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Title

Private Enterprise Productivity and Credit Market Financial Frictions in LDCs:
Policy Relevance from a DSGE Model of Nigeria

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ABSTRACT

The study examines the effect of credit market imperfections on economic activity in Nigeria. Theoretical evidences suggest that, stimulating private sector productivity is seen as the key way of promoting macroeconomic performances and economic development. In addition, one of the important determinants of private enterprises development is the existence of an effective financial system. However, despite the fact that stock markets are getting larger in Nigeria, they are still not large enough to be a significant source of funds to finance private enterprises activities. Consequently, private enterprises still face financial frictions in accessing to credit in Nigeria. To address this important issue, we develop a Dynamic Stochastic General Equilibrium model with financial friction of Nigeria. The model feature two type of debt in the financial contract. A debt denominated in domestic currency and a debt denominated in foreign currency. Financial friction appears because private enterprises face an External Finance Premium in the credit market. Results reveal that alleviating financial frictions is key to fostering producers' productivity and ensuring broad-based growth. Furthermore, monetary policy performs better than fiscal policy in reducing credit market imperfections with expansionary effect on macroeconomic outcomes. As for policy implications, it comes out that, National authority should promote financial inclusion for producers to adopt the productivity and income enhancing technologies that drive investment development in Nigeria.

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1. Introduction

The mid-2007 global economic crisis motivated a surge of interest in private enterprises development in low-income countries, including Africa economies. Theoretical evidences suggest that, stimulating private sector is seen as the key way of promoting macroeconomic performances and economic development. One of the important determinants of private enterprises development is the existence of an effective financial system (Bruck et al. 2014; Naude 2010; Acs et al. 2008; Wohlmuth et al. 2004). However, despite the fact that stock markets are getting larger in Nigeria, they are still not large enough to be a significant source of funds to finance private enterprises activities. In average, for the period of 1990-2013, the share of market capitalization in GDP is less than 50 percent (14.6%), with a stocks traded total value of 1.72% of GDP and a stocks traded turnover ratio of 8.54% (Bayraktar 2014). In addition, even if Nigeria have implemented several banking sector reforms, the real sector is still finding it difficult to access financial resources especially from the commercial banks that hold about 90% of the total financial sector assets. As result, private enterprises still faced financial frictions in accessing to credit in Nigeria (Oluwu 2012; Damiano and Mwakubo 2014).

Basically, the financial frictions refer to the socio-cultural context, which highlights social norms, social values and social practices, and can, be classified in two categories: endogenous factors and exogenous factors (Essel 1996; Ifelunini and Wosowei 2013). Endogenous constraints due to private enterprises are first related to their financing capabilities to undertake an activity. The existence of information asymmetry related to the different types of enterprises within financial institutions reduces accessibility to credits for private enterprises (Asiedu and al. 2012; Wekwete 2014). Identification of exogenous factors in private enterprises contractor is directly related to the operation of the banking sector and other external condition such as conflict. Private enterprises engaged in small activity in term of capital assets, in a start-up development process are exposed to high interest rate on their credit demand to banks, because those types of projects have high-risk default (Stiglitz and Weiss 1981; Ifelunini and Wosowei 2013; Wekwete 2014).

To this extend, to address the research question, we develop a Dynamic Stochastic General Equilibrium (DSGE) model with financial frictions. In fact, to understand the

role of private enterprises in economic development process, one needs to understand both how enterprises relate to microeconomic issue, as well as to macroeconomic issue. Until now, most researches have dealt with the former, typically focusing on the role of innovative private enterprises in their productivity and profit. The issue of private enterprises and credit market imperfections has been considerably neglected. Moreover, the relationship between financial frictions, firms' productivity and macroeconomic performances is not well understood in the scientific literature. Given the shallowness of financial market in Africa and in presence of financial exclusion, the lack of research on the challenges faced by enterprises to overcome financial frictions is a significant lacuna. This research would contribute to fill this lacuna by focusing on the link between firms' financial frictions in the credit market and macroeconomic outcomes. To the best of our knowledge, this study would be the first research trying to feature financial contract with frictions in the DSGE model for a less developed country. The rest of the paper is structured as follows. The next section contains a brief review of the literature. Section 3 presents some stylised facts. In Section 4, the paper presents the framework for analysis and Section 5 presents model calibration and the steady state. Simulation results are discussed in Section 6 while Section 7 concludes with policy recommendations.

2. Brief Literature Review

Credit market frictions have been identified as sources of business cycle and financial fluctuations. Friction in credit markets arise in the absence of perfect markets characterized by equilibrium outcomes between supply and demand for loanable funds. In literature, there is consensus that credit market frictions or imperfection inhibits productive entrepreneurship and can spur income inequality and multiple equilibria (Baliamoune-Lutz, Brixiovia and Ndikumana 2011; Todaro and Smith ...). Credit market frictions are also assumed to be a source of cyclical fluctuations. Several studies beginning with Bernanke and Gertler (1989) have modeled financial factors such as entrepreneurs' net worth to be a source of friction to the aggregate economy. This is plausible in the face of information asymmetry problems between lenders and entrepreneurs. Specifically, Bernanke and Gertler (1989) construct an overlapping generation model to illustrate that information asymmetries in form of agency costs expose entrepreneurs to credit limits, since lenders considers the

entrepreneur's net worth as a signal of his credit worthiness. The authors assume that in a recession, entrepreneurs face lower net worth. In an environment where lender seeks to maximize interest earned and minimize risks, because of their low net worth, entrepreneurs face higher interest rates that lowers their profitability and investment and in the future lowers their level of external capital, productivity and net worth. This occurs vice versa for entrepreneurs with higher net worth, when the economy is booming. In a related study, Kiyotaki and Moore (1997) shows that changes in the value of firms' assets is the main source of shocks to entrepreneurs' net worth that is then amplified and propagated to the aggregate economy.

One finds that Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) are theoretical and qualitative in nature and so not relevant for policy evaluation. To address this, Calstrom and Fuerst (1997) quantitatively analyses Bernanke and Gertler (1989) by calibrating and simulating a real business cycle model where agency costs is the financial friction that propagates to the economy. Their results show that agency costs play a persistent and significant role in inducing cyclical fluctuations. However, the fact that Calstrom and Fuerst (1997) use a real business cycle model that assumes flexible price cannot be as compelling as using the new Keynesian framework, considering that the new Keynesian framework allows for stickiness in prices and imperfect markets. To address this, Bernanke, Gertler and Gilchrist (1999) empirically investigates the role of agency costs as a form credit market friction in the New Keynesian stochastic framework. They find that credit market frictions amplify shocks to the economy to a greater degree when compared to Carlstrom and Fuerst (1997).

Within the new Keynesian framework, specifically using the dynamic stochastic general equilibrium model, Christensen and Dib (2007); Gilchrist, Ortiz and Zakrajsek (2009) tests the importance of financial frictions in the United States using the Maximum Likelihood and Bayesian Maximum likelihood estimators, respectively. While Gilchrist, Ortiz and Zakrajsek (2009) finds evidence for significant financial accelerator in cyclical fluctuation, Christensen and Dib (2007) results show that credit market friction is not a minor source of output fluctuation.

In this study, the relevance of the credit market friction as a source of cyclical fluctuation is examined in a developing country like Nigeria using the new Keynesian DSGE model. The expectation is that credit market frictions and their relation to productive entrepreneurship will have stronger and significant effect on dynamics of fluctuations than what was found in Gilchrist, Oritz and Zakrajsek (2009); Christensen and Dib (2007).

3. Some Stylised Facts

This section of the paper presents and analyses the statistical properties of the Nigerian business cycles often referred to as stylised facts. The paper uses the quarterly data from 1990 to 2013. The cyclical components of the variables considered were obtained from the Hodrick-Prescott filter as it is often the practice in the literature (Agenor et. al., 2000; King and Rebelo, 1999). The logarithmic transformation of the variables was used to describe the business cycle properties. The variables considered include the real gross domestic product (GDP) and its components: consumption, public spending, agricultural GDP, industrial GDP, manufacturing GDP and service GDP. The other set of variables in the study are those relevant to the productive activities of the firms in the economy. This includes the following: labour, capital stock, market capitalization, interest rate, loans and the consumer price level.

