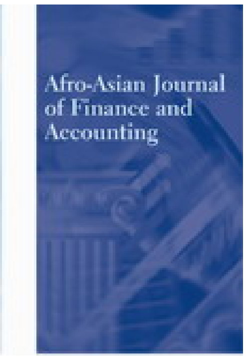

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Financial frictions and stabilisation policies

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Abstract: This research examines the implications of price and quantity-based financial frictions for the macroeconomic dynamics and effectiveness of stabilisation policies in Pakistan. Price and quantity-based financial frictions are captured through external finance premium and collateral constraint, respectively. Results from calibrating a new Keynesian dynamic stochastic general equilibrium model showed that quantity-based frictions generate strong financial accelerator mechanism and impede the stabilisation through monetary, fiscal and macroprudential policies. The effective management through stabilisation policies requires the rigorous handling of quantitative financial frictions.

Keywords: external finance premium; collateral constraint; financial accelerator mechanism; fiscal policy; macro-prudential policy; monetary policy.

JEL codes: E37, E44, E58, E63, G18.

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1 Introduction

The last two decades have seen a phenomenal growth in the theoretical and empirical investigation of the significance of financial frictions for macroeconomic fluctuations. Incorporating different features of financial sector in contemporaneous mainstream macroeconomic modelling (new Keynesian dynamic stochastic general equilibrium – NK-DSGE or DSGE) and exploring the role of financial frictions for shaping macroeconomic behaviour and for the conduct of the stabilisation policies are the pivotal constituents of this research (Cúrdia and Woodford, 2016; Gertler and Karadi, 2011; Gertler and Kiyotaki, 2010, 2015; Gertler et al., 2012).

Within DSGE framework, the macroeconomic implications of financial frictions are investigated by examining the transmission, amplification and persistence of nominal, real and financial shocks for macroeconomic fluctuations. Since Kiyotaki and Moore (KM, 1997) and Bernanke et al. (BGG, 1999) the research has shown that these financial frictions amplify macroeconomic fluctuations when induced by certain shocks, hence are usually referred to as financial accelerator.

The core of financial accelerator mechanism in BGG framework lies at the relationship between firm's leverage, financial composition of the firm and agency cost 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. EFP affects the economy via price of loans extended and its counter-cyclical nature accelerates and amplifies the effects and persistence of shocks through balance sheet channel.

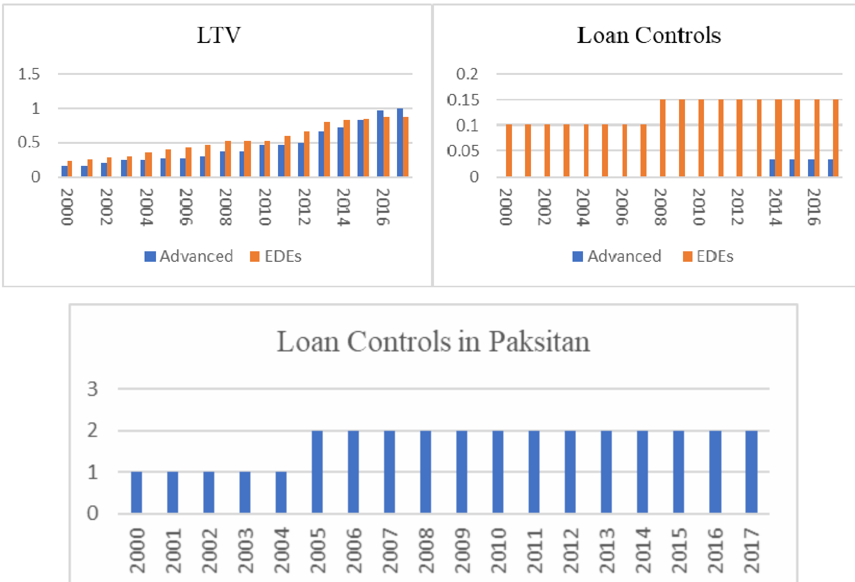
Kiyotaki and Moore (1997) introduced financial frictions through collateral constraints (CC) on borrowing due to incomplete contracts. The credit constraints are endogenously determined and interact with aggregate economic activity through rationing the quantity of loans over the business cycle. The level of credit rationing is counter-cyclical due to the pro-cyclical value of collateralised assets. The dynamic interaction between borrower's credit limits and price of collateralised assets, therefore acts as a financial accelerator by which the effects of shocks propagate, amplify, and persist.

Though EFP and CC both allow integrating financial frictions in workhorse macroeconomic models resulting in financial system pro-cyclicality, however, the implication of these financial-NK DSGE models for propagation mechanism of shocks, macroeconomic-financial linkages and conduct of macroeconomic policy may substantially differ. For the establishment of an insightful macroeconomic-financial framework, it seems critical to properly understand how price and quantity-based frictions work, and to ascertain the common and the distinct features of the two models (Brzoza-Brzezina et al., 2010). The application of these DSGE models remained confined to advanced economies. There have been sparse attempts to analyse the role of financial frictions for emerging and developing economies (EDEs). This leaves us with limited knowledge of the role of financial frictions for macroeconomic dynamics and stabilisation polices in these countries.

It is imperative to examine the issue for the EDEs for many reasons. First, the very reason for introducing the financial frictions in DSGE models of advanced economies, i.e. dissatisfaction with financial-structure irrelevance theorem, is equally relatable to EDEs. A number of price and quantity-based frictions prevail in EDEs. Figure 1 shows that credit constraints in the form of loan to value (LTV) ratio and restrains on credit growth in EDEs are on average higher than in advanced economies.

Similarly, financial intermediation in EDEs is also subject to a number of price-based financial restrictions including prime spread, high yield bond spread, interest rate spread and net interest margins. These spreads reflect the efficiency of financial intermediation which in case of EDEs is quite low as compared to advanced economies indicating the higher prevalence of price-based financial frictions as shown in Figure 2.

Figure 1 Quantity-based financial frictions (see online version for colours)



Notes: LTV shows the average of loan to value limits imposed by two sets of countries. Loan controls show the average of limits on loans imposed by two sets of countries.

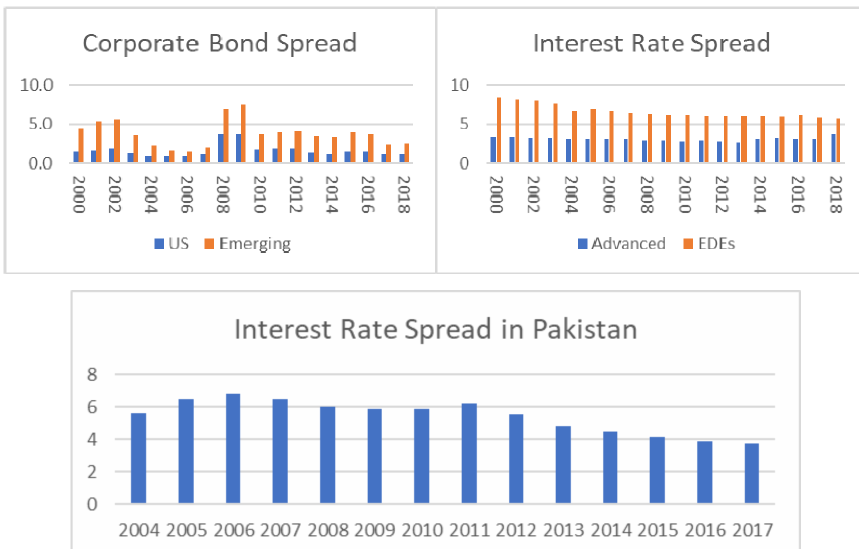
Source: Data is taken from borrower's macro-prudential policy index; graphs are constructed by authors

The types and extent of financial regulations resulting in various price and quantity-based financial frictions also vary substantially across different set of countries primarily owing to the differences in their financial landscape. Consequently, financial frictions may catalyse macroeconomic shocks differently in EDEs and may result in a kind of financial-macroeconomic interactions in EDEs that may be completely different from one observed for advanced economies.

Second, being at evolutionary stage capital markets in EDEs manifest considerable volatility (Mizen and Tsoukas, 2012). This evolution is envisaged to have substantial bearing on macro-financial linkages. Third, contrary to the financial structure of advanced economies which are largely market-dominated, financial systems in EDEs remained bank-dominated. Moreover, with low level of financial deepening and access in EDEs, investigating and comparing the strength of financial accelerator mechanism arising due to both price and quantity-based financial frictions is expected to provide insights useful for addressing the expected growth-stability trade-off.

Against this background, the present study attempts to quantify the role of price and quantity-based financial frictions *a la* BGG (1999) and *a la* KM (1997), respectively, for macroeconomic fluctuations in Pakistan. The rationale for analysing the role of financial frictions for EDEs (mentioned above) is 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 market in Pakistan is in its primitive stage and its evolution is erratic, on one hand, and on the other, wide credit spread continues to prevail owing to weak competition faced by banking sector as a source of external financing. Furthermore, quantitative regulations are quite prevalent in Pakistan and more prudent in many aspects than other emerging economies.

Figure 2 Price-based financial frictions (see online version for colours)



Source: Data for corporate bond spread (corporate option-adjusted spread) is taken from Federal Reserve economic data; data for interest rate spread (lending rate minus deposit rate) is taken from world development indicators; graphs are constructed by authors.

Given this background, the study addresses the following research questions:

1 How do the price and quantity-based financial frictions effect the transmission mechanism of shocks compared to standard New Keynesian (NK) framework that assume financial structure irrelevance?

2 Do the different stances for fiscal and financial policies affect the way different financial frictions interplay with macroeconomic dynamics?

3 What impact financial frictions exert on the macroeconomic stabilisation by monetary authority?

The study contributes to literature in three ways. First, since NK-DSGE models have become standard tools for macroeconomic analysis, it is important to understand the transmission mechanism of shocks in context of standard NK model. Though this exercise is extensively conducted for advanced economies, (Christiano et al., 2003; Smets and Wouters, 2003; Christensen and Dib, 2008; De Graeve, 2008), its evidences for an emerging economy like Pakistan are scarce.[1] According to authors limited knowledge, the present research is amongst the first very few to compare the role and strength of financial accelerator mechanism arising from price and quantity-based financial frictions for macroeconomic fluctuations in an emerging market context.

Secondly, the research contributes to literature by investigating the ways different arrangements for macro-prudential and fiscal policies interact with financial frictions to affect macroeconomic dynamics. While the use of DSGE models with financial frictions for monetary policy analysis is extensive for advanced countries and straightforward, their use for macro-prudential and fiscal policy analysis is at evolutionary stage in advanced economies and in fact scant in EDEs.

Last but not least, the policy implications of various shocks for the standard NK DSGE model augmented with financial frictions are derived in the literature and compared it with the model where financial-structure irrelevance is assumed. The literature has probed this issue by assigning different weights to feedback variables in Taylor rule and advocated that rigorous output stabilisation, 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 for standard NK model and then compares it for different financial frictions and policy stances.

The empirical exercise of the present study follows Brzoza-Brzezina et al. (2010) in the way financial frictions *a la* BGG and *a la* KM are compared. However, the present research departs from existing literature as it compares the financial accelerator mechanism arising due to price and quantity-based financial friction for different stances of macro-prudential and fiscal policies. Along with it, the study also contributes to literature focusing on optimal policy rules with financial accelerator turned on and off, respectively.

