[PRELIMINARY AND INCOMPLETE] Financial (in)stability, and the interaction of macro prudential regulation and monetary policy in the Russian Federation*

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Abstract

In the aftermath of the macroeconomic instability in the Russian economy of 2014–2016, the dual targets of inflation and financial stability have been increasingly interdependent. To study this we build a small open economy RBC and New Keynesian DSGE models with a heterogenous real and banking sector, and endogenous default. We show that the distribution of firm default rates results in a distinct transmission mechanism from real shocks to financial instability across the distribution of bank size. Idiosyncratic shocks to smaller banks permeate the economy via their contagious effects through large systemically important banks. Independent conduct of macroprudential and monetary policy further amplify and propagate these shocks through the banking system.

Keywords: Financial Stability, Macroprudential Regulation, Inflation Targeting, Russian Economy, Open Economy.

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1 Introduction

The Great Recession of 2007–2009 revealed the potential vulnerability of the real sector to the problems which financial intermediaries may face. As a result the Basel committee prepared the new version of banking regulation rules in 2010 — Basel III. More restrictive existing requirements as long as the new ones were aimed at decreasing this type of contagion risks.

On one hand, strict macroprudential policy allows central banks to significantly decrease the risk-taking of commercial banks and therefore to prevent potential insolvencies of financial intermediaries. On the other hand, as the measures of macroprudential policy impose restrictions on banks' business models, this may have a contractionary effect on credit market and therefore the growth of the whole economy. In this case a special attention should be paid to the interaction of macroprudential regulation and monetary policy of central banks. The Basel rules may negatively affect the effectiveness of monetary policy transmission mechanism and, as a result, the ability of a central bank to smooth economic cycles.

The question about the optimal interaction between macroprudential and monetary policies is still remaining relevant in the modern literature as the number of studies in this field is steadily increasing. (Nachane et al. (2006); Ghosh (2008); Gavalas (2015); Gambacorta and Shin (2016)) show that the more restrictive the rules (in particular, capital requirements), the more contractionary effect the monetary policy may have. In this sense it is non-surprising that the loan portfolios of small banks that have smaller capital adequacy ratios may respond more severely to the contractionary monetary policy impulses (Aiyar et al. (2014); De Marco and Wieladek (2015)). However, strict macroprudential regulation may have an opposite effect on banks' risk-taking. Gale (2010) suggests that too restrictive capital requirements may encourage banks to take higher risks in order to earn higher expected profits. In this case when monetary authorities increase interest rates this may not have a contractionary effect on credit market and the banks will form highly risky loan portfolios as costs of funding increase. As a result, defaults of the risky firms may create the threat to financial stability. It is also worth noting that not only macroprudential regulation has an impact on the monetary transmission mechanism. According to (Borio and Zhu (2012); de Moraes et al. (2016)), the stance of monetary policy may itself affect the optimal level of macroprudential regulation.

In Russia Basel III rules introduction was synchronised with the United States and European Union. It started in the beginning of 2014 by dividing a unique capital adequacy ratio into three separate. These are Common equity Tier 1 ratio (N.1.1), Tier 1 Capital adequacy ratio (N1.2) and Capital adequacy ratio (N1.0). The introduction of Basel III will be finished in the end of 2019 when the transition period for the main requirements (Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR)) of Basel III will be finished. The necessity of the transition period is strongly connected with the objective necessity of commercial banks' adaptation to the new environment. Imperfections of the Russian financial market (for example, narrow financial market, initially not enough high quality liquid assets) were taken into account. These imperfections impose restrictions on using different financial instruments by the Russian banks. Moreover, when the Bank of Russia started to introduce Basel III rules this made banks correct their whole business models. For instance, the banks needed to change the structure of their loan portfolios and funding. Such changes cannot occur immediately and take some time.

Now the Russian economy is steadily recovering after the period of overall macroeconomic instability uncertainty in 2014–2016. The main economic and geopolitical risks have materialised and the economic agents have adapted to the new environment of economic sanctions and low oil prices. As the Bank of Russia implements inflation targeting, the important question is the effectiveness of monetary policy transmission mechanism. Given the steadily restricting macroprudential rules, it is important for the Bank of Russia to take them into account when deciding upon the level of the key rate — the main indicator of the monetary policy stance in Russia. However, as far as we know, there is no literature discussing the principles of the optimal monetary policy in Russia in connection with the existence of macroprudential regulation. This article is the very first attempt to answer this important question.

This paper can be divided into two sections. In the first section, we build an RBC model with endogenous default and heterogeneous real and financial sectors. We compare the responses of the economy to different types of shocks. In the second section, we construct a New Keynesian DSGE model in order to analyze the interaction of manetary and macroprudential policies.

2 RBC Model for the Russian Economy

Our model is based on De Walque et al. (2010) which in turn is based on the static analysis of financial (in) stability of Goodhart et al. (2017), Goodhart et al. (2006) and Goodhart et al. (2013). The benchmark model is a small open economy RBC model with a perfectly competitive banking sector and financial frictions. The model economy is populated by households, two types of firms producing non-tradable goods ('lucky' and 'unlucky'), oil-extracting firms, systemically important (big) and small banks, capital producers and the Central Bank (responsible for macroprudential policy only). The possibility of endogenous default (on the behalf of 'unlucky' firms) and the presence of capital regulation are the two financial frictions of the model. Real frictions include investment, capital and assets (liabilities for small banks) adjustment costs. Endogenous default is important because it allows to model risk taking behaviour by firms justifying banking regulation by the Central Bank. Russia is a small open oil exporting economy, for this reason we distinguish between tradable and non-tradable sectors and include the oil sector. A negative shock to the oil price reduces households' wealth and leads to the fall in the demand for non-tradable goods. Firms reduce their demand for labor and unemployment increases.

2.1 Circular Flow of Funds

- Firms require funding to invest in physical capital in order to produce non-tradable goods. They use capital and labor to produce wholesale goods. Loans are repaid next period, but are defaultable.
- Tradable sector is not modeled explicitly, rather we assume that households are endowed with tradable goods which they can consume and/or sell abroad.
- Oil extracting firms extract oil and export it abroad.
- Capital producers operate in a perfectly competitive markets. They purchase undepreciated capital from firms and consumption goods on the goods market in order to produce new capital, production is subject to an investment adjustment cost.
- Banks combine households' deposits with their retained earnings and lend them to firms. Loan origination requires banks to hold certain amount of capital as a proportion of their risk-weighted assets.
- Households supply labor to firms, consume and deposit their income with banks. Households also receive all profits in the economy.
- The Central Bank regulates banks.

The circular flow of funds is summarised in figure 1.

2.2 Supply Side

2.2.1 Non-Tradable Sector: Firms

There are two-period firms. Firms (indexed by j) can default in equilibrium. Risky firms are identical ex-ante among each other, they borrow from banks in period 1 and repay the next period, however, with probability θ risky firm becomes unlucky and gets lower TFP $\underline{A}$, and with probability $(1-\theta)$ - higher TFP $\bar{A}$. Lucky firm will decide not to default, because non-pecuniary cost of default will be high enough ($\lambda = \infty$). Unlucky firm chooses to default partially on its debt: $0 < \delta < 1$. As a result a fraction θ of firms will choose to default in equilibrium. This is how we model heterogeneity across risky firms.

