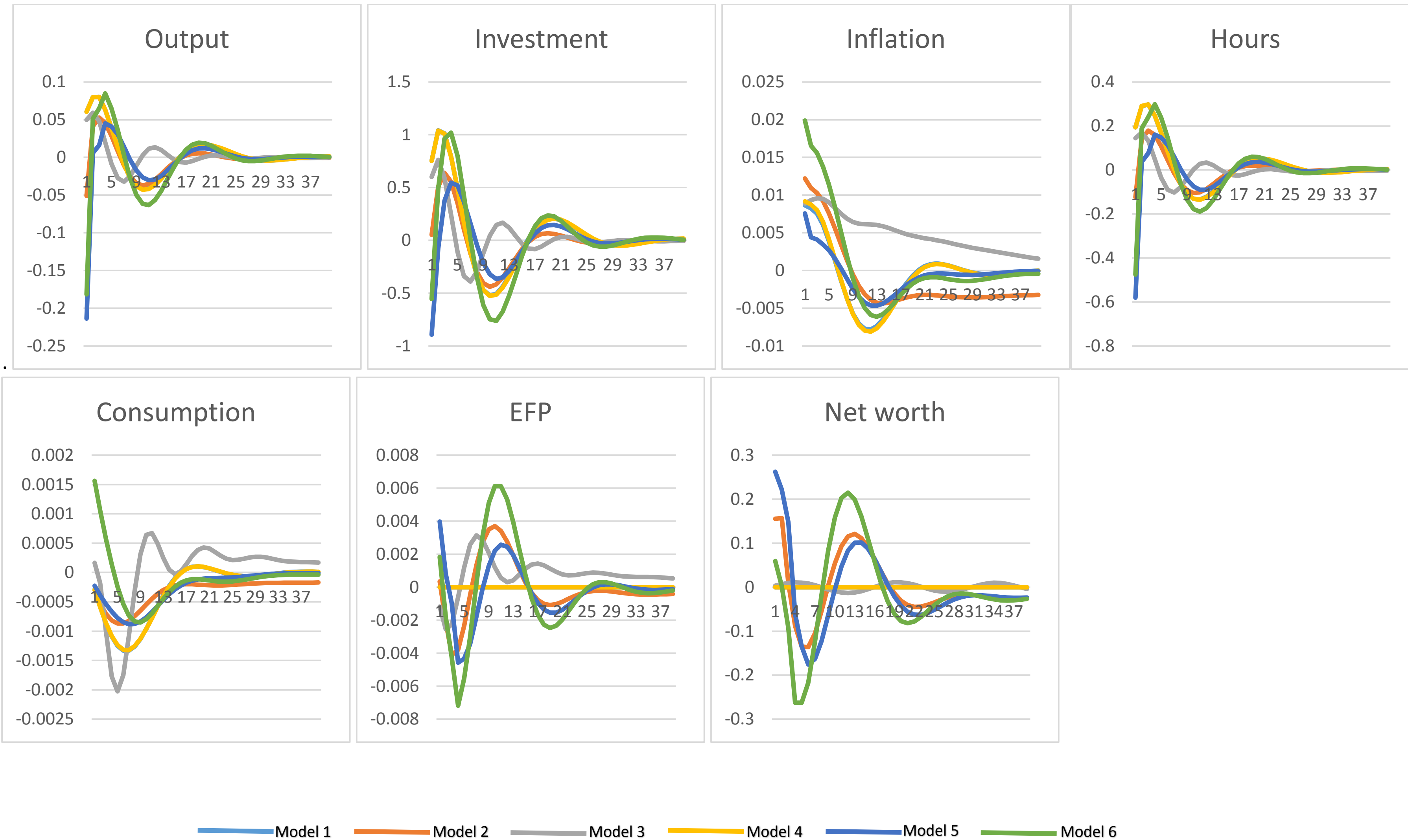
Appendix C

Figure 6: Adjustment Cost Shock

Note: Responses are percentage deviation of a variable from its steady state value

