Financial (in)stability in Chile

E. Kazakova [1] J-F. Martinez [2] M. U. Peiris [1] D. P. Tsomocos [3]

[1] National Research University Higher School of Economics, Russian Federation

[2] Central Bank of Chile

[3] Saïd Business School and St Edmund Hall, University of Oxford

4th Conference on Banking Development, Stability and Sustainability
November 16, 2018, Santiago, Chile

The paper in a nutshell

The question:

What is the impact of - real and nominal - shocks to financial stability?

What we do:

- We develop a comprehensive model of small open economy that allows us to study financial stability under the presence of financial frictions and monetary and real economy shocks.
- We provide theoretical and empirical evidence of the interplay of real and financial economy.
- This framework would allow us to study banking regulation and other effects in commodity exporter countries.

Financial (In)Stability in Chile

- Chile has experienced three relevant episodes in the last 40 years with different degrees of relevance and policy/regulatory environments.
- The current situation is the result of an evolution to an open economy with safer banking system. We have inflation targeting with free floating exchange rate, which acts as a natural stabilizer of international shocks.
- However, there is still dependence of copper prices that may feedback to the financial sector directly or **indirectly**.

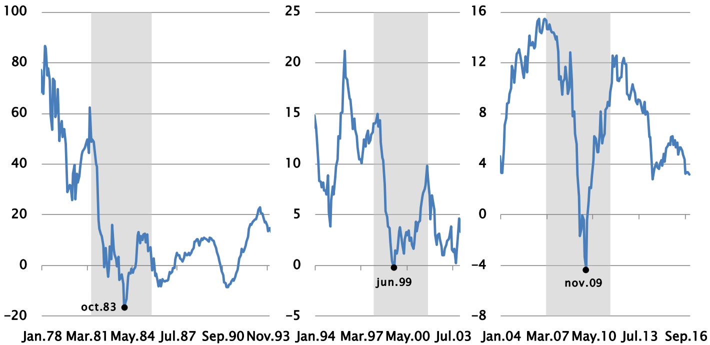
Period	Characteristics	Causes
Local banking crisis (LBC) $\sim$ 1982	Insolvency of many institutions. Credit risk increase. Profitability reduction. Balance-sheet effects. Credit crunch.	Financial liberalization. Regulation failures. Credit boom. Current account deficit.
Asian crisis (AC) $\sim$1998	Credit risk increase. Profitability reduction. Merge/exit of small credit agencies. Credit crunch.	Current account deficit. Households' credit boom. Capital inflows.
Global financial crisis (GFC) $\sim$2008	Credit risk increase. Liquidity restrictions. Credit crunch.	Credit boom (lower intensity). Capital inflows.

Source: Martínez et al. (2018).

Chilean credit growth

- Consistent to Goodhart et al. (2006) description of financial fragility periods, past Chilean episodes of vulnerability include sharp contractions in credit...

Figure: Real annual credit growth (percentage).

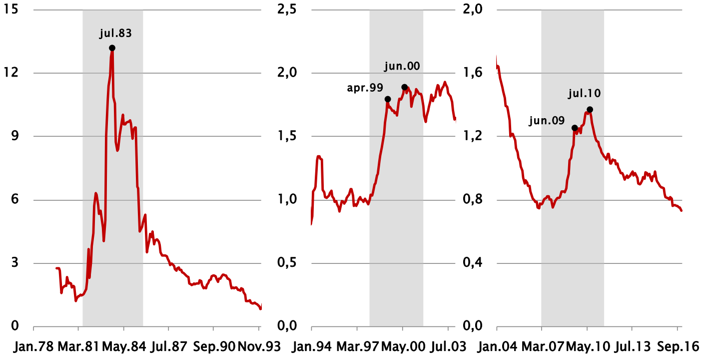


Source: Martínez et al. (2018).

Chilean past-due loans

...sizeable increases in default rates,...

Figure: Past due loans ratio (percentage of loans).