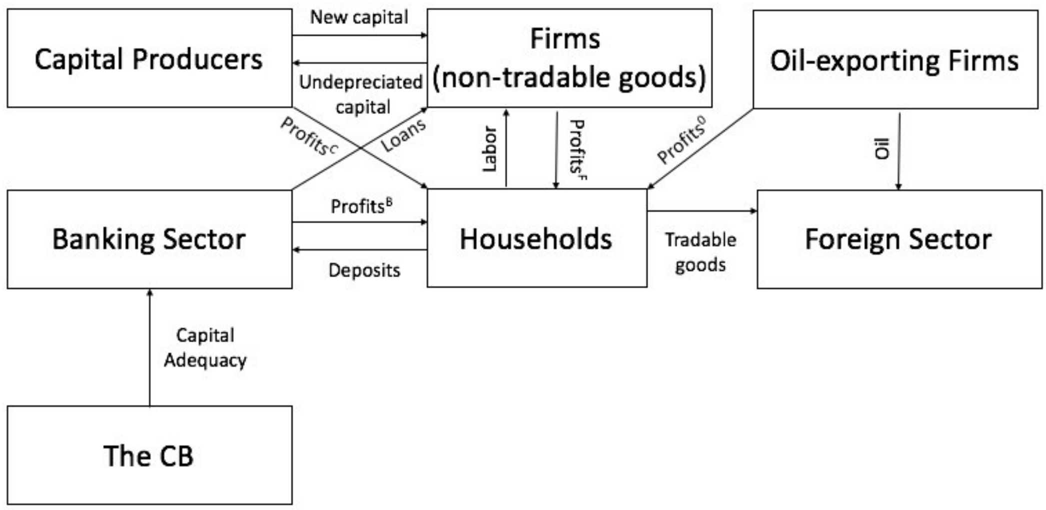

Figure 1: Circular Flows Diagram

Firms use capital (K_t^j), labor (L_t^j) and produce homogeneous wholesale consumption goods (Y_t^j) using similar technology:

$$Y_{t+1}^j = A_{t+1}(K_t^j)^{\alpha}(L_{t+1}^j)^{1-\alpha} \tag{1}$$

Productivity is given by AR(1) process. Firms live for 2 periods. In the first period they purchase capital in order to produce and sell goods in the second period. A purchase of new capital is constrained by the amount of loans provided by banks:

$$P_t^K K_t^j = q_t^j \mu_t^j + (1-r)P_{t-1}^K K_{t-1}^j + E_t^j \tag{2}$$

where, P_t^K denotes the price of capital. In period t, they choose the amount of capital to be used for production next period, K_t^j. μ_t^j is the amount of loans promised to be repaid next period, $\frac{1}{q_t}$ is the price of a loan.

In the second period firms also sell undepreciated capital $(1-\tau)K_t^j$ to Capital Producers at price P_{t+1}^K. BC of a firm is given by:

$$\Pi_{t+1}^j + (1-\delta_{t+1}^j)\mu_t^j + w_{t+1}L_{t+1}^j = P_{t+1}^N A_{t+1}(K_t^j)^{\alpha}(L_{t+1}^j)^{1-\alpha} \tag{3}$$

(Π_t^j) - nominal profits of a firm, δ_{t+1}^j is the default rate for risky firms, w_t is the nominal wage.

Firm then chooses capital K_t^j, loans μ_t^j and default rate δ_t^j in order to maximize its objective function:

$$\max_{K_t^j,\mu_t^j,\delta_{t+1}^j,L_{t+1}^j} \mathbb{E}\Big[\frac{1}{P_{t+1}^N}\Pi_{t+1}^j - \frac{\Omega_{t+1}}{2}\Big(\frac{\delta_{t+1}^j\mu_t^j}{P_{t+1}^N}\Big)^2\Big] \tag{4}$$

Where $\frac{\lambda_{t+1}}{2}\left(\frac{\delta_{t+1}^j\mu_t^j}{P_{t+1}^N}\right)^2$ is the non-pecuniary cost of default. λ_{t+1} varies with the aggregate debt, but individual firms do not internalize how their borrowing decisions affect the cost of default - pecuniary externality. λ_{t+1} evolves according to: $\Omega_t = \lambda_t \frac{\mu_{ss}^F\delta_{ss}^{\gamma_1}}{K_{ss}}\frac{K_{t-1}}{\mu_{t-1}^F\delta^{\gamma_1}}$.

FOC for K_t^j:

$$\begin{aligned}\alpha(K_t^j)^{\alpha-1}\,\mathbb{E}\,A_{t+1}(L_{t+1}^j)^{1-\alpha} - \mathbb{E}\,\frac{p_t^K}{q_t(1+\pi_{t+1}^N)} + \mathbb{E}\,\frac{\theta\delta_{t+1}^j\frac{p_t^K}{q_t}}{1+\pi_{t+1}^N} = \\ = \mathbb{E}\,\lambda_{t+1}(\delta_{t+1}^j)^2 p_t^K\frac{\tilde{\mu}_t^j}{q_t(1+\pi_{t+1}^N)^2}\end{aligned} \tag{5}$$

where $\tilde{\mu}_t^j$ - real loans. Later all variables x with $\tilde{x}$ will state for a real value.

FOCs for L_{t+1}^j

$$(1-\alpha)(\bar{L}_{t+1}^j)^{-\alpha}(K_t^j)^\alpha\bar{A}_{t+1} = \tilde{w}_{t+1}^j \tag{6}$$

$$(1-\alpha)(\underline{L}_{t+1}^j)^{-\alpha}(K_t^j)^\alpha\underline{A}_{t+1} = \tilde{w}_{t+1}^j \tag{7}$$

FOC for δ_{t+1}^j:

$$\frac{1+\pi_{t+1}^N}{\lambda_{t+1}\tilde{\mu}_t^j} = \delta_{t+1}^j \tag{8}$$

Where:

$$\mathbb{E}\,A_{t+1}(L_{t+1}^j)^{1-\alpha} = \theta(\underline{A})(\underline{L}_{t+1}^j)^{1-\alpha} + (1-\theta)\bar{A}(\bar{L}_{t+1}^j)^{1-\alpha} \tag{9}$$

$$\mathbb{E}\,\lambda_{t+1}{\delta_{t+1}^j}^2 = \mathbb{E}\,\frac{\theta(1+\pi_{t+1}^N)^2}{\lambda_{t+1}(\tilde{\mu}_t^j)^2} \tag{10}$$

(5) can be rewritten as

$$\alpha(K_t^j)^{\alpha-1}\,\mathbb{E}\,A_{t+1}(L_{t+1}^j)^{1-\alpha} = \mathbb{E}\,\frac{p_t^K}{q_t(1+\pi_{t+1}^N)} \tag{11}$$

Profits for a lucky firm:

$$\bar{\Pi}^j_{t+1} = P^N_{t+1}\bar{A}_{t+1}(K^j_t)^\alpha(\bar{L}^j_{t+1})^{1-\alpha} - w_{t+1}\bar{L}^j_{t+1} - \\ - \mu^j_t \tag{12}$$

Profits for an unlucky firm:

$$\underline{\Pi}^j_{t+1} = P^N_{t+1}\underline{A}_{t+1}(K^j_t)^\alpha(\underline{L}^j_{t+1})^{1-\alpha} - w_{t+1}\underline{L}^j_{t+1} - \\ - (1-\delta^j_{t+1})\mu^j_t \tag{13}$$

2.2.2 Tradable Sector

Tradable sector is modeled as endogenously given endowment of tradable output Y^T constant over time. Households can consume and export it abroad.

2.2.3 Oil Sector

The oil sector is modeled as in Hamann et al. (2016). A representative oil-extracting firm makes a decision of an oil extraction. At the beginning of a period, the economy gets s units of oil reserves and x units can be extracted and sold in a competitive international oil market at the given stochastic price $P^{x,*}_t$. $C(s, x)$ is the cost of extracting x units of oil. Profits and reserves of the firm are as follows:

$$\Pi^x_t = P^{x,*}_t x_t - C(s, x) \tag{14}$$

$$s_t = s_{t-1} + d_t - x_t \tag{15}$$

A representative firm solves then:

$$max_{x_t,s_t}\,\mathbb{E}_0\sum_{t=0}^{\infty}\frac{1}{P^N_t}\left[\beta^t_x\Pi^x_t\right] \tag{16}$$

Oil prices and discoveries (d_t) follow AR(1) processes. We assume that $C(s, x) = P^N_t\frac{\kappa}{2}\frac{x^2_t}{1+s_{t-1}}$. Substitute (14) and (13) into (15):

FOC for s_t:

$$(1-\beta)p^{x,*}_t + \frac{\kappa x_t}{1+s_{t-1}} = \frac{\beta\kappa}{2}\frac{(2x_{t+1}(1+s_t) - x^2_{t+1})}{(1+s_t)^2} \tag{17}$$

where $p^{x,*}_t$ is the real oil price in terms of nontradables. Oil prices and oil discoveries follow

AR(1) processes.