The paper captures the following business cycle statistics: volatility in the data is measured by the standard deviation of the variable (σ), relative standard deviation is designed to measure the volatility of a given variable to that of the GDP (σ_x/σ_y). The contemporaneous correlation, $\text{corr}(x_t, y_t)$ measures the pro-cyclical ($\rho_{xy} > 0$) or counter-cyclical ($\rho_{xy} < 0$) or acyclical ($\rho_{xy} = 0$) of a variable with respect to the GDP. The autocorrelation statistics is also employed in the study to capture the extent of persistent in the cyclical component of the variable. Finally, cross correlation statistics of the cyclical component of each series and the cyclical component of the GDP at various leads and lags ($\text{Corr}(x_t, y_{t-k})$) is used.

Table 1 shows the business cycle statistics of the Nigerian economy. The volatility of the GDP is 0.033 which is an estimation of figures obtained from developed and emerging economies (Ghate, Pandey and Patnaik, 2012). All the other variables under consideration exhibit similar trend showing a low volatility in the variables. This is contrary to findings in the literature that high volatility is considered both as a source as well as reflection of underdevelopment Loaya et al. (2007). Nigeria is still considered a developing country. The highest value for volatility is for the variable Loans at 0.217. This paper opines that what is observed in the data may not be unconnected with the growth observed in the economy. In this regard, the argument of Koren and Tenreyro (2006) as contained in Loaya et al. (2007: 353) that as development proceeds, countries choose technologies that are more resilient to shocks and thus allow for lower aggregate volatility.

Table1: Stylized Facts (1990:1-2013:4)

Variable	Std. Dev.	Rel. Std. Dev.	Cont. Corr.	First Ord. Auto Corr.	Corr. ($x_t: y_{t-4}$)
RGDP	0.033	1.00	0.885	0.855	0.106
Public Spending	0.330	10.02	0.818	0.694	0.241
Agric. GDP	0.052	1.57	-0.500	0.874	-0.249
Ind. GDP	0.035	1.05	0.315	0.866	-0.106
Manu. GDP	0.027	0.82	0.164	0.756	0.099
Ser. GDP	0.024	0.73	0.740	0.820	0.233
Consumption	0.104	3.15	-0.027	0.737	-0.109
Labour	0.001	0.04	-0.609	0.942	0.102
Capital Stock	0.141	4.28	-0.471	0.877	-0.488
Market	0.276	8.38	-0.161	0.841	0.038
Capitalisation	0.098	2.96	-0.338	0.854	-0.201
Interest Rate	0.217	6.58	-0.226	0.901	-0.132
Loans	0.080	2.44	0.416	0.877	0.078
Price Level					

Note: Std. Dev.: Standard Deviation; Rel. Std. Dev.: Relative Standard Deviation
Cont. corr.: Contemporaneous correlation; First Ord. Autocorr.: First Order autocorrelation

Corr. ($x_t: y_{t-4}$): Cross correlation

Source: Authors' Computation

Private consumption is found to be more volatile than the GDP and the relative volatility is high at 3.15. However, consumption is countercyclical and persistent. It leads the cycle. Public spending is more volatile than the GDP and its other components. This may not be surprising given the public spending pattern and the

susceptibility of public expenditure to external shocks in the Nigerian economy. It is highly volatile at 10.02 but pro-cyclical and persistent. This variable lags the GDP. Further, agric. is slightly more volatile than the GDP and the relative volatility is found to be 1.565. It is countercyclical, highly persistent and leading the GDP. It could be seen also that industry, manufacturing and service are pro-cyclical and highly persistent. While agriculture and industry lead the cycle, manufacturing and service were lagging the cycle. Looking at the other set of variables, labour, capital stock, market capitalization interest rate loans and price level are all more volatile than the GDP and the relative volatility is higher for all these series except for labour. All the variables exhibited counter-cyclicality except the price level. It is also observed that all the variables are highly persistent.

4. The DSGE Model with Financial Frictions of Nigeria

This paper develops a small open economy DSGE model with financial frictions to address the problem credit market imperfection on economy activity in Nigeria. The model grounds its analytic framework from the New-Keynesian approach. Given the salient features of Nigerian economy, the model features two types of debt in the financial contract. A debt denominated in domestic currency and a debt denominated in foreign currency. Financial friction appears because enterprises face an External Finance Premium (EFP) when accessing to financing. This posits the existence of credit imperfections problem between lenders and borrowers. Enterprises credit limits are affected by the presence of EFP. At the same time, the EFP's for loans are affected by the size of the credit limits. The dynamic interaction between credit limits and EFP turns out to be a powerful transmission mechanism by which the effects of shocks persist, amplify, and spill over to real sector. For the theoretical model, we use a simplified background including representative agents. Overall, we would consider an economy encompassing Households, Production Sectors, Financial Contract, Monetary Authority and Government and the Rest of the World.

1. Households

A continuum of infinitely lived households gains their utility from consumption (C_t), and labor supply (N_t). The intertemporal optimization problem of the representative household is to maximize lifetime utility function given as:

$$u_t = E_o \sum_{t=0}^{\infty} \beta^t u(C_t, N_t) \quad (1)$$

Here, $0 < \beta < 1$ stands for the household subjective intertemporal discount factor.

The representative household is subject to an intertemporal budget constraint:

$$P_t C_t + R_{t-1} D_{H,t-1} + R_{t-1}^* \Psi_{d,t-1}(d_{t-1}, \Phi_{t-1}) Z_t D_{F,t-1} = W_t N_t + D_{H,t} + Z_t D_{F,t} + \Pi_t - T_t \quad (2)$$

Where P_t is the consumer price index, W_t is the nominal wage, $D_{H,t}$ is the household deposit denominated in Naira with a domestic nominal gross interest rate R_t , $D_{F,t}$ is the household deposit denominated in foreign currency with the foreign gross nominal interest rate R_t^* . Z_t is the bilateral nominal exchange rate between Nigeria and the rest of the world. T_t denotes lump-sum taxes paid to government and π_t is the real profit from the monopolistic sector. Finally, $\Psi_{d,t-1}$ is a risk premium.

The Lagrangian for the household optimization problem can be written as follow:

$$L = E_o \left[\sum_{t=0}^{\infty} \beta^t u(C_t, N_t) + \sum_{t=0}^{\infty} \beta^t \lambda_t (W_t N_t + D_{H,t} + Z_t D_{F,t} + \Pi_t - T_t - P_t C_t - R_{t-1} D_{H,t-1} - R_{t-1}^* \Psi_{d,t-1}(d_{t-1}, \Phi_{t-1}) Z_t D_{F,t-1} - T_t) \right] \quad (3)$$

The representative household optimizes over C_t , N_t , $D_{H,t}$ and $D_{F,t}$ taking prices and the initial values of the price level P_0 and debt D_0 as given. The first order conditions of this optimization problem is given as¹:

$$\frac{(N_t)^\varphi}{(C_t)^{-\sigma}} = \frac{W_t}{P_t} \quad (4)$$

$$(C_t)^{-\sigma} = \beta R_t E_t \left[(C_{t+1})^{-\sigma} \frac{P_t}{P_{t+1}} \right] \quad (5)$$

$$(C_t)^{-\sigma} = \beta R_{t-1}^* \Psi_{d,t-1}(d_{t-1}, \Phi_{t-1}) E_t \left[(C_{t+1})^{-\sigma} \frac{P_t}{P_{t+1}} \frac{Z_{t+1}}{Z_t} \right] \quad (6)$$

¹ Here small variables indicates real quantities, for example $w_t = \frac{W_t}{P_t}$.

2. Production sector

Three productions sector are involved in the model namely, physical capital production sector, final goods production sector and retails goods production sector.

2.1.Final Goods Production sector

The representative final goods producer purchases physical capital K_t to the capital producers and hired labor N_t from households used to produce output by minimizing its production cost described as follow:

$$\min_{N_t, K_t} W_t N_t + MPC_t K_t \quad (7)$$

Here, MPC_t , stands for the nominal marginal productivity of capital, K_t represents the stock of physical capital.

The representative female entrepreneur solves the above problem subject to the following production function:

$$Y_t = a_t N_t^{1-\alpha} K_t^\alpha \quad (8)$$

Here $\alpha \in [0,1]$ represents the capital share in the production technology and a_t measures the total productivity factor.

