

Liquidity effects on asset prices, financial stability and economic resilience

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Agenda

- Motivation
- Model
- Solution
- Simulation results
- Preliminary conclusions

Results Preview

- Our framework can assess financial and economic consequences of monetary and regulatory policy.
- Micro-founded financial frictions are included in the model.
- Economic resilience is assessed in this paper as the response of economic variables to unexpected shocks.
- **Our results suggest that liquidity and default in equilibrium should be studied contemporaneously.**
- As a result, this work suggests that liquidity should be considered when designing metrics for financial stability.

Spread Compression and Decompression

We have observed this phenomenon during the (2007) financial crisis.

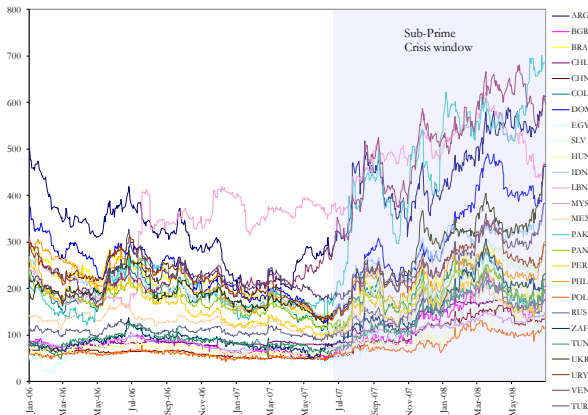


Figure: EMBI spreads compression and decompression

What drives the compression and the decompression? Fundamentals, liquidity, a *bubble*, others? **combined?**

Spread Compression and Decompression

Martinez (2010) suggests that fundamentals drive the spread compression but the decompression is due to liquidity among other factors.

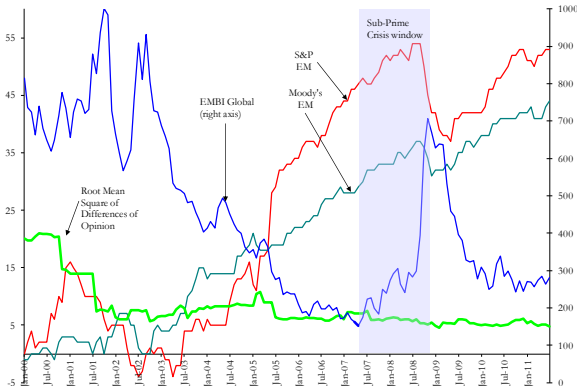


Figure: EMBI spreads versus credit quality

However, there is still a need for a theoretical framework to allow for feedback effects and to analyze what are the causes and effects of financial frictions into the asset price equilibrium.

Past literature on financial stability

- Partial equilibrium cannot cope with interactions between different agents (banks, households, regulators).
- Most models assume default as an out of equilibrium phenomenon.
- There are many potential channels for contagion, not just via the inter-bank market, but also through reputational channels, and via the effects of one bank's actions on the market prices and conditions facing other banks.
- Shubik (1999), Dubey & Geanakoplos (2003, 2005), Goodhart, Sunirand & Tsomocos, (2004-2006), Tsomocos (2003), provide a proper analytical framework to address financial stability. The remaining task is how to extend this literature to the Dynamic Stochastic framework. Why?

Some context on DSGE examples

- Bernanke et. al. (1999)
- Kiyotaki and Moore (2001)
- Meh and Moran (2010)
- Covas and Fujita (2010)
- de Walque (2010)

These models are very appreciated by Central Bankers because of its practicalities. However, there are some issues...

Contribution

There is still the need of a parsimonious benchmark economy model with the minimum features that allows to understand the interactions between liquidity, default, financial stability and economic resilience. We need a model in which we focus on financial stability rather than monetary policy. Here is our main contribution:

Liquidity effects on asset prices, financial stability and economic resilience

Model ingredients

A rigorous formulation of an equilibrium model require a minimum of structural characteristics, following (Goodhart, Tsomocos, et al.), are:

- 1 Dynamics, aggregate uncertainty and agent heterogeneity.
- 2 Money and Liquidity Constraints.
- 3 Commercial Banking Sector.
- 4 Regulatory Framework.
- 5 Endogenous Default.
- 6 Definition of Financial Stability, Contagion, Systemic Risk, etc.

