Credit Market Frictions and Business Cycle Dynamics in an Oil-Rich Emerging Economy Model

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November 13, 2017

Modelling Plan

- Develop a micro-founded DSGE model with financial frictions for the Nigerian Economy

i Incorporate important features peculiar to emerging and nonindustrial oil exporter economies

ii Add financial frictions in the form of credit constrained consumers, 'liability dollarization' and a 'financial accelerator' mechanism

iii Add policy

Modelling Plan...

- Questions:

  Do the new features improve the fit of the model?

  Are the simulations informative about the economy?

- Estimate and simulate the model:
  - Does the financial accelerator mechanism amplify the shocks in the model
  - Could such mechanism capture the impact of adverse economic conditions especially downturn on the nonindustrial oil exporter
  - Analyse impulse response functions

Impact of the GFC on the Oil exporter

- The GFC had a huge impact on the Nigerian economy

1. Sudden stop to capital flows
2. Cancelation of credit lines to banks
3. Capital flight (flight to safety)
4. Second-round effects on commodity and oil prices

Some Stylized Facts

- Nigerian Economy:

  Total GDP: USD405.1 billion (2016, WB)

  Crude Oil Exports: over 1.74 million (b/d) (OPEC, 2016)

  Dual economy with a large informal sector

Some Stylized Facts

- Some Demographics:

  Population: approximately 186 million (2016)

  Demographics: about 96.4 Adult popn. and 58.3 per cent under 35 years

  41.6 per cent of the 96.4 million adult population remains financially excluded (EfIna, 2016)

  Proportion of the financially included adult population that are banked is 38.3 per cent

Work so far

- Estimated Models
- Papers on the open economy: [Gabriel et al.(2010, 2016)], Bayesian estimated models for Nigeria [Adebiyi and Mordi (2010, 2012) and CBN (2013)).
- Related paper: Estimating DSGE models with credit market imperfections in Nigeria [Babilla et al. (2016)]

Optimizing Agents and model frictions

- At the core is an "RBC model":

  Representative households optimizes intertemporal utility by maximizing choice of consumption and labour supply over time subject a budget constraint

  Firms produce given a production technology and choose labour and capital inputs to maximize profits
- Labour, output and financial markets clear
- Add investment adjustment costs
- Add monopolistic competition in retail market and price stickiness
- Add macroeconomic policy via a monetary policy rule

Households...

- Households Euler equation, total consumption and hours are:

$$
\begin{aligned}
C_{1,t} &= W_t h_{1,t} &(1)\\
\frac{1}{R_{n,t}} &= \beta E_t \left[\frac{U_{C_{2},t+1}}{U_{C_{2},t}\Pi_{t+1}} \right] &(2)\\
C_t &= \lambda C_{1,t} + (1-\lambda) C_{2,t} &(3)\\
\frac{U_{L_{1},t}}{U_{C_{1},t}} &= \frac{U_{L_{2},t}}{U_{C_{2},t}} = W_t &(4)\\
h_t &= \lambda h_{1,t} + (1-\lambda) h_{2,t} &(5)
\end{aligned}
$$

Firms

- Firms maximize profits:

$$
\begin{aligned}
Y_t^W &= (A_t h_t)^{\alpha} K_t^{1-\alpha} && (6)\\
Y_t &= (1-c) Y_t^W && (7)\\
\frac{P_{H,t}^W}{P_{C,t}} &= MC_t \frac{P_{H,t}}{P_{C,t}} && (8)
\end{aligned}
$$

Firms...

Investment Adjustment Cost, Real Interest Rate and Capital Accumulation:

$$
\begin{aligned}
E_t\left[\Lambda_{t,t+1}R_{t+1}\right] &= \frac{E_t\Lambda_{t,t+1}\left[\frac{P^W_{H,t+1}}{P_{t+1}}(1-\alpha)\frac{Y^W_{t+1}}{K_t}+(1-\delta)Q_{t+1}\right]}{Q_t} \\
R_t &= \frac{R_{n,t-1}}{\Pi_t} \\
K_t &= (1-\delta)K_{t-1}+(1-S(X_t))I_t \\
S',\, S'' &\geq 0\,;\;\; S(1+g)=S'(1+g)=0 \\
X_t &= \frac{I_t}{I_{t-1}} \\
S(X_t) &= \frac{\phi_I}{2}(X_t-(1+g))^2
\end{aligned}
$$

$$
\frac{P_{I,t}}{P_{C,t}} = Q_t(1-S(X_t)-X_tS'(X_t))+E_t\left[\Lambda_{t,t+1}Q_{t+1}S'(X_{t+1})\,\frac{I^2_{t+1}}{I^2_t}\right]
$$

Liability Dollarization

Add *liability dollarization* as wholesale firms access funds from domestic and foreign financial intermediaries in two currencies exogenously determined. Thus risk premium and financial stress is given as $\varphi \in [0,1]$, hence the expected cost will be,

$$\Theta_t \varphi E_t \left[(1 + R_{n,t}) \frac{P_{C,t}}{P_{C,t+1}} \right] + \Theta_t (1-\varphi) E_t \left[(1 + R^*_{n,t}) \frac{P^*_{C,t}}{P^*_{C,t+1}} \frac{RER_{C}}{RER} \right.$$

$$= \Theta_t \left[\varphi E_t \left[(1 + R_{t+1}) \right] + (1-\varphi) E_t \left[(1 + R^*_{t+1}) \frac{RER_{C,t+1}}{RER_{C,t}} \right] \right]$$

Liability Dollarization...

