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Anticipated shock, monetary policy and welfare in the small open economy

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ABSTRACT

This paper judges the welfare implications of anticipated and unanticipated Productivity shocks in a small open economy. The purpose model is two country New Keynesian dynamic stochastic general equilibrium model with the characteristics of nominal rigidities and monopolistic competition. This study finds out the higher degree of openness increase the welfare cost in the anticipated shocks. The response of optimal policy to anticipated shocks demonstrates the larger and delayed on macroeconomic variables than unanticipated shocks. Optimal monetary policy rule has a potential to curb the inflation and meet an optimal level of the real exchange rate volatility. Movements in real exchange rate resist the terms of trade externality and upturn the effectiveness of monetary policy. In addition, monetary authorities focus on the goal of exchange rate stabilization in their policy decisions.

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1. INTRODUCTION

This paper examines whether or not the anticipated future shocks improves the welfare of the small open economy. For this purpose, this study computes and compares the welfare effect of anticipated and unanticipated shocks on macroeconomic variables. Furthermore, evaluates the effect of degree of openness on welfare cost of small open economy under anticipated and unanticipated shocks. Particularly, research hypothesis of this study suggest that the anticipated productivity shock can be welfare gaining in the small open economy. The present model based on two country small open economy model of (Gali and Monacelli, 2005) analyzes the domestic productivity shock on macroeconomic variables. To estimate the accuracy of the respective model, (Reid, 2009) suggests that this open economy model is stylized because of its simplicity and submission of few shocks in the economy but in the mean while there are some deficiencies to evaluate the major puzzles in macroeconomics. In addition the role of government sector in the baseline framework this study follows the (Furlanetto, 2006).[1] In this model the terms of trade, directly links in the New Keynesian Phillip's curve as a source of internal distortion. In addition, real exchange rate fluctuation describes the effect of home bias in order to examine the simple monetary policy rules. In a small open economy the presence of home bias restricts the optimal mark up volatility under unitary elasticity of substitution and terms of trade fluctuations affect

[1] (Furlanetto, 2006) extended the New Keynesian open economy model into the public sector and the outcome of this study to estimate the lower values of output multiplier and the bigger expansionary effect can occur in fixed exchange rate owing to fiscal shocks.

the real exchange rate volatility.[2] The stylized model assumes law of one price allows home base in household's preferences and optimal risk sharing in the home and the foreign country. The framework is base on monopolistic competition and nominal rigidities. Firms are assumed as monopolistic competitors facing the well-defined demand schedule for its own production maximization of profits. Nominal rigidities are the important element of the new-keynesian model and the main feature of the non neutrality of monetary policy. The assumption includes rational agents in the New Keynesian dynamic stochastic general equilibrium (DSGE) models such as household, firms and governments intending to maximization of their objective functions in time to illustrate the behaviour of the economy in the short-term period shocks.

This small open economy model characterizes the home bias in consumption, nominal rigidities, imperfect competition and complete asset markets. In recent studies (Corsetti and Pesenti, 2001), (Sutherland, 2002), (Parrado and Velasco, 2001) and (Benigno and Benigno, 2003) develop the New Keynesian small open economy model. The focus of these studies is examining the welfare implications of alternative monetary policy rules. The model framework includes IS curve, Phillip curve, based on forward-looking variables. These studies emphasize the importance of the role of monetary policy coordination associated with internal and external distortions in the economy. These studies show that when the elasticity of inter-temporal substitution between home and foreign products is one, then the terms of trade fluctuations become independent of giving utility function. (Corsetti and Pesenti, 2001) concluded that the expansionary monetary policy can create the worse effect in the long-term result as a reduction in the consumer's purchasing power in an open economy under these distortions. (Obstfeld and Rogoff, 1995) proposed the exchange rate redux model for welfare implications. The model features are monopolistic competition, one period advance price setting mechanism and availability of nominal bonds. This model also assumes no home bias in government spending as it illustrates the consumption of products are optimally consumed in government as well as domestic agent. Other studies which scrutinize the welfare of the small open economy model under price stickiness are (Scmitt and Uribe, 2000) and (Clarida et al., 2001). (Said et al., 2012) estimates the small open economy model to ponder the optimal monetary policy in Morocco and suggests that the Taylor rule with targeting exchange rate policy outperforms as an optimal monetary policy in Moroccan economy. (Adam et al., 2009) analyzes the implication alternatives monetary policy rules in African countries. The changes mainly occur in the monetary policy regimes when the export, Foreign aid and foreign direct investment inflows were increasing in these countries. There is a trade-off between interest rate and exchange rate (nominal and real) volatility, latter the lending behaviour of banking, quasi fiscal burden of upsurge domestic borrowing and raise concern about private investment. (Malik and Ahmed, 2010) explores the taylor rule and suggests that State Bank of Pakistan conduction the pro-cyclical policy means more focus on growth instead of inflation and output gap variability, which reduces to some extent after financial reforms. The external fiscal disturbance is the reason of monetary policy weakness. (Mahmood and Shahab, 2012) delves into the monetary policy reaction function use exchange rate in the policy rule under the New Keynesian approach and propose that flexible inflation targeting rule is more appropriate than the strict inflation targeting. The welfare loss can be reduced if the central bank avoids discretionary monetary policy. (Choudhri and Malik, 2012) inquest the open economy model for the monetary policy analysis, including the government borrowing constraints and proposed that strict interest rate rule help to curb the inflation and improvement in welfare of households. In response of interest targeting rule with output this study shows that there is a negative response of inflation variability and output which affect households at different income level.