The rest of the study is organised as follows. Section 2 presents the models and data used for the study. Section 3 presents results and discussion and Section 4 concludes the study.

2 Data and methodology

The basic model of the study is a closed economy DSGE model similar to that of Brzoza-Brzezina et al. (2010). They extended Smets and Wouters (SW, 2003) DSGE model to account for financial frictions *a la* BGG (1999) and *a la* KM (1997). 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 utilisation and Calvo-style price and wage rigidities along with incomplete indexation. Two alternatives for fiscal policy stance are considered. In first stance, fiscal policy is assumed exogenous while in second stance, government expenditures adjust counter-cyclically to debt deviation from a particular debt-to-GDP level. Second stance of fiscal policy is concomitant with fiscal rule under Fiscal Responsibility and Debt Limitation Act of Pakistan. Monetary policy in the model is conducted under Taylor rule where interest rate responds to inflation and output deviation and two stances of macro-prudential policies are considered depending on the way financial frictions are introduced in the model. In first stance, both EFP and CC are policy exogenous while in the second in EFP-based model, EFP responds counter-cyclically to credit growth while in CC type model feedback rule to loan-to-value ratio is considered. We present the log linearised version of model. We first outline the basic model without financial frictions and then describe the extension of the model that includes both types of financial accelerator mechanisms.[2]

2.1 A standard NK model without financial frictions

Households' maximisation problem is characterised with separable consumption (C_t) and labour (N_t) preferences.[3] Households maximise utility through intertemporal substitution in consumption and intra-temporal trade-off between consumption and labour. 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 consumption depends on intertemporal elasticity of substitution θ_c and habit persistence (h). The Euler equation for consumption is given as follows:

$$c_t = \frac{h}{1+h} c_{t-1} + \frac{1}{1+h} c_{t+1} - \frac{1-h}{1+h\theta_c}\left(r_t - \pi_{t+1}\right) + \frac{1-h}{1+h\theta_c}\left(\varepsilon_t^b - \varepsilon_{t+1}^B\right) \tag{1}$$

Household consumption behaviour is also subject to a preference shock ε_t^b that is defined by an AR(1) process.

Euler equation for investment is derived under the assumption that capital producer produces new capital stock K_t in the competitive market and rent it out to 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 maximisation problem of capital producer either by investing in additional capital I_t or by changing the utilisation 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:

$$i_t = \frac{1}{1+\beta} i_{t-1} + \frac{\beta}{1+\beta} i_{t+1} + \frac{\varphi}{1+\beta} q_t + \beta\varepsilon_{t+1}^I - \varepsilon_t^I \tag{2}$$

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. Investment shock ε_t^i is an exogenous AR(1) process.

Given the log-linearised standard capital accumulation equation

$$k_t = (1-\delta)k_{t-1} + \delta i_t \tag{3}$$

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 ($r_t - \pi_{t+1}$).

$$q_t = -\left(-\pi_{t+1}\right) + \frac{1-\delta}{1-\delta+\overline{r^k}} q_{t+1} + \frac{\overline{r^k}}{1-\delta+\overline{r^k}} mpk_{t+1} + \varepsilon_t^q \tag{4}$$

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.[4]

Households supply differentiated labour 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 optimise, set wages a mark-up μ_t^w over marginal rate of substitution between leisure and consumption mrs_t. Symbolically,

$$\mu_t^w = w_t - mrs_t \tag{5}$$

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

$$\begin{aligned} w_t = {} & \frac{\beta}{1+\beta} w_{t+1} + \frac{1}{1+\beta} w_{t-1} + \frac{\beta}{1+\beta} \pi_{t+1} - \frac{1+\beta_{\iota_w}}{1+\beta} \pi_{t-1} \\ & - \frac{1}{1+\beta\iota_w} \frac{1-\beta(1-\xi_w)}{\xi_w(\phi_w - 1)\varepsilon_w + 1} \mu_t^w + \varepsilon_t^w \end{aligned} \tag{6}$$

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 wages ε_t^w. The indexation of non-reoptimised 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 labour market.[5]

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.

$$y_t = \phi_p\left(\alpha k_t^s + (1-\alpha) n_t + \varepsilon_t^a\right) \tag{7}$$

where α captures the share of capital in production. Capital service k_t^s is the aggregation of existing capital stock and capital utilisation rate z_t and is given in equation below.

$$k_t^s = k_{t-1} + z_t \tag{8}$$

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

$$z_t = \frac{1-\psi}{\psi} mpk_t \tag{9}$$

where y is elasticity of utilisation cost with respect to capital inputs and mpk_t is marginal product of capital which under cost-minimisation problem takes the following form:

$$mpk_t = -\left(k_{ts}^s - n_t\right) + w_t \tag{10}$$

Marginal product of labour that also results from firm's cost minimisation problem is given below:

$$mpn_t = \alpha\left(k_t^s - n_t\right) + \varepsilon_t^a \tag{11}$$

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

$$\pi_t = \frac{\beta}{1+\beta\iota_p}\pi_{t+1} + \frac{\iota_p}{1+\beta\iota_p}\pi_{t-1} + \frac{1}{1+\beta\iota_p}\frac{1-\beta\xi_p\left(1-\xi_p\right)}{\xi_p\left(\phi_p - 1\right)\varepsilon_p + 1}\mu_t^p + \varepsilon_t^p \tag{12}$$

Equation (12) in a hybrid NK price Philips curve, where forward-looking behaviour 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 utilisation.

$$y_t = c_y c_t + i_y i_t + z_y z_t + \varepsilon_t^g \tag{13}$$

where c_y, i_y and z_y are steady state household consumption, investment and capital utilisation loss as a percentage of GDP, respectively. ε_t^g is government expenditure shock specified as $\varepsilon_t^g = \rho_{\varepsilon^g} * \varepsilon_{t-1}^g + \varepsilon_t^g$, where $\varepsilon_t^g \sim i.i.d\ N\left(0, \sigma_{\varepsilon^g}^2\right)$ and ρ_{ε^g} is coefficient of auto-covariance in exogenous AR(1) process defining the shock.

2.2 Financial frictions

2.2.1 External finance premium version

In EFP version, entrepreneurs finance their capital expenditure $q_t K_t$ using internal resources (net worth, nw_t) and bank loans b_t. Entrepreneurs face EFP, s_t, that derives a wedge between the expected return r_{t+1}^k on capital and risk free rate, r_t. The capital arbitrage conditions for entrepreneur under financial friction and resultant equation for EFP are given as follows:

$$r_{t+1}^k = \left[\frac{1-\delta}{1-\delta+\overline{r^k}}\right]q_{t+1} + \left[\frac{\overline{r^k}}{1-\delta+\overline{r^k}}\right]mpk_{t+1} - q_t \tag{14}$$

$$s_t = r_{t+1}^k - \left(r_t - \pi_{t+1}\right) \tag{15}$$

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

$$S_t = -\chi\left(n_t - q_t - k_t\right) + \varepsilon_t^{fd} \tag{16}$$

where parameter χ measures the elasticity of EFP to variation in entrepreneurial balance sheet, measured by net worth relative to capital expenditures.[6] 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:

$$nw_t = \frac{k}{nw}\left(r_t^k - {}_{t-1}r_t^k\right) + {}_{t-1}r_t^k + \theta nw_{t-1} + \varepsilon_t^{nw} \tag{17}$$

where $\frac{K}{nw}$ 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

$$c_t^e = (1-\theta)nw_t \tag{18}$$

The resource constraint modified in the following manner

$$y_t = c_y c_t + c_y^e c_t^e + i_y i_t + z_y z_t + \varepsilon_t^g \tag{19}$$

where c_y^e is steady state entrepreneurial consumption as a percentage of GDP.

2.2.2 Collateral constraint version

Entrepreneurs in CC version maximise utility from consumption and finance their consumption and capital expenditures by renting capital to intermediate good producers and bank loans. The key friction under CC version arises from the assumption that entrepreneurs need collateral to take loans. The Euler equation for entrepreneurial consumption is given as follows:

$$-\theta_c^e \frac{1}{1-h^e}\left(c_t^e - h^e c_{t-1}^e\right) = -\theta_c^e \frac{1}{1-h^e}\left(c_{t+1}^e - h^e c_t^e\right) + v\left(r_t - \pi_{t+1}\right) + (v-1)\Delta_t \tag{20}$$

Loans taken by entrepreneurs are subject to following collateral constraint.

$$b_t + r_t = m_t + q_{t+1}^k + \pi_{t+1} + k_t \tag{21}$$

where m_t is the loan-to-value ratio (LVR), which dictates the maximum permissible leverage ratio. Since both households and entrepreneurs consume, aggregate consumption is the sum of their consumption expenditures.

2.3 The policy environment

2.3.1 Monetary policy

For standard NK model, monetary policy following a Taylor rule with interest rate smoothing is assumed. Symbolically,

$$r_t = \rho_r r_{t-1} + \left(1-\rho_r\right)\rho_\pi \pi_t + \left(1-\rho_r\right)\rho_y\left(y_t - y_{t-1}\right) + \varepsilon_t^r \tag{22}$$

where ρ_r, ρ_π and ρ_y are policy coefficients specified by central bank and ε_t^r is a monetary policy shock which is an exogenous AR(1) process.

2.3.2 Macro-prudential policy

2.3.2.1 Exogenous macro-prudential tools

In this case in EFP and CC versions of model, EFP is assumed to follow equation (16) while LTV is assumed to be exogenous following an AR(1) process with i.i.d normal innovations.

2.3.2.2 Rule-based macro-prudential policy

For introducing role of macro-prudential policies, we combine a macro-prudential rule with a standard Taylor rule assuming macro-prudential authority as primary overseer of financial sector with central bank pursuing inflation targeting only.

2.3.2.3 EFP version

Following literature, macro-prudential tool is incorporated as a component of EFP and gets feedback from contemporaneous credit growth. The macro-prudential policy is also subject to an exogenous shock.

$$s_t = -\chi(n_t - q_t - k_t) + \varepsilon_t^{fd} + \tau_t \tag{23}$$

$$\tau_t = \rho_\tau(cg_t) + \varepsilon_t^\tau \tag{24}$$

where $\tau_t > 0$ and ρ_τ is feedback coefficient chosen by policy maker who may be central bank or not. The macro-prudential policy shock is entailed in ε_t^τ.

2.3.2.4 CC version

Macro-prudential policy for CC version of financial friction is given below where macro-prudential authority tends to respond to contemporaneous credit growth counter-cyclically along with LTV smoothing.

$$m_t = \rho_m m_{t-1} + (1 - \rho_m) cg_t + \varepsilon_t^m \tag{25}$$

ρ_m is feedback policy variable chosen by macro-prudential authority and ε_t^m is exogenous AR(1) process defining the shock.