In the steady state:

$$(1-\beta)p^{x,*}+\frac{\kappa d}{1+s}=\frac{\beta\kappa}{2}\frac{(2d(1+s)-d^2)}{(1+s)^2} \tag{18}$$

2.2.4 Capital Production Sector

Capital producers purchase undepreciated capital $(1-\tau)K_t = (1-\tau)\int K_t^j dj$ at price P_t^k from both types of firms and consumption goods i_t from non-tradable goods market. K_t^j in its turn is composed from the capital of lucky and unlucky firms. Capital Producers combine both components into new capital $K_{t+1}=\int K_{t+1}^j dj$, using the following production function:

$$K_{t+1}=(1-\tau)K_t+i_t\Big(1-\frac{K_i}{2}\Big(\frac{\epsilon_t^K i_t}{i_{t-1}}-1\Big)^2\Big) \tag{19}$$

Each capital producer, therefore, maximizes

$$\mathbb{E}_0\sum_{t=0}^{\infty}\beta^t\frac{1}{P_t^N}\Big[P_t^K(K_{t+1}-(1-\tau)K_t)-P_t^N i_t\Big] \tag{20}$$

This yields the following capital price equation:

$$1=\begin{array}{c} p_t^K\left(1-\frac{K_i}{2}\left(\frac{\varepsilon_t^K i_t}{i_{t-1}}-1\right)^2-K_i\left(\frac{\varepsilon_t^K i_t}{i_{t-1}}-1\right)\frac{\varepsilon_t^K i_t}{i_{t-1}}\right)\\ +E_t\beta\left[p_{t+1}^K K_i\left(\frac{\varepsilon_{t+1}^K i_{t+1}}{i_t}-1\right)\left(\frac{\varepsilon_{t+1}^K i_{t+1}}{i_t}\right)^2\right]\end{array}. \tag{21}$$

where $p_t^K=\frac{P_t^K}{P_t^N}$ is the real price of capital.

2.3 Financial Sector: Banks

The main distinctive feature of the Russian banking sector is its pronounced heterogeneity. As in many developing countries, it can be viewed as having a two-level structure: the major part is concentrated within several large credit institutions while the other several thousands of banks together have only a small market share. We explicitly model this feature by introducing two types of one-period living banks in our model: Systemically Important (Big) banks and Small banks

The Small banking sector consists of banks who take a relatively small share of the market. All banks are subject to capital requirements introduced by financial regulator. However, systemically important banks are subject to higher capital requirements. This is consistent with The Russian Federal Law. For example, while capital requirement for a small bank stays at 8%

it is 11% for a systemically important bank. Moreover, banks should also create reserves for assets, which vary depending on asset quality. This is reflected in a capital requirement ratio.

All banks of any category are identical ex ante, because risky firms are identical. Ex post those banks that lent to unlucky firms will suffer from partial default on the loans. We call these banks 'unlucky' banks. 'Lucky' banks will suffer no default on loans that they lent. It should be noticed that systemically important banks will suffer less, because they invest less in risky firms ex ante.

2.3.1 Systemically important banks

Systemically important banks (s) lend to a pool of risky firms so that ex post they are subject only to the aggregate risk in contrast to small banks (ns) who can lend to only a one firm at a time and are subject to both idiosyncratic and aggregate risk. BC of a systemically important bank is given by:

$$\int q_t \mu_t^{s,j} dj = d_t^{\gamma,s} + E_t^{\gamma,s} - \xi^{\gamma,s} \int q_t \mu_t^{s,j} dj \tag{22}$$

Equity for systemically important banks is evolving according to:

$$E_t^{\gamma,s} = ei_t^{\gamma,s} + \xi^{\gamma,s} \int q_t \mu_t^{s,j} dj + \nu^s E_{t-1}^{\gamma,s} \tag{23}$$

$$re_t^{\gamma,s} \equiv \frac{(1-\nu^s)E_{t-1}^{\gamma,s} + \Pi_t^{\gamma,s}}{ei_{t-1}^{\gamma,s}} \tag{24}$$

Profit function of a systemically important bank is given by:

$$\varepsilon_3 + \Pi_{t+1}^{\gamma,s} + \varepsilon_2 d^{\gamma,s} + E_t^{\gamma,s} = \varepsilon_1 \int (1-\delta_{t+1}^j)\mu_t^{s,j} dj - (1+\rho_t) d_t^{\gamma,s} - 0.5 P_t^N [k^{\gamma,s} - \bar{k}^s]^2 - \\ - \frac{0.01}{2}\Big(\frac{\mu_t^{s,j} - \bar{\mu}^{s,j}}{P_t^N}\Big)^2 P_t^N - \frac{0.01}{2}\Big(\frac{d_t^{s,j} - \bar{d}^{s,j}}{P_t^N}\Big)^2 P_t^N \tag{25}$$

The bank chooses the amount of loans to each risky firm $j(\mu_t^{s,j})$ and demand for deposits $d_t^{\gamma,s}$ to maximize the following objective function:

$$\mathbb{E}_t \frac{(\frac{1}{P_{t+1}^N}\Pi_{t+1}^{\gamma,s})^{1-feta_b}}{1-feta_b} \tag{26}$$

Whenever banks hold equity capital as a proportion of the risk-weighted assets $(k_t^{\gamma,s})$ over the requirements $\bar{k}^s$, they gain utility from doing so, while losing it in the case of failing to satisfy the requirements.

The capital adequacy ratio is defined as the ratio of capital net of reserves to risk weighted assets net of reserves, for a systemically important bank:

$$k_t^{\gamma,s} = \frac{E_t^{\gamma,s} - Res_t^{\gamma,s}}{rwa_t^{\gamma,s}} = \frac{E_t^{\gamma,s} - \int Res_t^{j,s} dj}{\int r\bar{w}_t^{j,s}(q_t \mu_t^{s,j} - Res_t^{j,s}) dj} \tag{27}$$

Risk weights are assigned to assets. Reserves are defined as a constant proportion of loans:

$$Res_t^{j,s} = \xi^s q_t \mu_t^{s,j} \tag{28}$$

Objective function where $\mu_t^{s,j}$, $d_t^{s,j}$ and $E_t^{s,j}$ are in real terms:

$$\mathbb{E}_t \frac{(\frac{1}{P_{t+1}^N/P_t^N} \Pi_{t+1}^{\gamma,s})^{1-feta_b}}{1-feta_b} = \mathbb{E}_t \frac{\left(\frac{1}{P_{t+1}^N/P_t^N}\Big[\theta\varepsilon_1 \int (1-\delta_{t+1}^j)\mu_t^{s,j} dj + (1-\theta)\varepsilon_1 \int \mu_t^{s,j} dj - (1+\rho_t) d_t^{\gamma,s} - \right.}{1-feta_b}$$
$$\frac{\left. -0.5[k^{\gamma,s} - \bar{k}^s]^2 - \frac{0.01}{2}\left(\mu_t^{s,j} - \bar{\mu}^{s,j}\right)^2 - \frac{0.01}{2}\left(d_t^{s,j} - \bar{d}^{s,j}\right)^2 - E_t^{\gamma,s} - \varepsilon_3 - \varepsilon_2 d_t^{\gamma,s}\Big]\right)^{1-feta_b}}{1-feta_b} \tag{29}$$

Maximize (29) s.t. (22), (23), (27), given (28). FOC for loans:

$$\begin{aligned}
&\mathbb{E}\frac{1}{(\Pi_{t+1}^s)^{feta_b}(1+\pi_{t+1}^N)}\Big(\theta\varepsilon_1(1-\delta_{t+1}^j) + \varepsilon_1(1-\theta) - (1+\rho_t)(q_t(1+\xi^s) - \xi^s q_t) - \\
&- [k^{\gamma,s} - \bar{k}^s]\frac{\omega^s(1-\xi^s)q_t\mu_t^{s,j}(\xi^s q_t - \xi^s q_t) - \omega^s q_t(1-\xi^s)(E_t^s - \xi^s q_t \mu_t^s)}{(rwa_t^{\gamma,s})^2} - \\
&- 0.01(\mu_t^{s,j} - \bar{\mu}^{s,j}) - 0.01(d_t^{s,j} - \bar{d}^{s,j})q_t - \xi^s q_t - \varepsilon_2(q_t(1+\xi^s) - \xi^s q_t)\Big) = 0
\end{aligned} \tag{30}$$

Which can be rewritten as follows:

$$\begin{aligned}
&\mathbb{E}\frac{1}{(\Pi_{t+1}^s)^{feta_b}(1+\pi_{t+1}^N)}\Big(\varepsilon_1(1-\theta\delta_{t+1}^j) - (1+\rho_t)q_t + [k^{\gamma,s} - \bar{k}^s]\frac{\omega^s q_t(1-\xi^s)(E_t^s - \xi^s q_t \mu_t^s)}{(rwa_t^{\gamma,s})^2} - \\
&- 0.01(\mu_t^{s,j} - \bar{\mu}^{s,j}) - 0.01(d_t^{s,j} - \bar{d}^{s,j})q_t - \xi^s q_t - \varepsilon_2 q_t\Big) = 0
\end{aligned} \tag{31}$$

$$\varepsilon_3 = (\varepsilon_1 - 1)\int \mu_t^{s,j}(1-\delta_{t+1}^j) dj - \varepsilon_2 d_t^{\gamma,s} \tag{32}$$

