6. FINANCIAL SEGMENTATION AND TRANSMISSION OF MONETARY AND REAL SHOCKS: IMPLICATIONS FOR CONSUMPTION, LABOUR, AND CREDIT DISTRIBUTION

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Abstract

The study examines the transmission mechanism of domestic and foreign monetary policy shocks in an economy with financial segmentation. We address how local and international shocks affect the users of formal and informal finance in terms of consumption, labour, and credit in a New-Keynesian Dynamic Stochastic General Equilibrium Model. We demonstrated that domestic monetary policy is less successful when the formal financial sector competes with the informal sector for lending. For foreign monetary policy shock, formal financial sector provides the complete hedge. The study also showed that informal loans are considered inferior means of financing for informal borrowers. It is recommended that incorporating feedback from the informal sector in the conduct of monetary policy is expected to improve its understanding and hence, effectiveness.

***Keywords**: Financial sector, Informal Financial sector, Monetary Policy, DSGE Modelling, Simulations*

***JEL Classification:** E44 E27 G21*

1. Introduction

In contemporary economies, the financial sector holds a central position owing to its multifaceted activities. Along with its primary role in the allocation of financial resources and smooth conduct of economic transactions, over time, it has also gained prominence for its role as the transmitter of monetary and other shocks to the macroeconomy. Consequently, mainstream macroeconomic models are evolving to incorporate different features of the financial sector (Curdia & Woodford, 2016; Gertler & Karadi, 2011; Gertler *et al.*, 2012) and exploring their implications for economic activities (Lacoviello, 2005, Gertler & Karadi, 2011, Gerali *et al.* 2010, Yang, 2019). Notwithstanding this theoretical development, these models are limited in their representation and

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application of some of the peculiarities associated with the financial sector of developing economies. One such dimension is financial dualism/segmentation, that is, the co-existence of formal and informal financial sectors.

Despite the policy precedence on increasing financial inclusion at the international level, the size of the informal financial sector remained sheer in developing economies, rendering its implications non-trivial for the economy. Being unrecorded in official transactions, its existence effectively underestimates the volume of financial transactions bringing into question the timing and the effect of monetary policy (Ngalawa and Viegi, 2011). More specifically, any attempt by the monetary authority to restrict deposit creation by raising the policy rate may only shift the share of deposits from the formal to the informal sector with negligible impact on overall deposit creation (Xiao, 2020). The potential shift in the credit share could cause retail interest rates in the formal system to be less responsive to the policy rate, consequently, undermining the policy efforts for economic management (Ayisi, 2016).

As far as resource mobilization and the welfare role of finance are concerned, recent evidence is leading to a shift perception of informal finance from being exploitative to complementary to formal finance (Atieno, 2001). This complementarity may arise since a sufficient amount of formal credit constitutes the informal sector's liabilities (Rahman, 1992). Interestingly, this complementarity in the service provision by formal and informal sectors co-exists with substitutability between these two types of finances for service consumers, which limits borrowers' usage of formal finance (Madestam, 2014). Due to this conflicting relationship at provision and consumption levels, respectively, welfare and resource distribution between consumers of formal and informal finance are becoming increasingly crucial in determining the true impact of local and international shocks.

Although important, empirical evidence examining the nature of the relationship between formal and informal financial activities is sparse and disparate. The economic implications of the informal financial sector depend on the sensitivity of informal finance to formal financial activities as well as its response to monetary and macroprudential regulatory actions. Moreover, when financial dualism is taken into consideration, consumption, working hours, and credit distribution, among different economic agents, can differ dramatically.

According to Anyanwu *et al.* (2020), households that engage in informal financial activities have a higher degree of welfare due to easier access to credit. The implications of informal finance in an open economy setting are likewise a substantial study gap. The following objectives are pursued in this study due to the scarcity of evidence.

To begin, the study compares the monetary transmission mechanism (MTM) of a standard DSGE model without informal financial intermediation with the MTM of a model with informal financial intermediation in both closed and open economy settings. Moreover, the MTM is also analyzed for both domestic and foreign monetary policy. The second objective of the study is to look at how different shocks affect consumption, working hours, and credit distribution among economic agents who are differentiated by their interactions with the formal and informal financial sectors. The analysis is conducted for both domestic (productivity and financial) and foreign shocks (productivity and exchange rate).

This study is related to two strands of literature and contributes to both respective constituents. First, it adds to work that views informal lenders either as bank competitors (Jain and Mansuri, 2003) or as a channel of bank funds (Hoff and Stiglitz, 1998). There are very few studies incorporating both roles of informal sectors simultaneously in a framework (Madestam, 2014). On the one hand, by linking the formal and informal sectors vertically in a standard DSGE model, this study introduces the informal sector as a channel of bank funds. On the other hand, by imposing an endogenous constraint on formal borrowing, this study accounts for informal finance as a substitute for formal finance. This study contributes to the literature by theoretically accounting for

the empirical regularity that informal finance complements as well as substitutes for formal finance in a general equilibrium model.

Second, it contributes to a growing body of financial DSGE work aimed at improving the understanding of macro-finance linkages by allowing for different financial structures. To relate the closed and open economy dynamics in the context of financial segmentation, this paper develops financial dualism in an open economy scenario. Apart from its relationship with existing literature, the study is novel in its application for policies aiming at the consumption, labor, and credit mobilization between groups distinct by their mode of financing for intertemporal optimization. In this regard, the study is expected to bring to light the factors that can enhance the welfare of both groups.

The existence of financial dualism in Pakistan makes it a very intriguing and interesting case study for understanding the interaction between formal and informal financial sectors. The informal financial sector has a long history of predating the formal financial sector, and it is widely present in both urban and rural areas in Pakistan. Despite the development of the formal financial sector, it still caters to a large chunk of the population, especially the poor masses. This is because of slow progress in the formal financial sector as well as the fact that informal financing is perceived as more secure and accessible due to contract simplicity. However, the informal financial sector is characterized by higher interest rate and also has a significant spread between deposit and lending rates (Qadir, 2005).