Appendix C

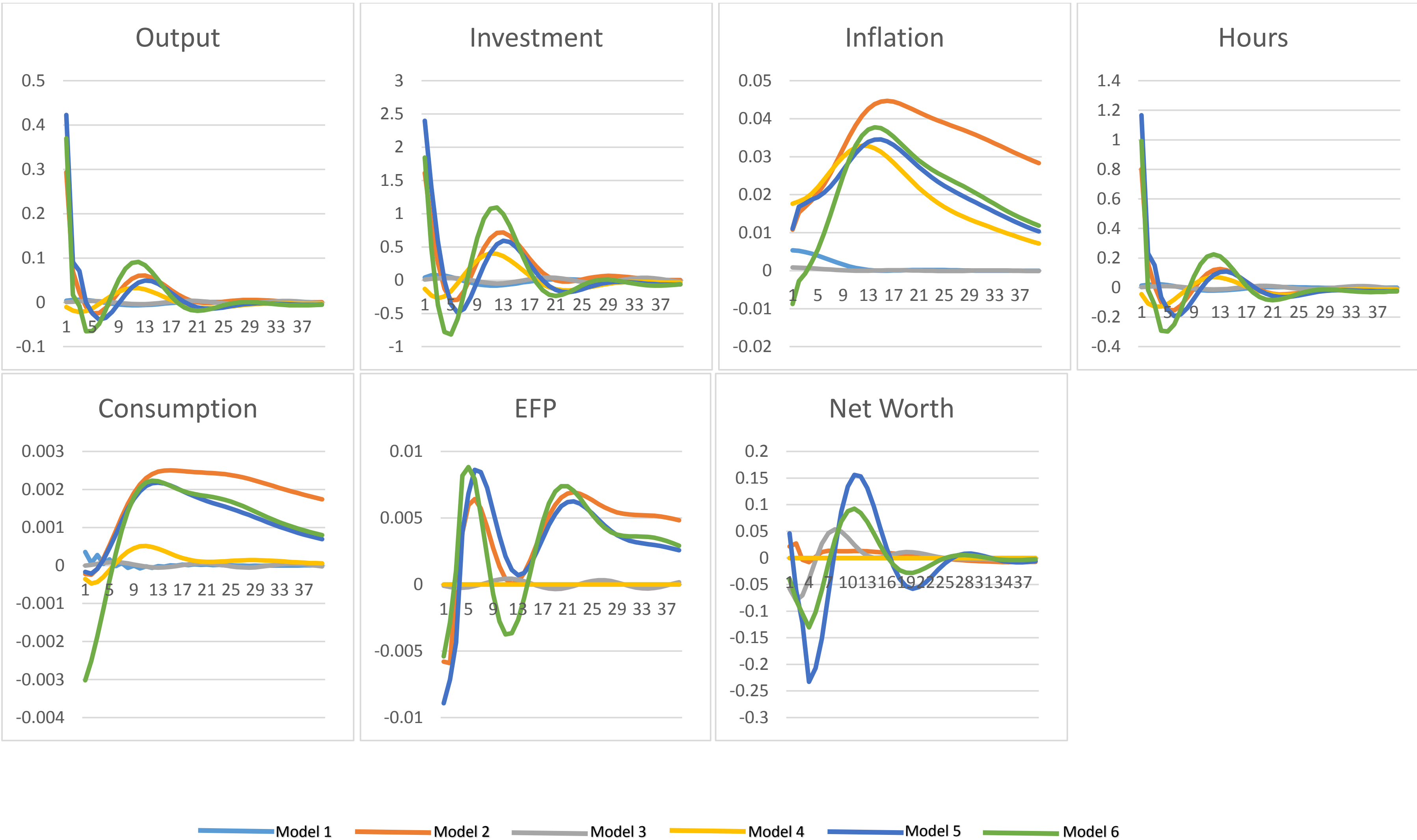
Figure 7: Capital Price Shock



Note: Responses are percentage deviation of a variable from its steady state value