The first-order minimization conditions for labor demand and capital demand and loans demand are expressed as:

$$W_t = (1 - \alpha) MC_t \frac{Y_t}{N_t} \quad (9)$$

$$MPC_t = \alpha MC_t \frac{Y_t}{K_t} \quad (10)$$

Here stands for the Lagrange multiplier associated to the minimization problem and measures the nominal marginal cost of the representative final goods producers. Assuming that the costs of production takes in account only the domestic inflation, we will obtained, the real marginal cost, the real wage and the real marginal productivity of capital, respectively as follow:

$$mc_t = \frac{C_t}{P_{H,t}} \quad (11)$$

$$w_t = (1 - \alpha) mc_t \frac{Y_t}{N_t} \frac{P_{H,t}}{P_t} \quad (12)$$

$$mpc_t = \alpha mc_t \frac{Y_t}{K_t} \frac{P_{H,t}}{P_t} \quad (13)$$

2.2. Capital Production Sector

The representative capital producer purchases final goods from final good producers as investment goods I_t and transforms them into physical capital. The capital producers choose thus the quantity of investment to maximize its profits as follow:

$$\max_{I_t} E_t \left[q_t I_t - I_t - \frac{\Psi}{2} \left(\frac{I_t}{K_t} - \delta \right)^2 K_t \right] \quad (14)$$

Here q_t represents the price of physical capital, δ stands for the depreciation rate of the physical capital and Ψ denotes the parameter that measures the adjustment cost elasticity.

The representative female entrepreneur solves this optimization problem subject to the following adjustment cost of physical capital:

$$\Lambda(I_t, K_t) = \left[\frac{I_t}{K_t} - \frac{\Psi}{2} \left(\frac{I_t}{K_t} - \delta \right)^2 \right] K_t \quad (15)$$

The first order optimization condition for the investment demand is given by:

$$E_t \left[q_t - 1 - \Psi \left(\frac{I_t}{K_t} - \delta \right) \right] = 0 \quad (16)$$

This equation simple implies that the level of investment is chosen such that the effective price of physical capital net of the adjustment cost is equal to unity.

The accumulation of aggregate physical capital stock evolves thus as follow:

$$K_{t+1} = \left[\frac{I_t}{K_t} - \frac{\Psi}{2} \left(\frac{I_t}{K_t} - \delta \right)^2 \right] K_t + (1 - \delta)K_t \quad (17)$$

2.3. Retails Goods Production Sectors

The retails goods are the combination of goods produced in the domestic economy and imported goods.

2.3.1. Domestic Retails Goods Production Sector

The representative producer of domestic retails goods, purchases final goods from final goods producers at a price equals to nominal marginal cost of producer $P_{H,t}$, repackages them and retails them afterward, at price $P'_{H,t}$ in domestic market. We assume that the producers of domestic goods evolve in a monopolistic competition environment in the local market whereas in the foreign market, it evolves in the perfect competitive market². At each period, a share of $(1 - \eta^H)$ of retailers are randomly selected to set new prices while the remaining fraction η^H of retailers keep their prices unchanged³. Each retailer j of them which sets price at t will choose the optimal price that maximizes the expected profits for v periods, expressed by:

$$\max_{P'_{H,t}(j)} E_t \left[\sum_{v=0}^{\infty} (\beta \eta^H)^v \frac{\lambda_{t+v}}{\lambda_t} [Y_{H,t+v}(j) (P'_{H,t}(j) - P_{H,t+v} mc_{t+v})] \right] \quad (18)$$

Here $\frac{\lambda_{t+v}}{\lambda_t}$ denotes the households' marginal utilities ratio between period $t + V$ and t period⁴, $Y_{H,t+v}$ stands for the aggregate final goods demand function, $P'_{H,t}(j)$ represents the level of adjusted prices of the period, mc_{t+v} measures the real marginal cost of the given retailer and $P_{H,t}$ is the domestic price index (DPI).

The representative domestic retails goods producer solves this optimization problem subject to the following final goods demand function:

$$Y_{H,t+v}(j) = \left(\frac{P'_{H,t+v}(j)}{P_{H,t+v}} \right)^{-\chi} Y_{H,t+v}(j) \quad (19)$$

² The law of one price gag (lopg) is involved when the producer of the domestic retails goods exports its goods. However, the lopg doesn't involve when he imports goods produced abroad.

³ For simplicity, these fractions are assumed to be equals within the two groups of retailers.

⁴ Households owned retailers' and received from them an intertemporal utility via the profits they yields.

Here χ denotes the elasticity of substitution between different varieties of goods.

The first order conditions for this maximization problem for the goods demand is expressed by:

$$P'_{H,t}(j) = \frac{\chi}{\chi-1} \frac{E_t \left[\sum_{V=0}^{\infty} (\beta \eta^H)^V \lambda_{t+V} (Y_{H,t+V}(j)) P_{H,t+V} m c_{t+V} \right]}{E_t \left[\sum_{V=0}^{\infty} (\beta \eta^H)^V \lambda_{t+V}^H (Y_{H,t+V}(j)) \right]} \quad (20)$$

Here $\frac{\chi}{\chi-1}$ represents the markup applied to the sequence of upcoming real marginal costs.

Therefore, the domestic price index (DPI) of domestic final goods represents a combination of the above adjusted prices of domestic retails goods and prices that have not been revised in the period, expressed as follow:

$$P_{H,t} = \left[(1 - \eta^H) (P'_{H,t})^{1-\chi} + \eta^H (P'_{H,t})^{1-\chi} \right]^{\frac{1}{1-\chi}} \quad (21)$$

Combining the log-linearized version of the first order condition and the DPI yields an expression of inflation rate for domestically produced retails goods, defined by the following new Keynesian Phillips curve:

$$\hat{\pi}_{H,t} = \beta E_t \hat{\pi}_{H,t+1} + \frac{(1-\eta^H)(1-\beta\eta^H)}{\eta^H} \widehat{m c}_t \quad (22)$$

Where $\widehat{m c}_t$ is the log deviation of the real marginal cost from its steady-state value and $\hat{\pi}_{H,t+1}$ is the log deviation of the domestic inflation from its steady-state value.

2.3.2. Imported Retails Goods Production sector.

The representative producer of imported retails purchases final goods from foreign producers in a perfect competitive market at a price equals to nominal marginal cost of foreign producer, $P_{M,t}$. These producers of imported retails goods retail those goods in domestic market at domestic price $P'_{M,t}$. The imported details goods sector optimization problem is symmetrical the previous sector, except for the real marginal costs of the imported retails goods which equals the law of one price gap.

The first order conditions for this maximization problem for the goods demand is expressed by:

$$P'_{M,t}(j) = \frac{\chi}{\chi-1} \frac{E_t \left[\sum_{V=0}^{\infty} (\beta \eta^M)^V \lambda_{t+V} (Y_{M,t+V}(j)) P_{M,t+V} \log g_{t+V} \right]}{E_t \left[\sum_{V=0}^{\infty} (\beta \eta^M)^V \lambda_{t+V}^M (Y_{M,t+V}(j)) \right]} \quad (23)$$

Therefore, the domestic price index (DPI) of imported final goods represents a combination of the adjusted prices of imported retails goods and prices that have not been revised in the period, expressed as follow:

$$P_{M,t} = \left[(1 - \eta^H) (P'_{M,t})^{1-\chi} + \eta^M (P'_{M,t})^{1-\chi} \right]^{\frac{1}{1-\chi}} \quad (24)$$

Combining the log-linearized version of the first order condition and the DPI yields an expression of inflation rate for imported retails goods, defined by the following new Keynesian Phillips curve:

$$\hat{\pi}_{M,t} = \beta E_t \hat{\pi}_{M,t+1} + \frac{(1-\eta^M)(1-\beta\eta^M)}{\eta^M} \widehat{\log g}_t \quad (25)$$

Where $\widehat{\log g}_t$ is the log deviation of the logg from its steady-state value and $\hat{\pi}_{M,t+1}$ is the log deviation of the rest of the world imported inflation from its steady-state value.

Finally, the CPI inflation, $\hat{\pi}_t$ is a composite of the DPI of domestic final goods and the DPI of the imported final goods defined as:

$$\hat{\pi}_t = (1 - \theta) \hat{\pi}_{H,t}^H + \theta \hat{\pi}_{RW,t}^H \quad (26)$$

Here θ stands for the degree of openness of the economy.