In brief, the main findings of this study are as follows (i) Pakistan is emerging small open economy and monetary authorities have choice to adopt the targeting rules in the economy, (ii) The Taylor style interest targeting rule supports for the better alternative option for monetary authorities to attain the highest welfare in an open economy, (iii) The impulse response to anticipated shocks

[2] Other studies extended this model are (Sedghi, 2009) compares optimal monetary policy with financial stability and (Paoli, 2009) for small open economy model.

demonstrate the persistent, larger and delayed response on macroeconomic variables than unanticipated shocks, (iv) unanticipated shock has lower variation from steady state as compare to anticipated shock in macroeconomic variables (v) Taylor rule helps to improve the macroeconomic stability when economy is facing multiple shocks.
The rest of paper continues as includes: In section 2 and 3 formats the two country endowments DSGE model to show the monetary policy in the presence of domestic shocks. Section 4 demonstrates the parameter estimation of the quantitative model. Section 5 concludes.

2. STRUCTURE OF THE MODEL

The structure of the model follows the approach of (Gali and Monacelli, 2005) and (Silveira, 2006) as a baseline framework for the open economy model. Two countries represent home and foreign, one is consider as small open economy and other is the rest of the world. The characteristics of these countries are having homogeneous consumption, similar technology and all goods are traded. Home country policy decisions are ineffective for the foreign country. The features of this model are monopolistic competition, nominal rigidities, and home bias in consumption. Including the nominal rigidities, followed the sticky price model of (Calvo, 1983). In this setup, fractions of firms to choose the price taking decision over time. Taking the assumption of monopolistic competition means households in both countries producing the differentiated goods.

2.1. Households

The households are the representative of the complex structure of a small open economy. The utility function of the representative household is

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t) \tag{1}$$

Where N_t denotes hours of labour, and C_t is the composite consumption index defied by

$$C_t \equiv \left[(1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \tag{2}$$

Where $\eta > 0$ the parameter of elasticity of is the intertemporal elasticity of substitution between home C_H and foreign-produced goods C_F. The consumption of differentiated products produces at home and foreign can be illustrated as sub indices. The $C_{H,t}$ is the index of consumption of domestic goods given by constant elasticity of substitution (CES) production. Where $j \in [0,1]$ denotes the good variety. $C_{F,t}$ is an index of imported goods given by:

$$C_{H,t} \equiv \left[\int_0^1 C_{H,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{3}$$

$$C_{F,t} \equiv \left[\int_0^1 (c_{i,t})^{\frac{\gamma-1}{\gamma}} di \right]^{\frac{\gamma}{\gamma-1}} \tag{4}$$

$c_{i,t}$ is the index of the quantity of goods imported from country i and consumed by domestic household. The given CES function is

$$C_{i,t} \equiv \left[\int_0^1 (c_{i,t})^{\frac{\varepsilon-1}{\varepsilon}} dj \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{5}$$

Here $\varepsilon > 1$ is the elasticity of substitution between varieties produced in the given country. The parameter $\alpha \in [0,1]$ represents the natural index of openness and it is inversely related to the degree of home bias in consumption. Parameter $\theta > 0$ represents the intertemporal substitution between home and foreign goods. While γ represents the intertemporal substitution between production of products in different foreign countries. The demand function of respective goods and country is given for all $i, j \in [0,1]$,

$$C_{H,t}(j) = \left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\varepsilon} C_{H,t} \quad C_{i,t}(j) = \left(\frac{P_{i,t}(j)}{P_{i,t}}\right)^{-\varepsilon} C_{i,t}$$

Where $P_{H,t}(j) \equiv \int_0^1 P_{H,t}(j)dj^{\frac{1}{1-\varepsilon}}$ is the price index of domestic produced goods and $P_{i,t} \equiv \left(P_{i,t}(j)^{1-\varepsilon}dj\right)^{\frac{1}{1-\varepsilon}}$ is the price index of imported goods in the domestic country for all i ϵ [0,1] followed from the demand function that $\int_0^1 P_{H,t}(j)\, C_{H,t}(j)dj = P_{H,t}C_{H,t}$ and $\int_0^1 P_{i,t}(j)C_{i,t}\,(j)dj = P_{i,t}C_{i,t}$. On the origin the optimal allocation of expenditure on imported goods implies $C_{i,t} = \left(\frac{P_{i,t}}{P_{f,t}}\right)^{-\gamma} C_{F,t}$ for all ∈ [0,1], and where $P_{f,t} \equiv (\int_0^1 P_{i,t}^{1-\gamma}di)^{\frac{1}{1-\gamma}}$ is the imported goods index price in terms of domestic currency. This implies the total spending on imported goods as $\int_0^1 P_{i,t}\, C_{i,t}di = P_{f,t}C_{F,t}$