2.3.2 Small banks

BC (nominal terms) of a small bank is given by:

$$q_t \mu_t^{ns,j} = d_t^{\gamma,ns} + E_t^{\gamma,ns} - \xi^{\gamma,ns} q_t \mu_t^{ns,j} \tag{33}$$

$$E_t^{\gamma,ns} = ei_t^{\gamma,ns} + \xi^{\gamma,ns} q_t \mu_t^{ns,j} + \nu^{ns} E_{t-1}^{\gamma,ns} \tag{34}$$

$$re_t^{\gamma,ns} \equiv \frac{(1-\nu^{ns})E_{t-1}^{\gamma,ns} + (\theta \underline{\Pi}_t^{\gamma,ns} + (1-\theta)\bar{\Pi}_t^{\gamma,ns})}{ei_{t-1}^{\gamma,ns}} \tag{35}$$

Profit function of a small bank is given by:

$$\varepsilon_3 + \varepsilon_2 d^{\gamma,ns} + \Pi_{t+1}^{\gamma,ns} + E_t^{\gamma,ns} = \varepsilon_1(1-\delta_{t+1}^j)\mu_t^{ns,j} - (1+\rho_t)d_t^{ns,j} - 0.5P_t^N[k^{\gamma,ns} - \bar{k}^{ns}]^2 - \\ - \frac{0.01}{2}\Big(\frac{d_t^{ns,j} - \bar{d}^{ns,j}}{P_t^N}\Big)^2 P_t^N - \frac{0.01}{2}\Big(\frac{\mu_t^{ns,j} - \bar{\mu}^{ns,j}}{P_t^N}\Big)^2 P_t^N \tag{36}$$

Where δ_{t+1}^j can take either a positive value or zero. The bank chooses the amount of loans to each risky firm $j(\mu_t^{ns,j})$ and demand for deposits $d_t^{\gamma,ns}$ (we substitute the budget constraint of a Bank so that it chooses only loans) to maximize the following objective function:

$$\mathbb{E}_t\, \beta^\gamma \Big(\theta \frac{(\frac{1}{P_{t+1}^N}\underline{\Pi}_{t+1}^{\gamma,ns})^{1-feta_b}}{1-feta_b} + (1-\theta)\frac{(\frac{1}{P_{t+1}^N}\bar{\Pi}_{t+1}^{\gamma,ns})^{1-feta_b}}{1-feta_b}\Big) \tag{37}$$

For a small bank capital adequacy ratio looks like:

$$k_t^{\gamma,ns} = \frac{E_t^{\gamma,ns} - Res_t^{\gamma,ns}}{rwa_t^{\gamma,ns}} = \frac{E_t^{\gamma,ns} - Res_t^{j,ns}}{\omega^{ns}(q_t \mu_t^{ns,j} - Res_t^{j,ns})} \tag{38}$$

Risk weights are assigned to assets. Reserves are defined as a constant proportion of loans:

$$Res_t^{j,ns} = \xi^{ns} q_t \mu_t^{ns,j} \tag{39}$$

FOC for risky loans (in real terms):

$$
\mathbb{E}\Big[\frac{\theta}{(1+\pi_{t+1})(\underline{\Pi}_{t+1}^{\gamma,ns})^{feta_b}}\Big(\varepsilon_1(1-\delta_{t+1}^j)-(1+\rho_t)q_t+
$$
$$
+[k^{\gamma,ns}-\bar{k}^{ns}]\frac{\omega^{ns}q_t(1-\xi^{ns})(E_t^{ns}-\xi^{ns}q_t\mu_t^{ns})}{(rwa_t^{\gamma,ns})^2}-0.01(d_t^{ns,j}-\bar{d}^{ns,j})q_t-0.01(\mu_t^{ns,j}-\bar{\mu}^{ns,j})-
$$
$$
-\xi^{ns}q_t-\varepsilon_2 q_t\Big)+\frac{1-\theta}{(1+\pi_{t+1})(\bar{\Pi}_{t+1}^{\gamma,ns})^{feta_b}}\Big(\varepsilon_1-(1+\rho_t)q_t-0.01(\mu_t^{ns,j}-\bar{\mu}^{ns,j})+[k^{\gamma,ns}-\bar{k}^{ns}]
$$
$$
\frac{\omega^{ns}q_t(1-\xi^{ns})(E_t^{ns}-\xi^{ns}q_t\mu_t^{ns})}{(rwa_t^{\gamma,ns})^2}-0.01(d_t^{ns,j}-\bar{d}^{ns,j})q_t-\xi^{ns}q_t-\varepsilon_2 q_t\Big)\Big]=0 \tag{40}
$$

$$
\varepsilon_3=(\varepsilon_1-1)\int\mu_t^{ns,j}(1-\delta_{t+1}^j)dj-\varepsilon_2 d_t^{\gamma,ns} \tag{41}
$$

Real profits for a lucky small bank:

$$
\begin{aligned}
\bar{\Pi}_{t+1}^{\gamma,ns}&=\frac{\mu_t^j-d_t^{\gamma,ns}(1+\rho_t)-\frac{1}{2}[k_t^{\gamma,ns}-\bar{k}^{ns}]^2-\frac{0.01}{2}\Big(d_t^{ns,j}-\bar{d}^{ns,j}\Big)^2-E_t^{\gamma,ns}}{1+\pi_{t+1}^N}-\\
&-\frac{\frac{0.01}{2}\Big(\mu_t^{ns,j}-\bar{\mu}^{ns,j}\Big)^2}{1+\pi_{t+1}^N}
\end{aligned} \tag{42}
$$

Real profits for an unlucky small bank:

$$
\begin{aligned}
\underline{\Pi}_{t+1}^{\gamma,ns}&=\frac{(1-\delta_{t+1}^j)\mu_t^j-d_t^{\gamma,ns}(1+\rho_t)-\frac{1}{2}[k_t^{\gamma,ns}-\bar{k}^{ns}]^2-\frac{0.01}{2}\Big(d_t^{ns,j}-\bar{d}^{ns,j}\Big)^2-E_t^{\gamma,ns}}{1+\pi_{t+1}^N}-\\
&-\frac{\frac{0.01}{2}\Big(\mu_t^{ns,j}-\bar{\mu}^{ns,j}\Big)^2}{1+\pi_{t+1}^N}
\end{aligned} \tag{43}
$$

Real profits for a systemically important bank:

$$
\begin{aligned}
\Pi_{t+1}^{\gamma,s}&=\frac{\theta\int(1-\delta_{t+1}^j)\mu_t^j dj+(1-\theta)\int\mu_t^j dj-d_t^{\gamma,s}(1+\rho_t)-\frac{1}{2}[k_t^{\gamma,s}-\bar{k}^s]^2-\frac{0.01}{2}\Big(\mu_t^{s,j}-\bar{\mu}^{s,j}\Big)^2}{1+\pi_{t+1}^N}-\\
&-\frac{E_t^{\gamma,s}-\frac{0.01}{2}\Big(d_t^{s,j}-\bar{d}^{s,j}\Big)^2}{1+\pi_{t+1}^N}
\end{aligned} \tag{44}
$$

2.4 Demand Side: Households

Households choose how much labor to supply and how much to consume. They save at both banks. Households receive profits from selling oil extraction services, exporting oil, producing and selling tradable and non-tradable goods. Households receive their profits from lucky and unlucky firms and banks.

Households also can trade on the set of Arrow-Debreu commodities, indexed by household j (because of a wage-adjustment risk). $D_{j,t}$ is the amount of securities paying one unit of consumption (in terms of nontradables) in event $u_{j,t+1}$, p_t^Q is its price. In the end their equilibrium price ensure that consumption is independent of idiosyncratic shocks.