2.3.3 Fiscal policy

2.3.3.1 Exogenous fiscal policy

Financial friction augmented models are examined for two stances of fiscal policy. In first stance fiscal policy enters in resource constraint as exogenous government spending shock as depicted in resource constraints given in equations (13) and (19)

2.3.3.2 Rule-based fiscal policy

In second stance of fiscal policy, government expenditure respond counter cyclically to debt growth along with smoothing fiscal expenditures overtime. Symbolically,

$$g_t = \rho_g g_{t-1} + (1-\rho_g)\rho_{yg}(y_{t-1} - y_{t-2}) + (1-\rho_g)\rho_g(debt_t - debt_{ss}) + \varepsilon_t^g \quad (26)$$

Table 1 Estimated parameters

Parameter	*Description*	*Value*	*Estimation*	*Data sources*
		Fixed		
β	Discount factor	0.998	Inverse of interest rate	Quarterly data/IMF
δ	Depreciation rate	0.025	Average of depreciation rate	Annual data/SBP and Penn World Table. Parameters adjusted for quarterly response
g	Habit persistence	0.86	GMM	Quarterly data/Hanif et al. (2013)
α	Share of capital in production	0.49	Cointegration	Annual data/coefficients adjust for quarterly response
ρ_G	Government spending smoothing	–0.1	FMOLS	Annual data. Parameters adjusted for quarterly response
ρ_{yG}	Response to output change	–0.22		
ρ_r	Interest rate smoothing	0.93	FMOLS with and without financial indicator in Taylor rule	Quarterly data/IMF
ρ_π	Response to inflation	0.14/ 0.18		
ρ_y	Response to output	0.10		
ρ_{cg}	Response to credit growth	0.05		
c_y	Consumption to GDP ratio	0.66	Average value of consumption to GDP ratio	Handbook of statistics on Pakistan Economy
i_y	Investment to GDP ratio	0.08	Average value of investment to GDP ratio	Handbook of Statistics on Pakistan Economy
g_y	Government Spending to GDP ratio	0.24	Average value of government expenditures to GDP ratio	Handbook of Statistics on Pakistan Economy

2.4 Data and estimation technique and estimated parameters' value

The parameters are divided into two sets. The first set contains the parameters which can be estimated due to the availability of observed data. The second set contains parameters for the estimation of which relevant data is not available. These parameters are obtained from existing literature in DSGE framework preferably for Pakistan and other developing countries. The data, empirical methodology and result of parameters estimated using observed data is reported in Table 1. The table contains set of parameters which are estimated along with data sources and estimation technique. Details are provided as follows.

The discount factor, β, is computed by taking the inverse of long term average quarterly interest rate. The quarterly data on interest rate is taken from International Financial Statistics. The interest rate is made real and deseasonalised. Quarterly gross interest rate has been obtained from the 4th order geometric mean of annualised net interest rate and trend/steady state in the following manner:

$$r_t = \log\left(1+\frac{r_t^{data}}{4\times 100}\right) - \log\left(1+\frac{r_{trend,t}^{data}}{4\times 100}\right)$$

This interest rate is then used to calculate discount factor by the following formula:

$$\beta = \left(\frac{1}{r_t}\right)$$

The value of discount factor is 0.998 that is consistent with steady state annualised real interest rate of 4%.

To calculate the value of depreciation rate, δ, annual data on depreciation rate is taken from Penn World Table from 2001–2017. Its average is taken to depict the average depreciation rate and is then 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%. The annual balance sheet analysis of non-financial corporation listed at Karachi Stock Exchange also revealed that depreciation rate has remained closer to 10% per annum since 2001 to 2015.

For the households' block we estimated the value of habit persistence by estimating the Euler equation in following form:

$$c_t = \gamma_0 + \gamma_1 r_t + hc_{t-1} + u_t$$

where h depicts habit persistence. The data covers the time period from 1972 Q-I to 2017Q-IV for consumption inflation and interest rate. For consumption, data has been taken from Hanif et al. (2013) till 2013 and extrapolated for the remaining quarters. The data on the interest rate and inflation has been taken from International Finance Statistics. As the model is in log linearised form, all the variables are expressed as percentage deviation from deterministic steady state. In order to make the observables consistent with variables in model, data is transformed. Specifically, at first step all the consumption is deseasonalised and transformed into log form. As consumption is a trending variable, it is detrended by using one-sided HP filter. To match inflation and interest rate with log-linearised variables in model percentage deviation of gross inflation and gross interest rate from a respective time-varying steady state/trend has been taken where quarterly gross interest rate has been obtained from the 4th order geometric mean of annualised net interest rate. Symbolically,

$$\pi_t = \log\left(\pi_t^{data}\right) - \log\left(\pi_{trend,t}^{data}\right)$$

$$r_t = \log\left(1+\frac{r_t^{data}}{4\times 100}\right) - \log\left(1+\frac{r_{trend,t}^{data}}{4\times 100}\right)$$

By applying generalised method of moments, the value of h is estimated to be 0.86.

From production block, we estimated the production function in the following form:

$$\ln Y_t = \alpha_0 + \alpha_1 \ln K_t + \alpha_2 \ln N_t + \vartheta_t$$

The annual data on output, capital stock and employment has been taken from Pakistan Economic Survey from 1980–2017. All variables are found to be integrated of order one, I(1). Consequently, cointegration technique by Johansen and Juselius (1990) has been employed. The long run coefficient of share of capital in production is estimated as 0.49. Approximately the same value has been used by Ahmed et al. (2012) and is also reported reasonable for developing countries.

Parameters pertaining to the policy block of the model are estimated using and fully modified ordinary least square (FMOLS).[7] The following equations are estimated:

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

$$g_t = \rho_g g_{t-1} + (1-\rho_g)\rho_{yg}(y_{t-1} - y_{t-2}) + (1-\rho_g)\rho_{dg}(debt_t - debt_{ss}) + \varepsilon_t^g$$

For monetary policy rule the data on interest rate and inflation has been taken from IFS and transformed as mentioned above. Fiscal policy rule is estimated using annual data taken from Pakistan Economic Survey. The results showed that government spending smoothing parameter turned out to be 0.7 while government response to lagged difference output in – 0.22 while for deviation of debt from steady state is set at 0.05. For simple Taylor rule response of interest rate to inflation is estimated to be 0.18. The interest rate smoothing parameter and response to difference output remained at 0.93 and 0.10.

2.5 Calibrations

The rest of the parameters of the study are calibrated using literature from Pakistan, developing countries and DSGE literature.

Prices are reported less sticky than wages, 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 0.40. Elasticity of substitution between different varieties of intermediate good is also set as 6, which ensures a price mark-up rate of 20%.

The value of risk aversion parameter is assumed to be closer to one in a number of DSGE models for emerging economies. Following Choudhri and Malik (2012) its value is set at 1.01. Similarly, the Frisch elasticity of labour 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 parameter 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.

In the extension to financial sector set-up, we analysed the data on net worth and interest expenses of the firms from the balance sheet of non-financial corporation and calculated it to be 17% annually. Mizen and Tsoukas (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 survival rate for entrepreneur is set to 0.99% which implies an entrepreneur lives on average for more than 24 quarters or 6 years. The response of both EFP and LTV to credit growth is taken to be 0.30with negative sign for LTV.

3 Results and discussion

This section is arranged to address the three research questions of the study. The comparison between the working and strength of financial accelerator mechanism with standard NK model is done using impulse response function. To assess the impact of exogenous and rule-based macro-prudential and fiscal policies impulse response functions are extracted and then main findings are summarised in tabular form. Lastly, the change in monetary stabilisation of the economy ascribed to financial frictions and difference policy stances are presented in form of optimal policy responses.

3.1 Financial frictions and transmission mechanism of shocks

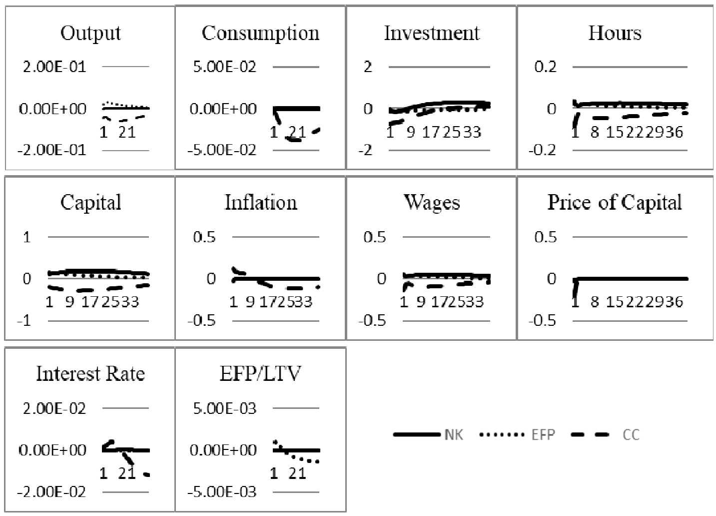
3.1.1 Fiscal policy shock

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. Fiscal expansion crowds-out private investment on impact and after the gestation lag of almost 7 quarters, investment increases, however could not induce output to increase. Response of consumption to fiscal shock also reinforces that consumption is governed by intertemporal optimisation. Government expenditures also appear not to be responsible for inflationary pressure in a model where financial frictions are not considered nor the exogenous fiscal expansion influence the monetary management of the economy.

The presence of financial frictions alters the transmission mechanism of exogenous fiscal shock in contrasting way where EFP model exhibiting a picture closer to standard NK model. The presence of EFP accelerates the government spending multiplier with positive impact on output which is very small as compared to what adhered for other EDEs (0.70) and advanced (0.8–1.5) countries (Bhattarai and Trzeciakiewicz, 2017): the reason being the ineffectiveness of expansionary fiscal shock to raise consumption and investment.

Expansionary fiscal contraction hypothesis is conspicuous in CC version of the model. The attenuation in CC version may be attributed to monetary contraction, higher inflation and decrease in the value of debt that in turn causes negative fiscal multiplier. More importantly, the results conform to theoretical work like those of Baxter and King (1993) and Linnemann and Schabert (2003) that support the view of strong negative wealth effect resulting from an increase in government demand. The strong presence of this effect leads to decrease in wages and consumption that is evident in CC version of model. Ilzetzki et al. (2010) demonstrated a statistically insignificant and/or negative response of output to government spending shock quite prevalent in developing countries. It is further asserted that through credit channel of fiscal transmission mechanism productive government spending negatively effects the spread by alleviating the cost of external financing of credit constrained entrepreneurs. For initial quarters, a fiscal shock induces EFP to increase and leverage to decrease in the model reinforcing the futility of government expenditures in Pakistan.

Figure 3 Fiscal policy shock



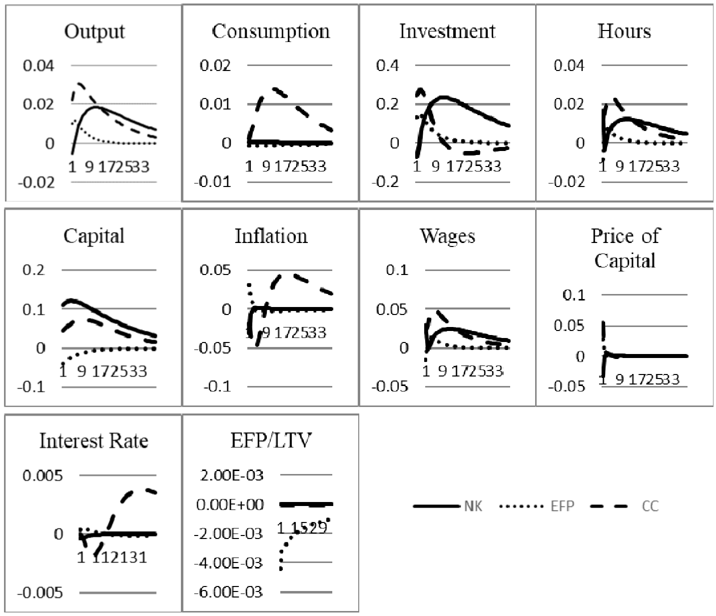
3.1.2 Productivity shock

The dynamic response of variables to a positive productivity shock depends on the type of financial friction assumed. The shock induces a hump shaped response in output and investment, and pushes consumption only slightly away from steady state in absence of financial frictions. Financial frictions enhance the favourability of positive productivity shock and turned out to be accelerating for output and investment where magnitude is high in CC version as compared to EFP version of financial frictions.