Only 10.3 percent of the adult population in Pakistan are utilizing formal financial services, which is well below the South Asian average of 33 percent and 41.4 percent of lower and middle-income countries. Sixty-six percent of adults do not use formal or informal services, whereas 36 percent save, and only 4 percent deposit in formal financial institutions. Only 3% of the population loans via the formal financial sector, although one-third of the population borrows from other sources. The artis dominate the informal credit market in agriculture. This intermediary is competitive but lacks scalability and transparency and is focused on high interest rates. Artis are deeply integrated with the supply chain of agricultural products that substitute for bank loans, although costly. They provide credit with 62 percent to 80 percent interest rates and non-financial services, including crop sales to farmers (SBP Research series, 2019).

Although formal financial institutions have become more important than the informal financial sector, large sectors of households still have limited access to formal sources. The situation is deteriorating, which is depicted in the dismal financial profile of the country (IMF, 2005). As a result, understanding the macroeconomic consequences of informal finance has become crucial for the design of effective monetary policy and the process of financial development.

The remainder of the study is organized as follows. Section 2 specifies a brief literature review, and section 3 describes the DSGE model. Section 4 is based on the results and discussions. Section 5 concludes and provides policy recommendations.

2. Literature Review

Since the 1980s, numerous interrelated shifts in the domestic and global economic landscape of world economies have sparked a rapid change and development process in the financial sector, as well as in many other spheres of human endeavor (Yay and Oktayer, 2009). There are a number of studies exploring overall informal sector such as Davidescu (2014), Albu (2008) and Sen and Cevik (2021), only a few have explored the informal financial sector. Over time, the informal financial sector has come to be seen as a vital component of the larger financial system. The informal financial sector, according to Chipeta and Mkandawire (1991) and Steel *et al.* (1997), has a vital role in reducing poverty by mobilizing resources as well as the utilization of resources to earn and obtain credit. Similarly, informal financial sources provide financing to small

businesses and organizations that are unable to contact commercial banks and comply with their complex terms and conditions (Atieno, 2001). Given the magnitude of the informal sector, policy effects should be enormous; yet empirical evidence suggests that these effects are equivocal and depend on whether informal markets are independent, competitive, complementary, or responsive to formal financial markets. As a result, the interaction between informal and formal financial sectors either aggravates or strengthens the monetary policy (Acharya and Madhura, 1983; Sundaram and Pandit, 1984). In the semi-formal financial sector, factors like technology, average loan size, rural outreach, and institutional age are positively correlated with technical efficiency. The marginal impacts differ greatly, and occasionally they are not monotonic among percentile groups. The most significant marginal impact on reviving the rural formal financial sector would come from supporting younger, technologically underdeveloped banking organizations (Paxton, 2007).

The literature based on the interaction between the formal and informal financial sectors in the DSGE framework is scant. Verona and Martins (2013) argued that formal financial banks invest in low-riskier projects, whereas informal financial institutions provide credit to riskier firms. Ngalawa and Viegi (2013) investigated the interaction between the formal and informal financial sector and their influence on economic activity in quasi-emerging economies. They suggested that both markets are complements, as increased use of the formal sector generates additional productive capacity, which requires more informal sector credit to sustain equilibrium. Moreover, the interest rates do not move in the same direction in the formal and informal sectors leading to interest rate differential and the ineffectiveness of monetary policy.

Mazelis (2014) extended the Gertler and Karadi framework with informal financial intermediaries and investigated the influence of monetary policy shocks on aggregate loan supply They concluded that an increased share of the informal financial sector reduced the aggregate loan supply after a monetary policy shock. Cull *et al.* (2019) emphasized that informal credit plays a significant role in household finances in many developing nations, and interest-free informal loans based on reciprocal personal ties are very common. Wealth is frequently linked to increased formal and informal financial usage, which is not surprising. In developing economies, a "dual credit market" is beginning to take shape. While younger, wealthier households with better political connections and financial literacy are increasingly using formal finance, the poor, politically disconnected, and households with larger family sizes remain heavily dependent on informal finance, the majority of which are interest-free. Daianu (2012), on contrary, demonstrated that reducing the considerable size of the informal financial sector by Increasing efficiency in identifying noncompliance, stricter sanctions for those who practice and commit tax evasion and severe punishment should all be taken into account by the authorities

The latest study by Wang (2019) further extends the formal financial market into local financial markets, in which entrepreneurs decide on over-borrowing and saving. In his framework, households have excess to formal and informal credit markets exogenously, but their interest rates are determined endogenously through demand and credit supply. He showed that more productive households are more benefitted through the policies due to the expansion of borrowing access, whereas low productive households lost their savings in welfare terms. Without the informal sector, the overall gains are much smaller, as predicted by the model. .

The interaction between formal and informal markets has long been discussed in the international literature like Chipeta and Mkandawire (1991), Steel *et al.* (1997), Ngalawa and Viegi (2013), Mazelis (2014) Wang (2019). Some of the studies like Guo *et al.* (2021) analyzed the effects and distributional perspective of monetary policy shock and other external shocks. In emerging economies including Pakistan, studies like Qadir (2005), Wahid and Zia (2014), and the SBP report (2019), focused on the role of the informal financial sector in agriculture. Ahmed *et al.* (2012) introduced informality in the labor and product market in the General Equilibrium framework. No other study focused on the interaction between the formal and informal financial

sectors and the role of the informal financial sector in consumption, labor supply, and credit distribution in the General Equilibrium framework for emerging economies like Pakistan.

3. The Model

The Benchmark Model

The representative households maximize the expected utility using constant relative risk aversion (CRRA) utility function with consumption (C_t), working hours (N_t), and money. So, the Household Euler consumption equation is defined as follows:

$$c_t^{ff} = \frac{h}{1+h} c_{t-1}^{ff} + \frac{1}{1+h} c_{t-1}^{ff} - \frac{1-h}{1+h\theta_c}(r_t - \pi_{t+1}) \quad \dots \quad \dots \quad \dots \tag{1}$$