Appendix C

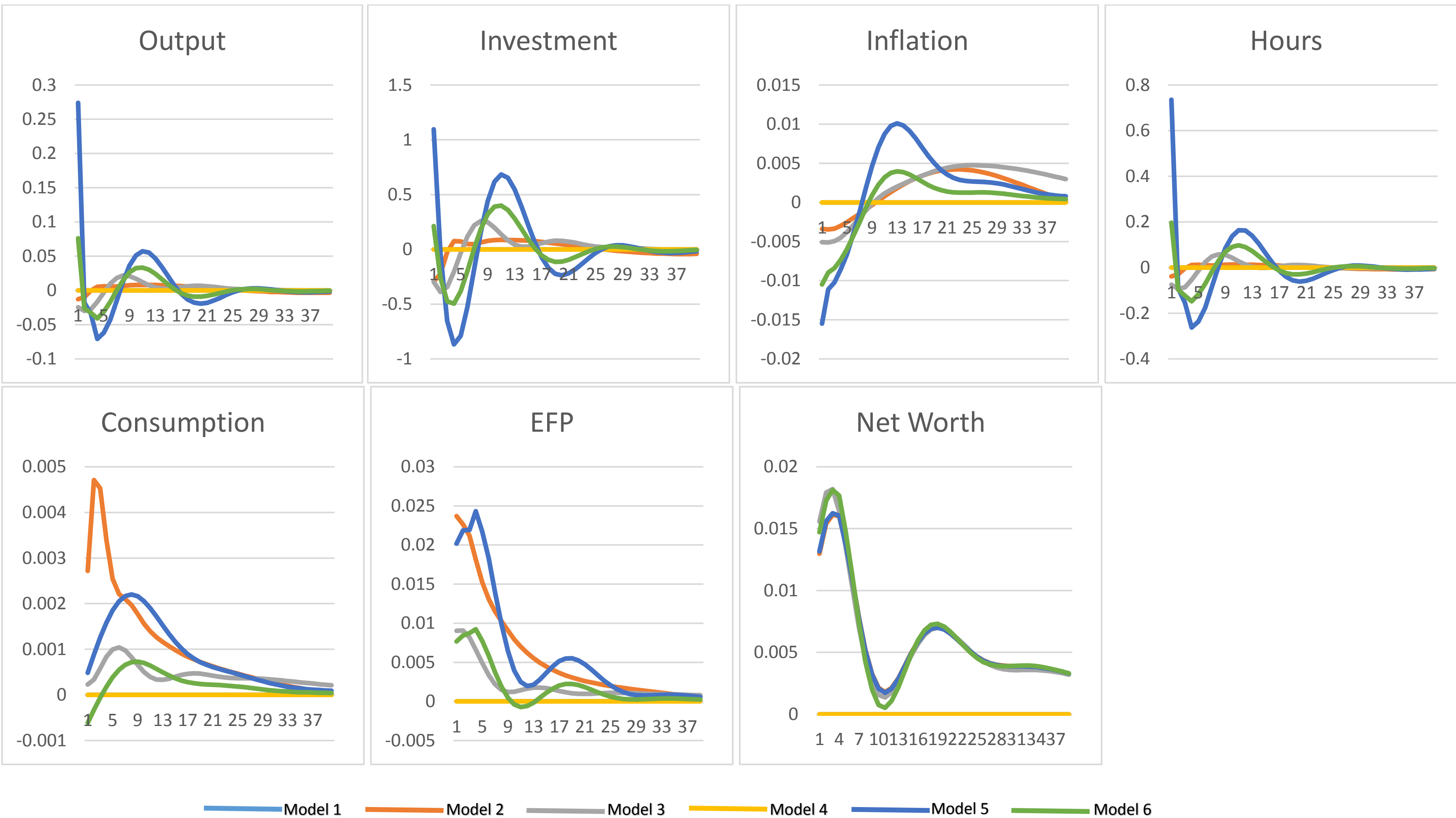
Figure 8: Monetary Policy Shock



Note: Responses are percentage deviation of a variable from its steady state value