If $\varphi = 1$ or if UIP holds this becomes $(1 + \Theta_t)E_t\left[1 + R_{t+1}\right]$. In (9), $RER_{C,t} \equiv \frac{P^*_{C,t}S_t}{P_{C,t}}$ is the real exchange rate, $R_t \equiv \left[(1 + R_{n,t-1})\frac{P_{t-1}}{P_t}\right] - 1$ equals the ex post real interest rate over $[t-1, t]$ and $\Theta_t \geq 0$ is the external finance premium

External finance premium

Secondly, external finance premium Θ_t will have firms equate expected returns to expected borrowing costs as follows

$$E_t[1+R_{k,t+1}] = E_t\left[\Theta_{t+1}\left(\varphi E_t\left[(1+R_{t+1})\right] + (1-\varphi)E_t\left((1+R^*_{t+1})\frac{RE}{R}\right.\right.\right. \tag{10}$$

where

$$\Theta_t = s\left(\frac{N_t}{Q_{t-1}K_t}\right)\ ;\ s'(\cdot) < 0 \tag{11}$$

In (11), N_t is net worth and $Q_{t-1}K_t - N_t$ is now the requirement firms must meet to access funding externally. Therefore $\frac{Q_{t-1}K_t - N_t}{N_t}$ represents the leverage ratio, and hence (10) and (11) implies capital cost is an increasing function of the leverage.

Financial Accelerator Mechanism

Assuming entrepreneurs exit under the probability $1 - \xi_e$, then firms net worth accumulates in line with

$$N_{t+1} = \xi_e V_t + (1 - \xi_e) D_t^e \qquad (12)$$

where D_t^e are transfers made exogenously to new entrants from existing firms, while V_t is the net value carried to the next period. D_t^e is consistent with a balance growth path and is given by

$$V_t \;=\; (1 + R_{k,t}) Q_{t-1} K_t - \Theta_t \Big[\varphi(1 + R_t) + (1 - \varphi)(1 + R_t^*) \frac{RER_{C,t}}{RER_{C,t-1}}$$

where $R_{k,t}$ is the *ex post* return

$$1 + R_{k,t} \;=\; \frac{(1-\alpha)\frac{P_t^W}{P_t}\frac{Y_t^W}{K_t} + (1-\delta) Q_t}{Q_{t-1}} \qquad (14)$$

Demand for capital is then given by

$$E_t[1 + R_{k,t+1}] \quad = \quad \frac{E_t\left[(1-\alpha)\frac{P^W_{t+1}}{P_{t+1}}\frac{Y^W_{t+1}}{K_{t+1}} + (1-\delta)Q_{t+1}\right]}{Q_t} \tag{15}$$

Finally, exiting entrepreneurs consume the residual equity so that their consumption

$$C^e_t = \frac{1-\xi_e}{\xi_e} N_t \tag{16}$$

which becomes a part of total consumption.

Oil production sector

- Oil price is assumed to follow a random walk without a drift as estimated in Hamilton (2009),

$$\log p_t^{O*} = \log p_{t-1}^{O*} + \varepsilon_t^{po},$$

- The trade balance include oil exports as shown below,

$$TB_t = S_t P_{O,t}^{*} Y^{O} + P_{H,t} Y_t - P_{C,t} C_t - P_{I,t} I_t - P_{H,t} G_t$$

Fiscal Policy

$$T_t^O = \tau_t^O p_t^{O*} y_t^O.$$

Government spending G_t and accumulates debt according to

$$D_t = R_t D_{t-1} + G_t - T_t^O \tag{17}$$

Now define $d_t \equiv \frac{D_t}{Y_t}$, $g_t \equiv \frac{G_t}{Y_t}$ and $d_t^O \equiv \frac{T_t^O}{Y_t}$ respectively. Then in terms of these ratios (17) becomes

$$d_t = R_t d_{t-1} \frac{Y_{t-1}}{Y_t} + g_t - t_t^O = \frac{R_t}{1 + \Delta Y_t} d_{t-1} + g_t - t_t^O \tag{18}$$

where $\Delta Y_t \equiv \frac{Y_t - Y_{t-1}}{Y_{t-1}}$ is the GDP growth rate.

Fiscal Policy...