The impact of productivity shock on inflation and interest rate are contrary in both versions of model where EFP version is characterised with slight monetary contraction accompanied with increase in inflation while monetary expansion with reduction in inflation in CC versions in initial quarters while otherwise in later quarters is clearly observed. Lower level of inflation in CC version materialises in high level of consumption while for EFP version of the model an increase in inflation pushes consumption below steady state slightly.

In the CC model, lower inflation also raises the real value of loans, thus increasing leverage. Though, LTV is exogenously determined, but high price of capital relaxes the lending standards and ensures the amplified impact on macroeconomic variables already from the beginning. The alternative side of an increase in real value of loans is an increase in the real value of households' deposit. The wealth effect boosts consumption which is non-existent in NK and EFP version. With the increase in inflation in later year accompanied with higher interest rate dampens the initial expansionary spillover effect throughout the economy and becomes weaker than NK model. In EFP version of model, relaxed lending constraints in the form of lower EFP are countered with higher inflation level leading to lower leverage and a weaker macroeconomic response as compared to NK version of model.

Figure 4 Productivity shock



Our results are contrary to literature studies that reported that productivity shocks are more amplified when entrepreneurs face price-based friction. In our case quantity-based financial frictions have more pronounced amplifying effects for productivity shocks with persistence of shock being highest in standard NK model. It is demonstrated that magnitude of endogenous amplification crucially depends on the fraction of asset used as collateral and high inefficiencies in debt enforcement procedures which conforms accurately to the state of quantitative restrictions in Pakistan.

3.1.3 Monetary policy shock

Figure 5 plots the responses of major macroeconomic variable to unexpected monetary policy shock. Persistence of monetary tightening following a monetary shock is attributed to deliberate policy inertia where central bank enforces partial adjustment process on its instrument (Clarida et al., 2000). The presence of *price puzzle* also results from the influence of interest rate smoothing on inflation expectation (Woodford, 1999, 2003). It is also consistent with the dominance of 'supply channel' over 'traditional demand channel' in the transmission mechanism of monetary policy shock. A contractionary monetary policy shock induces output and investment to decline, and with peak response materialising at fourth quarter, respectively. These responses conform to conventional evidence regarding both the strength of the monetary transmission mechanism as well as the length of the average lag of the economy's response to monetary policy actions. This largely owes to some of real frictions in the economy particularly habit persistence and investment adjustment cost. Models with financial frictions largely neutralise the adversity of monetary contraction for real side of economy giving rise to non-standard results that money is neutral in presence of financial frictions. Except for the response of consumption and inflation, propagation mechanism and persistence of shocks under both models is similar and contrary to NK model.

Figure 5 Monetary policy shock

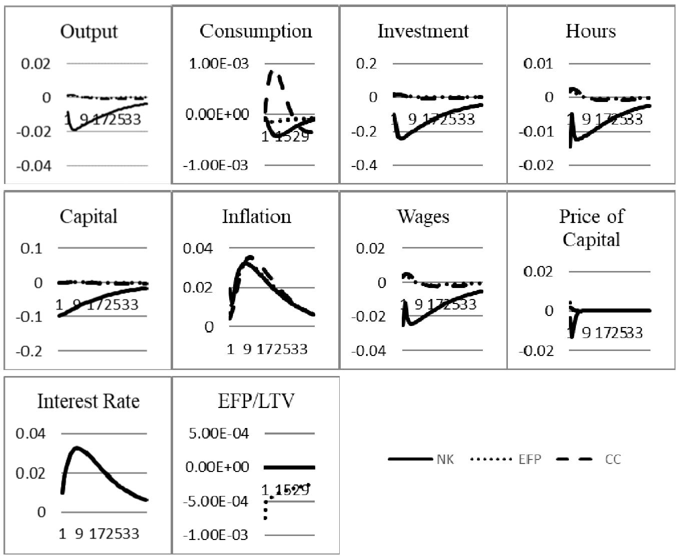
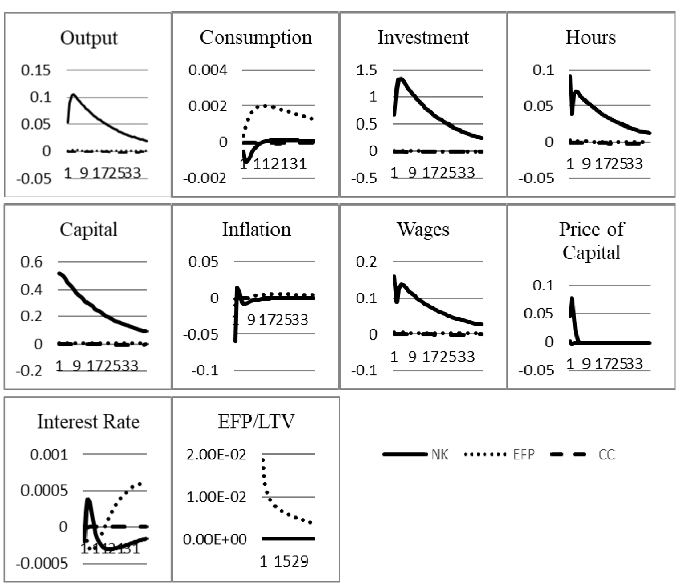


Figure 6 Price of capital shock



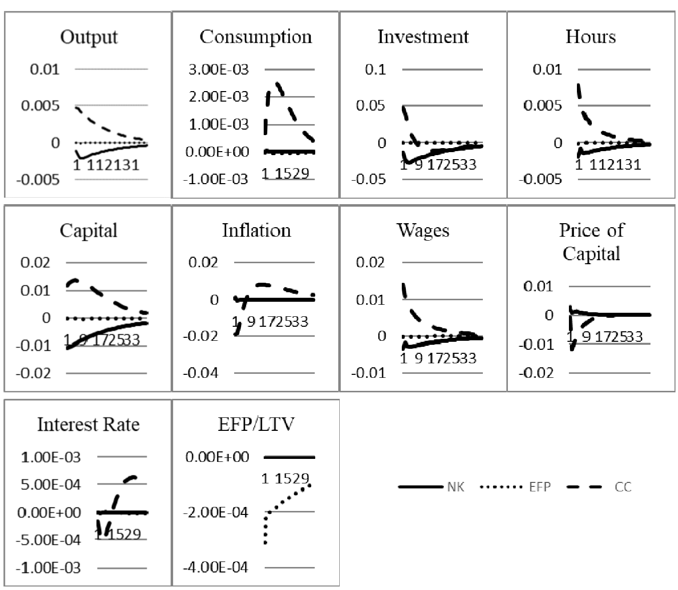
Note: Responses are percentage deviation of a variable from its steady state value.

3.1.4 Investment related shocks

A negative investment shock that materialises 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 decrease, inflation, interest rate and consumption remain fairly stable. The significant contribution of financial frictions may also be observed that completely placates the effect of investment adjustment cost for real economy in case of EFP model while becomes favourable in model with collateral constrained entrepreneurs.

This favourability partially emerges from the decline in the relative price of capital that leads to investment boom. However, results can also be contributed to expansionary monetary policy in initial quarters. The shock to the price of capital, on impact, increases investment and output in a model without financial frictions probably owing to higher value of Tobin's q. However, with financial frictions, increase in capital price is also matched with lower value of collateral and higher external finance premium leading to attenuation by limiting the amount of credit. Despite the fact that price of capital shock ignites completely contrary monetary responses in price and quantity-based financial friction, the effect on key macroeconomic variables in both versions of model is fairly similar. Like us, Christiano et al. (2014) observed that contribution of investment related shock to business cycle fluctuations diminish when EFP is introduced in the model. Similarly, Kamber et al. (2015) reported that contribution of investment specific shocks to cyclical dynamics is largely annihilated with financial frictions in the model. They also demonstrated that role of financial frictions for consumption reflects the dynamics of entrepreneurial consumption which is also evident in our case.

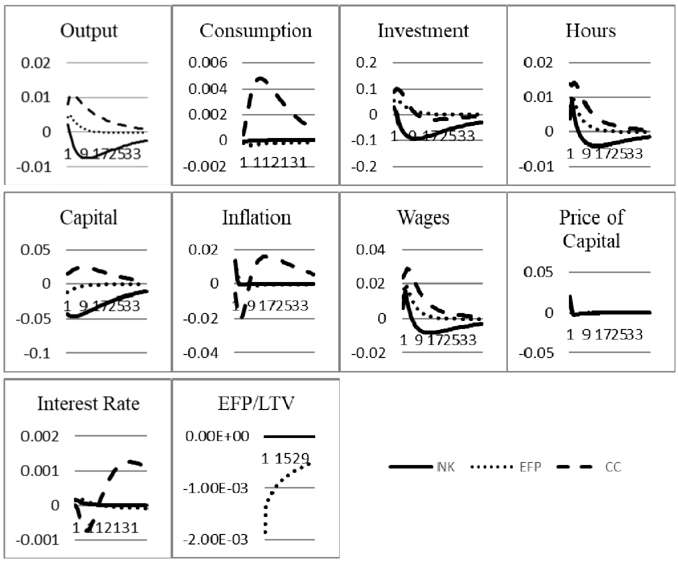
Figure 7 Investment efficiency shock



3.1.5 Mark-up shocks

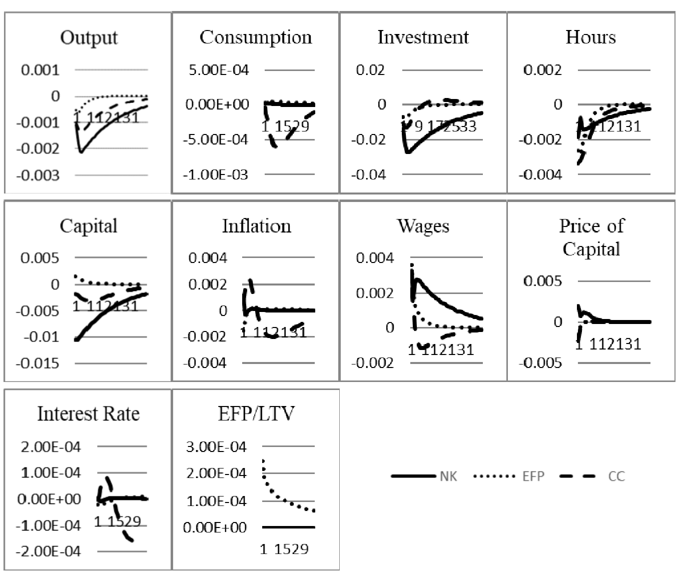
Given the current parameterisation of model, a positive cost push and price mark-up shock are generally contractionary for the output and investment in standard NK framework with contractions more severe in case of price mark-up shock.

