Traditional and matter-of-fact financial frictions in a DSGE model for Brazil: the role of macroprudential instruments and monetary policy

WORK IN PROGRESS – PRELIMINARY RESULTS

Fabia Carvalho  
Research Department

Marcos Castro  
Research Department

Silvio Costa  
Research Department

The views expressed in this work do not necessarily represent those of the Central Bank of Brazil or its members
Purpose

- Investigate and assess the full-blown effects of macroprudential policies on the Brazilian economy
  - Reserve requirements
  - Capital requirement
  - Sectoral risk weights on banks’ assets for capital adequacy computation
  - Basle III
Methodology

- Dynamic stochastic general equilibrium model (DSGE) with a relevant role of the banking system
- Theoretical improvements to existing DSGE models to better represent the Brazilian banking system
- Current version is a closed economy model
- Bayesian estimation with Brazilian data
Motivation

– Brazil: active use of RR as a policy instrument
  • Existing studies based on partial-equilibrium analysis
– Brazilian agenda of convergence to the Basle-3
– Mainstream literature focuses on advanced economies
  • Full collateralization of loans through capital or housing
  • Monopolistic competition in time deposits
  • Unremunerated reserve requirements
Our main contributions

– Risky retail loan concessions based on expected labor income, not on physical collateral
  Stylized facts:
  • 50% of retail loans are uncollateralized through physical assets
  • Another 1/3 is extended for vehicle purchases, which might or might not be collateralized

– Time-varying Loan-to-Value ratios
  Stylized fact:
  • Income commitment with debt is trending upwards

– Ample and realistic set of reserve requirements
  • Time deposits, demand deposits, savings accounts, additional requirements, non-compliance with mandatory housing loans

– Bank liquidity buffer
Further adjustments

- Tight regulation on savings accounts and housing loans
- Return on time deposits is exogenous to the bank
- Target for the liquidity buffer
- Targets and adjustment costs for time deposits
- Endogenous lending spread
  - Markup + default + adm costs + tax + regulatory costs
The theoretical model

- **Households**
  - Savers
  - Borrowers

- **Entrepreneurs (as in BGG)**

- **Firms**
  - Intermediate goods
  - Retailers/Distributers
  - Final goods: private consumption, government consumption, investment, capital and housing

- **Government (monetary, fiscal and macroprudential policies)**

- **Investment fund**

- **Bank conglomerate**
  - Treasury department
  - Deposit branches (time deposits, savings accounts, demand deposits)
  - Lending branches (retail loans, investment loans, housing loans)
Financial flows
Selected economic segments

MACROPRUDENTIAL POLICIES
CAPITAL REGULATION
RESERVE REQUIREMENTS

BANKING SYSTEM

LABOR INCOME

Borrowers

Savers

DEMAND DEPOSITS

DEPOSITS

SAVINGS DEPOSITS

TIME DEPOSITS

Investment fund

Wholesale Branch

BANK CAPITAL

RETAIL LOANS

HOUSING LOANS

INVEST. LOANS

Entrepreneurs

Government

BONDS

REQUIRED RESERVES

Wholesale Branch

MON. POLICY IR

Not remunerated

Regulated IR

Wholesale Branch

MACROPRUDENTIAL POLICIES
CAPITAL REGULATION
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Specific Model Features

- Remunerated reserve requirements
- Capital requirement and bank funding cost
- Regulated savings deposits and housing loans
- Debt constraints of household loans
Reserve Requirements and the Bank Balance Sheet

Standard model specification for reserve requirements:
- RR as a fraction of deposits;
- Unremunerated reserve requirements;

Unremunerated RR poses costs to the banking system, as they must be funded by costly deposits.

In Brazil, no mismatch between RR and time deposits remuneration.
In this situation, the standard model for RR becomes inoperative: banks may comply costlessly with any increase in RR by issuing more time deposits.
Reserve Requirements and the Bank Balance Sheet (ctd.)

A different modeling approach was developed, taking into account the following evidence:

- Brazilian banks continuously try to avoid any exposition to RR, suggesting that even remunerated RR are costly;

- Banks acquire liquid assets that yield roughly the same interest rate as those paid on time deposits.
Reserve Requirements and the Bank Balance Sheet (ctd.)