3. Financial contract and External Finance Premium

The banking sector provides loans to the final goods production sector to finance a share of capital used in the production process. At the end of each period, the final goods production sector purchases capital K_{t+1} that will be used in the next period at real price q_t . The total funding needed by the sector to purchase capital is expressed as follow:

$$q_t K_{t+1} \quad (26)$$

The capital acquisition is also partly financed by the final goods production sector net worth NF_{t+1} . The total loans received from the banking sector is thus defined as:

$$D_{t+1} = q_t K_{t+1} - NF_{t+1} \quad (27)$$

However, the total loans receive by the production sector is a combination of domestic currency denominated loans and foreign currency denominated loans defined as follow:

$$D_t = D_{H,t} + D_{F,t} \quad (28)$$

Since the economy is partly involved in the international financial transaction it is exposed to a risk premium. The economy's risk premium $\Psi_{d,t}$ is thus expressed as follow:

$$\Psi_{d,t}(d_t, \Phi_t) = \exp \left[-\psi_d \left(\frac{Z_t D_t}{Y P_t} \right) + \Phi_t \right] \quad (29)$$

Here d_t stands for the real aggregate level of the net-foreign assets (NFA) position in percentage of steady-state output, Φ_t represents an exogenous shocks on risk premium and ψ_d measures the elasticity of the risk premium with respect to NFA position⁵.

Hence, the optimal financial contract between the final goods production sector and banking sector implies an external finance premium ($\Psi_{E,t}$) which depends on the production sector leverage ratio and expressed as follow⁶:

$$\Psi_{E,t+1}(\cdot) = \left(\frac{NF_{t+1}}{q_t K_{t+1}} \right)^{-\gamma} \quad (30)$$

⁵ The real aggregate level of net-foreign assets (NFA) position in percentage of steady-state output is defined as follow: $d_t = \frac{Z_t D_t}{Y P_t}$

⁶ The leverage ratio is defined as the ratio of capital to net worth.

Here NF_{t+1} represents the final goods production sector net worth and γ measures the elasticity of the external finance premium with respect to firm's leverage ratio⁷.

The optimal demand of capital by the production sector satisfies the equality between expected real return on capital and the expected marginal finance cost expressed as⁸:

$$E_t(R_{K,t+1}) = E_t \left[R_t^* \Psi_{d,t}(d_t, \Phi_t) \Psi_{E,t+1}(\cdot) \frac{Z_{t+1}}{Z_t} \frac{P_t}{P_{t+1}} \right] \quad (31)$$

Moreover, the capital demand must satisfy the differentiation between the ex post marginal return on capital and the marginal productivity of capital at $t+1$ which is the rental rate of capital:

$$E_t(R_{K,t+1}) = E_t \left[\frac{mpc_{t+1} + (1-\delta)q_{t+1}}{q_t} \right] \quad (32)$$

Here δ stands for the capital depreciation rate and $(1-\delta)q_{t+1}$ measures the value of one unit of capital used in $t+1$.

In each period t , producers face a constant probability $(1-\nu)$ of leaving the economy. In order to ensure that new producers start out with a positive net worth, we assumed that newly entering producers inherit a fraction of the net worth of those, which exit from the economy. Consequently, aggregate net worth accumulation of the final goods production sector depends on profits earned in previous periods plus the legacy, Ω_t , that newly entering producers receive from those who leave the economy, and evolves according to:

$$NF_{t+1} = \nu \left[R_{K,t} q_{t-1} K_t - R_t^* \Psi_{d,t}(d_t, \Phi_t) \left(\frac{NF_t}{q_{t-1} K_t} \right)^{-\gamma} \frac{Z_{t+1}}{Z_t} \frac{P_t}{P_{t+1}} (q_{t-1} K_t - NF_t) \right] - (1-\nu)\Omega_t \quad (33)$$

⁷ $(\Psi_{E,t+1}(\cdot))' < 0$ and $\Psi_E(1) = 1$. The expression implies that the External Finance Premium represents the specific risk premium.

⁸ The external marginal financing cost is the sum of the gross premium for external finance and the gross real interest rate on the borrowing.

4. Monetary Authority

Based of the monetary policy framework of the Central Bank of Nigeria, the model features a monetary authority, which practices the managed floating exchange rate policy according to the following augmented Taylor-type rule:

$$\hat{R}_t = \beta_0 \hat{R}_{t-1} + (1 - \beta_0)[\beta_1 \hat{\pi}_t + \beta_2 \hat{y}_t + \beta_3 \hat{Z}_t] + e_{R,t} \quad (34)$$

$\hat{R}_t$, $\hat{\pi}_t$, $\hat{y}_t$ and $\hat{Z}_t$ are respectively, the log-deviation from their steady-state values of the nominal interest rate, the inflation, the output and the nominal effective exchange rate of the domestic economy.

5. Government

The government in each economy of the monetary union finances its expenditures in purchases of aggregate public goods using lump-sum taxes paid by households, such as that:

$$P_t G_t = T_t \quad (35)$$

The public spending is assumed to be exogenous and follows the autoregressive process:

$$\hat{g}_t = \rho_g \hat{g}_{t-1} + \hat{\eta}_g \quad (36)$$

Here ρ_g represents the autoregressive coefficient and $\hat{\eta}_g$ stands for the i.i.d. zero mean normal random variable with standard deviation equals to σ_g .

6. Rest of the world

The rest of the world in this model is assumed to be exogenous and its variables follows an autoregressive process such that:

$$AB_t^{RW} = \rho_{AB_t^{RW}} AB_{t-1}^{RW} + e_{AB_t^{RW},t} \quad (37)$$

AB_t^{RW} stands for the absorption of the rest of the world, $\rho_{AB_t^{RW}}$ represents the coefficient of autoregressive process and $e_{AB_t^{RW},t}$ is the i.i.d. zero mean normal random variable with standard deviation equals to $\sigma_{e_{AB_t^{RW},t}}$

5. Exogenous Stochastic Variables

The six exogenous stochastic variables include, the risk premium shock $\hat{\eta}_\phi$, the productivity shock $\hat{\eta}_a$, the fiscal policy shocks $\hat{\eta}_g$ the monetary policy shock $\hat{\eta}_r$, the foreign demand shock $\hat{\eta}_{y^*}$ and the foreign price shock $\hat{\eta}_{p^*}$. We assume that the exogenous stochastic variables follow AR (1) processes with $\rho \in (0, 1)$.

Specifically, we defines:

- **The risk premium shock:**

$$\hat{\phi}_t = \rho_\phi \hat{\phi}_{t-1} + \hat{\eta}_\phi \quad (38)$$

Here ρ_ϕ represents the autoregressive coefficient and $\hat{\eta}_\phi$ stands for the i.i.d. Zero mean normal random variable with standard deviation equals to σ_ϕ .

- **The productivity shock:**

The total productivity factor (a_t) is defined as:

$$\hat{a}_t = \rho_a \hat{a}_{t+1} + \hat{\eta}_a \quad (39)$$

Here ρ_a represents the autoregressive coefficient and $\hat{\eta}_a$ stands for the i.i.d. Zero mean normal random variable with standard deviation equals to σ_a .

- **The foreign demand shock**

The foreign demand is modeled as an exogenous variable as follow:

$$\hat{Y}_t^* = \rho_{Y^*} \hat{Y}_{t+1}^* + \hat{\eta}_{Y^*} \quad (40)$$

Here ρ_{Y^*} represents the autoregressive coefficient and $\hat{\eta}_{Y^*}$ stands for the i.i.d. zero mean normal random variable with standard deviation equals to σ_{Y^*} .

- **The foreign price shock**

The foreign price is modeled as an exogenous variable as follow:

$$\hat{\pi}_t^* = \rho_{\pi^*} \hat{\pi}_{t+1}^* + \hat{\eta}_{\pi^*} \quad (41)$$

Here ρ_{π^*} represents the autoregressive coefficient and $\hat{\eta}_{\pi^*}$ stands for the i.i.d. zero mean normal random variable with standard deviation equals to σ_{π^*}

6.Steady State and Calibration

All the equations of the steady state are available upon request. Table 1 illustrates the results of the steady state of the model. The benchmark represents the economy's steady state when producers face EFP whereas the alternative case is when the financial constraint is loose.

Table 1: Features of the Economy's Steady State

Variables	Benchmark	Alternative Case
Capital Net Worth Ratio $\left(\frac{K}{NW}\right)$	2	2.4
Risk Premium Elasticity with respect to NFA position (ψ_d)	0.001	0.002
EFP Elasticity with respect to firm's leverage ratio (γ)	1	0.5
Consumption to GDP ratio $\left(\frac{C}{Y}\right)$	0.55	0.650
Entrepreneurs probability of leaving the economy $(1 - \nu)$	0.02	0.08
Public expenditure to GDP ratio (G/Y)	0.20	0.24

Table 18 presents the results of the calibration of the model. The time preferences, the production sectors, the monetary authority and goods market parameters are calibrated by means of Bayesian computation based on Nigerian economy features.