Appendix C

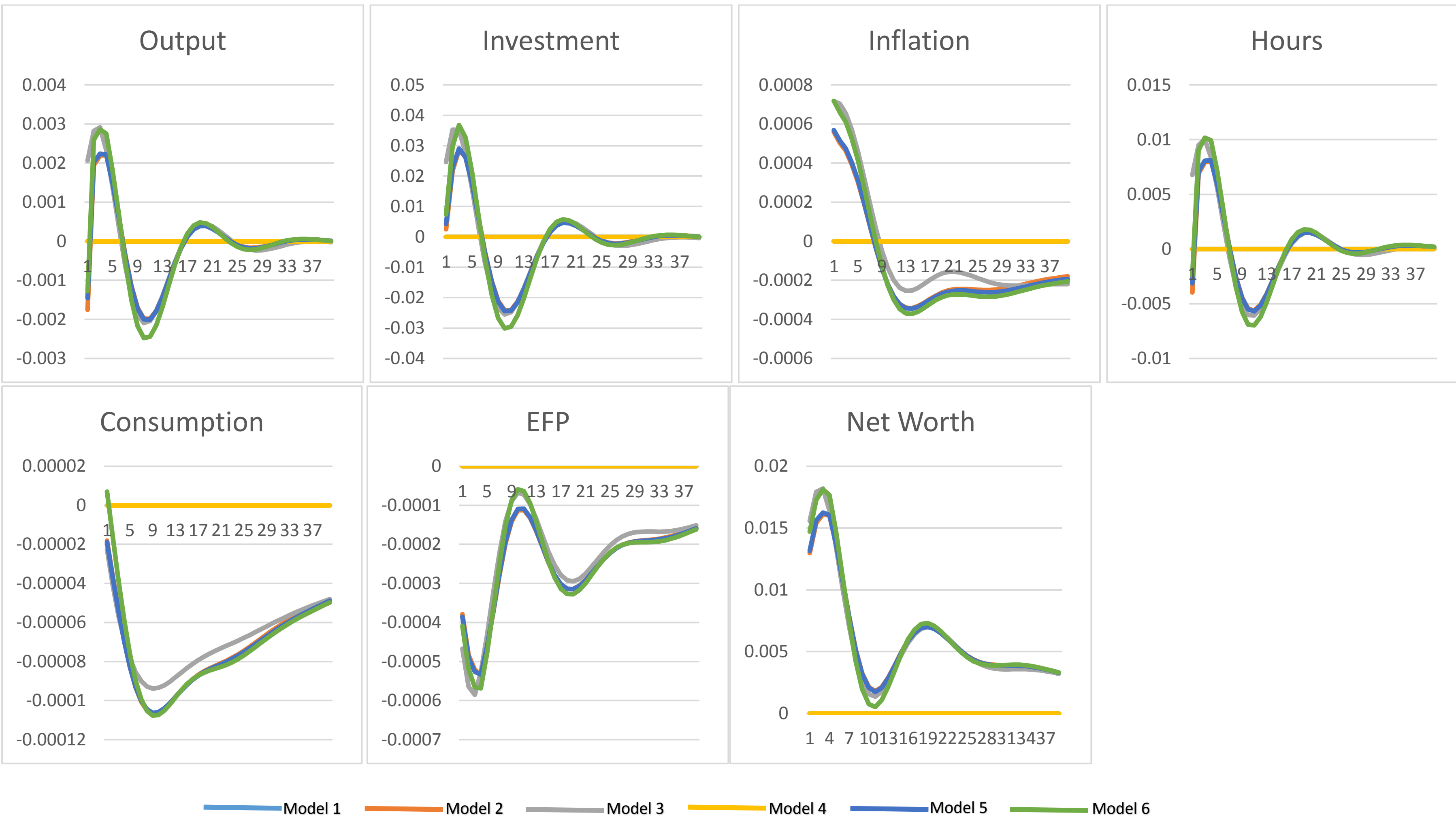
Figure 9: EFP Shock



Note: Responses are percentage deviation of a variable from its steady state value

Appendix C

Figure 10: Net worth Shock



Note: Responses are percentage deviation of a variable from its steady state value