Bank Balance Sheet (simplified):

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liq. Bonds</td>
<td>D</td>
</tr>
<tr>
<td>RR</td>
<td></td>
</tr>
<tr>
<td>Loans</td>
<td>K</td>
</tr>
</tbody>
</table>

Optimal Liq/Assets ratio:

\[
\frac{XOM}{2} \left( \frac{BOM_{j,t}}{Lb_{j,t}} - \nu_t^{OM} \right)^2 Lb_{j,t}
\]

Optimal D/Liab. ratio:

\[
\frac{X_{d,T}}{2} \left( \frac{D_{j,t}^T}{Lb_{j,t}} - \nu_t^{d,T} \right)^2 Lb_{j,t}
\]

Costly variation of D:

\[
\Gamma_T \left( \frac{D_{j,t}^T}{D_{j,t-1}^T} \right) D_{j,t}^T
\]
A common modeling approach to relate bank capital to bank funding costs and lending rates is Gertler & Karadi (2011):

- higher bank leverage implies in higher interest rates on bank deposits. These higher funding costs are passed through to lending rates.

- This rationale derives from a moral hazard problem between banks and depositors.

This might hold true for small banks which depend mostly on wholesale deposits funding.

Not so evident for large banks, which are responsible for the bulk of the credit supply and can count on diversified and stable sources of funding.
Capital Requirement and Bank Funding Cost (ctd.)

Instead, we chose to relate bank capital to an internal funding cost associated with bank leverage. The higher the bank capital excess over prudential requirement, the lower this internal funding cost. A rationale for this can be found in Van den Heuvel (2007):

– if bank capital falls below regulatory minimum, the regulator prevents banks from distributing dividends or making new loans.

– in order to avoid that, banks accumulate capital in excess over regulatory minimum. When this buffer is small, banks are less willing to provide new loans, lest an adverse shock might reduce its capital below that minimum.
Capital Requirement and Bank Funding Cost (ctd.)

This behavior can be represented in reduced form as an internal cost of capital:

\[ \Gamma_{bank^K} \left( \frac{B{I_t}}{\gamma_t} \right) Bankcap_t \]

where

\[ BI_t = \frac{BankCap_t}{\sum \tau_k B_{k,t}} \]

\( \Gamma'_{bank^K} \left( \frac{B{I_t}}{\gamma_t} \right) < 0, \Gamma''_{bank^K} \left( \frac{B{I_t}}{\gamma_t} \right) > 0 \)

\[ \frac{BI}{\gamma_{bank^K}} > 1 \quad \text{in steady state} \]
The bank's program (simplified)

$$\max E_0 \left\{ \sum_{t \geq 0} \beta^t_{Bank} \left[ \frac{1}{1 - \sigma_B} \left( \frac{C_{B,j,t}}{\epsilon_t} \right)^{1-\sigma_B} \right] \varepsilon^t_{\beta,B} \right\}$$

Balance sheet: \( L_{j,t} + Bonds_{j,t} + RR_{j,t} = D_{j,t} + Bankcap_{j,t} \)

Capital Accumulation: \( Bankcap_{j,t} = Bankcap_{j,t-1} + FC^b_{j,t} - P_{C,t}C_{B,j,t} + Bankcap_{j,t} \varepsilon^t_{bankcap} \)

Reserve Requirement: \( RR_{j,t} = \tau_{RR,T,t} D_{j,t} \)

Loan Demand (plus Calvo rigidity in interest rates): \( L_{j,t} = \left( \frac{R^L_{j,t}}{R^L_t} \right)^{\frac{\nu^R_{L-1}}{\nu^R_L}} L_t \)