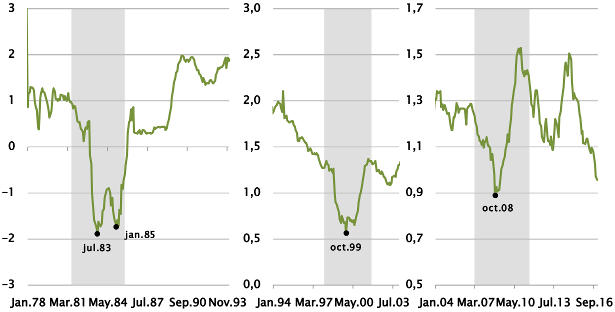
Source: Martínez et al. (2018).

Chilean ROA

...and, as a result, periods of considerably low profitability.

- So that it becomes relevant to progress in assessing the impact of several shocks in an integrated model to understand possible channels of shocks transmission and dynamics of key financial variables.

Figure: Return over assets (percentage).

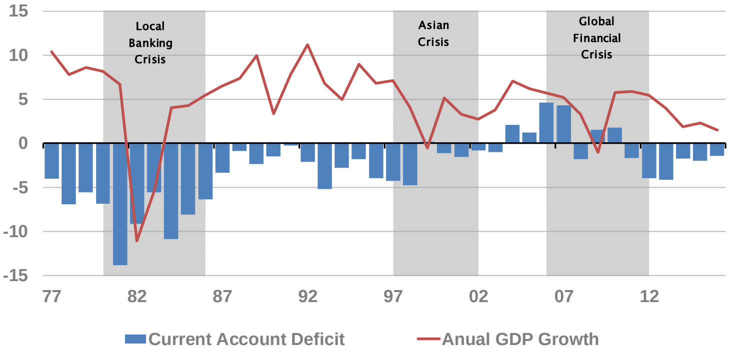


Source: Martínez et al. (2018).

Economic activity and country's external position

- Size of impacts depends also on the country's external position...

Figure: Financial Fragility and Economic Activity (percentage)

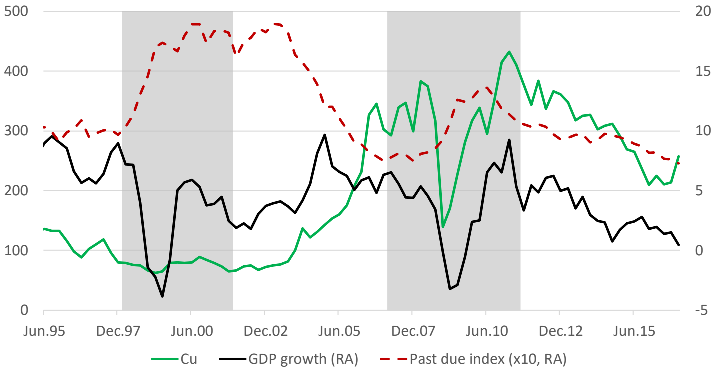


Source: Own elaboration. Grey areas based on Martínez et al. (2018).

Commodity price shocks' role

- In particular, recent periods of fragility seem related to commodity price fluctuations...

Figure: Financial Fragility and Economic Activity (percentage)



Source: Own elaboration. Grey areas based on Martínez et al. (2018).

Recent context

- In 2018 the Chilean economy is recovering after a period of slow macroeconomic activity in 2014-2016.
- The main global economic and geopolitical risks have materialized in lower and volatile copper prices that could receive further shocks.
- Given its mandate of price and financial stability*, the CBC may be interested in evaluating its potential financial stability effects.
- Furthermore, there is scope for discussing monetary policy in Chile in connection with the existence of macro-prudential regulation derived from the convergence to international standards, such as Basel III.
- In particular, there is need to explore in detail the channels of transmission.

Framework

- Medina & Soto (2007), present a small open economy setting for monetary policy analysis. This explains the business cycles that occurred in the Chilean economy from 1987 to 2005.
- Del Negro & Schorfheide (2008), perform a similar analysis, with some additional robustness checks, from 1999 to 2007.
- García-Cicco et al. (2014) have tested combinations of a simplified version of Medina & Soto (2007), with Gertler & Karadi (2011) and Bernanke et al. (BGG) (1999). These models include nominal rigidities and consider that the primary source of financial frictions is the presence of asymmetric information as it is manifested in costly state verification and moral hazard.
- We keep the financial acceleration mechanism and allow for endogenous (strategic) default is described in Dubey et al. (2005) and Goodhart et al. (2006a).