Appendix C

Table 5: Optimal Policy Response

Shocks	Parameters	Estimated with simple Taylor rule	Estimated with Augmented Taylor rule	Model 1	Model2	Model3
Preference Shock	ρ_π	0.18	0.14	0.338809	-0.96064	0.153109
	ρ_y	0.10	0.10	-0.099	-0.5228	0.104312
	ρ_r	0.93	0.93	0.962471	0.944496	0.999999
	ρ_G	-0.01	-0.01	-0.09469	-0.05398	-0.09995
	ρ_{yG}	-0.22	-0.22	-0.27967	0.051313	-0.21408
	ρ_{cg}	-	0.05	-	-	0.032358
Productivity Shock	ρ_π	0.18	0.14	0.149099	0.142772	0.733728
	ρ_y	0.10	0.10	0.405888	0.540789	0.184533
	ρ_r	0.93	0.93	0.117887	0.640027	-0.25874
	ρ_G	-0.01	-0.01	-0.09952	0.007984	-0.10033
	ρ_{yG}	-0.22	-0.22	-0.13471	0.103083	-0.32256
	ρ_{cg}	-	0.05			0.301157
Fiscal Shock	ρ_π	0.18	0.14	0.139869	0.140389	0.184014
	ρ_y	0.10	0.10	0.100073	0.054755	0.083982
	ρ_r	0.93	0.93	0.929455	0.891034	-0.28332
	ρ_G	-0.01	-0.01	-0.64468	-0.80328	-0.61453
	ρ_{yG}	-0.22	-0.22	-0.22362	-0.0833	-0.12977
	ρ_{cg}	-	0.05			0.716427
Price Mark-up Shock	ρ_π	0.18	0.14	0.734424	0.722529	0.824473
	ρ_y	0.10	0.10	0.032193	-0.12802	0.019251
	ρ_r	0.93	0.93	-0.04993	0.253717	0.820853
	ρ_G	-0.01	-0.01	-0.08821	0.028651	-0.09711
	ρ_{yG}	-0.22	-0.22	-0.31301	0.339088	-0.06982
	ρ_{cg}	-	0.05			1.06084
Cost-push Shock	ρ_π	0.18	0.14	0.786009	-4.41974	0.799916
	ρ_y	0.10	0.10	1.62962	4.45048	8.61697
	ρ_r	0.93	0.93	0.516734	0.92998	0.836346
	ρ_G	-0.01	-0.01	-0.09549	0.999999	-0.16918
	ρ_{yG}	-0.22	-0.22	-0.35336	0.387805	6.12687
	ρ_{cg}	-	0.05			1.35092
Investment Shock	ρ_π	0.18	0.14	0.157913	0.306308	12.3312
	ρ_y	0.10	0.10	0.061023	0.134542	2.34017
	ρ_r	0.93	0.93	0.978551	0.606366	10.1453
	ρ_G	-0.01	-0.01	-0.09872	-0.03374	0.785949
	ρ_{yG}	-0.22	-0.22	-0.23335	-0.02536	-3.13414
	ρ_{cg}	-	0.05			47.8879

Capital Price Shock	ρ_{π}	0.18	0.14	0.158292	0.839295	0.877385
	ρ_{y}	0.10	0.10	0.0602	0.001805	0.104014
	ρ_{r}	0.93	0.93	0.979574	0.695842	0.781055
	ρ_{G}	-0.01	-0.01	-0.09869	-0.00794	-0.09987
	ρ_{yG}	-0.22	-0.22	-0.23363	0.029291	-0.26901
	ρ_{cg}	-	0.05			1.52253
Monetray Shock	ρ_{π}	0.18	0.14	-0.00782	0.175804	10.5386
	ρ_{y}	0.10	0.10	0.09453	0.065619	-0.25155
	ρ_{r}	0.93	0.93	-0.83904	0.969018	2.03761
	ρ_{G}	-0.01	-0.01	-0.09988	-0.03092	-0.08762
	ρ_{yG}	-0.22	-0.22	-0.2206	-0.00338	-0.09448
	ρ_{cg}	-	0.05			-0.08443
EFP Shock	ρ_{π}	0.18	0.14		-1.81437	0.568645
	ρ_{y}	0.10	0.10		-13.9013	0.091197
	ρ_{r}	0.93	0.93		0.641833	0.817578
	ρ_{G}	-0.01	-0.01		-0.16153	-0.09996
	ρ_{yG}	-0.22	-0.22		-1.27057	-0.24944
	ρ_{cg}	-	0.05			0.683921
Net worth Shock	ρ_{π}	0.18	0.14		0.138432	0.557369
	ρ_{y}	0.10	0.10		0.082734	0.073134
	ρ_{r}	0.93	0.93		0.968081	0.95908
	ρ_{G}	-0.01	-0.01		-0.09648	-0.10014
	ρ_{yG}	-0.22	-0.22		-0.21554	-0.2569
	ρ_{cg}	-	0.05			-0.41358