It is a conventional forward-looking Euler equation with habit persistence (h). The real wage rate for households is positively dependent on past wage rates via partial indexation. In addition, it is positively related via Calvo pricing with the expected future wage rate. Wages are also reliant on current, past and future inflation. The log-linearized form of wage is presented below:

$$w_t = \frac{\beta_{ff}}{1+\beta_{ff}} w_{t+1} + \frac{1}{1+\beta_{ff}} w_{t-1} + \frac{\beta_{ff}}{1+\beta_{ff}} \pi_{t+1} - \frac{1+\beta\iota_w}{1+\beta_{ff}} \pi_t + \frac{\iota_w}{1+\beta_{ff}} \pi_{t-1} - \frac{1}{1+\beta_{ff}\,\iota_w} \frac{1-\beta_{ff}\xi_w(1-\xi_w)}{\xi_w(\phi_w-1)\varepsilon_w+1} \mu_t^w \quad \dots \tag{2}$$

The Entrepreneur Euler equation is presented below as:

$$c_t^E = \frac{h}{1+h} c_{t-1}^E + \frac{1}{1+h} c_{t+1}^E - \frac{1-h}{1+h}(r_t - \pi_{t+1}) + \frac{1-h}{1+h\theta_{Ec}} \quad \dots \quad \dots \quad \dots \tag{3}$$

Entrepreneur consumption equation only depends on past and expected consumption. Unlike household consumption, entrepreneur consumption relies on real lending rates. Therefore, the consumption decision of the entrepreneur is not affected by the probability of default. The investment Euler equation is linearized and presented below as:

$$i_t = \frac{1}{1+\beta_E} i_{t-1} + \frac{\beta_E}{1+\beta_E} i_{t+1} + \frac{\varphi}{1+\beta_E} qk_t \quad \dots \quad \dots \quad \dots \quad \dots \tag{4}$$

Like consumption, current investment (i_t) is dependent on past investment (i_{t-1}), future investment (i_{t+1}) and capital price (qk_t). Whereas φ is the investment adjustment cost. Capital accumulation equation indicated the evolution of capital stock and is presented below:

$$k_t = (1-\delta)k_{t-1} + \delta i_t \dots \quad \dots \quad \dots \quad \dots \tag{5}$$

Equation (6) presents the real rate of capital, whereas $u_t^{\wedge}$ is the capital utilization rate:

$$r_t^{\wedge K} = y_t^{\wedge} - u_t^{\wedge} - k_{t-1}^{\wedge} + \varphi_t^{\wedge} \quad \dots \quad \dots \quad \dots \tag{6}$$

$$u_t^{\wedge} = \psi r_t^{\wedge K}$$

Monopolistic competitive entrepreneurs produce intermediate goods. Perfect competitive final goods producers transform them into homogenous final goods. Aggregate output function y_t consists of fixed cost ϕ_p, capital utilization rate, and technology shock ϵ_t^a. All entrepreneurs uniformly faced this shock. The production function of the model is the standard Cobb-Douglas function. It is presented as:

$$y_t = \phi_p(\alpha k_t^{\xi} + (1-\alpha)n_t + \epsilon_t^a) \dots \dots \quad \dots \quad \dots \tag{7}$$

Monopolistic firms set their prices in the form of Calvo-staggered contracts. Firms with constant Calvo probability$(1-\xi_p)$ can change their prices and put them as μ_t^p. The prices are not revised,

but partially indexed to past inflation and denoted as ι_p. The inflation dynamics are described as follows:

$$\pi_t = \frac{\beta_E}{1+\beta_E\iota_p}\pi_{t+1} + \frac{\iota_p}{1+\beta_E\iota_p}\pi_{t-1} + \frac{1}{1+\beta_E\iota_p}\frac{1-\beta_E\xi_p(1-\xi_p)}{\xi_p(\phi_p-1)\varepsilon_p+1}\mu_t^p + \epsilon_t^p \ldots \quad \ldots \quad \ldots \tag{8}$$

The financial side of the economy is presented by Gerali *et al.* (2010)'s setup. The first key feature of this setup is monopolistic competition in retail banking. The other main feature of this setup is that banks have to satisfy the balance sheet identity, which is presented as:

$$B_r = D_r + K_b \ldots\ldots \quad \ldots \quad \ldots \tag{9}$$

Equation (9) tells that banks can finance their credit volume B_r using their deposits D_r or bank capital K_b. Both sources are perfect substitutes. The retail branches are responsible for providing loans to entrepreneurs and accepting deposits from the household at monopolistic rates, subject to adjustment costs. However, the wholesale branch deals with the capital position of entrepreneurs. It is also responsible for raising wholesale loans and deposits in the interbank market. Out of retained earnings, the accumulated bank capital is explained as:

$$k_t^b(j) = (1-\delta^b)k_{t-1}^b(j) + \omega^b j_{t-1}^b(j) \ldots \quad \ldots \quad \ldots \tag{10}$$

Bank equity for bank j is denoted by k_t^b, j_t^b is the total profit earned by all three branches of the bank j. The dividend policy is summarized by ratio $(1-\omega^b)$. δ^binvolved the resources utilized in bank capital and intermediation activities of banks. The loan rate setting equation is presented below as:

$$\hat{r}_t^l = \frac{\kappa_l}{\varepsilon_t^l-1+(1+\beta_E)\kappa_l}\hat{r}_{t-1}^l + \frac{\beta_E\kappa_l}{\varepsilon_t^l-1+(1+\beta_E)\kappa_l}E_t\hat{r}_{t+1}^l + \frac{\varepsilon_t^l-1}{\varepsilon_t^l-1+(1+\beta_E)\kappa_l}\hat{R}_t^l \ldots \quad \ldots \quad \ldots \quad \ldots \tag{11}$$

Equation (11) tells that the loan rate is dependent on the previous loan rate, future expected loan rate, and the cost of borrowing of the respective bank. In the case of flexible loan rate, κ_l will be zero, and the maximization problem will reduce to $r_t^l = \frac{\varepsilon_t^l}{\varepsilon_t^l-1}\hat{R}_t^l$. Similarly, banks set their deposit rate by the following equation:

$$\hat{r}_t^d = \frac{\kappa_d}{1+\varepsilon_t^d+(1+\beta_E)\kappa_d}\hat{r}_{t-1}^d + \frac{\beta_E\kappa_d}{1+\varepsilon_t^d+(1+\beta_E)\kappa_d}E_t\hat{r}_{t+1}^d + \frac{1+\varepsilon_t^d}{1+\varepsilon_t^d+(1+\beta_E)\kappa_d}\hat{r}_t \ldots \quad \ldots \quad \ldots \quad \ldots \tag{12}$$

Like the loan rate equation, the deposit rate depends on the previous deposit rate, expected deposit rate, and the bank offered lending rate. Similarly, In the case of a perfectly flexible deposit rate, κ_d will be zero, and the simplified maximization problem will be $r_t^d = \frac{\varepsilon_t^d}{\varepsilon_t^d-1}r_t$ and $\hat{r}_t^d = \hat{r}_t$.