Focus of Analysis

Our paper concerns **macroprudential regulation** in **fragility times** with macroeconomic shocks being amplified due to the presence of **pecuniary externalities**. The two sources of the externalities are:

- Cost of default
- Collateral constraints dependent on market valuation of capital

Banking sector consists of big and small banks and is perfectly competitive, and there is ex post heterogeneity manifested in idiosyncratic shocks experienced by small banks.

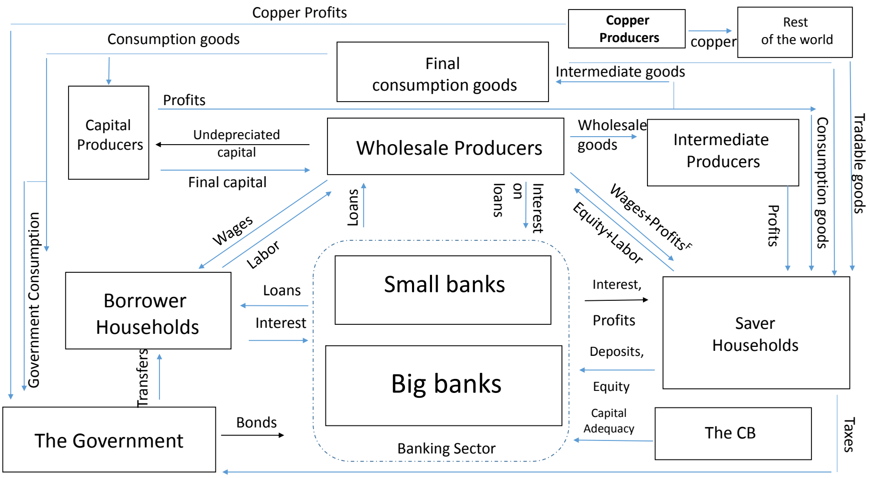
Frictions and assumptions

- New-Keynesian DSGE model with nominal rigidities.
- Considers a commodity exporter Small Open Economy.
- Assume that all goods are tradable and there are no barriers to trade.
- There is households, firms, external sector Central Bank, Regulator and Government.
- Heterogenous 2-period lived Firms with idiosyncratic risk and default.
- Heterogenous households (long lived saver and 2-period lived borrower).
- Heterogenous 2-period lived banks, and capital requirements.
- Hence, there is default - for secured and collateralized loans - and capital requirements.
- Consider further bank heterogeneity in the form of systemic and small banks.

Implication

This set of assumptions implies a role for Monetary Policy, Financial Stability and Regulation.

Flow of funds



Formulation: firms (ex ante)

- Two period lived firms
- Secured vs unsecured borrowing

$$p_t^K k_{t+1}^f + T_t^f + \frac{a_\mu}{2}\left(\mu_{t+1}^{f,u} - \bar{\mu}^{f,u}\right)^2 + \frac{a_\mu}{2}\left(\mu_{t+1}^{f,s} - \bar{\mu}^{f,s}\right)^2 + \frac{a_K}{2}\left(k_{t+1}^f - \bar{k}^f\right)^2 = \mu_{t+1}^f + (1-\tau)p_t^K k_t^f + e_t^f \quad (1)$$

$$\mathbb{E}(1 + r_{t+1}^{f,s})\mu_{t+1}^{f,s} \leq coll(1-\tau)k_{t+1}^f \, \mathbb{E}\, p_{t+1}^K \quad (2)$$

Formulation: firms (ex post)