Figure 8 Price mark-up shock



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

Figure 9 Wage mark-up shock

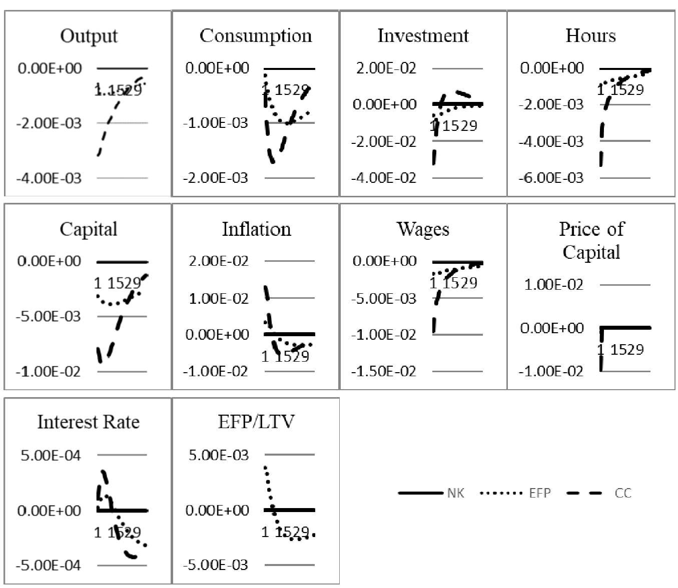


Employment increases with price mark-up shock but reduces with cost push shock with negligible effect on consumption and interest rate. Though financial frictions attenuate both mark-up shocks with higher extent of attenuation observed in case of price mark-up shocks.

3.1.6 Financial shocks

The response of macroeconomic variables to exogenous financial shocks is presented in Figure 10. These exogenous financial shock can be considered a shock to entrepreneur riskiness in EFP case while to spread in CC version of model. As far as propagation of shock is concerned, degree of comparability between these two shocks is very high. The exogenous financial shock makes borrowing more expensive by pushing constraints high, makes financial condition stringent and default probability high and resultantly reduces output. The qualitative difference in the implication of models is evident in terms of the magnitude of macroeconomic response to shock. In CC variant almost all real variables except consumption are most strongly affected on impact. In the EFP version, output consumption, and investment display an inverted hump-shaped pattern. In both models, shocks act like cost push shocks, driving output and inflation in opposite direction.

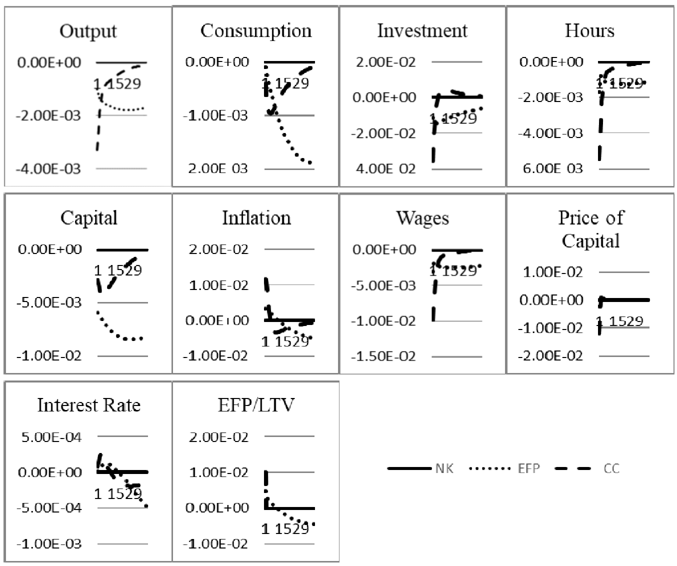
Figure 10 Exogenous financial shock



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

In Figure 11, we compare the impact of a shock to EFP and CC where both are exogenously determined. In EFP setup, it may take the form of decrease in the survival rate of entrepreneur, decreasing their stakes in investment projects, and effectively reducing their ability to attract funds. Resultantly, investment decreases and is accompanied with persistent decrease in consumption and output. The transmission of an LTV shock in the CC model is also fairly intuitive. Entrepreneurs decrease borrowing followed by a decrease in investment and consumption which reduces the output, results in capital unemployment and resultant decrease in price of capital. Again the main difference between two alternative specifications concerns how the responses are spread over time.

Figure 11 Shock to EFP/LTV



The generalised overview of results showed that response of most of the variables to shocks conforms to existing literature for the standard NK model. For the models with financial frictions it is ubiquitous that irrespective of the nature of shock (demand side, supply side and financial shocks) the response is more amplified (or attenuated) when entrepreneurs face quantitative financial restrictions. Attenuation of the shocks (either favorable or adverse) usually occurs if there arises competing use for limited credit (as in case of fiscal policy) or the price of capital is relatively irresponsive to shocks. Except for EFP shock, most of the shocks are short lived in EFP version of the model. Moreover, for most of the shocks EFP is counter-cyclical. Finally, some of the impulse responses are counterintuitive in direction. One notable example is attenuation of negative monetary shock in presence of financial frictions. Another is related to the macroeconomic expansion in CC version of model following an investment efficiency shock.

3.2 Do rule-based macro-prudential and fiscal policy affect the financial acceleration?

In this section, pertaining to the second research question of the study we investigate the implications of rule-based macro-prudential and fiscal policies for the financial accelerator of both models. In this regard, impulses obtained from exogenous macro-prudential and fiscal policies' regime are compared to rule-based policies and scrutinised on the basis of three criteria, that are, propagation, amplification [both on impact (I) and long run (LR)] and persistence of shock. The results are summarised and presented in Tables 2 and 3 while the source impulses are given in Appendix B from Figure B1 to B10 for the first case and Figures C1 to C10 for the second.

Table 2 Price-based financial frictions and policy stances

Variables	*Propagation*		*Amplification*		*Persist*	*Propagation*		*Amplification*		*Persist*
	I	*LR*	*I*	*LR*		*I*	*LR*	*I*	*LR*	
	Fiscal shock					*Productivity shock*				
Output			≡			↔	↔	↑	↔	↔
Consumption	+ → –	↔	↑	↔	↓	↔	+ → –	↑	↑	↓
Investment			≡			↔	↔	↑	↔	↔
Hours			≡			↔	↔	↑	↔	↔
Capital			≡					≡		
Inflation	↔	↔	↑	↑	↔	↔	↔	↓	↔	↔
Wages			≡					≡		
Price of capital	-→ +	↔	↑	↔	↔	≡				
Interest rate	↔	↔	↑	↑	↑	↔	↔	↓	↓	↓
	Price of capital shock					*Investment efficiency shock*				
Output	+ → –	↔	↑	↔	↔	– → +	↔	↓	↓	↑
Consumption	+ → –	↔	↓	↓	↓	+ → –	↔	↓	↓	↓
Investment	+ → –	↔	↓	↔	↔	– → +	↔	↓	↔	↔
Hours	+ → –	↔	↓	↔	↔	– → +	↔	↓	↔	↔
Capital	↔	+ → –	↓	↓	↓	↔	– → +	↓	↓	↓
Inflation	– → +	↔	↑	↔	↔	+ → –	– → +	↓	↑	↑
Wages	+ → –	↔	↑	↔	↔	– → +	↔	↓	↔	↔
Price of capital	+ → –	↔	↑	↔	↔	↔	↔	↓	↔	↔
Interest rate	+ → –	↔	↑	↓	↓	+ → –	+ → –	↓	↓	↓

Notes: I = on impact; LR = long-run. ↔ = similar; ↑ = amplification ; ↓ = attenuation; + → – = positive to negative; – → + = negative to positive.

Table 2 Price-based financial frictions and policy stances (continued)

Variables	*Propagation*		*Amplification*		*Persist*	*Propagation*		*Amplification*		*Persist*
	I	*LR*	*I*	*LR*		*I*	*LR*	*I*	*LR*	
	Wage mark-up shock					*Price mark-up shock*				
Output	↔	↔	↑	↔	↔	↔	↔	↑	↔	↔
Consumption	↔	+ → –	↓	↓	↓	↔	– → +	↓	↓	↓
Investment	↔	↔	↑	↔	↔	↔	↔	↑	↔	↔
Hours			≡					≡		
Capital			≡			↔	↔	↔	↓	↔
Inflation	↔	↔	↓	↓	↓	↔	↔	↔	↔	↓
Wages			≡					≡		
Price of capital	↔	↔	↑	↔	↔	↔	↔	↑	↔	↔
Interest rate	↔	↔	↑	↓	↓	↔	↔	↓	↓	↓
	Monetary shock					*Financial shock*				
Output	↔	↔	↑	↔	↔	– → +	↔	↓	↓	↓
Consumption	– → +	+ → –	↑	↑	↑	– → +	↔	↓	↓	↓
Investment	↔	↔	↑	↔	↔	– → +	↔	↓	↔	↔
Hours	↔	↔	↑	↔	↔	– → +	↔	↓	↔	↔
Capital	↔	↔	↑	↓	↓	↔	– → +	↓	↓	↓
Inflation			≡			+ → –	– → +	↓	↑	↑
Wages	↔	↔	↑	↔	↔	– → +	↔	↓	↔	↔
Price of capital	↔	↔	↑	↔	↔	+ → –	+ → –	↓	↑	↓
interest rate			≡					≡		

Notes: I = on impact; LR = long-run. ↔ = similar; ↑ = amplification ; ↓ = attenuation; + → – = positive to negative; – → + = negative to positive.

Table 3 Quantity-based financial frictions and policy stances

Variables	*Propagation*		*Amplification*		*Persist*	*Propagation*		*Amplification*		*Persist*
	I	*LR*	*I*	*LR*		*I*	*LR*	*I*	*LR*	
	Fiscal shock					*Productivity shock*				
Output	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Consumption	↔	↔	↓	↔	↔	↔	↔	↔	↓	↔
Investment	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Hours	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Capital	↔	↔	↓	↔	↔	↔	↔	↔	↓	↔
Inflation	↔	↔	↓	↔	↔	-→+	↔	↓	↔	↔
Wages	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Price of capital	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Interest rate	↔	↔	↓	↔	↔	↔	↔	↔	↓	↔
	Price of capital shock					*Investment efficiency shock*				
Output	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Consumption	↔	↔	↓	↓	↓	↔	↔	↔	↓	↔
Investment	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Hours	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Capital			≡			↔	↔	↓	↔	↔
Inflation	↔	↔	↓	↓	↔	↔	↔	↓	↔	↔
Wages	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Price of capital	↔	↔	↓	↔	↔			≡		
Interest rate	+→-	↔	↓	↓	↓	↔	↔	↔	↓	↔

Notes: I = on impact; LR = long run. ↔ = similar; ↑ = amplification; ↓ = attenuation; + → – = positive to negative; – → + = negative to positive.