The benchmark model

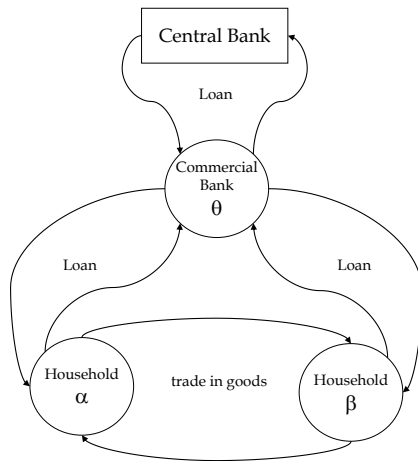
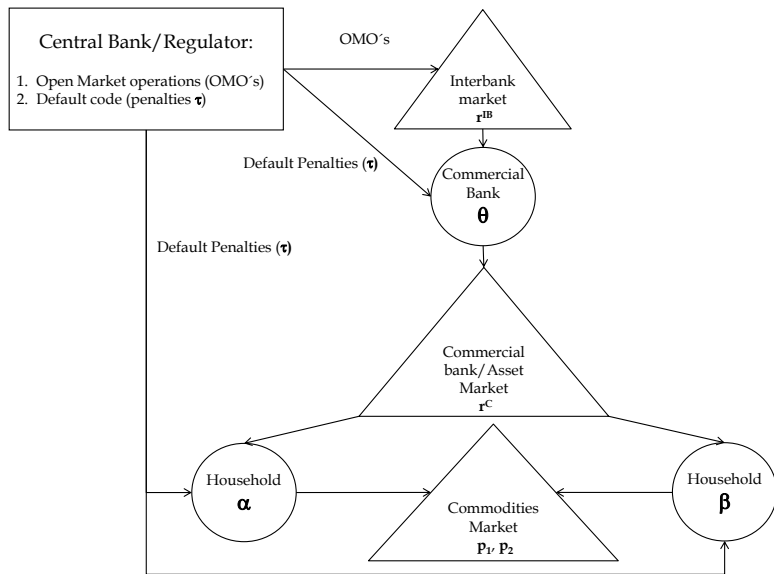


Figure: Nominal flows in the economy

Market structure of the model



Financial Frictions

Default

- Agents are allowed to default partially: they choose the fraction of outstanding debt they repay
- Default choice trade-offs the benefit of defaulting (more consumption) and its cost (credit costs)

Money

- Introduced by a cash-in-advance (liquidity) transaction technology
- Enters the system as just *inside* money (enters the system accompanied by an offsetting obligation → exits the system with accrued interest and net of default).

Financial Frictions

Liquidity

- There are two main sources of liquidity, through the injections by the Central Bank, or by the goods that are sold at every period. There is a fraction of the latter that can be used immediately as a mean of payment.
- Liquidity in goods is modeled in three main cases: no liquidity, partial symmetric and asymmetric liquidity.
- The interpretation for this exogenous parameter is considering it as **speed of liquidation**.

Stochastic endowment

- Model the production sector in a reduced fashion, using a Lucas tree form of the economy.
- Assume a stochastic endowment of one of the commodities for each agent.
- The only way to smooth consumption across agents is through trade on the commodities between the households.
- The following equation describes the form of the stochastic endowment.

$$\ln(e_{h,t}^l) = \rho_e^h \ln(\bar{e}_h^l) + (1 - \rho_e^h) \ln(e_{h,t-1}^l) + \epsilon_{h,t}^l \quad \text{for } h \in \{\alpha, \beta\} \quad \text{and } l \in \{1, 2\}$$

Inflation

We need to define a **price index** for our model, we use the Laspeyres (1864):

$$P_t = \frac{p_{1,t}\bar{q}_1^\alpha + p_{2,t}\bar{q}_2^\beta}{\bar{p}_1\bar{q}_1^\alpha + \bar{p}_2\bar{q}_2^\beta} \quad (1)$$

This index defines an **inflation rate** given by:

$$\pi_t = (1 + \hat{\pi}_t) = \bar{\pi} + \frac{P_t}{P_{t-1}} = \bar{\pi} + \frac{p_{1,t}\bar{q}_1^\alpha + p_{2,t}\bar{q}_2^\beta}{p_{1,t-1}\bar{q}_1^\alpha + p_{2,t-1}\bar{q}_2^\beta} \quad (2)$$