We assume that the consumption goods basket for the representative household is a Cobb-Douglas compound of tradable and non-tradable goods as follows:

$$c_t = (c_t^N)^{\varphi}(c_t^T)^{1-\varphi} \tag{45}$$

Budget Constraint of a Household:

$$\begin{aligned}
&d_t^H + P^T c^T + P^N c^N + \int p_{j,t+1}^Q D_{j,t+1} du_{j,t+1} + ei_t^{\gamma,s} + ei_t^{\gamma,ns} + E_t^j \\
&\leq P_t^T Y^T + (1+\rho_{t-1})d_{t-1}^H + D_{j,t} + w_{t,i}l_{t,i}^s + (1-\theta)\int \bar{\Pi}_t^j dj + \theta \int \underline{\Pi}_t^j dj + \\
&+ \int \Pi_t^{\gamma,s} d\gamma + (1-\theta)\int \bar{\Pi}_t^{\gamma,ns} d\gamma + \theta \int \underline{\Pi}_t^{\gamma,ns} d\gamma + Q_t\Pi_t^x + Q_t C(s,x) - 0.5adj(d_t^H - d_{ss}^H)^2
\end{aligned} \tag{46}$$

Π_t states for profits received from ownership of firms and banks ($Q_t C(s,x)$ - profits from supplying oil field services to the oil firm). Deposits are not subject to default risk due to Deposit Insurance. In period t, banks are obliged to repay the amount of $(1+\rho_{t-1})\, d_{t-1}^H$. $P_t^T = Q_t P_t^{T,*}$ where Q_t is the real exchange rate. Households transfer equity to firms and banks $ei_t^{\gamma,s} + ei_t^{\gamma,ns} + E_t^j$. Household then chooses consumption of tradables, non-tradables, deposits and labor supply by maximizing the following objective function:

Households maximize their discounted utility s.t. the BC:

$$\sum_{t=0}^{\infty} \beta^t [\frac{c_t^{1-feta_h}}{1-feta_h} + \gamma_H \frac{(l_t^s)^2}{2}]$$

FOC for d_t^H:

$$\lambda_{i,t}^H(1 + adj(d_t^H - d_{ss}^H)) = \mathbb{E}\,\beta \frac{1+\rho_t}{1+\pi_{t+1}^N}\lambda_{i,t+1}^H \tag{47}$$

FOC for c_t^N:

$$\frac{(c_t^N)^{\phi-1}(c_t^T)^{1-\phi}}{c_t^{feta_h}} = \frac{\lambda_{i,t}^H}{\phi} \tag{48}$$

FOC for c_t^T:

$$\frac{(c_t^N)^{\phi}(c_t^T)^{-\phi}}{c_t^{feta_h}} = \frac{\lambda_{i,t}^H p_t^T}{1-\phi} \tag{49}$$

FOC for l_t^s:

$$\gamma_H l_t^s = \lambda_{i,t}^H w_t \tag{50}$$

where $\lambda_{i,t}^H$ is a Lagrange multiplier. Denote $\gamma_H = \frac{\varepsilon}{\varepsilon - 1}$.

2.5 The Central Bank

The Central Bank sets capital requirements for small and big banks.

2.6 Market clearing conditions

Aggregate demand for non-tradable goods:

$$\begin{aligned} Y^{N,d} &= P_t^N c_t^N + P_t^K(K_{t+1} - (1-\tau)K_t) + 0.5P_t^N[k^{\gamma,s} - \bar{k}^s]^2 + 0.5P_t^N[k^{\gamma,ns} - \bar{k}^{ns}]^2 + \\ &+ \frac{.01}{2}\Big(\frac{d_t^{ns} - \bar{d}^{ns}}{P_t^N}\Big)^2 P_t^N + \frac{.01}{2}\Big(\frac{\mu_t^s - \bar{\mu}^s}{P_t^N}\Big)^2 P_t^N \end{aligned} \tag{51}$$

Aggregate supply is given by:

$$Y_t = P_t^N Y_t^N + P_t^T Y_t^T + P_t^x x_t \tag{52}$$

$$Y_t^{N,s} = \theta \int \underline{Y}_t^j dj + (1-\theta)\int \bar{Y}_t^j dj \tag{53}$$

Goods (nontradable) market clears

$$Y_t^{N,s} = Y_t^{N,d} \tag{54}$$

Balance of payments:

$$p_t^T c_t^T = p_t^T Y_t^T + p_t^x x_t \tag{55}$$

4. Labor market clears: $l_t^s = \theta \underline{L}_t + (1-\theta)\bar{L}_t$
5. Deposit market: $\int_0^\kappa d_t^s d\gamma + \int_\kappa^1 d_t^{ns} d\gamma = d_t^H$
6. Loan market: $\mu_t^F = \int_0^\kappa \mu_t^s d\gamma + \int_\kappa^1 \mu_t^{ns} d\gamma$

3 Calibration

We have calibrated our economy using the Russian financial and real sector data at a quarterly frequency. We set the deposit rate $\rho = 4\%$ to reflect the average medium term rate for Russia. From the data we can also estimate the average cost of borrowing over the medium term $q = \frac{1}{1+r} = 0.85$. The default rate for the firms is taken to be 50%. Probability of default θ is estimated to be equal to 1 % (proportion of firms that default). The ratio of TFPs in high and low states are given by 1.2. We calibrate the ratio of nontradable to tradable consumption, so that $z = 1.5$. The value for wage elasticity is taken from the previous studies. The probability that the wages are sticky the next period is set to $\theta_H = 0.67$. Income share of capital is $\alpha = 0.6667$.

As for the oil price, price of tradable goods and oil discoveries we estimate an AR(1) process and find the steady state. The parameters for the banking sector such as the relative risk weights assigned to banking assets ω, capital requirement ratios k and reserves on assets ξ are calibrated in accordance with the RCB policies and rules. We calibrate an asset share of systemically important banks as 50% which is consistent with the data. Capital requirement for small banks is 8% and for the big banks is set at 11%. Reserve requirements for systemically important banks and small banks are given by 20% and 10% respectively.

Parameter	Description	Value
div^F	Dividend payout ratio for firms	1
q	Cost of borrowing	0.85
δ	Default rate	0.5
ρ	Rate on deposits	0.04
θ	Probability of default	0.01
$\bar{A}$	TFP process for lucky firms	1.2
$\underline{A}$	TFP process for unlucky firms	1
r	Depreciation rate of capital	1
α	Income share for capital	0.6667
$\frac{m^s}{m}$	Share of systemically (s) important banks (loans)	0.5
div^B	Dividend payout ratio for banks	1
ω^s	Risk weight for s banks	0.1
ω^{ns}	Risk weight for ns banks	0.1
$\bar{k}^s$	Capital requirement for s banks	0.11
$\bar{k}^{ns}$	Capital requirement for ns banks	0.08
ξ^s	Reserve requirement for s banks	0.2
ξ^{ns}	Reserve requirement for ns banks	0.1
β	Discount factor	0.96
$\frac{c^N}{c^T}$	Nontradable to tradable consumption ratio	1.5
γ_H	labor disutility	101
p^T	Price of tradable goods	2
p^x	Price of oil	2
ϕ	Relative weight of nontradable consumption	0.4286

Table 1: Calibrated parameters

4 Steady State

Steady state values for the selected variables can be found in table 1. This section describes our method of calculating the steady state of the economy. We calibrate the prices using the Russian data. First, we solve the problem of the Firms, then we find the steady state values for the banking sector and then for the households.