Aggregation

Goods market equilibrium is achieved when the production is equal to consumption and resource utilization in capital production. It is presented below:

$$\hat{y}_{Ht} = \hat{c}_t + \hat{i}_t + \varphi(\hat{u}_t)\hat{k}_{t-1} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \tag{13}$$

Whereas $\hat{c}_t = \hat{c}_{ff} + \hat{c}_E$

Lastly, we close the model by stating Taylor-Rule for Pakistan. Following is the log-linearized version of the interest rate rule:

$$\hat{r}_t = \rho\hat{r}_{t-1} + (1-\rho)[\phi_\pi E_t\pi_{t+2} + \phi_{YH}\hat{y}_{Ht}] + \epsilon_t^r \ldots \quad \ldots \quad \ldots \quad \ldots \tag{14}$$

ρ indicates the interest rate smoothing and Taylor rule coefficients are presented as the expected inflation rate $\varphi\pi$ and the output gap $\hat{\varphi}_{YH}$. Monetary policy shock is denoted as ϵ_t^r.

Model with Informal financial sector

Now, we will incorporate the informal financial sector into the financial side of the model. There are two types of financial sectors: (1) Formal financial sector (FFS), (2) Informal financial sector (IFS). Based on the financial sector division, households are divided into two types. Household type is described by $s \in \{ff, ifs\}$; Household ff consumes and supplies labor, and takes loans from the formal sector, however, Household ifs also consumes and supplies labor, but their source of credit is the informal sector. The FFS gathers the deposits from the households s and supplies their credits to the entrepreneur and the informal financial sector. Whereas the informal financial sector moves correspondingly by accumulating deposits from the household and allocating available credit to the households.

Based on the above setup, the consumption Euler equation for Household ff is as follows:

$$c_t^{ff} = \frac{h}{1+h} c_{t-1}^{ff} + \frac{1}{1+h} c_{t-1}^{ff} - \frac{1-h}{1+h\theta_c}(r_t - \pi_{t+1})$$

Households who are the borrowers of the informal financial sector are presented in the Euler equation as:

$$\mathrm{c_t^{ifs}} = \frac{\mathrm{h}}{1+\mathrm{h}} \mathrm{c_{t-1}^{ifs}} + \frac{1}{1+\mathrm{h}} \mathrm{c_{t-1}^{ifs}} - \frac{1-\mathrm{h}}{1+\mathrm{h}\theta_c}\left(\mathrm{r_t^l} - \pi_{t+1}\right) \quad \ldots \quad \ldots \quad \ldots \tag{15}$$

The borrowing constraint for households s in the log-linearized form is presented as:

$$\mathrm{B_t^s} + \mathrm{r_t^{ls}} = \mu_{s,t} + (\mathrm{n_t^b} + \mathrm{w_{t+1}}) + \pi_{t+1} \ldots \quad \ldots \quad \ldots \quad \ldots \tag{16}$$

The loan to value ratio (stochastic) is denoted by $\mu_{s,t}$. It calculates the value of loans that banks offer at the discounted value of the collateral for each form of agent. Loan-to-value (LTV) ratio is treated as a shock that behaves as a stochastic variable following Gerali *et al.* (2010). The LTV shock follows an AR (1) process, which is indicated as:

$$\mu_{s,t} = \rho_{\mu_s} \mu_{s,t-1} + \varepsilon_t^{\mu_s} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \tag{17}$$

Where ρ_{μ_s} is defined as the auto-regressive coefficient and the error term is denoted by $\varepsilon_t^{\mu_s}$.

After introducing the informal financial sector, the loan rate setting equation has been modified, and it is presented below:

$$\mathrm{r_t^m} = \left(\frac{\kappa_m}{\epsilon_m - 1 + \kappa_e + \kappa_e * \beta_m}\right) * \mathrm{r_{t-1}^m} + \left(\frac{\beta_m * \kappa_m}{\epsilon_m - 1 + \kappa_e + \kappa_e * \beta_m}\right) * \mathrm{r_{t+1}^z} + \left(\frac{\epsilon_m - 1}{\epsilon_m - 1 + \kappa_m + \kappa_m * \beta_m}\right) * \mathrm{r_t} \quad \ldots \tag{18}$$

However, m= {Households ff, Households ifs, Entrepreneurs} and the discount factor are defined as β_m = {(Households ff, Households ifs, Entrepreneurs}. The above equation shows that the loan rate depends on the previous and future expected loan rates, and the associated marginal cost beared by the loan branch of the respective lender type.

Aggregation

The modified version of the model contains two types of households and financial sectors. So, the total volume of credit is the summation of credit advancement by both formal and informal financial sectors. So, at the equilibrium level, the total volume of credit advanced by financial sectors should equal the total credit demanded by both households and firms. The share of the informal financial sector is denoted as z, and the aggregate credit is defined as:

$$\mathrm{Br} = \mathrm{z} * \mathrm{Bifs} + (\mathrm{Bifs} + \mathrm{Be}(1-\mathrm{z})) \ldots \quad \ldots \quad \ldots \quad \ldots \tag{19}$$

The aggregate consumption is presented as follows:

$$\hat{c_{Dt}} = g * \hat{c_t^{ifs}} + v * \hat{c_t^{ff}} + (1 - v)\hat{c_t^{E}} \ldots \quad \ldots \quad \ldots \quad \ldots \quad (20)$$

Where the share of a household ifs is g and the share of a household ff is *v.*

Model with an open economy

So far, we have modified Gerali *et al.* (2010)'s setup by introducing the informal financial sector. Now, we are further introducing an open economy in the model. Final good producers combine intermediate goods of both domestic ($y_{h,t}$) and foreign retailers ($y_{f,t}$). So, the production function after incorporating an open economy is as follows:

$$\hat{y_t} = \gamma^{\frac{\mu}{1+\mu}} \left(\frac{y_H}{y}\right)^{\frac{1}{1+\mu}} \hat{y_{H,t}} + (1-\gamma)^{\frac{\mu}{1+\mu}} \left(\frac{y_F}{y}\right)^{\frac{1}{1+\mu}} y_{F,t} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (21)$$

γ is defined as a home bias parameter, and μ is the elasticity of substitution between domestic and imported goods.