Hence government spending as a proportion of GDP is given by

$$g_t = t_t^O + d_t - \frac{R_t}{1 + \Delta Y_t} d_{t-1} \tag{19}$$

We close the fiscal side of the model with a rule for the debt-GDP ratio which returns the target steady-state debt-GDP ratio d subject to persistence mechanism ρ_d and an exogenous random shock that captures political and implementation uncertainty regarding the rule.
In a balanced growth steady state we have

$$g = t^O + d + \frac{R}{1 + \Delta Y} d \tag{20}$$

Monetary Policy

$$\log\left(\frac{R_{n,t}}{R_n}\right) = \rho \log\left(\frac{R_{n,t-1}}{R_n}\right) + \theta_\pi \log\left(\frac{\Pi_t}{\Pi}\right) + \theta_y \log\left(\frac{Y_t}{Y}\right) + \epsilon_{MPS,t}$$

$$\begin{aligned} \log(R_{n,t}/R_n) &= \rho_r \log(R_{n,t-1}/R_n) + (1-\rho_r)(\theta_\pi E_t[\log \Pi_{t+j}]/\Pi \\ &+ \theta_s \log S_t/S) + \epsilon_{MPS,t} \end{aligned}$$

Calibration

Calibrated parameter	Symbol	Value for Nigeria
Discount factor	β	0.99
Depreciation rate	δ	0.025
Risk premium - scaling	k_B	1.00
FA risk premium	θ	1.00
Risk premium elasticity	χ_B	0.05
Implied ss relationship		
hours worked/time available	h	0.35
Preference parameter	ϱ	calibrated to hit prop. of hours worked
Imported investment share	is_{import}	0.15
Imported consumption share	cs_{import}	0.10
Exported investment share	is_{export}	0.02
Exported consumption share	cs_{export}	0.23
oil revenues/GDP	oil	0.09

Table: Baseline calibration

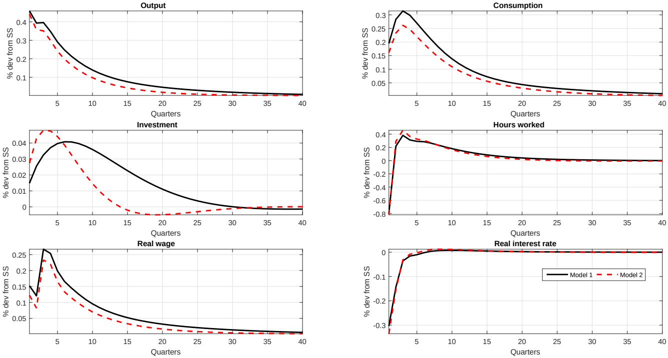

Figure: Technology Shock

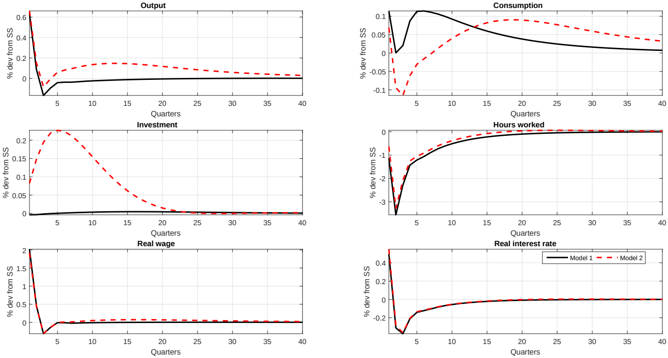

Figure: Government Shock

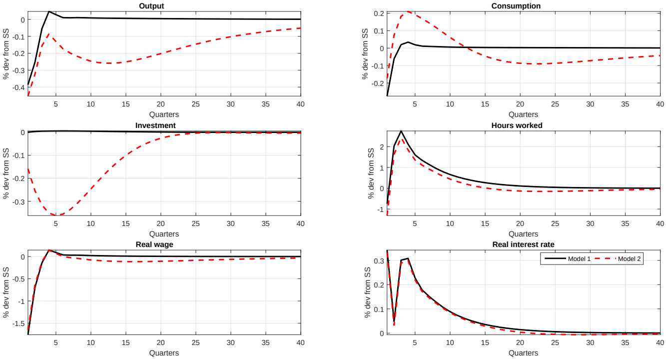

Figure: Monetary Shock

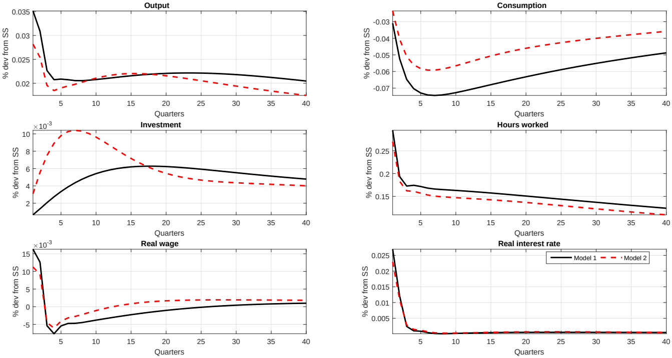

Figure: Price Shock

Policy Implications

- A financial accelerator mechanism: what implications for monetary policy in Nigeria
- With significant proportions of credit-constrained consumers the FA is realistic for empirical performance of the model with improved model fit
- However, without capturing informality other channels of propagation of shocks may be excluded (future research)