Given ρ, find β:

$$\beta = \frac{1}{1+\rho} \tag{56}$$

Given δ, ρ, θ we can use the two FOCs for loans by different Banks in the steady state in order to pin down $\varepsilon_1^s, \varepsilon_1^{ns}, \varepsilon_2^s, \varepsilon_2^{ns}$:

$$(1-\theta\delta)\varepsilon_1^s = (1+\rho+\xi^s+\varepsilon_2^s)q \tag{57}$$

$$(1 - q(1+\rho+\xi^{ns}) + q\rho(k^{ns}\omega^{ns}(1-\xi^{ns})))^{feta_b}\theta(\varepsilon_1^{ns}(1-\delta) - (1+\rho)q - q\xi^{ns} - q\varepsilon_2^{ns}) =$$
$$= (1 - \delta - q(1+\rho+\xi^{ns}) + q\rho(k^{ns}\omega^{ns}(1-\xi^{ns})))^{feta_b}(\theta-1)(\varepsilon_1^{ns} - (1+\rho)q - q\xi^{ns} - q\varepsilon_2^{ns}) \tag{58}$$

From (48) and (49):

$$re^s = re^{ns} = \frac{1}{\beta} \tag{59}$$

1. We find ϕ by calibrating z from the data:

$$\frac{c^N}{c^T} = z \tag{60}$$

FOCs for c^N and c^T give:

$$\phi = \frac{z}{p^T + z} \tag{61}$$

And

$$\lambda_H = \frac{z^{feta_H(\phi-1)}}{c^{feta_H} z^{\phi-1}\phi} \tag{62}$$

The solution to this equation depends on the steady state value of p^T which is set initially.
2. Define $\gamma_H = \frac{\varepsilon}{\varepsilon-1}$. Then from the FOC for labor supply:

$$l^s = \frac{\varepsilon-1}{\varepsilon} w\lambda^H$$

$$w = (1-\alpha)\underline{A}q^{\frac{\alpha}{1-\alpha}}(\alpha(\theta\underline{A} + (1-\theta)\bar{A}(\frac{\bar{A}}{\underline{A}})^{\frac{1-\alpha}{\alpha}}))^{\frac{\alpha}{1-\alpha}} \tag{63}$$

Given that $i = rK$ and the FOC for K by the Firm ($\alpha K^{\alpha-1}\,\mathbb{E}\,AL^{1-\alpha} = \frac{1}{q}$)

$$\frac{K}{\underline{L}} = (q\alpha\Big(\theta\underline{A} + (1-\theta)\bar{A}(\frac{\bar{A}}{\underline{A}})^{\frac{1-\alpha}{\alpha}}\Big))^{\frac{1}{(1-\alpha)}} \tag{64}$$

where $\bar{L} = \underline{L}(\frac{\bar{A}}{\underline{A}})^{\frac{1}{\alpha}}$ is used (which follows from 2 state-by -state focs for labor by Firms). We have

$$\lambda_H = \frac{z^{feta_H(\phi-1)}}{(Y^N - i)^{feta_H} z^{\phi-1}\phi} = \frac{z^{feta_H(\phi-1)}}{(\theta\underline{A}(K)^\alpha(\underline{L})^{1-\alpha} + (1-\theta)\bar{A}(K)^\alpha(\bar{L})^{1-\alpha} - rK)^{feta_H} z^{\phi-1}\phi} =$$
$$= \frac{z^{feta_H(\phi-1)}}{(KR)^{feta_H} z^{\phi-1}\phi} \tag{65}$$

Where R:

$$\begin{aligned} R = (\theta\underline{A}\Big(&\frac{1}{q\alpha(\theta\underline{A} + (1-\theta)\bar{A}(\frac{\bar{A}}{\underline{A}})^{\frac{1-\alpha}{\alpha}})}\Big) + \\ &+ (1-\theta)\bar{A}\Big(\frac{(\frac{\bar{A}}{\underline{A}})^{\frac{1-\alpha}{\alpha}}}{q\alpha(\theta\underline{A} + (1-\theta)\bar{A}(\frac{\bar{A}}{\underline{A}})^{\frac{1-\alpha}{\alpha}})}\Big) - r) \end{aligned} \tag{66}$$

So we can calculate:

$$\underline{L} = \frac{\frac{\varepsilon-1}{\varepsilon} w \frac{z^{feta_H(\phi-1)}}{(KR)^{feta_H} z^{\phi-1}\phi}}{\theta + (1-\theta)(\frac{\bar{A}}{\underline{A}})^{\frac{1}{\alpha}}}$$

And

$$\bar{L} = \underline{L}(\frac{\bar{A}}{\underline{A}})^{\frac{1}{\alpha}}$$

So

$$K = \Big(q\alpha(\theta\underline{A} + (1-\theta)\bar{A}(\frac{\bar{A}}{\underline{A}})^{\frac{1-\alpha}{\alpha}})\Big)^{\frac{1}{(1+feta_H)(1-\alpha)}} \Big(\frac{\frac{(\varepsilon-1)}{\varepsilon} w \frac{z^{feta_H(\phi-1)}}{(R)^{feta_H} z^{\phi-1}\phi}}{\theta + (1-\theta)(\frac{\bar{A}}{\underline{A}})^{\frac{1}{\alpha}}}\Big)^{\frac{1}{(1+feta_H)(1-\alpha)}} \tag{67}$$

Find λ_H from (65).

$$l^s = \frac{\varepsilon - 1}{\varepsilon} w \lambda_H \tag{68}$$

$$\underline{L} = \frac{\frac{\varepsilon-1}{\varepsilon} w \lambda_H}{\theta + (1-\theta)(\frac{\bar{A}}{\underline{A}})^{\frac{1}{\alpha}}} \tag{69}$$

$$\bar{L} = \underline{L}(\frac{\bar{A}}{\underline{A}})^{\frac{1}{\alpha}} \tag{70}$$

Outputs and profits can be calculated as:

$$\bar{Y} = \bar{A}(K)^{\alpha}(\bar{L})^{1-\alpha} \tag{71}$$

$$\underline{Y} = \underline{A}(K)^{\alpha}(\underline{L})^{1-\alpha} \tag{72}$$

$$\bar{\Pi} = \bar{Y} - w\bar{L} - \mu^{F} \tag{73}$$

$$\underline{\Pi} = \underline{Y} - w\underline{L} - (1-\delta)\mu^{F} \tag{74}$$

In the Oil Sector d s given by AR(1). From the BC:

$$x = d \tag{75}$$

FOC for s_{t+1}:

$$-p^{x} + \beta p^{x} - \beta\kappa\frac{d}{1+s} + \beta\kappa\frac{(d)^{2}}{2(1+s)^{2}} = 0 \tag{76}$$

$$s = -1 + \frac{-(1-\beta)d\kappa - D^{0.5}}{2p^{x}(\beta-1)} \tag{77}$$

Demand for consumption goods by capital producers:

$$i = rK \tag{78}$$

From the foc for capital by Capital Producers:

$$p^{K} = 1 \tag{79}$$

From the BC of a Firm:

$$\mu^{F} = \frac{rK - E^{j}}{q} \tag{80}$$

$$\mu = \mu^{F} \tag{81}$$

From the foc for δ

$$\lambda = \frac{1}{\delta\mu^{F}} \tag{82}$$

$$\mu^s = 0.6\mu \tag{83}$$

$$\mu^{ns} = \mu - \mu^s \tag{84}$$

$$d^s = q\mu^s(1 - k^s\omega^s(1 - \xi^s)) \tag{85}$$

$$E^s = q\mu^s(k^s\omega^s(1 - \xi^s) + \xi^s) \tag{86}$$

$$d^{ns} = q\mu^{ns}(1 - k^{ns}\omega^{ns}(1 - \xi^{ns})) \tag{87}$$

$$E^{ns} = q\mu^{ns}(k^{ns}\omega^{ns}(1 - \xi^{ns}) + \xi^{ns}) \tag{88}$$

Real profits for a systemically important bank:

$$\Pi^s = \theta(1 - \delta)\mu^s + (1 - \theta)\mu^s - d^s(1 + \rho) - E^s \tag{89}$$

Recover parameters for Banks:

$$\nu^s = 1 - \frac{\xi^s\mu^s re^s q + \Pi^s}{E^s(re^s - 1)} \tag{90}$$

$$ei^s = \frac{(1 - \nu^s)E^s + (\Pi^s)}{re^s} \tag{91}$$

Banks‘ profits of small banks are found from

$$\bar{\Pi}^{ns} = \mu^{ns} - d^{ns}(1 + \rho) - E^{ns} \tag{92}$$

$$\underline{\Pi}^{ns} = (1 - \delta)\mu^{ns} - d^{ns}(1 + \rho) - E^{ns} \tag{93}$$

Thus,

$$\nu^{ns} = 1 - \frac{\xi^{ns}\mu^{ns}re^{ns}q + \theta\underline{\Pi}^{ns} + (1 - \theta)\bar{\Pi}^{ns}}{E^{ns}(re^{ns} - 1)} \tag{94}$$

$$ei^{ns} = \frac{(1 - \nu^{ns})E^{ns} + (\theta\underline{\Pi}^{ns} + (1 - \theta)\bar{\Pi}^{ns})}{re^{ns}} \tag{95}$$