Table 2: Value of the Calibrated Parameters

Time Preferences			
β	φ	σ	
0.993	1	2	
Production			
ψ_I	δ	α	ν
0.5	0.04	0.3	0.92
Monetary Policy			
β_0	β_1	β_2	β_3
0.70	1.559	0.433	0.25
Goods Market			
η^H	η^M	θ	χ
0.8	0.8	0.22	0.75

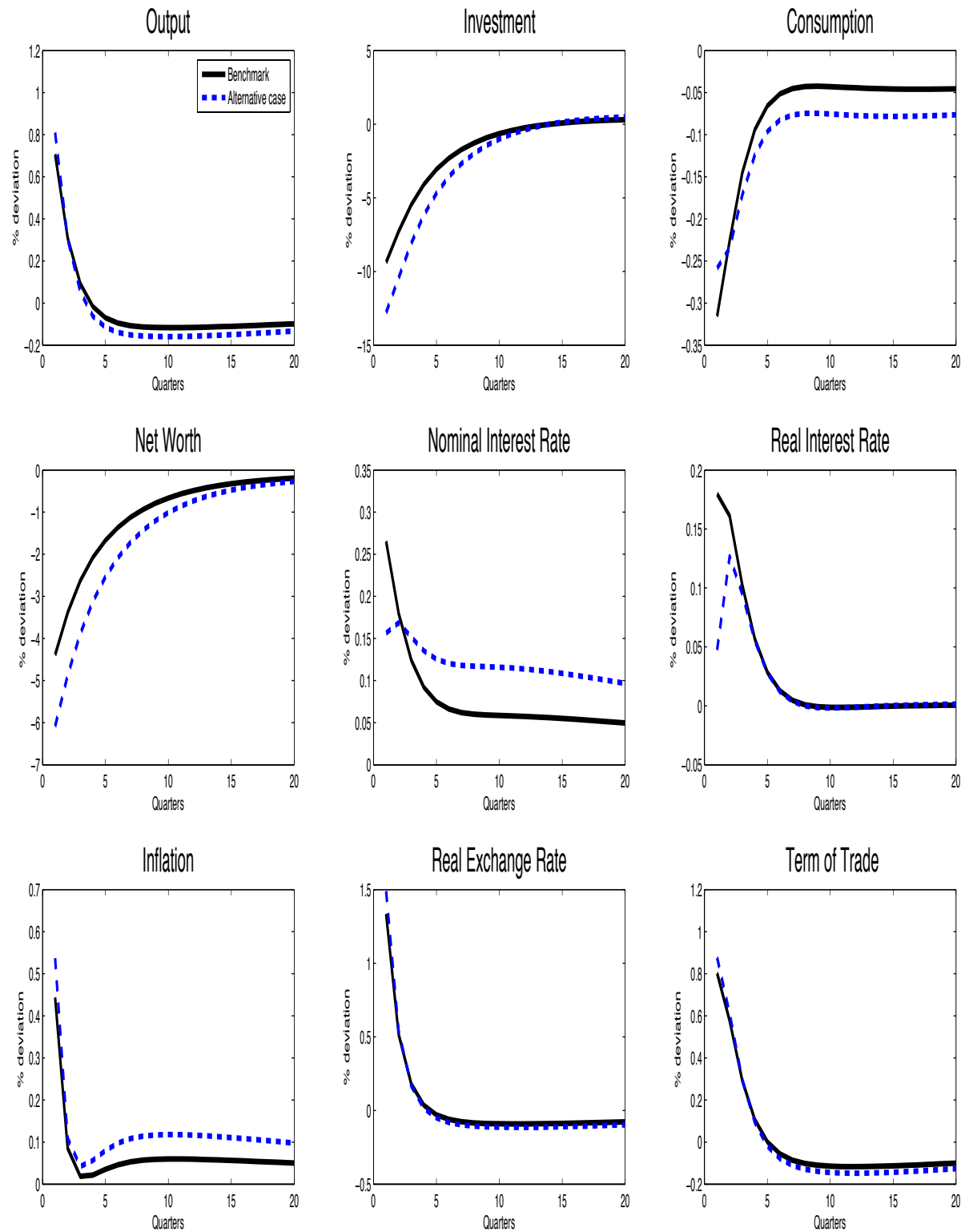
7. Simulations Results

The paper has so far some stylized facts, model description, steady state and calibration. In this section, it delves into the quantitative properties of the model. According to Funke, Mihaylovski and Zhu (2015) one way to learn about model properties is to examine impulse response functions (IRFs). Several shocks are introduced to show the implications of taking the DSGE model to the economy features. In all six shocks were introduced into the economy namely: risk premium, productivity, foreign demand, public spending, monetary policy and foreign price. In each case, the paper explore the response of the main components of the economic aggregate to a one percent point change of the shock to the key variables including: output, investment, consumption, producer net worth, nominal interest rate, real interest rate, inflation, real exchange rate and terms of trade. The results of these hypothetical experiments are presented below:

5.4.1 The Response of the Economy to Risk Premium Shock

In this case, we consider an unexpected risk premium shock. In figure 1, the solid lines give the baseline scenario results and the dotted lines in blue the outcome of the experiments i.e. the alternative case. The responses of the selected aggregate variables to a percentage point increase in risk premium policy are shown in the figure. In the figure, almost all the variables react as expected in all scenarios. An increase in risk premium leads to an increase in investment, consumption and producer net worth. However, output, real interest, nominal interest rate, inflation real exchange rate and terms of trade decline. Noteworthy is the near horizontal segment in the alternative scenario of the nominal interest rate after the sixth quarter. This may not be unconnected with the application of the Central bank of Nigeria, interest rate policy which has been on stable rate over a period of time. Similarly, at impact, the alternative scenario on the real interest rate is at 0.05 per cent against 1.18 per cent. The alternative case increases up to the third quarter and fell thereafter to coincide with the benchmark. This amplifies the volatility of real interest rate to risk premium.