Table 3 Quantity-based financial frictions and policy stances (continued)

Variables	*Propagation*		*Amplification*		*Persist*	*Propagation*		*Amplification*		*Persist*
	I	*LR*	*I*	*LR*		*I*	*LR*	*I*	*LR*	
	Fiscal Shock					*Productivity Shock*				
	Wage mark-up shock					*Price mark-up shock*				
Output	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Consumption	↔	↔	↓	↔	↔	↔	↔	↔	↓	↔
Investment	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Hours	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Capital	↔	↔	↓	↔	↔	↔	↔	↓	↓	↔
Inflation	↔	↔	↓	↓	↓	↔	↔	↔	↓	↔
Wages			≡			↔	↔	↓	↔	↔
Price of capital	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Interest rate	↔	↔	↑	↓	↔	↔	↔	↑	↓	↔
	Monetary shock					*Financial shock*				
Output	↔	↔	↓	↔	↔	↔	↔	↑	↑	↑
Consumption	↔	↔	↔	↓	↔	↔	↔	↑	↑	↑
Investment	↔	↔	↓	↔	↔	↔	↔	↑	↑	↔
Hours	↔	↔	↓	↔	↔	↔	↔	↑	↑	↔
Capital	↔	↔	↔	↓	↔	↔	↔	↑	↑	↑
Inflation			≡			↔	↔	↑	↑	↔
Wages	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Price of capital	↔	↔	↓	↔	↔	↔	↔	↓	↔	↔
Interest rate			≡			↔	↔	↔	↑	↑

Notes: I = on impact; LR = long run. ↔ = similar; ↑ = amplification; ↓ = attenuation; + → – = positive to negative; – → + = negative to positive.

Several differences appear in the working of financial accelerator arising from price and quantity-based financial frictions in EFP and CC variants respectively, when rule-based polices are assumed. These differences are generalised as follows. Firstly, with a switch to rule-based policies, propagation of shocks both on impact and in long run irrespective to the type of shocks and variables, remains unaltered, when entrepreneurs are credit constrained quantitatively. However, when price-based frictions are assumed, investment related and financial shocks significantly alter the on impact response of variables considered. Secondly, as far as amplification of shocks is concerned rule-based policies decelerate the on impact response of all shocks except financial shock for most of the variables where magnitude of deceleration is very low. Moreover, the attenuation in long run is hardly observed for any shock in CC version of model. The EFP model in this regard produces strikingly different results. Impact acceleration (attenuation) is not only common during shocks but also spread over longer run. Broadly speaking, considering rule-based policies under EFP framework attenuates the adversity of negative shocks (except monetary policy shock) and enhances the favorability of positive shocks (with some exceptions). Thirdly, persistence of shocks in CC variant is unanimous in exogenous and rule-based policy regimes. This is not the case for EFP version of model where shocks are quickly mitigated under rule-based policies.

3.3 Does financial accelerator affect optimal policy responses in monetary feedback rule?

Table 4 contains the optimal policy response against each shock for standard NK, EFP and CC models. Basic purpose of this exercise is to investigate how for different financial frictions, monetary authority stabilises inflation and output under optimal policy setup. Exercise is then repeated for rule-based macro-prudential and fiscal policies.

Table 4 Optimal policy responses

Shocks	*Parameters*	*Estimated/ calibrated*	*NK*	*Exogenous*		*Rule-based*	
				EFP	*CC*	*EFP*	*CC*
Preference shock	ρ_π	0.18	0.63	0.05	0.05	0.15	-8.7
	ρ_y	0.10	0.02	0.10	0.09	0.10	0.08
	ρ_r	0.93	0.27	0.99	0.99	0.91	0.90
	ρ_{yG}	–0.22				–0.20	0.07
	ρ_{gd}	–0.05				–0.05	–0.05
	ρ_{cg}	0.3				0.34	3.53
Productivity shock	ρ_π	0.18	0.37	0.11	0.07	0.14	0.07
	ρ_y	0.10	0.30	0.08	0.10	0.10	0.10
	ρ_r	0.93	0.04	0.99	0.99	0.93	0.99
	ρ_{yG}	–0.22				–0.16	–0.21
	ρ_{gd}	–0.05				–0.05	–0.05
	ρ_{cg}	0.3				–0.59	0.35

Source: Optimal policy parameters are obtained from optimal simple rule program of Dynare

Table 4 Optimal policy responses (continued)

Shocks	*Parameters*	*Estimated/ calibrated*	*NK*	*Exogenous*		*Rule-Based*	
				EFP	*CC*	*EFP*	*CC*
Fiscal shock	ρ_π	0.18	0.74	–0.13	0.043	0.12	–3.70
	ρ_y	0.10	0.33	–0.24	0.10	0.09	0.13
	ρ_r	0.93	–0.73	0.97	0.99	0.97	0.18
	ρ_{yG}	–0.22				–0.04	–0.06
	ρ_{gd}	–0.05				0.07	–0.09
	ρ_{cg}	0.3				–0.16	1.62
Price mark-up shock	ρ_π	0.18	0.36	0.11	0.07	0.13	0.08
	ρ_y	0.10	0.29	0.08	0.10	0.10	0.10
	ρ_r	0.93	0.07	0.99	0.99	0.94	0.99
	ρ_{yG}	–0.22				–0.15	–0.21
	ρ_{gd}	–0.05				–0.05	–0.05
	ρ_{cg}	0.3				0.59	0.36
Cost-push shock	ρ_π	0.18	0.38	0.11	0.06	0.13	–2.16
	ρ_y	0.10	0.31	0.1	0.10	0.10	0.17
	ρ_r	0.93	–0.01	0.9	0.99	0.93	0.52
	ρ_{yG}	–0.22				–0.15	0.09
	ρ_{gd}	–0.05				–0.05	–0.05
	ρ_{cg}	0.3				–0.54	1.5
Investment shock	ρ_π	0.18	0.82	0.007	0.09	0.14	0.09
	ρ_y	0.10	–0.04	0.11	0.10	0.10	0.10
	ρ_r	0.93	–0.20	0.98	0.99	0.92	0.99
	ρ_{yG}	–0.22				–0.21	–0.21
	ρ_{gd}	–0.05				–0.05	–0.05
	ρ_{cg}	0.3				–0.24	0.37
Capital price shock	ρ_π	0.18	0.71	–0.03	0.14	0.14	0.14
	ρ_y	0.10	–0.23	–0.14	0.10	0.10	0.1
	ρ_r	0.93	–0.83	0.9	0.93	0.92	0.93
	ρ_{yG}	–0.22				–0.21	–0.22
	ρ_{gd}	–0.05				–0.05	–0.05
	ρ_{cg}	0.3				–0.10	0.3
Monetary shock	ρ_π	0.18	0.09	–0.005	–0.01	0.004	–0.005
	ρ_y	0.10	0.10	0.10	0.1	0.10	0.10
	ρ_r	0.93	0.37	–0.85	–0.89	–0.74	–0.80
	ρ_{yG}	–0.22				–0.21	–0.22
	ρ_{gd}	–0.05				–0.05	–0.05
	ρ_{cg}	0.3				0.26	0.30

Source: Optimal policy parameters are obtained from optimal simple rule program of Dynare

As compared to observed policy practices, productivity shocks are dealt by relatively more aggressive inflation and output stabilisation and less interest rate smoothing under optimal policy setup for standard NK model. A contrary situation can be observed when financial frictions are assumed. Optimal policy adheres to less rigorous inflation and output stabilisation then observed practices and more interest rate smoothing with financial frictions turned on. With rule-based policies assumed, optimal monetary policy corresponds largely to observed policy, optimal fiscal policy with government spending counter-cyclical to output growth of lower magnitude and a rigorous pro-cyclical macro-prudential policy are adhered by EFP variant. In CC variant, under rule-based policy regime, productivity shocks are countered with excessive interest rate smoothing with no notable difference in macro-prudential and fiscal policy under optimal setup as compared to observed practices. It is worth observing that for all kinds of shocks having direct bearings for entrepreneurs, neither the remarkable difference can be discerned in the optimal policy parameters under exogenous and rule-based policy regimes in CC variant nor the observed macro-prudential and fiscal policies' feedback parameters diverge from optimal policy rules. Moreover, stabilisation usually relies on excess interest rate smoothing.

Monetary authority sets inflation and output feedback parameters substantially high in optimal policy setup when expansionary fiscal shock hits the economy. A policy reversal can also be observed in this regard where interest rate responds counter cyclically to its previous value. With financial accelerator turned on, price-based financial frictions require monetary policy to be pro-cyclical to inflation and output growth with higher interest rate smoothing while quantitative financial restriction again suggests very high interest rate inertia under exogenous policies' regime. With rule-based policies, the optimal rule for both fiscal and macro-prudential policies change substantially along with remarkable difference in monetary management of economy under CC variant. In EFP version, a fiscal expansion leads to less output stabilisation and pro-cyclicality of government spending to government debt. Moreover, optimal macro-prudential policy also tends to be pro-cyclical in face of fiscal shock. Increase in government spending requires interest rate to decrease with piling inflationary pressure with marginal interest rate smoothing in CC version of model. Optimal weights on output in government spending feedback rule also falls with a very stern counter-cyclical macro-prudential policy.

Price mark-up shocks are dealt under optimal policy set up similar to productivity shock in all models. The similarity in the optimal rules under CC variant is also notable for cost push and fiscal shock with rule-based policies. Optimal parameters of fiscal and monetary policy for both cost push and price mark-up shocks are similar in EFP version while macro-prudential tool behaving pro-cyclically in former and counter cyclically in case of later shock.

In face of investment related shocks, aggressive inflation stabilisation, a countercyclical response of interest rate to output growth and policy reversal under optimal set-up is obtained. Where inflation stabilisation has high weight in case of investment efficiency shock and counter cyclicality of interest rate and magnitude of policy reversal is high in case of price of capital shock. Both shocks are dealt similarly in CC variant irrespective of policy stance assumed. In EFP version investment efficiency shock causes excessive interest rate smoothing with relaxed inflation stabilisation while capital price shock leads to counter cyclical monetary management of inflation and output growth.

Optimal policy rule in face of monetary shock requires interest rate inertia to be low for standard NK model while for EFP and CC variant it requires a policy reversal of high magnitude with counter cyclical inflation stabilisation. With rule-based fiscal and macro-prudential policy stance, no notable difference is observed in optimal policy parameters except interest rate responding pro-cyclically to inflation in EFP version.

4 Conclusions and recommendations

With respect to an emerging economy, a noteworthy finding of the study is the considerable importance of price and quantity-based financial frictions for the extent and persistence of macroeconomic fluctuations. Consequently, these frictions become pivotal not only to the financial policy analysis but also to the other policies that are considered effective for demand management. The results clearly indicate that quantity-based financial frictions impede the transmission of stabilisation policies and, therefore, exacerbate macroeconomic fluctuations in face of both demand and supply side shocks. It is also evident that the presence of these frictions completely disrupts the feedback loop of monetary policy rule. Switching to rule-based fiscal and financial policies also adds to the persistence of macroeconomic fluctuations in presence of quantitative credit constraints.

These findings have very important policy implications. All over the world, the central banks in EDEs are striving to identify the factors that could facilitate the transmission of monetary policy actions and increase its effectiveness. In this regard, two major advancements have already been materialised:

1 abandoning the discretion in the implementation of monetary policy

2 handling the nominal rigidities.

On the basis of findings of this research we conjecture that along with switching to rule-based policy and effective management of nominal rigidities, quantitative controls in credit markets should be monitored very vigilantly for the effective working of monetary policy.