Timing of the model 1

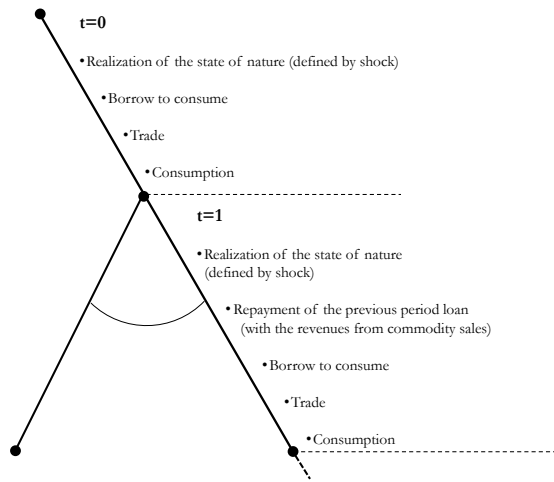


Figure: Timing tree for households

Timing of the model 2

	Money inflow		Money Outflow	
	Commercial Bank	Households	Commercial Bank	Households
Beginning	Loan taken from Central Bank	Loan taken from Commercial bank	Loan given to the households	Consumption
End	Repayment from households	Revenues from sales of commodities	Repayment to Central Bank	Repayment to Commercial bank

Household α optimization problem

$$\max_{\tilde{\mu}_t^\alpha, \tilde{b}_{2,t}^\alpha, v_t^\alpha, q_{1,t}^\alpha} E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \ln \left(e_{1,t}^\alpha - q_{1,t}^\alpha \right) + \ln \left(\frac{\tilde{b}_{2,t}^\alpha}{\tilde{p}_{2,t}} \right) - \frac{\tau_t^\alpha}{\pi_t} \text{Max}[0, (1 - v_t^\alpha) \tilde{\mu}_{t-1}^\alpha] \right\}$$

s.t.

$$v_t^\alpha \tilde{\mu}_{t-1}^\alpha \leq \tilde{p}_{1,t-1} q_{1,t-1}^\alpha \cdot (1 - \lambda_{t-1}^\alpha) \quad (\eta_{1,t}^\alpha)$$

Repayment \leq Last period illiquid sales of commodities.

$$\tilde{b}_{2,t}^\alpha \leq \lambda_t^\alpha \cdot \tilde{p}_{1,t} q_{1,t}^\alpha + \frac{\tilde{\mu}_t^\alpha}{1 + r_t^c} \quad (\eta_{2,t}^\alpha)$$

Money spent \leq Liquid portion of sales of commodities + Loan taken from the commercial bank.

Where:

β^t	stochastic discount factor.
$q_{1,t}^\alpha$	amount sold of good 1.
$\tilde{b}_{2,t}^\alpha$	amount of money spent in good 2.
μ_t^α	loan amount taken from the commercial bank.
v_t^α	loan repayment rate.
τ_t^α	default penalty for household α .
r_t^c	commercial bank loans rate.
λ_t^α	liquid portion of goods for household α .
$\eta_{i,t}^\alpha$	lagrange multiplier for constraint $i \in \{1, 2\}$ for household α .
\sim	on the top is for real amounts correction (division by p_t or p_{t-1}).

Household β optimization problem

$$\max_{\tilde{\mu}_t^\beta, \tilde{b}_{1,t}^\beta, v_t^\beta, q_{2,t}^\beta} E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \ln \left(\frac{\tilde{b}_{1,t}^\beta}{\tilde{p}_{1,t}} \right) + \ln \left(e_{2,t}^\beta - q_{2,t}^\beta \right) - \frac{\tau_t^\beta}{\pi_t} \text{Max}[0, (1 - v_t^\beta) \tilde{\mu}_{t-1}^\beta] \right\}$$

s.t.

$$v_t^\beta \tilde{\mu}_{t-1}^\beta \leq \tilde{p}_{2,t-1} q_{2,t-1}^\beta \cdot (1 - \lambda_{t-1}^\beta) \quad (\eta_{1,t}^\beta)$$

Utility \leq Expected Repayments - Repayment to Central Bank.

$$\tilde{b}_{1,t}^\beta \leq \lambda_t^\beta \cdot \tilde{p}_{2,t} q_{2,t}^\beta + \frac{\tilde{\mu}_t^\beta}{1 + r_t^c} \quad (\eta_{2,t}^\beta)$$

Credit extensions \leq Loan taken from Central Bank.