- 'Lucky' vs 'unlucky' firms: probability of default θ_f is the prob. of $\underline{A}$
- δ^f - loss given default
- Cost of negotiating the debt $\frac{\Omega^f_{t+1}}{2}\left(\delta^f_{t+1}\mu^{f,u}_{t+1}(1+r^{f,u}_{t+1})\right)^2$

$$\pi^f_{t+1} + (1-\delta^f_{t+1})\mu^{f,u}_{t+1}(1+r^{f,u}_{t+1}) + \mu^{f,s}_{t+1}(1+r^{f,s}_{t+1}) + w_{t+1}l^f_{t+1} = p^N_{t+1}A^f_{t+1}(k^f_{t+1})^{\alpha}(l^f_{t+1})^{1-\alpha} - \frac{\Omega^f_{t+1}}{2}\left(\delta^f_{t+1}\mu^{f,u}_{t+1}(1+r^{f,u}_{t+1})\right)^2 + p^K_{t+1}k^f_{t+1}(1-\tau) \quad (3)$$

- Firms'decision to default creates pecuniary externality
- Higher expected default rate raises the interest rate ax ante
- Macro variable:

$$\Omega^f_t = \lambda^f \frac{\int \mu^{f,u}_{ss} df (1+r^{f,u}_{ss})(\delta^f_{ss})^{\gamma_1}}{K_{ss}p^K_{ss}} \frac{K_t p^K_t}{\int \mu^{f,u}_t df (1+r^{f,u}_t)(\delta^f_t)^{\gamma_1}} \quad (4)$$

Capital producers

- Capital producers purchase non-depreciated 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 the Final Goods market.
- Capital Producers combine both components into producing new capital $K_{t+1} = \int k_{t+1}^j dj$.
  The production function takes the form:

$$K_{t+1} = (1-\tau)K_t + i_t\left(1 - \frac{\varkappa}{2}\left(\frac{\epsilon_t^K i_t}{i_{t-1}} - 1\right)^2\right) \tag{5}$$

  Each capital producer, therefore, maximizes:

$$E_0 \sum_{t=0}^{\infty} (\beta^{sav})^t \Lambda_t^{sav} \left[p_t^K (K_{t+1} - (1-\tau)K_t) - i_t\right] \tag{6}$$

Copper Sector

The Copper sector is modeled as in *Hamann et al. (2016)*. A representative copper-extracting firm makes a decision of an copper extraction. At the beginning of a period t, the economy has res_t units of copper reserves and discovers a further $disc_t$ units. The resource constraint is:

$$res_{t+1} + ext_t = res_t + disc_t. \tag{7}$$

Profits in real terms are given by:

$$\Pi_t^{ext} = p_t^o ext_t - cost(res_t, ext_t) \tag{8}$$

A representative firm solves then:

$$max_{ext_t, res_{t+1}} \mathbb{E}_0 \sum_{t=0}^{\infty} \left[(\beta^{sav})^t \Lambda_t^{sav} \Pi_t^o \right] \tag{9}$$

Systemically important banks

- New-born systemically important large banks are capitalised with equity of $e_t^{\gamma,s}$.
- They accept deposits from Saver households, extend secured and unsecured loans to firms and loans to Borrower households.

The first period budget constraint of a systemically important bank is given by

$$\int \mu_{t+1}^{big,f} df = \int d_{t+1}^{big,sav} d(sav) + e_t^{\gamma,big} - \frac{a_\mu}{2}\left(\mu_{t+1}^{big,f,u} - \bar{\mu}^{big,f,u}\right)^2 - \frac{a_\mu}{2}\left(\mu_{t+1}^{big,f,s} - \bar{\mu}^{big,f,s}\right)^2 - \frac{a_d}{2}\left(d_{t+1}^{big,sav} - \bar{d}^{big,sav}\right)^2 \quad (10)$$

The capital adequacy ratio is defined as the ratio of bank capital to risk weighted assets net of reserves ($rwa_t^{big,\gamma}$), for a systemically important bank:

$$k_t^{big,\gamma} = \frac{e_t^{\gamma,big}}{rwa_t^{big,\gamma}} = \frac{e_t^{\gamma,big}}{\left(\int \bar{rw}_t^{big,f,u}\mu_{t+1}^{big,f,u}df + \int \bar{rw}_t^{big,f,s}\mu_{t+1}^{big,f,s}df\right)} \quad (11)$$