Figure 1: The Response of the Economy to the Risk Premium Shock



5.4.2. The Response of the Economy to Productivity Shock

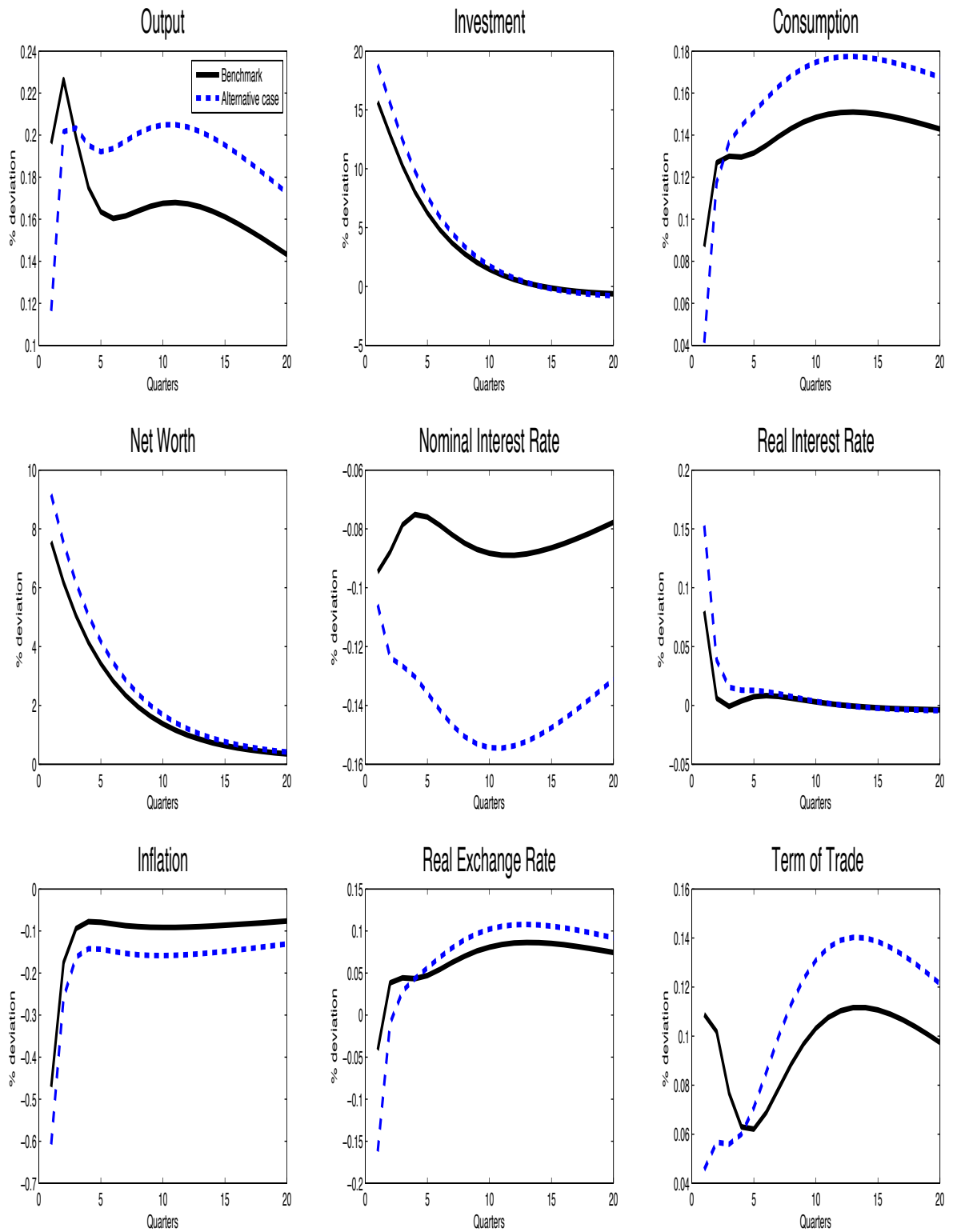
How responsive are the key macroeconomic variables to productivity? Shock to productivity is at the vanguard/origin of Real Business Cycle research and, therefore, one of the important elements of uncertainty in DSGE modeling. In figure 2, a percentage deviation in productivity brings about a decline in investment and net worth from the beginning to the end of the foreseeable horizon. Real interest rate declines up to the tenth quarter and coincide with the benchmark maintaining a horizontal line suggesting that real interest rate is neutral to productivity till the end of the horizon. This indicates that real interest rate is determined outside aggregate firm productivity in the economy.

This figure also indicates that at impact, the benchmark deviation is higher than the alternative scenario. However, the seeming hump shape of the alternative scenario is more pronounced than the benchmark implying the sensitivity of productivity to output. The figures show a decline from a maximum reached in the tenth horizon into the future keeping the alternative scenario comfortably above the benchmark. This is similar to what is observed in consumption, real exchange rate and terms of trade. The hump shape in the latter is more pronounced than in the output variable. Productivity shock leads to a sharp increase in inflation within the initial three quarters only to remain almost horizontal with the benchmark consistently remaining above the alternative scenario.

Thus, the productivity shock implies a steady inflation rate over the horizon which in turn positively affects output, consumption, real exchange rate and the terms of trade. The case of nominal interest rate is slightly different with the benchmark showing a counter-cyclical trend with the alternative scenario till the ninth quarter when the two curves exhibit pro-cyclicality beyond the horizon.

Overall, the enterprises favorable financing conditions helps to amplify the positive effect of the productivity shock in the economy, leading to an increase of macroeconomic outputs above the benchmark.

Figure 2: The Response of the Economy to the Productivity Shock



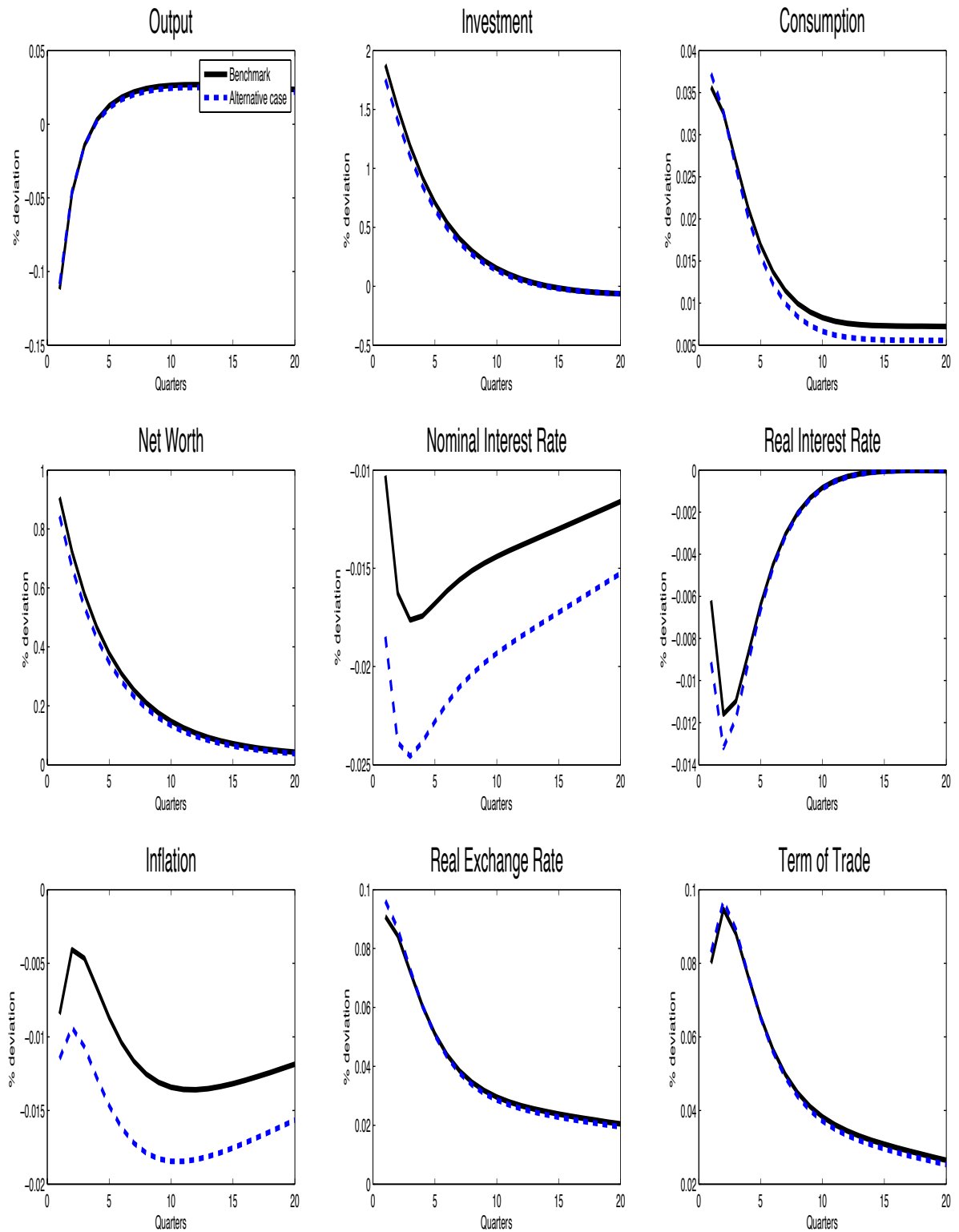
5.4.3. The Response of the Economy to Foreign Demand Shock

The response of the key variables to foreign demand shock is shown in figure 3. In a small open economy (SOE) like Nigeria, foreign demand shock could be a significant source of short run fluctuations in the economy. A shock to foreign demand brought about a sharp increase in output that quickly entered a decreasing growth rate and flattens out into the horizon. This shock leads to decrease in investment, consumption, net worth as well as real exchange rate and terms of trade indicating that foreign demand absorbs the increase in output. Shock to foreign demand brings about an increase at impact and subsequently declines non-linearly from the tenth quarter to the end of the horizon and seemingly beyond.

Figure 3 also indicates that falling net worth observed is a consequence of declining investment as a result of a positive foreign demand shock. Inflation, nominal and real interest rates exhibit similar behavior. While real interest rate fell at impact, it quickly follows an upward trend after the second quarter with both benchmark and alternative scenario merging till the end of the horizon. However, benchmark inflation remained above the alternative case over the horizon as it is found for the nominal interest rate. The lower interest rate has a positive contribution on output

These results implies that, for Nigeria to fully benefit from the increase of foreign demand, more financial resources' are needed for enterprises in order to increase their productive capacity and respond to the external demand by the equivalent supply. Else not, the positive effect of the foreign demand will be offset by the presence of friction in the credit market.