Finally, the allocation of spending between home and foreign goods is given by:

$$C_{H,t}(j) = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t \; C_{F,t}(j) = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t$$

$$P_t \equiv \left[(1-\alpha)\left(P_{H,t}\right)^{1-\eta} + \alpha\left(P_{F,t}\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}$$

The utility function (U) regarding consumption and hours worked can be expressed as

$$U(C,N) \equiv \frac{C^{1-\sigma}}{1-\sigma} - \frac{N^{1+\varphi}}{1+\varphi} \tag{6}$$

The maximization of utility function is subject to a sequence of budget constraints of the form:

$$\int_0^1 P_{H,t}(j)C_{H,t}(j)dj + \int_0^1\int_0^1 P_{i,t}(j)C_{i,t}(j)djdi + E_t\{Q_{t,t+1}D_{t+1}\} \le D_t + W_tN_t \tag{7}$$

Here $P_{i,t}(j)$, is the price of variety j imported from home country, D_{t+1} represents the nominal payoff in period $t+1$ of the portfolio held at the end of period t, and w_t represents the nominal wage. The given units of domestic currency, $Q_{t,t+1}$ is the stochastic discount factor for one period ahead nominal payoff relevant to the domestic household. Given that, aggregate consumption expenditure of the domestic household is $P_{H,t}\, C_{H,t} + P_{F,t}\, C_{F,t} = P_tC_t$. Thus, budget constraint in the given period is respectively.

$$P_tC_t + E_t\{Q_{t,t+1}D_{t+1}\} + T_t \le D_t + W_tN_t \tag{8}$$

Thus the optimal condition for the household problem as follows.

$$C_t^{\sigma}N_t^{\varphi} = \frac{W_t}{P_t} \tag{9}$$

The log linear form of the equation (9)

$$w_t - p_t = \sigma c_t + \varphi n_t \tag{10}$$

The given standard intertemporal optimality condition is

$$\beta\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\left(\frac{P_t}{P_{t+1}}\right) = Q_{t,t+1} \tag{11}$$

To determine the Stochastic Euler equation take expectations on both sides then rearrange is given as follows.

$$\beta R_t\left\{\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\left(\frac{P_t}{P_{t+1}}\right)\right\} = 1 \tag{12}$$

$$c_t \equiv E_t\{c_{t+1}\} - \frac{1}{\sigma}(r_t - E_t\{\pi_{t+1}\} - \rho) \tag{13}$$

The lower case letters represents the logs of the respective variables, here $\rho \equiv \beta^{-1} - 1$ is the time discount rate and $\pi_t \equiv p_t - p_{t-1}$ is consumer price index (CPI) inflation. The $R_t = \frac{1}{E_T\{Q_{t,t+1}\}}$ denote

as the gross return on riskless discount bond for one period payoff in terms of per unit domestic currency in next period.

2.2. Domestic inflation, CPI inflation, real exchange rate, and terms of trade

The effective term of trade between home and foreign country is written as

$$S_t \equiv \frac{P_{F,t}}{P_{H,t}} \tag{14}$$

The log linear form of the given equation

$$s_t = \int_0^1 s_{i,t}\, di \tag{15}$$

The equation of CPI is expressed in log linear form with a symmetric steady state under the condition of purchasing power parity.

$$p_t \equiv p_{H,t} + \alpha s_t \tag{16}$$

Where $s_t \equiv p_{F,t} - p_{H,t}$ represents the log of effective term of trade, inflation is defined as the rate of change in good price index and the link between inflation and term of trade is expressed as

$$\pi_t = \pi_{H,t} + \lambda \Delta s_t \tag{17}$$

Here λ represents the index of openness which fulfills the gap of two measures of inflation in terms of percentage changes in terms of trade. The given assumption of law of one price holds for individual goods at all the times implies that $\pi_t = \pi_t^*$.

$$P_{F,t} = e_t + p_t^* \tag{18}$$

Where $e_{i,t} = \int_0^1 e_{i,t}\, di$ is the log of nominal effective exchange rate and $P_{i,t}^i = \int_0^1 P_{i,t}^i(j)^{1-\varepsilon} dj$ is the log of domestic price index for i's country and $P_t^* = \int_0^1 P_{i,t}^i di$ is the log of world price index respectively. In world domestic and consumer price indices are similar. From the terms of trade's definition the following expression can be obtained.

$$s_t = e_t + P_t^* - P_{H,t} \tag{19}$$

The next step determines the relation between the real exchange rate and term of trade. The bilateral exchange rate for country i can be defined as $Q_{i,t} \equiv \varepsilon_{i,t} P_{i,t}/P_t$ the consumer price index ratios of both countries expressed in their domestic country respectively. Now $q_t \equiv \int_0^1 q_{i,t}$ is the log of effective real exchange rate expressed as:

$$q_t = (1-\alpha)\, s_t \tag{20}$$

2.3. Note on international risk sharing

The first order condition for the country's representative housed while assuming the structure of complete asset markets can be expressed for country i:

$$\beta\left(\frac{C_{t+1}^{i}}{C_{t}^{i}}\right)^{-\sigma}\left(\frac{P_{t}^{i}}{P_{t+1}^{i}}\right)\left(\frac{\varepsilon_{t}^{i}}{\varepsilon_{t+1}^{i}}\right)=Q_{t,t+1} \tag{21}$$