Three types of retailers are operating under monopolistic competition: (1) Domestic retailers, (2) Exporting retailers, and (3) Importing retailers. All three types of retailers buy homogenous products from entrepreneurs and transform them into differentiated products. Domestic retailers sell them in domestic markets, while exporting and importing retailers sell them in international markets. So, in that fashion, the log-linearized domestic inflation can be presented as:

$$\pi_{Dt} = \frac{\beta_E}{1+\beta_E \iota_p} \pi_{Dt+1} + \frac{\iota_p}{1+\beta_E \iota_p} \pi_{Dt-1} + \frac{1}{1+\beta_E \iota_p} \frac{1-\beta_E \xi_p (1-\xi_p)}{\xi_p (\phi_p - 1)\varepsilon_p + 1} \mu_t^p \quad \ldots \quad \ldots \quad \ldots \quad (22)$$

Similarly, the log-linearized form of foreign inflation is presented as:

$$\pi_{Ft} = \frac{\beta_E}{1+\beta_E \iota_p} \pi_{Ft+1} + \frac{\iota_p}{1+\beta_E \iota_p} \pi_{Ft-1} + \frac{1}{1+\beta_E \iota_p} \frac{1-\beta_E \xi_p (1-\xi_p)}{\xi_p (\phi_p - 1)\varepsilon_p + 1} \mu_t^p \quad \ldots \quad \ldots \quad \ldots \quad (23)$$

So, the overall inflation can be described as:

$$\pi_t = (1 - ð)\pi_{Dt} + ð\pi_{Ft} \ldots \quad \ldots \quad \ldots \quad \ldots \quad (24)$$

ð is the degree of openness.

The Terms of Trade (TOT) are defined as $Z_t = \frac{P_{F,t}}{P_{H,t}}$ (in log form $z_t = P_{F,t} - P_{H,t}$). An increase in TOT increases the competitiveness for the domestic economy because foreign goods prices will increase. The aggregate price after adding TOT can be written in the log-linearized form as:

$$p_t = (1 - ð)p_{H,t} + ð p_{F,t} = p_{H,t} + ð\, z_t \ldots \quad \ldots \quad \ldots \quad \ldots \quad (25)$$

Gali and Monacelli (2005) assumed that one price law operates for wholesale importers, but fluctuations exist in purchasing price parity due to monopolistic competition within the importers. At the domestic level, they charge a price above marginal cost, while at borders, one price law holds. Foreign products are sold to domestic consumers with markup. So, a disparity exists between the prices of foreign and domestic products after converting into the same currency. Then deviation of the one price law can be presented as:

$$\aleph_t = -[\Omega_t + (1 - ð)z_t] \ldots \quad \ldots \quad \ldots \quad \ldots \quad (26)$$

Ω_t is defined as real exchange rate, and TOT are denoted as z_t. Equation 26 shows that the one price law deviation is inversely related to the domestic economy's real exchange rate and the degree of international competitiveness.

Considering the assumption of complete foreign financial markets and perfect mobility of capital markets, the expected return on bonds (risk-free) must be equal to domestic foreign currency return on foreign bonds. So, the log-linearized uncovered interest parity can be presented as:

$$\Delta E_t \Omega_{t+1} = -\{(r_t - E_t \pi_{Dt+1}) - (r_{Ft} - E_t \pi_{Ft+1})\} \ldots \quad \ldots \quad \ldots \quad \ldots \tag{27}$$

Equation (27) tells that the expected change in the real exchange rate Ω_t is dependent on the differentials of current domestic (r_t) and foreign real interest rates (r_{Ft}). Lastly, the rest of the world monetary policy rule is presented below:

$$\hat{r_{Ft}} = \rho_F * \hat{r_{Ft-1}} + (1 - \rho_F)[\phi_{\pi F} E_t \pi_{Ft+2} + \phi_{YF} \hat{y_{Ft}}] + \epsilon_t^r \ldots \quad \ldots \quad \ldots \quad \ldots \tag{28}$$

Aggregation

For goods market-clearing, the domestic output must equal the sum of domestic consumption and foreign consumption for export goods, resource utilization in capital production, and foreign economy.

$$\hat{y_{Dt}} = (1 - \eth)\ \hat{c_{Dt}} + \eth\, \hat{c_{Ft}} + \hat{i_t} + \varphi(\hat{u_t})\hat{k_{t-1}} + \eth\, \theta_c\, \aleph_t + \eth\, \theta_c\, Z_t \ldots \quad \ldots \quad \ldots \quad \ldots \tag{29}$$

However,

$$\hat{c_t} = \hat{c_{Dt}} + \hat{c_{Ft}}$$

The model will return to a closed economy model when $\eth = 0$.

4. Calibrations

To closely match with Pakistan's economy, the model has been calibrated with parameter estimates from a wide range of information available. Some of the parameters are estimated, those for which the data was available. While other parameter values were taken from the literature in DSGE modeling specifically for Pakistan and other emerging economies. Table 1 (Appendix A) presents the values of the parameters of model equations with sources.

The discount factor for the formal financial sector β_{ff} was computed to be 0.995 by taking the inverse of the average long-term real interest rate. The discount factor is calculated using annual data from 1970 to 2018. The formula used to calculate the discount factor is $\beta = 1/(1+d)$ and d is the discount rate. The discount factor for FF households is the same as for the entrepreneurs and it is consistent with the overall discount factor as the FF households take the loans from formal sources. Whereas $\beta_{ifs}$is computed to be 0.975 using the interest rates charged by micro-finance institutions4. Our value of the discount factor is close to one estimated by Tufail and Ahmed (2018).

The depreciation rate δ is set to be 0.10 annually, which is in line with the literature to produce an annual depreciation rate of 10 percent. This value is also consistent with the non-financial reports of the Karachi Stock Exchange (KSE) from 2001 to 2015. The coefficient of labor supply ϕ in the utility function is taken to be 1.5 by following the study of Fagan and Messina (2009).