Figure 3: The Response of the Economy to the Foreign Demand Shock

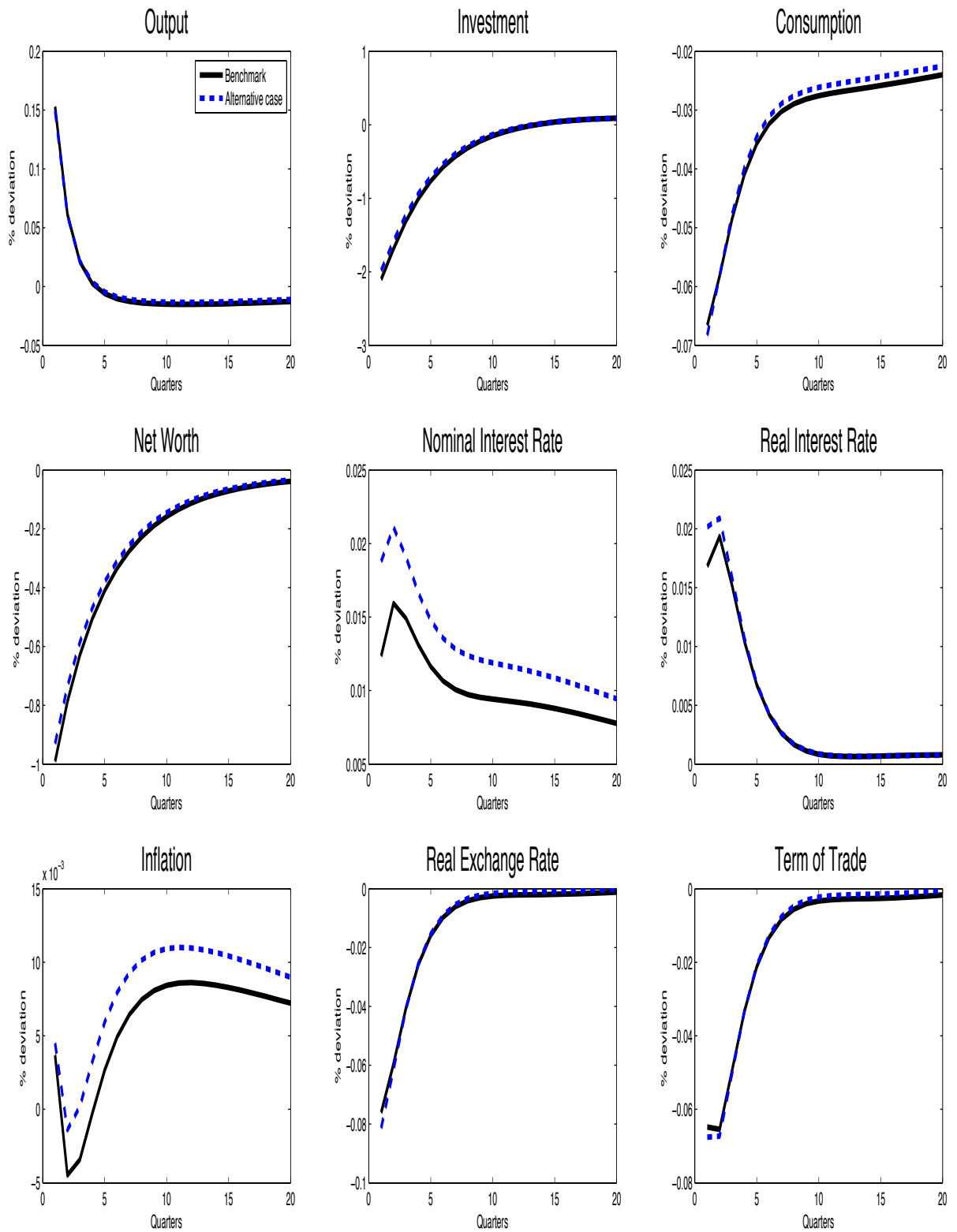


5.4.4. The Response of the Economy to Public Spending Shock

In figure 4 the paper shows, as in the preceding sub-sections, the response of components of aggregate output to a percent change in public spending shock. It is expected that variations in public spending should moderate the effects of the business cycles on the economy. Positive shock to public spending leads to an increasing trends in investment, consumption, net worth, real exchange rate and terms of trade. In all these cases, the benchmark and alternate scenario coincide indicating that the outcomes were the same before and after the experiments. This is also observed in the case of output. The fall in output leads to higher inflation rate and this leads higher nominal interest rate. It is worthy of note that monetary policy of the Central Bank of Nigeria, in recent years, have tended to keep real interest rate positive. This is designed to encourage inflow of foreign capital and competitiveness of the economy. Consequently, public spending an inverse effect on output, did not crowd out investment as theoretically expected, a change in public spending which had the intended positive effect on interest rate which could have engendered the growth in investment.

As whole, theses results demonstrates that fiscal policy exerts no effect in the reduction of financial frictions in the credit market for producers, leading the aggregate output in the alternative case to remain identical to the benchmark output.

Figure 4: The Response of the Economy to the Public Spending Shock



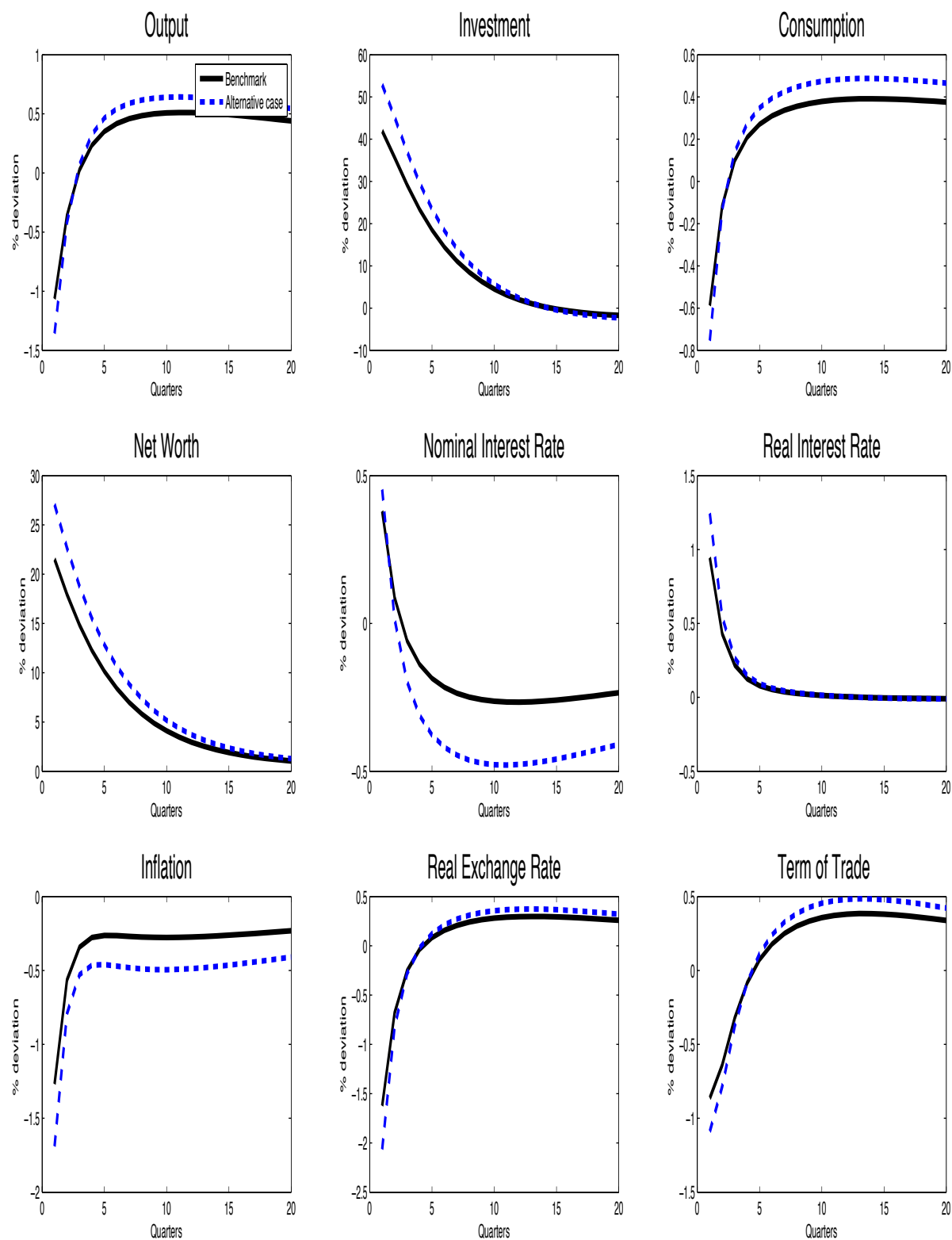
5.4.5. The Response of the Economy to Monetary Policy Shock

Examining the role of monetary policy, figure 5, shows the response of the key variables of the model to one percent deviation in monetary policy shock. In consonance with the notion of non-neutrality of monetary policy, one percent deviation in monetary policy shock leads to increase in output. Inflation rate in alternate scenario remained below the benchmark, which implies higher output and growth in the consumption function and this result, therefore, signifies an improvement in welfare confirming the non-neutrality of monetary policy in line with the theoretical base of this paper that is the New Keynesian DSGE approach.