Combining equations (11) and (21) the real exchange rate can be expressed as

$$C_{t}\equiv\ \vartheta_{i}\ C_{t}^{i}\ Q_{i,t}^{\frac{1}{\sigma}} \tag{22}$$

Here constant ϑ_i depends on the initially certain conditions associated with relative net asset positions, such as zero steady state of net foreign asset holdings under this condition it values is equal to one for all i. In the condition of symmetric steady state while holding the law of one price the domestic and foreign consumption as well as exchange rate is also equal to one.

$$C_{t}=C_{t}^{*}+\frac{1}{\sigma}\ q_{t} \tag{23}$$

Where $c_t^* \equiv \int_0^1 c_t^i di$ represents the log of world consumption index. In first order approximation holds the equality condition under the condition of $\eta \neq 1$. This assumption makes the linkage between domestic and world consumption at international level. Under the complete risk sharing assumption, the optimal price of riskless bond in term of foreign currency is $\varepsilon_{i,t}\left(R_t^i\right)^{-1}=E_t\{Q_{t,t+1}\varepsilon_{i,t+1}\}$. The combination of pricing equation with domestic bond pricing equation $(R_t)^{-1}=\ E_t\{Q_{t,t+1}\}$ determines the interest parity condition. The log linear form is given:

$$r_{t}-r_{t}^{*}=E_{t}\{\Delta e_{t+1}\} \tag{24}$$

Combine with terms of trade (in log terms) definition the stochastic difference equation of the above equation is denoted by:

$$s_{t}=(r_{t}^{*}-\ E_{t}\{\pi_{t+1}^{*}\})-\left(r_{t}-E_{t}\{\pi_{H,t+1}\}\right)+E_{t}\{s_{t+1}\} \tag{25}$$

Steady state under the condition of purchasing power parity implies the zero mean of the real interest rate differential as in first difference terms of trade is stationary. This can happen only in the case of unit root in technology parameter. This equation illustrates the combination of Euler's equation of consumption for both domestic and foreign economies associated with the complete risk sharing.

2.4. Firms

Productions function with the linear technology of the differentiated goods that produce in the firms of the home economy.

$$Y_{j}(j)=\ A_{t}N_{t}(j) \tag{26}$$

A represents the labour productivity thus the stochastic process can be expressed as

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a \tag{27}$$

Here $N_t \equiv \int_0^1 N_t(j)dj = \frac{Y_t Z_t}{A_t}$ and $Z_t \equiv \int_0^1 \frac{Y_t(j)}{Y_t} dj$ j symbolize the firm-specific index and real marginal cost of all identical domestic firms is given by:

$$mc_t = -v + w_t - p_{H,t} - a_t \tag{28}$$

Herev $\equiv -\log(1-\tau)$, τ stands for the employment subsidy. The domestic aggregate output index as for the consumption represent as

$$Y_t \equiv \left[\int_0^1 Y_t(j)^{1-\frac{1}{\varepsilon}} dj\right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{29}$$

The aggregate relationship in the first order approximation requires

$$y_t = a_t + n_t \tag{30}$$

2.5. Price setting mechanism

This model is based on the assumption of Calvo-type staggered price setting mechanism. This assumption considers the domestically differentiating goods thus inclusion of domestic firm's participation, $1-\alpha_t$ Is the fraction of random selection of domestic firm's decision based optimal prices while α_t is the fraction of firms having sticky prices. The optimal price of producers can set their prices at time T is therefore:

$$\left(P_{H,t}\right)^{1-\sigma} = \alpha P_{H,t-1}^{1-\sigma} + (1-\alpha)\left(P_t(h)\right)^{1-\sigma} \tag{31}$$

$P_{H,t}$ symbolize the newly domestic prices in log terms and $\mu = log\left(\frac{\varepsilon}{\varepsilon-1}\right)$, is the markup in the economy. The pricing behavior is selected as adaptive and firms set their prices as a markup as expected optimal marginal cost for the future rather than to observe only marginal cost of current period. The complete flexible price economy represent as $\alpha \to 0$. Now the markup rule is $P_{H,t} = \mu + mc_t + p_{H,t}$.

$$P_{H,t} = \mu + (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k E_t\{mc_{t+k} + p_{H,t}\} \tag{32}$$

3. EQUILIBRIUM

3.1. Goods market equilibrium

The goods market equilibrium condition for the home requires

$$Y_t(j) = C_{H,t}(j) + \int_0^1 C_{H,t}^i(j)di + G_t(j)$$

$$Y_t(j) = \left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\varepsilon}\left[(1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t + \alpha\int_0^1\left(\frac{P_{H,t}}{\varepsilon_{i,t}P^i_{F,t}}\right)^{-\gamma}\left(\frac{P^i_{F,t}}{p^i_t}\right)^{-\eta} C^i_t di + G_t(j)\right] \quad (33)$$