The domestic risk aversion parameter is estimated to be 1.01. We estimate the Euler equation for Pakistan using the annual data from 1970 to 2018. For that purpose, consumption per capita[5] and real interest rate data have been used. The lag values of both variables were used as an instrument in the estimation. The estimated value of domestic risk aversion is consistent with the

[4] *Performance of Micro-finance institutions, SBP Data*

[5] *Data for consumption has been taken from the Economic Survey of Pakistan*

value set by Choudhry and Malik (2013). The value is also consistent with the number of DSGE models for emerging economies.

The capital share in output production α is computed to be 0.49. The value is calculated by estimating the production function using the cointegrating estimation technique. The value is the same as the one estimated by Tufail and Ahmed (2018) using FMOLS. The value is also consistent with the one set by Ahmed et. al (2012). Liu (2008) also set the value very close to the estimated value for developing countries. AR coefficient of technology shock is also estimated using this regression.

For the estimation of domestic monetary policy-related parameters, the Taylor rule equation was estimated by following the approach applied by Malik and Ahmed (2007). For that purpose, three equations were estimated using OLS regression. The interest rate response to domestic inflation was computed as 0.53 and the response to domestic output is 0.2, whereas the interest rate smoothing parameter is estimated to be 0.93 using OLS estimation. The estimated values are close to the ones of Tufail and Ahmed (2018), Ahmad and Pasha (2015), and Aleem and Lahiani (2011). The result is also consistent with Malik and Ahmed (2007).

Foreign Taylor rule parameters and foreign productivity parameters were taken from the literature using the values used by Leon (2018), Winkelried (2013), and Castillo *et al.* (2013). The degree of openness parameter was taken from Umer (2014). The capital requirement $V^b$for Pakistan in 2019 is set to be 11.9 percent as per the imposed capital requirement of Basel II. The required value is 8 percent, while the set value is slightly higher than the required rate. Accordingly, the central bank pegs its capital requirement ratio above the Basel requirement. The proportion of informal financial sector households g is set to be 0.49 for 2019 and the proportion of FF households υ is 0.51, as indicated by the financial inclusion report (2019) of SBP.

The cost parameters for the formal sector are chosen following Gerali *et. al* (2010), who estimated these parameters using Bayesian Estimation for the Euro market. The parameters $k_d, k_{kb,} and\ k_l$ are set to be 110, 5, and 70, respectively. Whereas the cost parameters values for the informal sector are taken from the literature based on shadow banking in emerging economies. The parameters $k_{dm}\ and\ k_{bm}$ are set to be 100 and 60, respectively. The elasticities parameters based on formal and informal banking sectors were taken from the literature due to the unavailability of data for informal sources in Pakistan. Whereas the set values are per the values of other emerging economies.

5. Results and Discussions

To achieve the objectives of the study, responses of relevant macroeconomic variables to three types of shocks, i.e., monetary policy shock, productivity shock, and macro-prudential shocks, are discussed in this section. For a detailed analysis of the transmission mechanism of different shocks, four types of models are considered. Firstly, a standard model based on Gerali *et al.* (2010) was developed for a closed and open economy. Secondly, the standard model was modified by introducing informality in the financial sector both in the closed and open economy setups.

Transmission Mechanism of Domestic and Foreign Monetary Policy Shock

Considering the first objective of the study, monetary policy shock responses are reported in Figure 1 and Figure 2 for a closed and open economy, respectively. The responses are considered for both standard models and the models in the informal financial sector.

Domestic Monetary Policy Shock

Figure 1 compares the MTM of monetary policy shock of a standard DSGE model with and without the informal financial sector in a closed economy setup. A contractionary monetary policy shock induces output and investment to decline, with peak response materializing in the third quarter. These responses conform to the 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 the real rigidities in the economy, particularly habit persistence and investment adjustment costs.

The retail rate follows the unanticipated increase in policy rate but sluggishly, leading to incomplete interest rate pass-through primarily due to monopolistic competition in the banking sector. Along with incomplete interest rate pass-through, the price puzzle is also evident in the response of inflation to monetary shock. The earlier literature in Pakistan confirmed the existence of the price puzzle and attributed it to the asset price channel (Mariyam and Malik, 2020) and the cost channel of monetary policy (Tufail and Ahmed, 2018). Consequently, consumption also decreases as households smooth their consumption pattern in response to an increase in prices.

With the presence of the informal financial sector, an attenuation in the retail rate is observed after an increase in the policy rate. With the recognition that an alternative source of finance is available to economic agents, formal financial institutions remain irresponsive to contractionary monetary policy shock to maintain their share of credit volume. This reduces the strength of interest rate pass-through, making the transmission of monetary policy to the real sector of the economy almost negligible. The decrease in the volume of credit due to monetary shock is substantially lower when the informal financial sector is included in the model, showing that instead of a decrease in the volume of credit, there is a transfer of credit from the formal to the informal sector after a monetary policy shock (Ngalawa and Viegi, 2013). It is also evident from the meager responses of output, investment, and consumption.

The increase in credit volume to the informal sector is attributed to the decrease in the retail rate of the informal financial institutions observed in response to the policy rate shock. Increased dependence on informal finance is explained by the uncertainty channel, according to which uncertainty would endanger higher precautionary demand for cash, especially if inflationary expectations are not well-anchored. A contractionary monetary policy could exacerbate the uncertainty for the informal sector borrowers with uneven cash flows, further increasing the dependence on informal finance. The response of the informal retail rate is, to large extent, consistent with the existing literature, which reported that formal and informal retail rates move in the opposite direction given a monetary policy shock (Ghosh and Kumar, 2015). Due to the informal financial sector, the responses of the macroeconomic variables are less pronounced, indicating that monetary policy is less effective in the presence of the informal financial sector in the economy.