This is also true for fiscal and financial policies. Many EDEs are striving to attain sustainable budgetary position and financial stability primarily to lessen macroeconomic uncertainties. This end can be achieved by reducing the policy uncertainty associated with discretionary actions of fiscal and financial authorities and opting for rules in policy implementation. However, the results showed that presence of quantity controls may keep the policy uncertainty noticeable even after the regime switching, thus, completely undermining the policy makers' efforts to achieve sustainability and stability. This implies that quantitative controls being the discretionary policy interventions largely conciliate the possible effects rule-based fiscal and macro-prudential policies can exert on macroeconomy. For the monetary channel of fiscal and macro-prudential rule-based policies to be active, unconventional monetary policy interventions or quantity-based financial frictions have to be elevated. Another important aspect in this regard is the coordination among different demand management policies which becomes essentially weak in the presence of quantity-based financial frictions.

Interestingly, financial frictions assumed in the study have been used as tools (in broader perspective) by Central Banks, with credit constraint as unconventional and spread (being proxy of EFP) as conventional tools of monetary policy. With this hindsight, the strength and magnitude of accelerator mechanism generated by credit quantity controls depicts the significance of unconventional monetary tools for determining the macroeconomic behaviour. Exercising the direct controls on the volume of credit requires policy rate to be highly inertial as adhered by optimal monetary policy commitments making policy rate ineffective to shape macroeconomic behaviour. This is also depicted in the transmission mechanism of monetary policy shock where monetary contraction is largely mitigated in presence of financial frictions.

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Notes

1 Haider and Khan (2008) and Ahmed et al. (2012) and its estimated version (Ahmed et al., 2017).

2 For full-blown exposition of model, we refer the readers to Smets and Wouters (2003).

3 In log-linearised form of model, these variables will appear in small letters.

4 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.

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

6 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).

7 Though OLS estimators are super consistent when there exists a cointegrating relationship yet for small samples the convergence of OLS estimators can be low. Moreover, FMOLS take care of endogeneity and use White heteroscedasticity errors.

Appendix A

Calibrations

Table A1 Parameters of the models

Parameter	*Description*	*Value*	*Estimation*	*Data/reference*
		Fixed		
β	Discount factor	0.998	Data	Quarterly Data/IMF
δ	Depreciation rate	0.025	Data	Annual data/SBP and Penn world table. Parameters adjusted for quarterly response
		Households		
h	Habit persistence	0.86	GMM	Quarterly data, Hanif et al. (2013)
θ_c	Intertemporal elasticity of substitution	1.01	Literature	Choudhri and Malik (2012)
θ_n	Frisch elasticity of labour supply	2	Literature	
ι_w	Degree of wage indexation	0.36	Literature	Ahmed et al. (2012)
ξ_w	Degree of wage stickiness	0.75	Literature	
ϕ_w	Proportion of sticky wages	0.15	Literature	
ε_w	Curvature of Dixit-Stigler aggregator	6	Literature	Choudhri and Malik (2012)
		Producers		
α	Share of capital in production	0.49	Cointegration	Annual data/coefficients adjust for quarterly response
ϕ_p	share of fixed cost in production	0.5	Literature	
ψ	Elasticity of capital utilisation	0.54	Literature	
ι_p	Degree of price indexation	0	Literature	Choudhri and Malik (2012)
ξ_p	Degree of price stickiness	0.70	Literature	Choudhri and Malik (2012)
ϕ_p	Proportion of sticky prices	0.08	Literature	Ahmed et al. (2012)
ε_p	Curvature of Dixit-Stigler aggregator	6	Literature	Choudhri and Malik (2012)
φ	Curvature of adjustment cost function	4		
		Policy rule		
ρ_G	Government spending smoothing	-0.1	FMOLS	Annual data. Parameters adjusted for quarterly response
ρ_{yG}	Response to output change	-0.22		

Table A1 Parameters of the models (continued)

Parameter	*Description*	*Value*	*Estimation*	*Data/reference*
		Policy rule		
ρ_r	Interest rate smoothing	0.93	FMOLS with and without financial indicator in Taylor rule	Quarterly data/IMF
ρ_π	Response to inflation	0.14/ 0.18		
ρ_y	Response to output	0.10		
ρ_{cg}	Response to credit growth	0.05		
		Financial frictions		
χ	Elasticity of EFP with respect to leverage	0.041	Literature	Mizen and Soukas (2012)
θ	Entrepreneurial survival rate	0.01	Literature	Bernanke et al. (1999)
		Steady state values in model economy		
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 utilisation	0.01	Literature	
g_y	Government spending to GDP ratio	0.24	Data	Handbook of statistics on Pakistan Economy