Decreasing trend in Investment shows its consequences on net worth of the firm. This may not be unconnected with the downward trend of the real interest rate and the nominal interest rate that has dropped drastically over the period of analysis. The combined effect of these is an increasing trend in the terms of trade with a consequent positive effect on competitiveness of the economy and aggregate welfare.

These results imply that monetary policy can create pace to ease access to finance in Nigeria with end of fostering economy activity.

Figure 5: The Response of the Economy to the Monetary Policy Shock

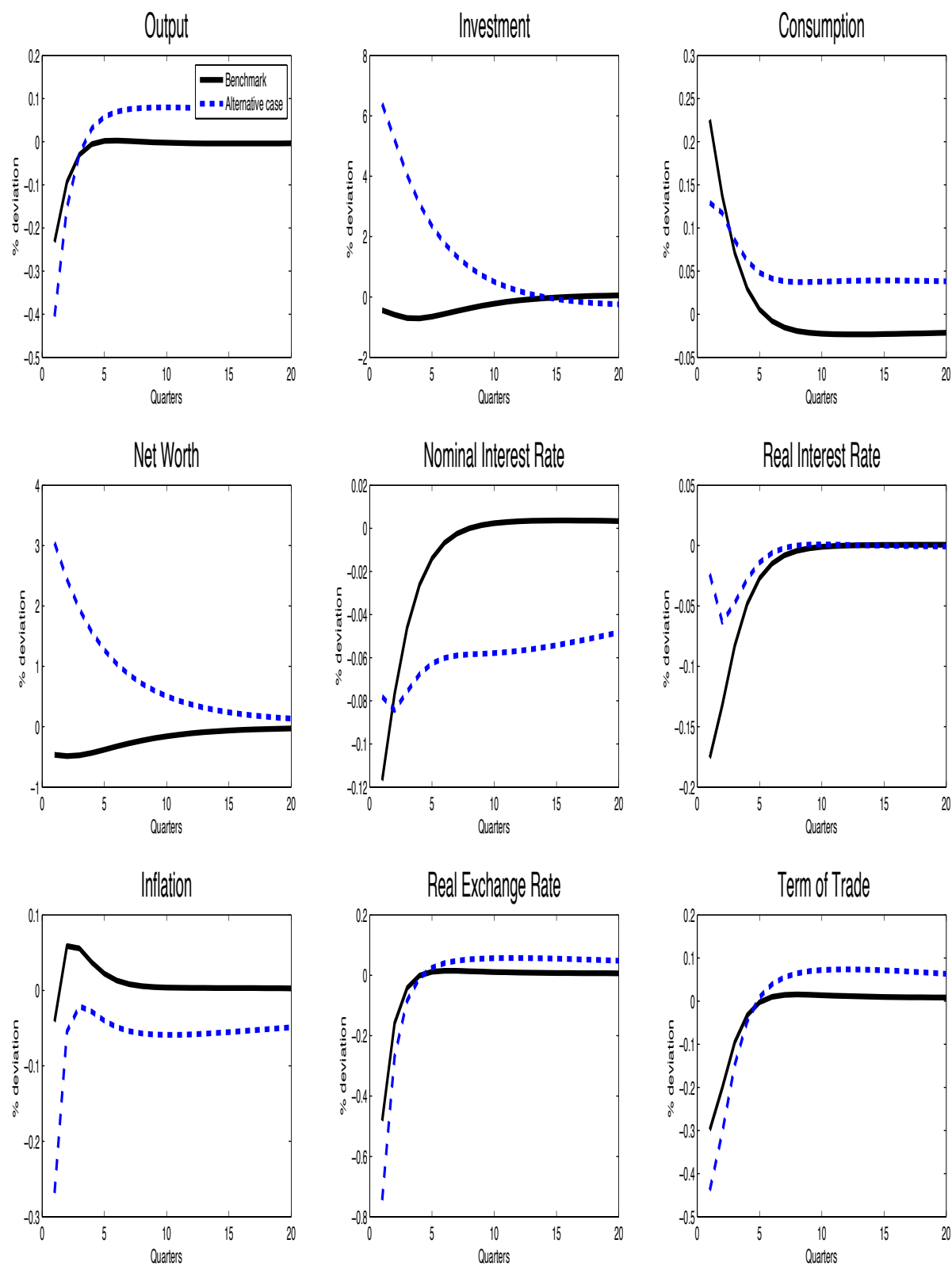


5.4.6. The Response of the Economy to Foreign Price Shock

Finally, the case of the impact of foreign price shock is considered on the key variables of the model presented in this paper. The notion of SOE becomes evident in this scenario. In effect, Nigeria as a SOE is a price taker in the international market. Consequently, international shocks particularly foreign price shocks have unpredictable effect on the economy depending on initial the position of the economy. Many irregularities were observed in the curves of the key variables. The benchmark position of output follows an upward trend from the beginning of the period till the third quarter. However, the alternative scenario exhibits similar trend but the curve crosses that of the benchmark at the fifth quarter and remains consistently above in the horizon. This situation might have been facilitated by inflation rate that was rising till the third quarter but in which the alternative scenario curve remain below the benchmark and almost horizontally over the horizon. This observation coupled with lower interest rate must have combined to engender the growth in output.

As against the observation in the preceding paragraph, behavior of investment presents a more radical difference. In effect, the benchmark scenario follows an increasing trend over the period of simulation. However, the alternative scenario is on the downward trend from the first quarter to the last quarter. As a consequence of this, the net worth depicts an increasing trend but flatter than in the case of investment. In the alternative scenario, the curve declines from the first quarter and become asymptotical to the benchmark from the fifth quarter. One can deduce that foreign price shock undesirable effect on investment and net worth with the attendant decline in welfare. Finally, exchange rate and terms of trade display similar trend both in the benchmark and the alternative scenario keeping the curve of the former below the latter. This suggests an improvement in the international competitiveness of the economy.

Figure 6: The Response of the Economy to the Foreign Price Shock



8. Conclusion and implications

Financial frictions in the credit market matter in the sluggishness of economy activity in Nigeria. Basically, the aim of this paper was to assess the effect of credit market imperfections on economic activity in Nigeria. To address this important issue, we develop a Dynamic Stochastic General Equilibrium model with financial friction of Nigeria. The model feature two type of debt in the financial contract. A debt denominated in domestic currency and a debt denominated in foreign currency. Financial friction appears because private enterprises face an External Finance Premium in the credit market. Firstly, results reveal that alleviating financial frictions is key to fostering producers' productivity and ensuring broad-based growth. Secondly, monetary policy performs better than fiscal policy in reducing credit market imperfections with expansionary effect on macroeconomic outcomes. Thirdly, the presence of financial sector in the model plays a key role in amplifying the magnitude by which macroeconomics indicators respond to shocks. Fourthly, the loosening financial constraint tends to improve producers productivity with expansionary implications in the macroeconomic outcomes.

As for policy implications, it follows from this analysis that financial incentives are critical for producers to adopt the productivity and income enhancing technologies and practices that drive investment development and inclusive economic growth. National authority in Nigeria should promote financial inclusion by reducing the cost of banking intermediation via the introduction of credit reporting system and establishing more transparent and credit-information sharing.

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