Where:

β^t	stochastic discount factor.
$q_{2,t}^\beta$	amount sold of good 2.
$b_{1,t}^\beta$	amount of money spent in good 1.
μ_t^β	loan amount taken from the commercial bank.
v_t^β	loan repayment rate.
τ_t^β	default penalty for household β .
r_t^c	commercial bank loans rate.
λ_t^β	liquid portion of goods for household β .
$\eta_{i,t}^\beta$	lagrange multiplier for constraint $i \in \{1, 2\}$ for household β .
\sim	on the top is for real amounts correction (division by p_t or p_{t-1}).

Bank θ optimization problem

$$\max_{\tilde{\pi}_t^\theta, \mu_t^\theta, l_t^\theta, v_t^\theta} E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \ln(\tilde{\pi}_t^\theta) - \frac{\tau_t^\theta}{\pi_t} \text{Max}[0, (1 - v_t^\theta) \tilde{\mu}_{t-1}^\theta] \right\}$$

s.t.

$$\tilde{\pi}_t^\theta = \frac{R_t \tilde{l}_{t-1}^\theta (1 + r_{t-1}^c)}{\pi_t} - v_t^\theta \frac{\tilde{\mu}_{t-1}^\theta}{\pi_t} \quad (\eta_{1,t}^\theta)$$

Profits = Household expected repayment - Repayment to the Central Bank

$$\tilde{l}_t^\theta \leq \frac{\tilde{\mu}_t^\theta}{1 + r_t^{IB}} \quad (\eta_{2,t}^\theta)$$

Money lent to households \leq Loan taken from the Central Bank.

Where:

β^t	stochastic discount factor.
Π_t^θ	profits obtained by the commercial bank θ .
l_t^θ	loan amount given to the households.
μ_t^θ	loan amount taken from the Central Bank.
v_t^θ	loan repayment rate.
τ_t^θ	default penalty for commercial bank θ .
r_t^{IB}	interbank loans rate, provided by Central Bank.
R_t	expected delivery rate from households loan.
$\eta_{i,t}^\theta$	lagrange multiplier for constraint $i \in \{1, 2\}$ for bank θ .
\sim	on the top is for real amounts correction (division by p_t or p_{t-1}).

Closing the model

Rational Expectations

Commercial bank expected repayment rate:

$$R_t \begin{cases} \frac{v_t^\alpha \tilde{\mu}_{t-1}^\alpha + v_t^\beta \tilde{\mu}_{t-1}^\beta}{\tilde{\mu}_{t-1}^\alpha + \tilde{\mu}_{t-1}^\beta}, & \text{if } \tilde{\mu}_{t-1}^\alpha + \tilde{\mu}_{t-1}^\beta > 0; \\ \text{Arbitrary,} & \text{if } \tilde{\mu}_{t-1}^\alpha + \tilde{\mu}_{t-1}^\beta = 0. \end{cases}$$

Market Clearing Conditions

Goods Market

$$\tilde{b}_{1,t}^\beta = \tilde{p}_{1,t} q_{1,t}^\alpha$$

$$\tilde{b}_{2,t}^\alpha = \tilde{p}_{2,t} q_{2,t}^\beta$$

Consumer Loans Market

$$1 + r_t^c = \frac{\tilde{\mu}_t^\alpha + \tilde{\mu}_t^\beta}{\tilde{l}_t^\theta}$$

REPO Market

$$1 + r_t^{IB} = \frac{\tilde{\mu}_t^\theta}{M_t}$$

Equilibrium

Decision Variables

$$\Sigma^\alpha = \left\{ \tilde{\mu}_t^\alpha, \tilde{b}_{2,t}^\alpha, v_t^\alpha, q_{1,t}^\alpha \right\}_t^\infty$$

$$\Sigma^\beta = \left\{ \tilde{\mu}_t^\beta, \tilde{b}_{1,t}^\beta, v_t^\beta, q_{2,t}^\beta \right\}_t^\infty$$

$$\Sigma^\theta = \left\{ \tilde{\pi}_t^\theta, \tilde{\mu}_t^\theta, \tilde{l}_t^\theta, v_t^\theta \right\}_t^\infty$$

Macroeconomic variables

$$\kappa = \left\{ M_t, \pi_t, r_t^c, r_t^{IB}, R_t, \tau_t^\alpha, \tau_t^\beta, \tau_t^\theta, \lambda_t^\alpha, \lambda_t^\beta \right\}_{t=0}^\infty$$

Variables being shocked

$$\varphi = \left\{ M_t, e_{1,t}^\alpha, e_{2,t}^\beta, \tau_t^\alpha, \tau_t^\beta, \tau_t^\theta, \lambda_t^\alpha, \lambda_t^\beta \right\}_{t=0}^\infty$$