We have explored the issue further in an open economy setup. Figure 2 compares the responses of a macroeconomic variable without and with the informal financial sector in response to monetary policy shock in an open economy. It is worth mentioning here that responses of the

macroeconomic variable in an open economy setup are weak except the retail rate, showing almost complete pass-through. The responses to output, investment, and consumption after a contractionary monetary policy shock are declining and conforming to the existing literature. After the inclusion of the informal financial sector, the responses of the macroeconomic variables not only differ in propagation but also amplification and persistence. However, the dynamics of the macroeconomic variables in response to monetary policy shock with the informal financial sector included are consistent with each other. This might be due to the reason that domestic monetary policy shock in the case of a small open economy like Pakistan does not attract foreign variables to play their role in the domestic economy.

Foreign Monetary Policy Shock

The transmission mechanism of foreign monetary policy shock is presented in Figure 2, which depicts that foreign monetary policy propagates to the domestic economy through its impact on the policy rate. The response of policy rate to foreign monetary shock is substantial and works through a direct interest rate channel as explained in Giovanni and Shambaugh (2008). The retail rate of the formal sector remains irresponsive. This highlights a very interesting characteristic of the Pakistan banking industry, where banks follow exogenous movement in the policy rate, but remain irresponsive to the endogenous movement arising due to changes in the foreign policy rate. The output declines in the standard model and assumes a positive path after a few lags. The inflation, investment, and total credit volume respond positively in a model without the informal financial sector.

With the inclusion of the informal financial sector, propagation, amplification, and persistence of shock vary across different variables. For instance, the response of the policy rate and output is similar to the one of the standard model, but the lagged response over a few quarters is humped shaped and more pronounced. However, the response is not sustainable in the long run. The credit volume of the formal sector after the inclusion of the informal sector is lower, hence, this is the case for investment and inflation. The decrease in overall credit volume in the initial quarters is attributed to the less allocation of credit to formal entrepreneurs, though households continued to capture a sufficient share of total credit. The decrease in the credit to informal households is spread over many quarters, after which it takes positive paths.

Consumption, Labor and Credit Allocation Implications of Informal Financial Sector

Owing to the second objective of the research, we have examined the consumption, labour, and credit allocation implications of the informal financial sector. For this purpose, we have considered both domestic and foreign productivity, and financial shocks.

Productivity shock

Figure 3 reports the responses of relevant variables to productivity shock for a closed economy with and without an informal financial sector. Consistent with the existing literature, the favorable productivity shock in a closed economy is expansionary for an economy without an informal financial sector. With the inclusion of the informal financial sector, a productivity shock increases welfare for the households interacting with the financial sector while reduces it for the informal sector households. The financial resources are also diverted to the formal sector, as depicted in the decline of credit volume in the informal sector. The response to the labor supply of households interacting with the financial sector is highly consistent with the theoretical underpinnings of the general equilibrium models, which state that labor supply increases in face of a temporary productivity shock. However, the labor supply of households borrowing from the informal financial sector declines.

The overall results show that a favorable productivity shock not only enhances welfare but also distributes credit and labor supply in favor of the formally included households. It might be due to the response of formal and informal retail rates to productivity shock. The productivity shock in an open economy setup is depicted in Figure 4. Similar to the closed economy case, the economy without the informal sector expands in terms of consumption and credit while overall labor supply reduces. After the inclusion of the informal sector, the formally included households face ample decline in welfare. The immediate welfare loss is also evident for the informally included households. The entrepreneurs experience a huge increase in consumption. All economic agents face a decline in their share of credit volume except in the initial quarters when the informal households obtained a positive share of credit volume. The labor supply of the informal households also increases after an initial dip, however, the formally included economic agents reduce their labor supply given a foreign productivity shock.

Figure 1: Domestic Monetary Policy Shock

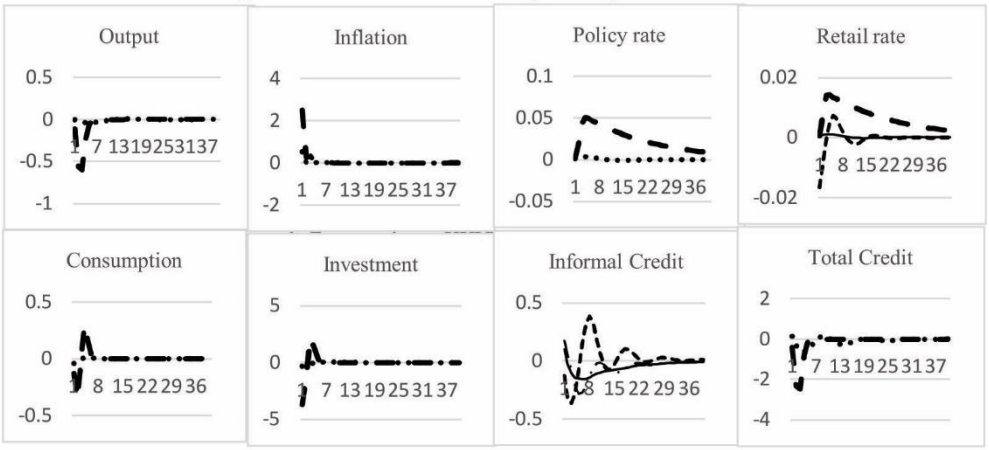


Figure 2: Foreign Monetary Policy Shock

Figure 3: Productivity Shock Closed Economy

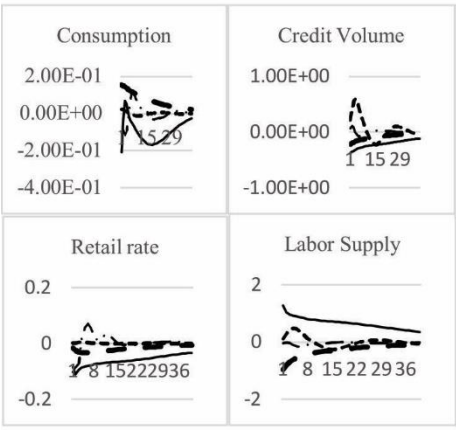
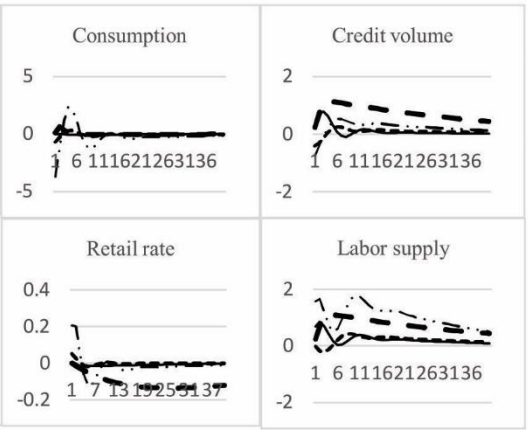