Big banks then choose how much of secured and unsecured debt to lend out to firms:

$$\Pi_{t+1}^{\gamma,big} = [\theta_f(1+r_{t+1}^{f,u})\int(1-\delta_{t+1}^{f})\mu_{t+1}^{big,f,u}df + (1-\theta_f)(1+r_{t+1}^{big,f,u})\int \mu_{t+1}^{big,f,u}df + \\ + (1+r_{t+1}^{f,s})\int \mu_{t+1}^{big,f,s}df - [(1+r_{t+1}^{d})\int d_{t+1}^{big,sav}d(sav)] \quad (12)$$

Given $\left\{\delta_{t+1}^{f}, r_{t+1}^{f,u}, r_{t+1}^{f,s}, r_{t+1}^{d}\right\}$, **banks choose** $\left\{\mu_{t+1}^{big,f,u}, \mu_{t+1}^{big,f,s}, d_{t+1}^{big,sav}\right\}$ **to maximize the following objective function:**

$$\mathbb{E}_t\beta^{big}\frac{(\hat{\Pi}_{t+1}^{\gamma,big})^{1-\varsigma_{big}}}{1-\varsigma_{big}} - a_{cap}0.5[k_t^{\gamma,big} - \bar{k}^{big}]^2 \quad (13)$$

Small banks

Small banks have the following BC:

$$\mu_{t+1}^{small,f} = d_{t+1}^{small,sav} + e_t^{\gamma,small} - \frac{a_\mu}{2}\left(\mu_{t+1}^{small,f,s} - \bar{\mu}^{small,f,s}\right)^2 - \frac{a_\mu}{2}\left(\mu_{t+1}^{small,f,u} - \bar{\mu}^{small,f,u}\right)^2 - \frac{a_d}{2}\left(d_{t+1}^{small,sav} - \bar{d}^{small,sav}\right)^2 \quad (14)$$

The profit of a small bank takes the form:

$$\Pi_{t+1}^{\gamma,small} = [(1 + r_{t+1}^{u,f})(1 - \delta_{t+1}^{f})\mu_{t+1}^{small,f,u} + (1 + r_{t+1}^{f,s})\mu_{t+1}^{small,f,s} - (1 + r_{t+1}^{d})d_{t+1}^{small,sav}] \quad (15)$$

For a small bank capital adequacy ratio looks like:

$$k_t^{\gamma,small} = \frac{e_t^{\gamma,small}}{rwa_t^{\gamma,small}} = \frac{e_t^{\gamma,small}}{rw_t^{small,f,u}\mu_{t+1}^{small,f,u} + rw_t^{small,f,s}\mu_{t+1}^{small,f,s}} \quad (16)$$

Given $\left\{\delta_{t+1}^{f}, r_{t+1}^{f,u}, r_{t+1}^{f,s}, r_{t+1}^{d}\right\}$, banks choose $\left\{\mu_{t+1}^{small,f,u}, \mu_{t+1}^{small,f,s}, d_{t+1}^{small,sav}\right\}$ to maximize the following objective function:

$$\mathbb{E}_t \beta^{sav}\Lambda_{t+1}^{sav}\left(\theta_f \frac{(\Pi_{t+1}^{\gamma,small})^{1-\varsigma_{small}}}{1-\varsigma_{small}} + (1-\theta_f)\frac{(\bar{\Pi}_{t+1}^{\gamma,small})^{1-\varsigma_{small}}}{1-\varsigma_{small}}\right) - \Lambda_t^{sav} 0.5 a_{cap}[k_t^{\gamma,small} - \bar{k}^{small}]^2 \quad (17)$$

Saver Households

Consumption bundle:

$$c_t^{sav} = (c_t^{sav,N})^{\varphi}(c_t^{sav,imp})^{1-\varphi} \tag{18}$$

Budget Constraint of a Household:

$$\begin{aligned}
& b_{t+1}^{sav} + b_{t+1}^{sav,*}Q_t + p_t^{imp}c_t^{sav,imp} + c_t^{sav,N} + e_t^f + (1-\tau)p_t^K K_t + e_t^{\gamma,small} + e_t^{\gamma,big} \\
& \leq (1+r_t^d)d_t^{sav} + (1+r_t^{b,*})b_t^{sav,*}Q_t + w_t l_t^{sav} + (1-\theta)\int \bar{\Pi}_t^f df + \theta \int \underline{\Pi}_t^f df + \\
& (1-\theta)\int \bar{\Pi}_t^{\gamma,small} d\gamma + \theta \int \underline{\Pi}_t^{\gamma,small} d\gamma + \\
& + \int \Pi_t^{\gamma,big} d\gamma + \Pi_t^{cap} + \Pi_t^{ret} - T_t + Tr_t - 0.5a_e(e_{ss}^{\gamma,small} - e_{ss}^{\gamma,small})^2 - 0.5a_e(e_{ss}^{\gamma,big} - e_{ss}^{\gamma,big})^2 - \\
& - 0.5a_e(e_t^f + (1-\tau)p_t^K K_t - (e_{ss}^f + (1-\tau)p_{ss}^K K_{ss}))^2 - \frac{a_d}{2}\left(d_{t+1}^{big,sav} - \bar{d}^{big,sav}\right)^2
\end{aligned} \tag{19}$$

Savers maximize their discounted utility s.t. their BC:

$$\sum_{t=0}^{\infty}(\beta^{sav})^t[\frac{(c_t^{sav})^{1-\sigma}}{1-\sigma} - \gamma^{sav}\frac{(l_t^{sav})^2}{2}]$$

The CB and the Government

- The Central Bank controls the interest rate i_t^b according to the following rule:

$$\frac{1+i_t^b}{1+i_{ss}^b} = \Big(\frac{1+i_{t-1}^b}{1+i_{ss}^b}\Big)^{r_R} \Big(\frac{1+\pi_t}{1+\pi_{ss}}\Big)^{(1+r_\pi)(1-r_R)} \Big(\frac{Y_t}{Y_{ss}}\Big)^{r_Y(1-r_R)} \epsilon_t^R \tag{20}$$

- The Government Budget Constraint:

$$G_t + Tr_t + B_{t-1}^g \frac{(1+i_{t-1}^b)}{1+\pi_t} \leq B_t^g + \Pi_t^o + cost_t(res, ext) + T_t + \int T_t^f df \tag{21}$$

Calibration: matching financial variables moments

Parameter	Description	Value	Source
$\bar{A}$	TFP in SS, lucky firms	12	Own Estimation
$\underline{A}$	TFP in SS, unlucky firms	10	OE
τ	Capital depr.rate	0.05	Medina and Soto (2007)
α	Capital share in prod.	0.35	Medina and Soto (2007)
δ^f	Loss Given Default (LGD) in SS	0.5	Basel III
$coll$	Margin (collateral constr.)	0.25	OE
γ_1	Default Ampl.	0.955	Peiris and Tsomocos (2018)
r^d	Deposit rate in SS	0.567	Average(2014-2017)
θ^f	Probability of default	0.1	Crisis episodes
$\frac{\mu^{big,f}}{\mu^f}$	Share of big banks (assets)	0.66	Garcia-Cicco and Kirchner (2015)
$rw^{big,f}$	Risk weight for big banks	1	Basel III
$rw^{small,f}$	Risk weight for small banks	1	Basel III
$\bar{k}^{big}$	Capital requirement for big banks	0.115	Basel III
$\bar{k}^{small}$	Capital requirement for small banks	0.09	Basel III
ς_{big}	Risk aversion of large banks	1	De Walque et al. (2010)
ς_{small}	Risk aversion of small banks	0	Standard
σ	Risk aversion of households	1.5	Medina and Soto (2007)
r_R	MP(interest rate elasticity)	0.82	Garcia-Cicco and Kirchner (2015)
r_π	MP (inflation elasticity)	0.57	Garcia-Cicco and Kirchner (2015)
r_Y	MP (output elasticity)	0.12	Garcia-Cicco and Kirchner (2015)
θ_c	Calvo price (elast.)	10	Medina and Soto (2007)
θ_{ps}	Calvo price (prob.)	0.7	Medina and Soto (2007)
ρ_a	AC temp. TFP shock	0.68	Garcia-Cicco and Kirchner (2015)
ρ_i	AC MP shock	0.34	Garcia-Cicco (2010)
ρ_{po}	AC copper pr. shock	0.8618	Hamann (2016)