The production of goods is equal to domestic consumption plus foreign consumption of domestic goods j plus public consumption of same good Here $C^{i}_{H,t}(j)$ stands for demand for goods j from country i's that produced in the home country. Substituting equation (32) into aggregate domestic output's definition $Y_t \equiv \left[\int_0^1 Y_t(j)^{1-\frac{1}{\varepsilon}}dj\right]^{\frac{\sigma}{\sigma-1}}$ thus to obtain:

$$Y_t - G_t = \left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t\left[(1-\alpha) + \alpha\int_0^1 \left(S^i_t S_{i,t}\right)^{\gamma-\eta} Q_{i,t}^{\eta-\frac{1}{\sigma}} C^i_t di\right] \quad (34)$$

S^{i}_{t} stands for the effective terms of trade for country i and $S_{i,t}$ represents the bilateral term of trade across both countries. As for the special case of $\varsigma = \theta = \gamma = 1$ the above condition can be expressed as

$$Y_t = C_t S_t^{1-v} \quad (35)$$

From previous $\int_0^1 (S^i_t) di = 0$, the first order approximation of equation (34) expressed as a log linear form in symmetric steady state:

$$\begin{aligned} y_t - \varrho g_t &= c_t + \alpha\gamma s_t + \alpha\left(\eta - \frac{1}{\sigma}\right) q_t \\ &= c_t + \frac{\alpha\omega}{\sigma} s_t \\ g_t &= \rho_g g_{t-1} + \varepsilon_g \end{aligned} \quad (36)$$

Here $\omega \equiv \sigma\gamma + (1-\alpha)(\sigma\eta - 1)$ the condition $\sigma = \eta = \gamma = 1$ implies $\omega = 1$. This condition similar across countries, for country i expressed as $y^i_t = c^i_t + \frac{\alpha\omega}{\sigma} s^i_t$. The world market equilibrium condition can be expressed as

$$y^*_t \equiv \int_0^1 y_i di \quad (37)$$

Here c^{*}_{t} and y^{*}_{t} are the log term indexes of world's output and consumption. Combining (36) with (22) and (13).

$$\begin{aligned} y_t &= y^*_t + \frac{1}{\sigma_\alpha} s_t \\ \sigma_\alpha &\equiv \frac{\sigma}{(1-\alpha) + \alpha\omega} > 0 \end{aligned} \quad (38)$$

Combine equation (36) with Euler equation (13):

$$y_t = E_t\{y_{t+1}\} - \frac{1}{\sigma}(r_t - E_t\{\pi_{t+1}\} - \rho) - \frac{\alpha\omega}{\sigma} E_t\{\Delta s_{t+1}\} \quad (39)$$

Here $\Theta = (\sigma\gamma - 1) + (1-\alpha)(\sigma\eta - 1) = \omega - 1$.

3.2. Supply side: Marginal cost and inflation dynamics

The link between inflation dynamics and real marginal cost in the small open economy is expressed as:

$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \lambda \widehat{mc}_t \tag{40}$$

$$\lambda \equiv \frac{(1-\beta\alpha)(1-\alpha)}{\alpha}$$

Now determine the real marginal cost expressed as function of domestic output is different in open economy as compare to the close economy due to difference in their respective consumption and output. Particularly it shows:

$$mc_t = -v + \sigma y_t^* + \varphi y_t + s_t - (1+\varphi)a_t \tag{41}$$

Above equation is the equality of equations (23) and (30) demonstrates the marginal cost is rising. Real wage effect is illustrated through the intertemporal consumption and leisure relationship as wealth effect influence on labour supply. Any changes in term of trade directly effects on the wages of products associated with real wage. The real marginal cost associated with domestic output and productivity owing to technological innovations occurs in small open economy demonstrates:

$$mc_t = -v + (\sigma_\alpha + \varphi)y_t + (\sigma - \sigma_\alpha)y_t^* - (1+\varphi)a_t \tag{42}$$

3.3. Equilibrium dynamics

Although for some special cases, real marginal cost is directly converge into the foreign output movements in the above expressions. In the model the x_t is the output gap represents as a log deviation of domestic output y_t and natural output $\bar{y}_t$. In the absence of nominal rigidities the equilibrium of output is $x_t \equiv y_t - \bar{y}_t$. While the natural level of output is determine by applying $mc_t = -\mu$ at t and solve for the output thus obtain

$$\bar{y}_t = \Omega + \Gamma a_t + \alpha\psi\, y_t^* \tag{43}$$

Here $\Omega \equiv \frac{\vartheta-\mu}{\sigma_\alpha+\varphi}$, $\Gamma \equiv \frac{1+\varphi}{\sigma_\alpha+\varphi} > 0, and\ \psi \equiv -\frac{\Theta\sigma_\alpha}{\sigma_\alpha+\varphi}$.