Figure 4:Productivity Shock Closed Economy



Domestic Financial and Exchange Rate Shock

Figure 5 to 11 (Appendix B) reports the impact of a favorable financial shock given to the LTV of households interacting with the formal and informal financial sector, respectively. A favorable financial shock to the formal LTV improves the welfare of the relevant households slightly. The households dealing with the informal financial sector experienced a substantial decrease in welfare. The distribution of credit volume is even more skewed in favor of the formal households. It is also observed that credit volume in the informal sector remained largely irresponsive to the formal LTV. As far as labor supply is concerned, the households with formal finance opt for less work as compared to the ones with informal finance.

Substantial differences are observed when LTV for households with informal finance increases. The consumption of informal households experienced a reduction, while for the formal sector a slight increase is observed. It is interesting to observe that LTV shock to the informal financial sector leads to an increase in credit volume of the financial sector. An exchange rate shock has a negligible impact on consumption in the standard model, however, the inclusion of the informal sector changes the dynamics of the economy. The entrepreneur benefits the most in terms of consumption, while they get a negligible share of the overall credit volume. In terms of credit and labor supply, distribution skews in favor of the formal households. The informal households are worse off in the initial quarters. Moreover, their share in credit volume is also negligible and a reduction in labor supply is evident. Dukic *et al.* (2023) also conformed to our results that enterpreuers and tradeable sector gain following a exchange rate shock.

Figure 12 (Appendix B) depicts the welfare and resource distribution between formal and informal financial sectors in an open economy setup in face of foreign productivity shock. Foreign productivity shock happens to be welfare enhancing in the standard model but with the informal finance, the welfare of economic agents is affected remarkably. Only formal households face an increase in welfare, while a substantial decrease in informal households and entrepreneurs is observed. The credit volume and labor supply formal sector face expansion, while the informal finance and labor supply of the respective households are contracted.

6. Discussion

Pertaining to the first objective of the study, we examined the transmission mechanism of domestic and foreign monetary policy shock with and without the informal financial sector. Results underscored several important implications. For instance, after a foreign monetary policy shock, the domestic policy rate increases to minimize the differential and maintain parity with the foreign interest rate. This might be to reduce uncertainties in capital movement particularly to avoid

sudden capital outflows. This implies that monetary authority regulates the policy rate to completely pass through the foreign monetary policy shock. One important justification for this response lies in sterilization, where the central bank pursues to maintain the parity in terms of the exchange rate.

Despite the proportional response of the domestic policy rate to foreign monetary shock, the effect of a shock on the economy is hindered by the reactions of the formal financial sector. It is evident from the responses that the formal retail rate remains irresponsive to the movements in policy rate when a foreign monetary shock hits the economy. This highlights a very important characteristic of the banking industry in Pakistan, where banks can clearly differentiate between different motives of the central bank's change in the policy rate and determine their reactions accordingly. When the State Bank of Pakistan impulses an exogenous shock to the economy, the formal financial sector passes through that shock to pursue the motives of the central bank albeit partially keeping their motives intact. However, in the case of the endogenous movements to

policy rates arising to accommodate foreign monetary policy shock, the foreign financial sector remains completely neutral.

The role of the informal financial sector in the dissemination of both domestic and foreign monetary shocks has also been instrumental. However, the informal financial sector reacts similarly to an increase in domestic policy rate as its response to foreign monetary policy shock. Being unregulated, the informal financial sector lacks the motivation to pursue the strategies of the central bank.

Pertaining to the second objectives of the research, the response of different sectors to productivity shock also underscores very important and interesting implications. Productivity shock is beneficial for the formal sector, highlighting the technological gap existing between the formal and informal financial sectors. The formal financial sector immediately caters to the need of economy expansion owing to productivity shock due to the quick adoption of technological advancement, thus, raising the welfare of those associated with the formal sector. However, neither the pace nor the economies of scale are materialized by the informal financial sector to get the benefits of a favorable productivity shock.

As far as financial shocks to the formal and informal regulations are concerned, the reduction in requirements for securing loans is welfare enhancing for the formal sector. This indicates that informal loans are considered inferior means of financing for informal borrowers. Similarly, the advantage of exchange rate depreciation is also attained by the formal sector with the informal sector getting worse off. Due to the valuation effects, the assets and liabilities of formal financial institutions are denominated in foreign currencies, hence, affecting their profitability profiles. This may result in expanding its outreach and credit expansion by the formal sector.

Conclusion and Recommendations

We extended a standard DSGE model to include the informal financial sector for both closed and open economy setups to achieve the objectives of the study. Firstly, the implications of informal finance are examined for the transmission mechanism of domestic and foreign monetary policy by comparing the models with and without the informal financial sector. Secondly, welfare and resource distribution among different economic agents in presence of informal finance is ascertained for different domestic and foreign innovations to the economy.

The findings showed that the informal financial sector is an integral part of the overall financial system in Pakistan. The sector corresponds to economic activity intently along with its formal counterpart. Not only its credit intermediation process is as dynamic as that of the formal sector but also competes with the financial sector given certain circumstances. This suggests that the relative size of the formal and informal financial sectors determines the direction and the effect of monetary policy in an economy with a dual financial market.

We provided preliminary evidence regarding how monetary policy can be formulated to cater to the feedback from the informal sector. In this way, despite being unrecorded, the informal sector can be streamlined with formal finance, which is an important step towards the major plank of inclusive growth, i.e., financial inclusion. Along with it, incorporating feedback from the informal sector in the conduct of monetary policy is expected to improve its effectiveness remarkably.

The welfare and resource distribution implications of the informal financial sector render it extremely important for ascertaining the usefulness or undesirability of different shocks and stimuli to the economy. By focusing on the formal sector only, the welfare response to different real and nominal shocks may be over or underestimated. Similarly, resource distribution can be well targeted by the policy makers by including the informal financial sector in the overall analysis.

Data Availability Statement:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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