Source: Dynare generated output

Appendix C

Table 6: One-quarter-ahead Forecast Variance Decomposition

Variable	Percentage Contribution Owing to									
	Fiscal	Preference	Price of Capital	Productivity	Adjustment Cost	Cost-push	Price-markup	Monetary	EFP	Net worth
C_t	0.09	0.01	3.59	0.03	0.00	91.20	4.98	0.10		
I_t	0.04	0.01	2.12	0.11	0.00	76.68	19.43	1.62		
N_t	0.03	0.08	69.30	0.28	0.03	20.39	9.36	0.52		
r_t	0.09	0.01	3.95	0.03	0.00	90.75	5.08	0.10		
G_t	0.14	0.00	3.69	0.02	0.00	92.03	4.03	0.08		
r_t	0.02	0.10	22.33	0.07	0.01	68.86	6.94	1.67		
G_t	0.02	35.70	12.24	0.06	0.01	47.79	4.09	0.10		
Model 2										
y_t	0.12	0.01	1.50	0.71	0.00	57.26	34.17	2.28	3.94	0.00
π_t	0.13	0.01	0.18	0.74	0.00	59.41	32.03	7.18	0.33	0.00
C_t	0.07	0.02	4.83	0.38	0.00	36.99	35.09	1.77	20.78	0.07
I_t	0.11	0.01	0.28	0.80	0.00	57.03	38.75	2.08	0.93	0.00
N_t	0.12	0.01	0.86	0.94	0.00	56.59	37.17	2.01	2.30	0.00
r_t	0.10	0.02	2.19	0.62	0.00	55.52	32.90	2.75	5.89	0.01
G_t	4.77	0.04	5.90	0.39	0.00	54.30	17.19	2.69	14.71	0.01
Model 3										
y_t	1.07	0.06	2.36	12.31	0.03	58.24	21.05	2.01	1.98	0.89
π_t	0.48	0.02	0.48	5.91	0.01	47.97	38.38	5.73	0.52	0.49
C_t	0.55	0.23	34.66	12.48	0.05	11.29	18.00	9.98	12.24	0.53
I_t	0.83	0.07	3.08	13.00	0.03	56.42	21.48	1.90	2.31	0.89
N_t	0.79	0.08	4.11	12.13	0.04	54.98	22.72	1.35	2.88	0.92
r_t	0.52	0.08	11.78	9.63	0.03	41.70	28.11	4.10	3.45	0.62
G_t	6.87	0.12	9.93	16.53	0.04	37.02	22.53	1.13	4.99	0.84
Model 4										
y_t	0.01	0.11	20.67	0.16	0.01	50.81	11.31	4.43		
π_t	0.00	0.11	4.30	0.01	0.00	2.97	10.40	86.79		
C_t	0.00	0.25	41.20	0.01	0.02	12.89	26.41	8.65		

I_t	0.00	0.11	21.49	0.16	0.01	50.29	11.23	4.45		
N_t	0.00	0.11	21.49	0.13	0.01	53.01	8.91	4.62		
r_t	0.00	0.00	0.03	0.00	0.00	0.02	0.00	100.47		
G_t	44.88	0.11	27.45	0.02	0.01	21.41	5.02	2.39		
Model 5										
y_t	0.05	0.01	1.76	0.48	0.00	74.66	12.98	6.56	3.28	0.00
π_t	0.00	0.04	0.81	0.02	0.00	5.25	7.13	84.41	3.53	0.01
C_t	0.02	0.01	4.17	0.03	0.00	6.49	22.41	67.93	25.77	0.14
I_t	0.04	0.01	1.25	0.53	0.00	72.78	15.18	5.91	3.00	0.00
N_t	0.05	0.01	1.71	0.61	0.00	74.70	12.98	6.13	3.34	0.00
r_t	0.00	0.00	0.02	0.00	0.00	0.53	0.09	99.52	0.04	0.00
G_t	0.37	0.00	2.27	0.41	0.00	79.58	10.18	6.32	3.88	0.00
Model 6										
y_t	0.05	0.01	2.84	0.43	0.00	78.15	10.13	7.49	0.62	0.00
π_t	0.02	0.02	3.10	0.24	0.00	31.21	16.42	55.02	0.78	0.01
C_t	0.04	0.00	2.20	0.34	0.00	69.11	8.37	35.46	1.10	0.06
I_t	0.03	0.02	4.50	0.39	0.00	76.44	8.10	8.96	1.09	0.01
N_t	0.04	0.01	3.14	0.54	0.00	78.91	9.42	7.17	0.71	0.00
r_t	0.03	0.00	2.18	0.31	0.00	59.51	7.65	31.75	0.39	0.00
G_t	0.40	0.00	2.36	0.40	0.00	82.29	9.82	6.28	0.44	0.00

Source: Dynare generated output