From the market clearing conditions:

$$Y^s = \theta \int \underline{Y}^j dj + (1-\theta) \int \bar{Y}^j dj \tag{96}$$

$$Y^N = Y^s \tag{97}$$

$$c^N = Y^N - i \tag{98}$$

$$c^T = (\frac{(1-\phi)(c^N)^{\phi(1-feta_H)}}{(p^T \lambda_H)})^{\frac{1}{(\phi+feta_H(1-\phi))}} \tag{99}$$

$$\Pi_t^x = p_t^x x_t - C(s,x) \tag{100}$$

$$C(s,x) = \frac{\kappa}{2} \frac{x^2}{1+s} \tag{101}$$

$$\Omega = \lambda \tag{102}$$

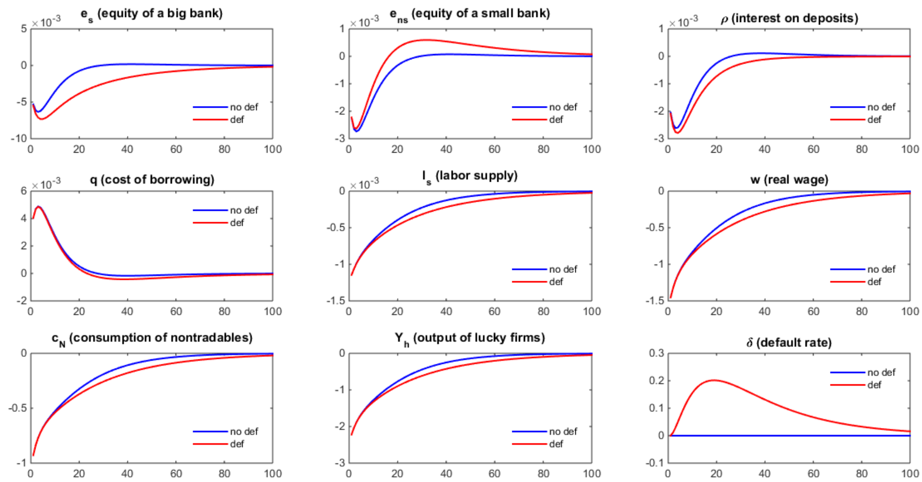

Figure 2: negative shock to TFP (1)

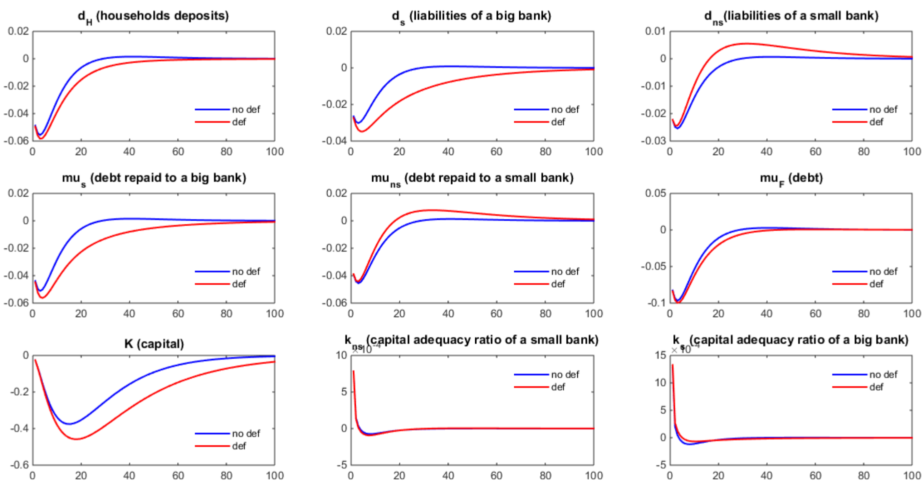

Figure 3: negative shock to TFP (2)

5 Impulse Responses

Figures 2 and 3 give the impulse responses following a negative TFP shock, figures 4 to 6 give the impulse responses following a positive shock to the oil price. 7 and 8 show the transmission after an icrease in the variance of the TFP. The last two figures give impulse responces of a shock to the real exchange rate (real depreciation).

Economy shrinks as a result of a egative shock to the TFP and default rate increases. We can observe greater amplification effects in case of an economy with defaultable loans. Financial variables (deposits and debt) are affected much stronger, similarly real variables fall more in case of default and it takes more time for them (capital, output, consumption) to recover. Big banks and small banks respond differently to the change in financial conditions (reduce interest

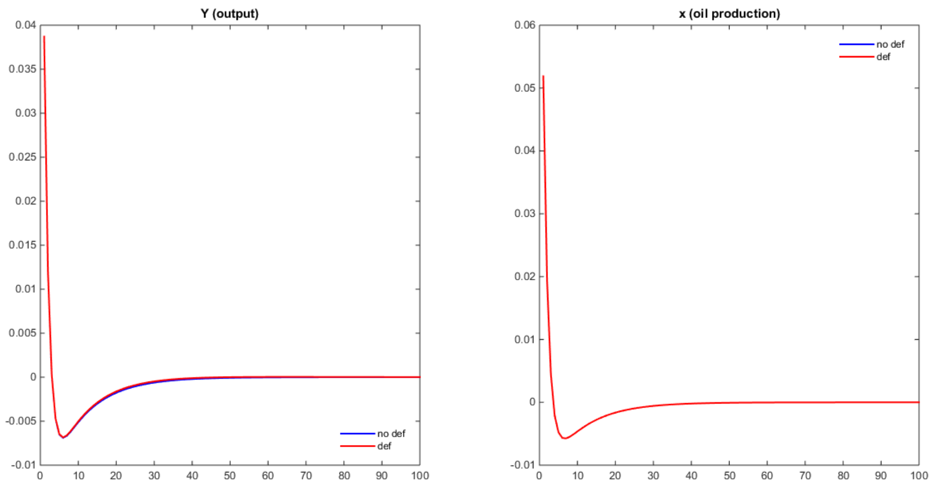

Figure 4: positive shock to oil price (1)

rates and higher rate of defautl), An increase in income decreases the cost of honouring debt resulting in lower default rate and more favourable credit conditions (lower cost of debt). Big banks reduce their lending and borrowing from the Households, while the opposite is true for the small banks. There is an increase in capital adequacy ratios on impact as big banks constiture a larger share of the market. Overall, economy with default is characterized by higher real costs.

Households' wealth increases as a result of a positive shock to the oil price and they substitute labor for consumption. This leads to a decrease in labor force and higher wages. Firms substitute labor for capital so that there is an increase in investment in the economy. Production of non-tradable goods falls as firms face higher costs. Overall, there is an increase in aggregate output as the decrease in production of non-tradable goods is compensated by a higher level of oil production.

Increased variance of the TFP affects differently small and big banks when the default rate is positive. Systemically important banks extend more loans and take on more deposits as they lend to both types of firms and benefit from a lower default rates. The real sector responds with higher demand for capital as the cost of borrowing is reduced. Interest rate on deposits goes up as there is an increase in demand for deposits from the banks. Capital adequacy ratio is first reduced on impact, but rather quickly returns to its steady state value. Equity is proportional to the lending, so its behaviour is similar. The effects of the real depreciation are similar to the oil price, because it also produces positive wealth effect and increases wages.

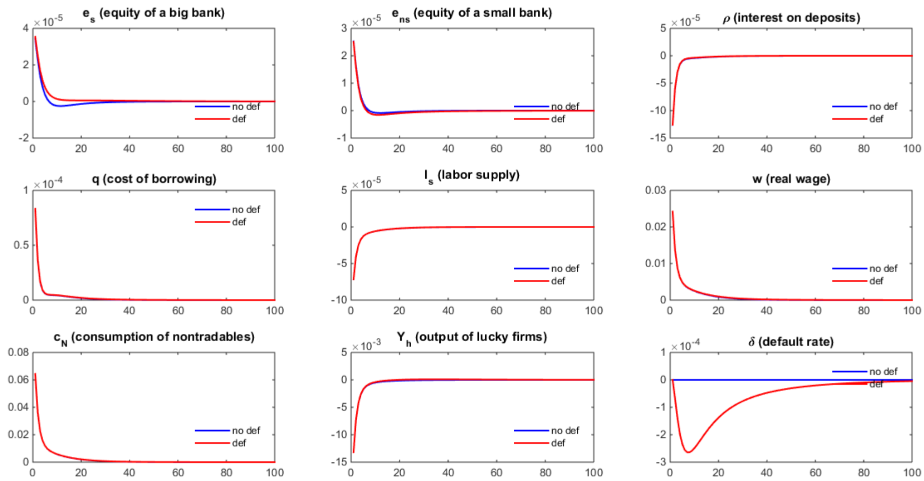

Figure 5: positive shock to oil price (2)