The link between real marginal cost and output gap illustrated as $\widehat{mc}_t = (\sigma_\alpha + \varphi)x_t$ and now combine with equation (40) to determine the equation of New Keynesian Phillips curve (NKPC) regarding output gap for small open economy:

$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + k_\alpha x_t \quad (44)$$

Here $k_\alpha \equiv \lambda(\sigma_\alpha + \varphi)$. for the special case of $\sigma = \eta = \gamma = 1$ as in the absence of openness the slope coefficient forms the NKPC for the close economy. Follow the equation (39), to determine the dynamic IS equation for small open economy regarding the output gap

$$x_t = E_t\{x_{t+1}\} - \frac{1}{\sigma_\alpha}(r_t - E_t\{\pi_{H,t+1}\} - \overline{rr}_t) \quad (45)$$

$$\bar{r}_t \equiv \rho - \sigma_\alpha \Gamma(1-\rho_a)a_t + \alpha\sigma_\alpha(\Theta + \psi)E_t\{y^*_{t+1}\} + \frac{\gamma\sigma_\alpha\varphi(1-\rho_g)}{\varphi(1-\gamma)+\sigma_\alpha}g_t + \frac{\gamma\varphi(\sigma-\sigma_\alpha)(1-\rho_g)}{\varphi(1-\gamma)+\sigma_\alpha}g^*_t \quad (46)$$

The $\overline{rr}_t$ is natural rate of interest for the small open economy. The degree of openness creates an impact on responsiveness of the output gap regarding changes in interest rate.

3.4. Welfare cost

The consumer welfare loss because of deviations from the optimal policy can be expressed as steady state consumption requires that

$$W = -\frac{1-\alpha}{2}\sum_{t=0}^{\infty}\beta^t\left[\frac{\varepsilon}{\lambda}\pi^2_{H,t} + (1+\varphi)x^2_t\right] \quad (47)$$

Taking expectations to equation (47) and $\beta \to 1$ the resultant welfare loss of the policy deviated from strict inflation targeting can be demonstrated as variance of inflation and output gap:

$$V = -\frac{1-\alpha}{2}\left[\frac{\varepsilon}{\lambda}var(\pi_{H,t}) + (1+\varphi)var(x_t)\right] \quad (48)$$

3.5. Monetary policy rule

In this model the interest targeting rule as an optimal monetary policy is used to examine the difference asset market structures. The optimal policy rule stabilized the interest rate with output, inflation and real exchange under alternative asset market structure. In the policy rule, 'i' is the interest rate, 'q' is the real exchange rate, 'y' is the output, 'y^*' is the potential output and π_t is the consumer prices inflation. In addition, w_y, w_q, w_π are the weights relative to output gap, real exchange rate, and inflation.[3]

$$i_t = w_y(y-y^*)_t + w_q q_t + w_\pi \pi_t \quad (49)$$

4. EMPIRICAL ANALYSIS

[3] The coefficients of the policy rules can estimate through the regression equation the series is taken as Pakistan money market rate, consumer price index and output gap. Data series taken from 1971-2012 and source is International Financial Statistics.

4.1. Calibration

The benchmark values of parameters are described below in order to evaluate the research analysis.[4] The elasticity of substitution between home and foreign goods is calibrated as $\eta = 1$. The inverse of intertemporal substitution can be taken as $\varepsilon = 1$. The inverse elasticity of labour supply is calibrated as $\varphi = 2$. The degree of openness in the baseline framework set as $\alpha = 0.34$ implies the average annual values of (import + export / GDP) ratio start of the period from 1971 to 2012. The discount factor is calibrated as $\beta = 0.98$. The measure of price stickiness of the firm is taken as $\theta = 0.75$ is taken as average annual value of Pakistan consumer price index (price changes) from 1950 to 2010 and data source is federal bureau of statistics. The elasticity of substitution between differentiated products is set as $\sigma = 1$ on this model. In the baseline Taylor rule coefficients with respect to inflation, output and real exchange rate is set as $w_{\pi} = 0.31$, $w_{x} = 0.18$ and $w_{q} = 1.2$. The variables taken for estimation of Taylor coefficient are the money market rate as nominal interest rate, consumer price inflation and GDP growth rate as an output and real exchange rate. The selected variables periods start from 1971 to 2012 and data source is federal bureau of statistics. This study uses HP-filtered annual based data for stochastic shock process. In the productivity shock output per worker is taken as a proxy for labour productivity in Pakistan and the sample period of this series from 1980 to 2012. The data source of this series is taken from world development indicators and international financial statistics.

$$a_t = 0.9a_{t-1} + \varepsilon_{a_t} \qquad \sigma_{\varepsilon_a} = 0.025$$

4.2. Result analysis

In the result analysis pursue the impulse response and welfare approximation under anticipated and unanticipated productivity shock. The impulse response analysis explores the behaviour of macroeconomics variable under the positive productivity shock while the welfare approximation analysis compares the welfare loss in the flexibility and stickiness of prices, in addition, the comparison of welfare approximation under the open and close economy.

In figure 1, the impulse response to an unanticipated and anticipated productivity shock mention that boost in productivity raises demand of home goods relative to foreign goods, reduce the output gap. In an anticipated shock, low producer and consumer prices demands competitiveness of domestic good results expansion in production. The rise in productivity appreciates the nominal and real exchange rate after some periods the nominal and real exchange rate start decline towards the equilibrium, results to upturn the output and afterwards it start to declines toward steady state as the exchange rate appreciation boost the exports of home goods, terms of trade boosts the competitiveness of the domestic economy. In a similar pattern the domestic and consumer price inflation are little jumped before reached to steady state equilibrium. In an unanticipated shock the consumer price inflation fuel with productivity due to cutting in nominal interest rate and deviation from steady state is lower than anticipated shock. The rise in domestic productivity reduces the real marginal cost, expedites reduction in domestic inflation and boosts the output. The productivity shock responds negatively to the output gap and positive response in output boosts the net exports further improvement in terms of trade.