Cash flow: \( FC^b_{j,t} = R^L_{j,t-1} L_{j,t-1} - L_{j,t} + R_{RR,t-1} RR_{j,t-1} - RR_{j,t} + R_{t-1} Bonds_{j,t-1} - Bonds_{j,t} - R^T_{t-1} D_{j,t-1} + D_{j,t} - \Gamma_T \left( \frac{D_{j,t}}{D_{j,t-1}} \right) D_{j,t} - \Gamma_{bankK} \left( \frac{BI_{j,t}}{\gamma^t_{BankK}} \right) Bankcap_{j,t} - \frac{\chi_{OM}}{2} \left( \frac{Bonds_{j,t}}{D_{j,t} + Bankcap_{j,t}} - \nu^OM_t \right)^2 (D_{j,t} + Bankcap_{j,t}) - \frac{\chi_{d,T}}{2} \left( \frac{D_{j,t}}{D_{j,t} + Bankcap_{j,t}} - \nu^d_{T,t} \right)^2 (D_{j,t} + Bankcap_{j,t}) + \Pi^L_{j,t} + \Xi^b_{j,t} \)
Lending spread components

BANKING SYSTEM

TIME DEPOSITS

Funding costs

Wholesale Branch

Tax on profits
Regulatory costs

BANK CAPITAL

Borrowers

Funding costs

BONDS

REQUIRED RESERVES

Entrepreneurs

Default
Markup
Adm costs
Direct tax

WHOLESALE BRANCH

Retail Loans

Housing Loans

Invest. Loans
Regulated Savings Deposits and Housing Loans

– Savings deposits have government regulated remuneration lower than the base rate.
– 60% of these funds are earmarked to finance housing loans.
– Housing lending rates are also government regulated.
– Most of housing loan intermediation is performed by state-owned banks.

Savings deposits have government regulated remuneration lower than the base rate.

60% of these funds are earmarked to finance housing loans.

Housing lending rates are also government regulated.

Most of housing loan intermediation is performed by state-owned banks.
Regulated Savings Deposits and Housing Loans (ctd.)

• Optimizing banks have no control over interest rates on savings deposits or demand deposits, and take supply as given.
• Savings and demand deposits supply depend on household preferences.

• Optimizing banks have no control over interest rates on housing loans, and take demand as given. However, housing loans take part on risk-weighted assets and affect banks’ capital requirements.
• Demand for housing loans depends on household preferences and housing collateral value.

⇒ Housing stock is of little use as collateral for non-earmarked loans.
Retail Loans

Household borrowing is constrained by expected labor income.

Modeling strategy: a variant of BGG in which lending branches may seize a fraction of household labor income as collateral in case of default.

– Allows for consumption smoothing (as opposed to strict debt to income constraints).
– Allows for credit default.
Borrower’s Program

\[
\max E_0 \left\{ \sum_{t \geq 0} \beta_B^t \left[ \frac{1}{1 - \sigma_X} (\mathcal{X}_{B,t})^{1 - \sigma_X} - \frac{\varepsilon_L^L L_B}{1 + \sigma_L} (N_{B,t})^{1 + \sigma_L} + \frac{\psi_{D,B}}{1 - \sigma_D} \varepsilon_{D,B} \left( \frac{D_{B,t}}{P_{C,t} C_{B,t}} \right)^{1 - \sigma_D} \right] \varepsilon_t^\beta \right\}
\]

\[
\mathcal{X}_{B,t} = \left[ (1 - \varepsilon_t^H \omega_{H,B}) \frac{1}{\eta_H} \left( C_{B,t} - \bar{h}_B C_{B,t-1} \right)^{\frac{\eta_H-1}{\eta_H}} + (\varepsilon_t^H \omega_{H,B}) \frac{1}{\eta_H} \left( H_{B,t} \right)^{\frac{\eta_H-1}{\eta_H}} \right]^{\frac{\eta_H}{\eta_H-1}}
\]

\[
(1 + \tau_{C,t}) P_{C,t} C_{B,t} + P_{H,t} (H_{B,t} - (1 - \delta_H) H_{B,t-1}) + \gamma_{t,B,C} (1 - \tau_{\omega,t}) N_{B,t} W_t^N H_B (\overline{\omega}_B,t,0) + D_{B,t}^D
\leq B_{B,t}^C + B_{H,t}^H + D_{B,t-1}^D + (1 - \tau_{\omega,t}) (W_t^N N_{B,t}) + TT_{B,t} + \Pi_{B,t}^{LU}
\]