Table: Calibrated parameters

Calibrated Equilibrium

	St. Dev.	1st Ord. Autocorr.	Corr. GDP
$\Delta log(GDP)\%$	**3.2883**	-0.0986	1.000
$\Delta log(K)\%$	**1.9621**	0.9748	0.3180
$\Delta log(C)\%$	**5.5568**	-0.1417	0.9967
$\Delta log(\mu^{big})\%$	4.1334	0.4891	-0.0392
$\Delta log(\mu^{small})\%$	12.7441	0.4970	-0.3279
$\Delta log(\Pi^{big})\%$	40.5396	0.5682	0.4041
$\Delta log \Pi^{f,high}\%$	6.9894	-0.4397	0.8795
$\Delta log(\Pi^{f,low})\%$	6.4008	-0.4835	0.8219
$r^{f,u}$	**0.2662**	0.9687	-0.1953
$r^{f,s}$	**0.0446**	0.4684	-0.5014
δ^{f}	**2.4680**	0.9885	-0.1543
$\Delta log(w)\%$	11.6233	-0.1846	0.9803
π	**0.0506**	0.6678	0.2977

Table: Selected theoretical moments from the model

Shock to Copper Price

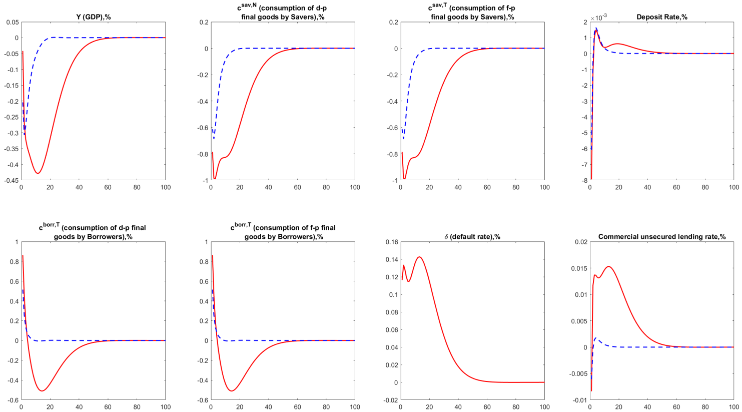


Figure: negative shock (1sd) to the price of copper, red is for the case with unsecured default

Shock to MPR

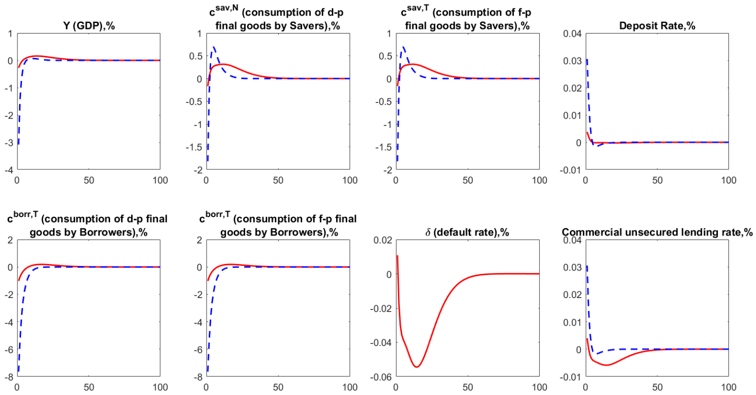


Figure: negative shock (1sd) to MPR, , red is for the case with unsecured default

Conclusions

- The model demonstrates that adverse shock to copper price significantly has both real and financial effects that reinforce each other.
- In a stylized fashion, we capture the effects of copper prices on repayment rates of the real sector.
- Hence, default rates transmit to interest on unsecured borrowing and reduces investment.
- We also study the effect of shocks on monetary policy to financial stability. We find that it may
- We are now studying to what extent prudential regulation (e.g. CCyB) would help to stabilize the economy.
- Additionally, we are dissecting the model, building core and periphery blocks in order to organize the assessment of transmission channels.