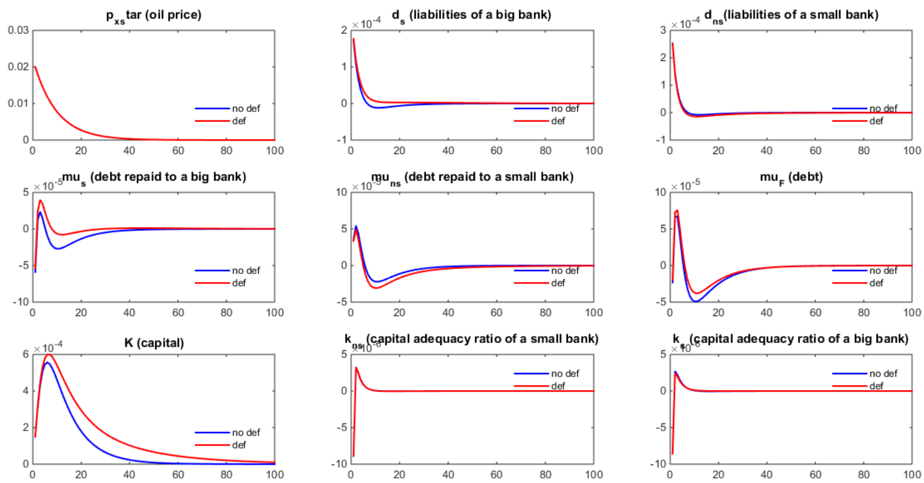

Figure 6: positive shock to oil price (3)

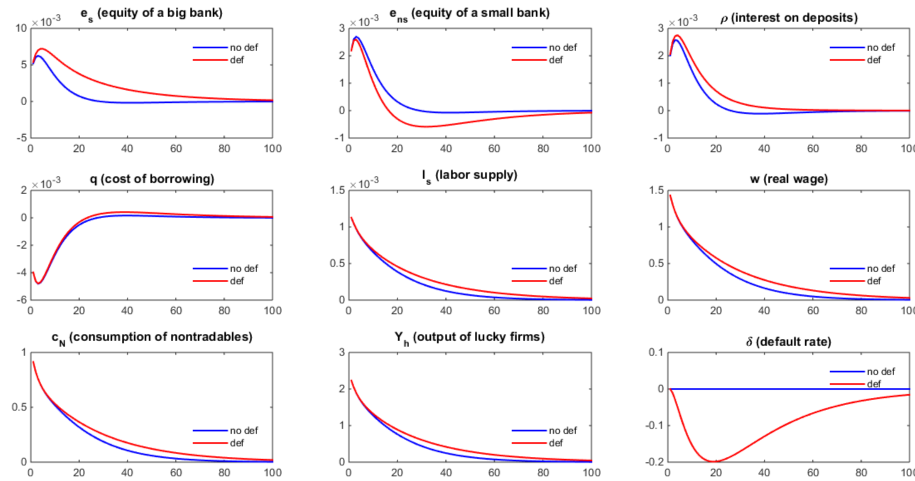

Figure 7: shock to the var of TFP: TFP high go up, TFP low go down (1)

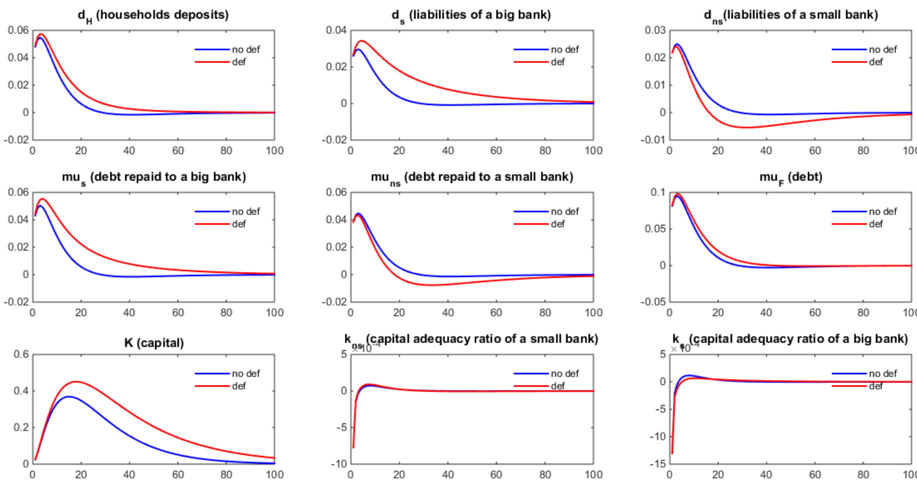

Figure 8: shock to the var of TFP: TFP high go up, TFP low go down (2)

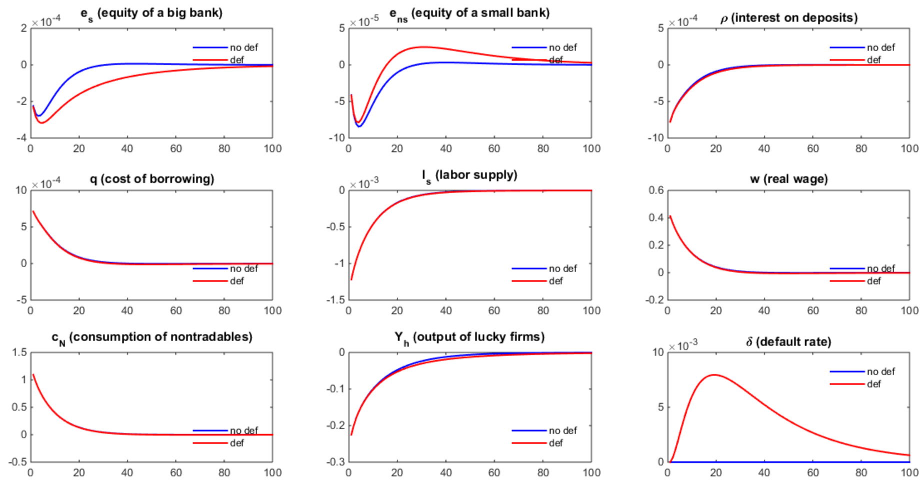

Figure 9: real depreciation (1)

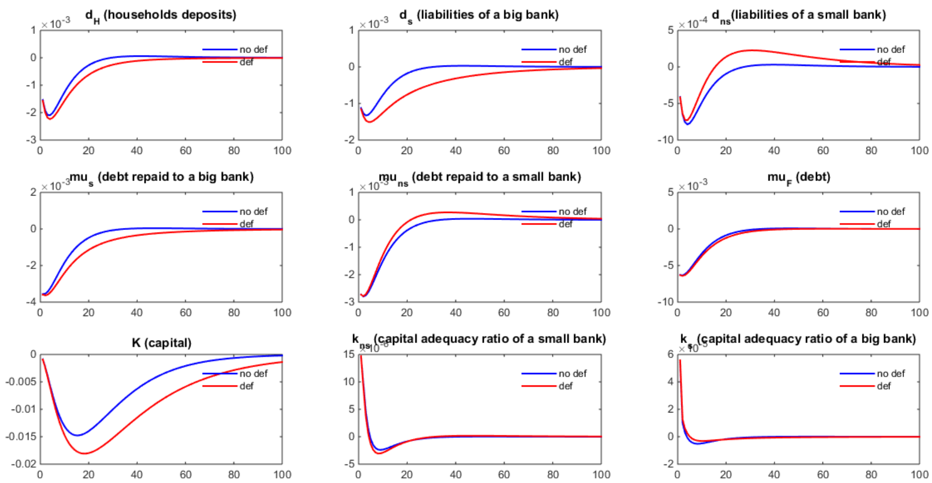

Figure 10: real depreciation (2)

6 Conclusion

Given the development and implementation of macro and microprudential regulation, it is important for policymakers to assess their interaction with monetary policy. Our model exhibits several novel features, but emphasises the role that firm level heterogeneity, and corresponding cross-sectional default rates, plays as a source of financial instability in a DSGE model with a heterogenous banking sector.

The first part of the paper analyzes the role of endogenous default in the RBC version of the model. We find that the small and big banks responces to various types of shocks are different in amplitude or in some cases are assymetric. It takes more time for both financial and real sectors of the economy to adjust in case of a positive default rate. The next step would be to analyze the optimal mix of monetary and macroprudential policy in the NK DSGE model.

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