Appendix B

Price-based financial frictions and rule-based policies

Figure B1 Fiscal policy shock

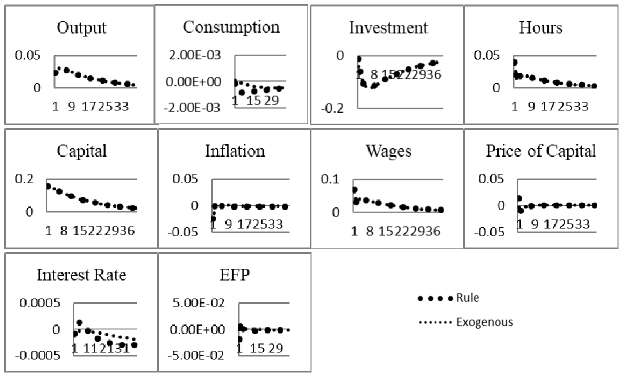


Figure B2 Preference shock

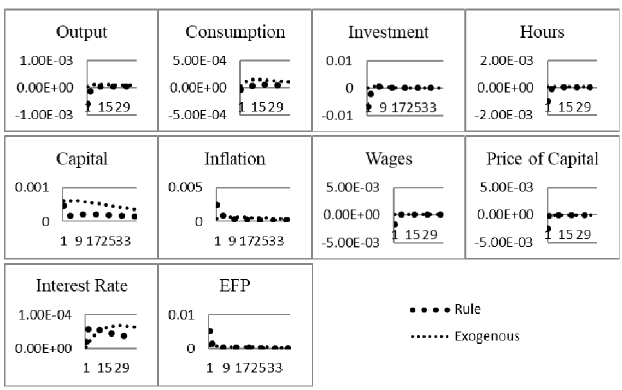


Figure B3 Productivity shocks

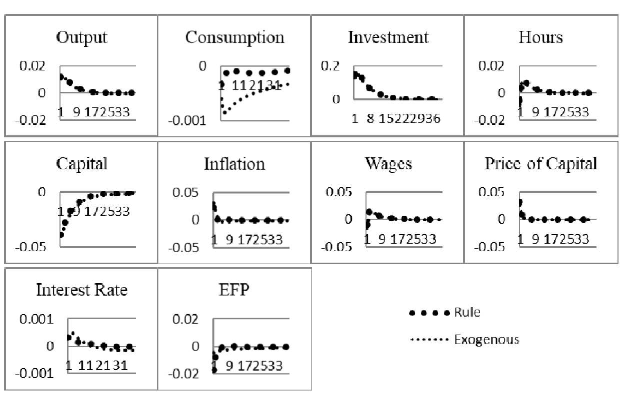


Figure B4 Price of capital shock

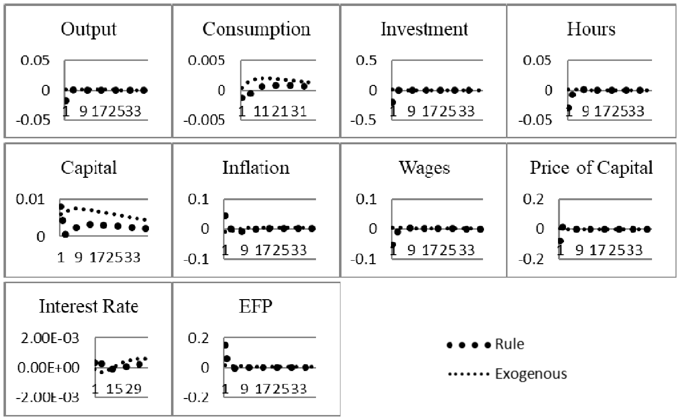


Figure B5 Investment efficiency shock

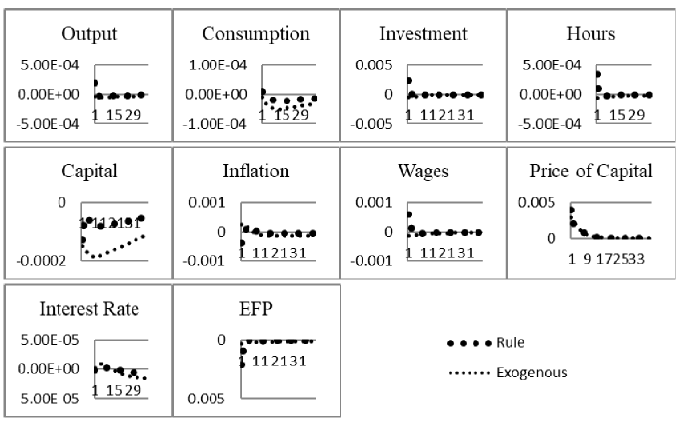


Figure B6 Wage mark-up shock

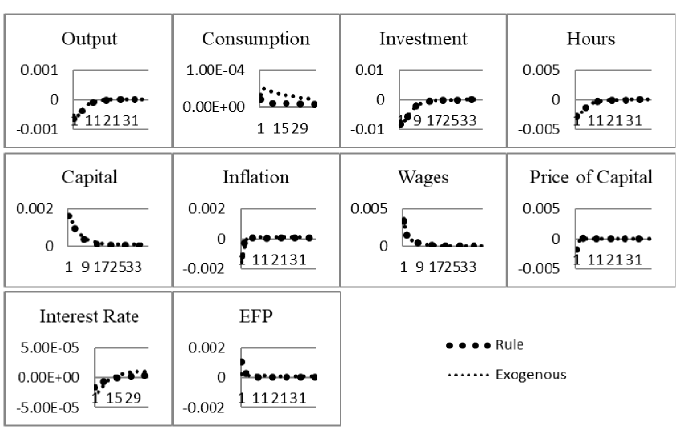


Figure B7 Price mark-up shock

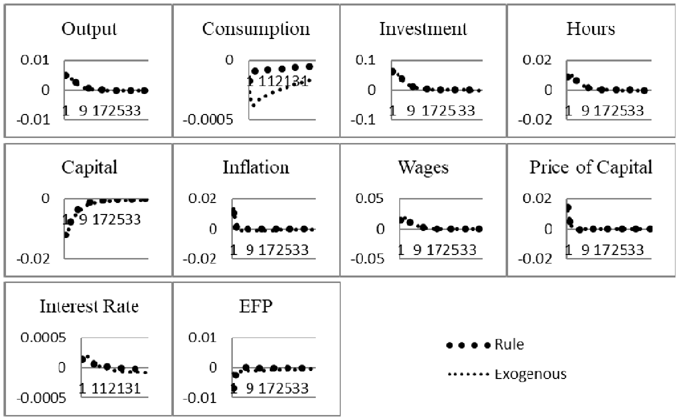


Figure B8 Monetary policy shock

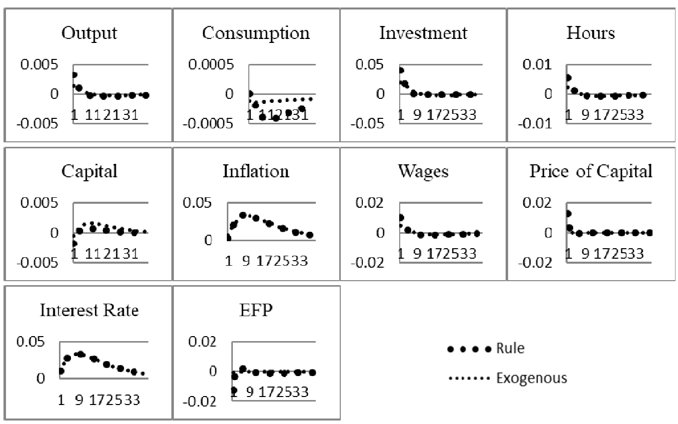


Figure B9 EFP shock

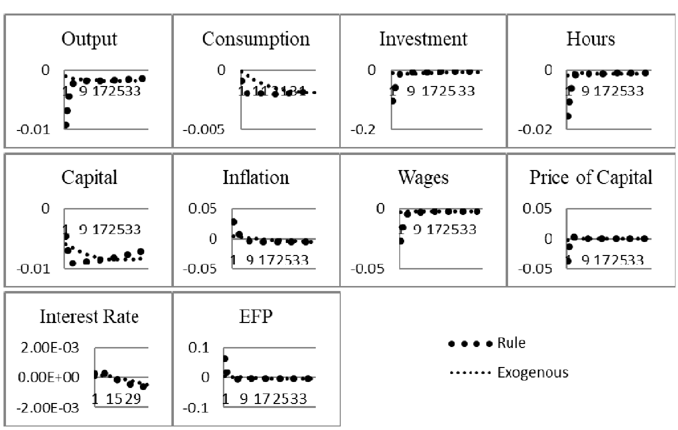
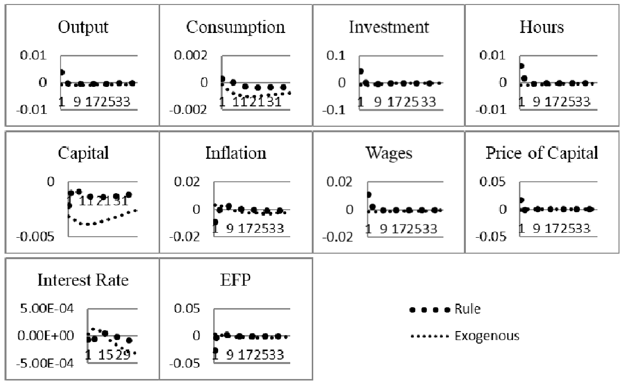


Figure B10 Financial shock



Appendix C

Quantity-based financial frictions and rule-based policies

Figure C1 Fiscal policy shock

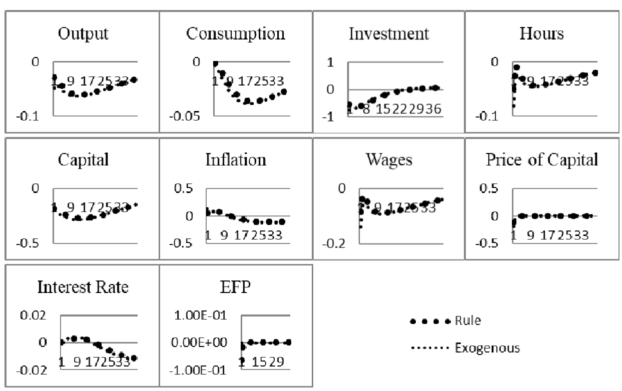


Figure C2 Preference shock

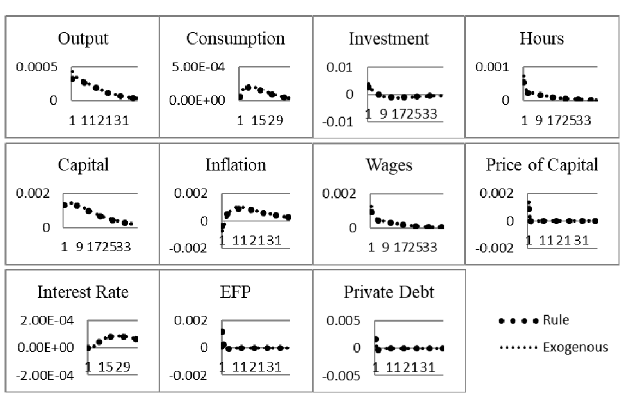


Figure C3 Monetary policy shock

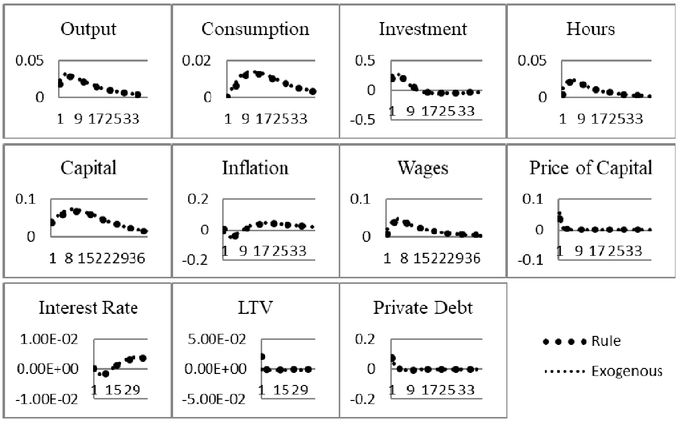


Figure C4 Price of capital shock

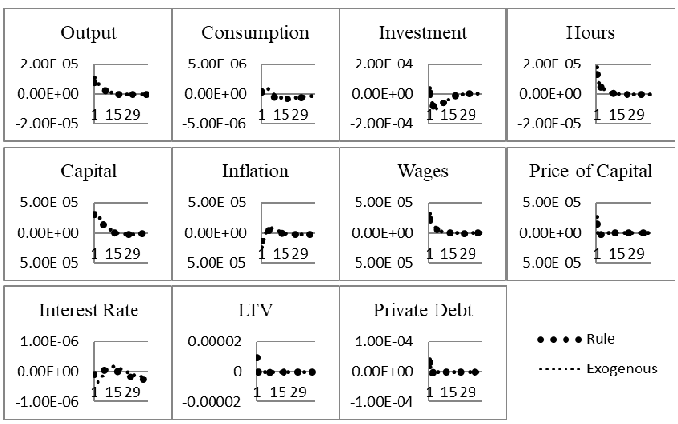


Figure C5 Investment efficiency shock

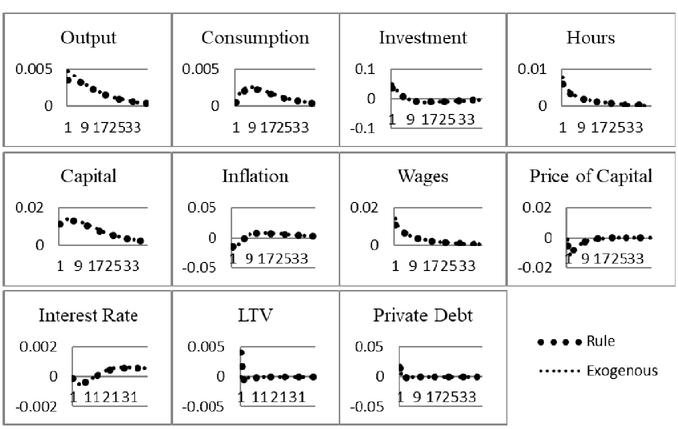


Figure C6 Wage mark-up shock

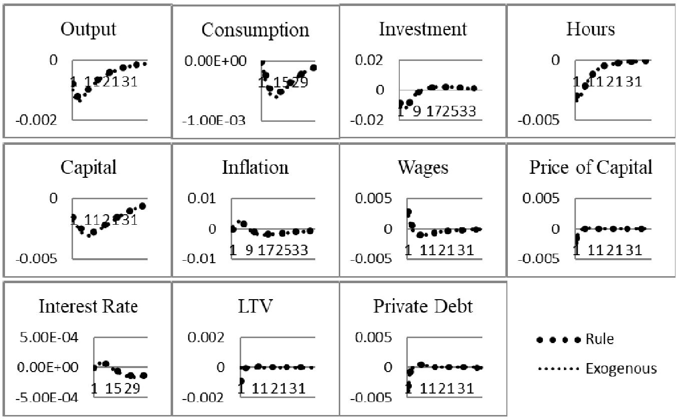


Figure C7 Price mark-up shock

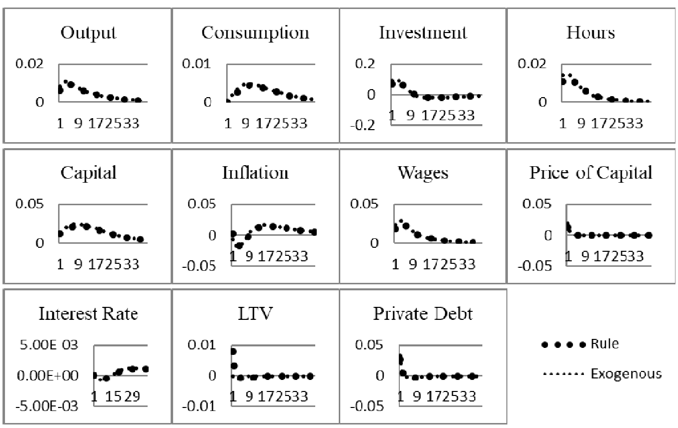


Figure C8 Monetary policy shock

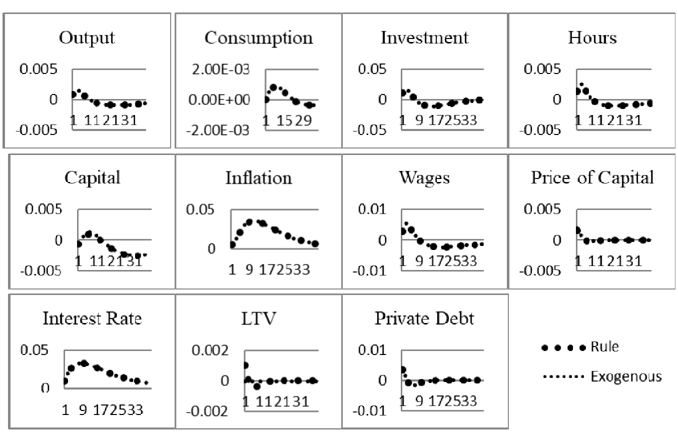


Figure C9 LTV shock

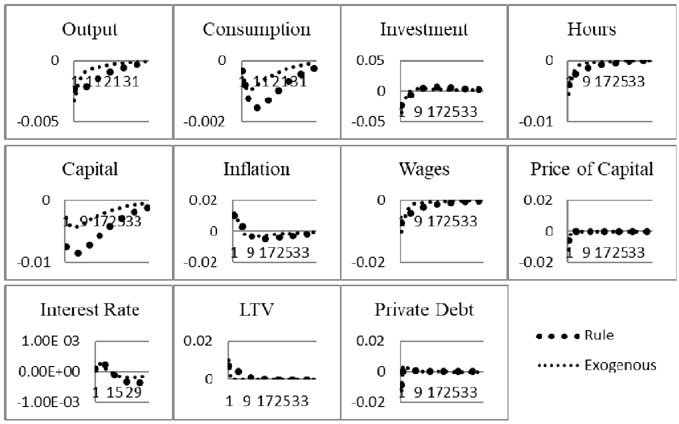


Figure C10 Financial shock