\[
\gamma_{t,B,C} E_t (1 - \tau_{\omega,t+1}) N_{B,t+1} W_{t+1}^N G_{B,C} (\overline{\omega}_{B,t+1}, \overline{\omega}_B^{H,t+1}) = R_{B,t}^C B_{B,t}^C
\]
\[
\gamma_{t,B,C} \omega_{B,t}^H (1 - \tau_{\omega,t}) N_{B,t} W_t^N = R_{B,t-1}^{L,H} B_{B,t-1}^H
\]
\[
B_{H,t}^H \leq \gamma_{t,H}^B P_{H,t} H_t^B
\]
\[
\gamma_{t,B,C} (\omega_{B,t} - \omega_{B,t}^H) (1 - \tau_{\omega,t}) N_{B,t} W_t = R_{B,t-1}^{L,C} B_{B,t-1}^C
\]
Rest of the model

- Savers, intermediate goods producers, retailers and labor union as usual in the literature.

- Traditional monetary and fiscal rules.

- Macroprudential instruments initially represented as persistent AR(1) shocks.

- Entrepreneur as in BGG. Slight modification: fraction of capital available as collateral is variant over time. This helps to accommodate trends in total amount of loans to firms.
IRFs of a 1p.p. Monetary Policy Shock

- Interest rate (bp, yearly)
- Inflation (4-Q % ss dev)
- GDP (% ss dev)
- Retail lending rate (bp, yearly)
- Retail loans (% ss dev)
- Consumption (% ss dev)
- Commercial lending rate (bp, yearly)
- Commercial loans (% ss dev)
- Capital investment (% ss dev)
IRFs of a 10 p.p. shock to Loan Risk Weights

• Shocks in risk weights spill over to the other credit segments
Reserve Requirement: scaling the size of the shocks 
(nonresponsive MP)

Values calibrated from historical averages

<table>
<thead>
<tr>
<th></th>
<th>Demand Deposits</th>
<th>Time Deposits</th>
<th>Savings Accounts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balances (% of GDP)</td>
<td>3%</td>
<td>21.5%</td>
<td>10%</td>
</tr>
<tr>
<td>RR ratio</td>
<td>49%</td>
<td>11.2%</td>
<td>11.7%</td>
</tr>
</tbody>
</table>
IRFs to a 1p.p. Capital Requirement Shock

- GDP (% ss dev)
- Inflation (4-Q % ss dev)
- Interest rate (bp, yearly)
- R_B_c (% ss dev)
- Retail Lending Rate (bp, yearly)
- Retail Loans (% ss dev)
- Commercial Loans (% ss dev)
- Dividend distribution (% ss dev)
- Basel ratio (pp)

Unanticipated shock to capital requirement
Anticipated shock to capital requirement
IRFs to a 5% Loss of Bank Capital

- Bank capital (% ss dev)
- Basel ratio (pp)
- Bank's dividend distr. (% ss dev)
- Retail lending rate (bp, yearly)
- Retail loans (% ss dev)
- Commercial lending rate (bp, yearly)
- Commercial loans (% ss dev)
- Liquidity buffer (% ss dev)
- Time deposits (% ss dev)
- Interest rate (bp, yearly)
- Inflation (4-Q % ss dev)
- GDP (% ss dev)
Concluding remarks

- Model with financial frictions both on the demand and the supply side of the banking sector
  - Theoretical set-up tailored to Brazil
  - Transmission mechanism of macroprudential policy
  - Endogenous lending spread: matter-of-fact decomposition

- Changes in reserve requirement ratios
  - Impact banks’ liquidity buffer, affecting lending rates and credit
  - Affect the real economy
  - Impact of remunerated RR (base-effect)
Concluding remarks

• Changes in capital requirement have a smaller yet more prolonged effect on credit-to-GDP with milder impact on output compared to MP shock.

• Shocks on sectoral risk weight on CAR induce banks to reshuffle their credit portfolio towards less risky loans.

• Next steps:
  – Open economy
  – Phase-in implementation of Basle 3
  – Bank heterogeneity (public vs. private, small vs. big)
Thank you!

fabia.carvalho@bcb.gov.br
marcos.castro@bcb.gov.br
silvio.costa@bcb.gov.br
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