[4] The Dynare 4 toolkit is used to analyze the impulse response of different shocks. Dynare is Matlab toolkit widely used for simulation and estimation of DSGE models.

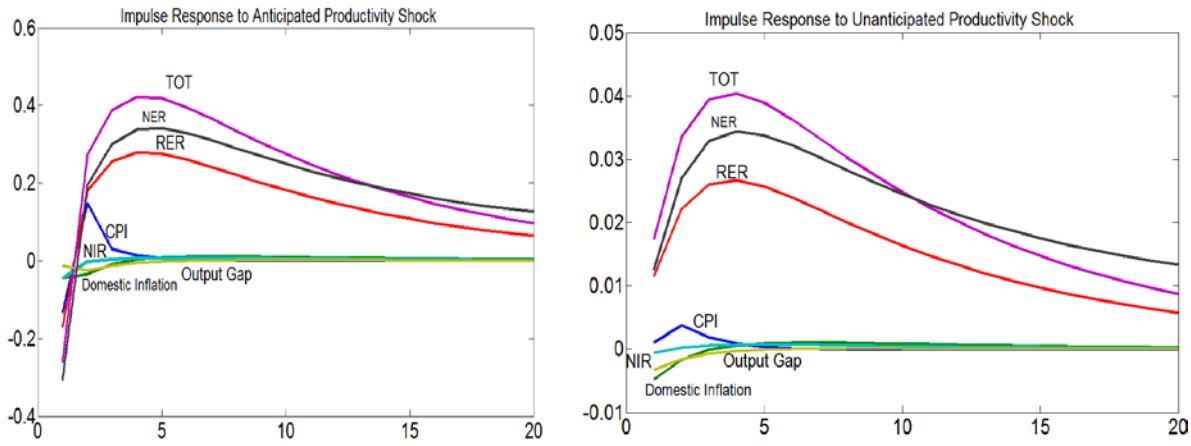


Figure 1: Impulse response to anticipated and unanticipated productivity shock

Figure 2 insinuates impulse response of macroeconomic variables under different elasticity of substitution. The solid line represents the anticipated shock and dashed line represents the unanticipated shock.

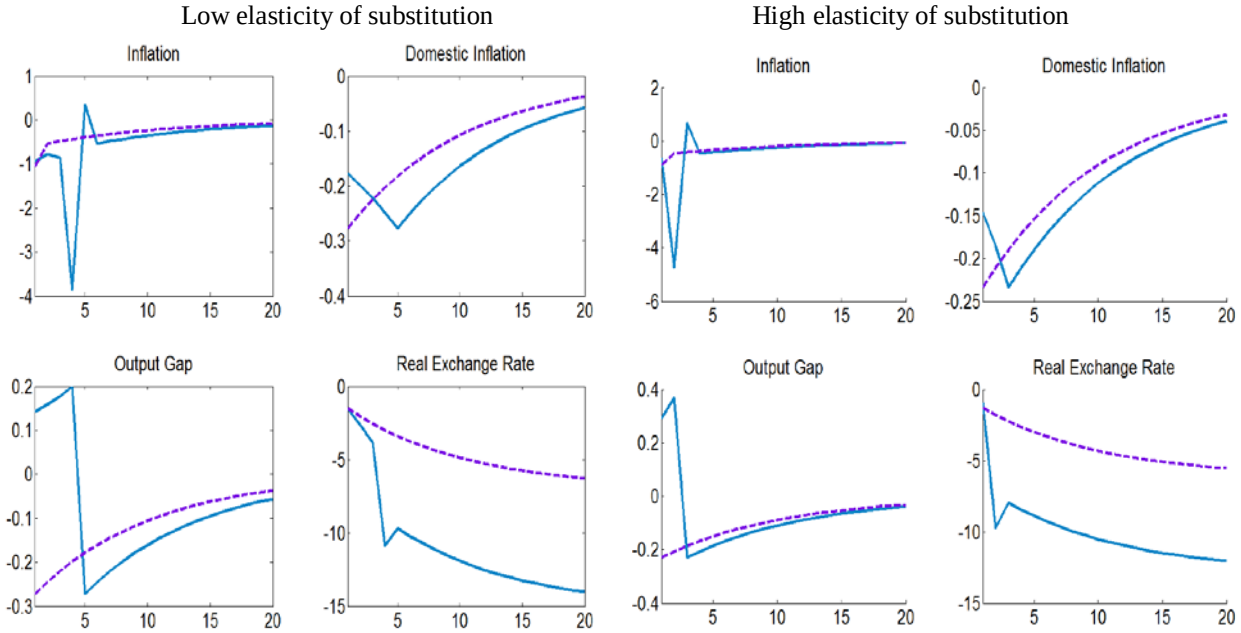


Figure 2: Impulse response to anticipated and unanticipated productivity shock

Monetary policy rule provides an incentive to focus on exchange rate or inflation stabilization because it depends on the elasticity of substitution between home and foreign goods. In low substitution elasticity, the anticipated changes in the productivity shock results the sharp incline in prices while reduces the output gap. Policy rule restricts the movement in exchange rate results the real exchange rate appreciation. The appreciation can shift the production from the domestic to foreign sector results reduction in domestic consumption. Therefore, focus on inflation stabilization can be welfare improving for the small open economy. In the high elasticity of substitution the exchange rate stabilization is welfare improving owing to the optimal risk sharing does not affect on consumption while the appreciation can shift the production stabilizes the domestic production. In our analysis focus on the policy rule with more exchange rate stabilization the complete asset markets will be welfare improving when home and foreign goods are close substitutes. High intertemporal substitution elasticity is welfare enhancing reign of the real exchange appreciation under the unanticipated productivity shock while, the anticipated shock significances the positive output gap associated with high inflation which decreases the welfare associated owing to the instability of the policy rule.

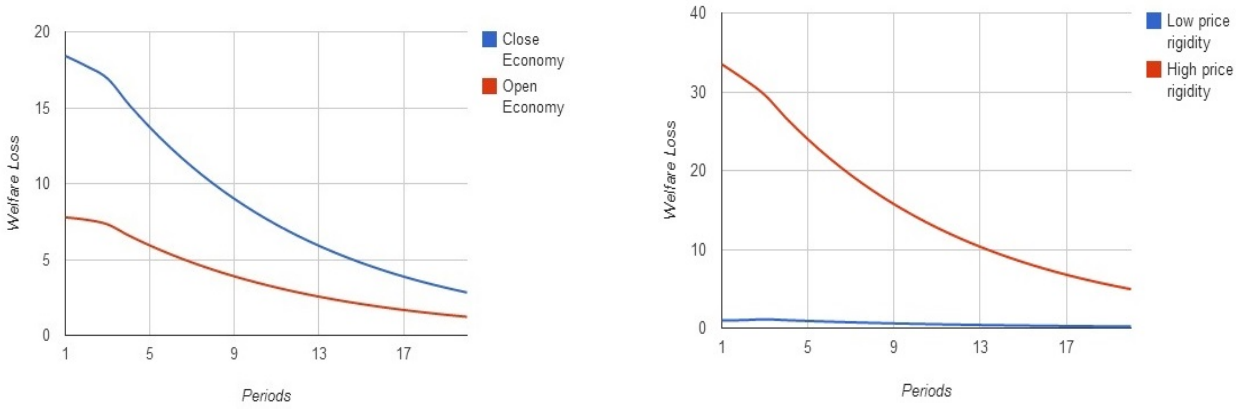
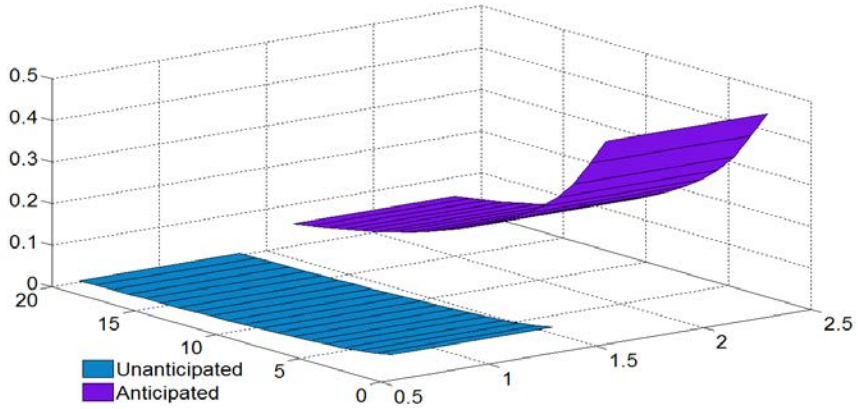


Figure 3: Anticipated welfare approximaton of policy rules

In welfare evaluation of the optimal monetary policy rule, the figure 3 exhibits the welfare loss of anticipated shock in the policy rule. Welfare approximation associated with policy rule is evaluated on extreme case of price rigidness and the price flexibility. Price stickiness produces the surge in inflation and output sharply raises the welfare loss. In comparison of price rigidities, the higher price rigidities cause higher welfare loss as compare to lower price rigidity. High trade openness can reduce the



macroeconomic adjustment cost in the economy.

Figure 4: Welfare cost approximation under Taylor rule

In comparison of degree of openness, the lower degree of openness have higher welfare cost associated to policy rule as compare to the higher degree of openness. In addition, this study analyzed the welfare approximation of policy rule not only with anticipated shock but also with unanticipated shock. For this purpose, figure 4 compares the welfare cost estimation under anticipated and unanticipated productivity shock. Anticipated shock has more welfare cost in contrast with unanticipated shock owing to higher anticipated output gap and inflation.

5. CONCLUSION

This study compares the welfare approximation of alternative policy rules under anticipated and unanticipated productivity shocks. The framework of the model is based on sticky prices and limited case featured the representation of the closed economy model. In comparison of shocks, an anticipated shock has higher welfare loss in policy rule as compare to the unanticipated shock while the welfare also depends on the nature and intensity of shock. In the flexible pricing system

reduces the welfare loss in anticipated shocks. Policy makers are act independently in monetary policy it enhance the welfare improvement in the small open economy. Monetary authorities have focus on exchange rate stabilization in their decision. The future exploration is including the interest parity shock to analyze the welfare effect in the small open economy.

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