Endogenous Variables

$$\left\{ \tilde{p}_{1,t}, \tilde{p}_{2,t}, r_t^c, r_t^{IB}, R_t, \tilde{\mu}_t^\alpha, \tilde{b}_{2,t}^\alpha, v_t^\alpha, q_{1,t}^\alpha, \eta_{1,t}^\alpha, \eta_{2,t}^\alpha, \tilde{\mu}_t^\beta, \tilde{b}_{1,t}^\beta, v_t^\beta, q_{2,t}^\beta, \eta_{1,t}^\beta, \eta_{2,t}^\beta, \tilde{\pi}_t^\theta, \tilde{\mu}_t^\theta, \tilde{l}_t^\theta, v_t^\theta, \eta_{1,t}^\theta, \eta_{2,t}^\theta \right\}_{t=0}^\infty$$

Parameters

$$\left(\bar{\eta}^{CB}, \bar{\lambda}^\alpha, \bar{\lambda}^\beta, \bar{\lambda}^\theta, \bar{e}_1^\alpha, \bar{e}_2^\beta, \beta, \hat{\beta}, \rho^{CB}, \rho_e^\alpha, \rho_e^\beta, \rho_e^\theta, \bar{M} \right)$$

Solution algorithm

- We write down the FOC.
- Using the equations, we find a version of the propositions
- We calibrate the parameters of the model and solve the steady state of the model.
- After the calibration, we recursively solve the path of the relevant variables.
- We shock the model, adding some policy measures and find out its effect on the relevant variables of the model.

Proposition 1: Money non-neutrality

This proposition implies that if there is a non-zero monetary operation by the Central Bank (i.e. $M_t \neq M_t' \Rightarrow r_t^c \neq r_t^{c'}$, from market clearing conditions), monetary policy is not neutral in the short-run. Therefore it affects the consumption and consequently real variables.

Suppose that for $\alpha, \beta \in H$, $b_t^h > 0$, for $l \in L$, $\lambda_t^h \in [0, 1)$ and some state of nature defined by the set of shocks at t . We have that at a **FSMLD**,

$$r_t^c \leq r_t^{c'}, \text{ and } \lambda_t^\alpha \geq \lambda_t^{\alpha'} \Rightarrow q_{1,t}^\alpha \geq q_{1,t}^{\alpha'}$$

Note that by symmetry the proposition holds also for household β .

Proposition 2: Fisher effect

Suppose that for $\alpha, \beta \in h$, $b_t^h > 0$, for $l \in L$, $\lambda_t^h \in [0, 1)$ and some state of nature defined by the set of shocks at t . We have that at a **FSMLD**, for agent α , we have,

$$\left(\frac{1}{1 - \lambda_t^\alpha} \left(\frac{\frac{\partial u(c_{1,t}^\alpha, c_{2,t}^\alpha)}{\partial c_{1,t}^h}}{\frac{\partial u(c_{1,t}^\alpha, c_{l,t}^\alpha)}{\partial c_{2,t}^\alpha}} \tilde{p}_{2,t} - \lambda_t^\alpha \right) \right)^{-1} = (1 + r_t^c) \quad (3)$$

whereas, for agent β , we have

$$\left(\frac{1}{1 - \lambda_t^\beta} \left(\frac{\frac{\partial u(c_{1,t}^\beta, c_{2,t}^\beta)}{\partial c_{2,t}^h}}{\frac{\partial u(c_{1,t}^\beta, c_{l,t}^\beta)}{\partial c_{1,t}^\beta}} \tilde{p}_{1,t} - \lambda_t^\beta \right) \right)^{-1} = (1 + r_t^c) \quad (4)$$

Taking logarithms and interpreting loosely, this proposition indicates that nominal **interest rates are approximately equal to real interest rates plus expected inflation and risk premium, which depends on liquidity and default**. Fisher effect explains how nominal prices are linked directly to consumption.

Proposition 3: Quantity theory of money

Assume no money is carried over. In an interior **FSMLD** equilibrium, $\forall t \in T$

$$(1 - \lambda_t^\alpha) \tilde{p}_{1,t} q_{1,t}^\alpha + (1 - \lambda_t^\beta) \tilde{p}_{2,t} q_{2,t}^\beta = M_t \quad (5)$$

Thus, the model possesses a non-trivial quantity theory of money, where prices and quantities are determined simultaneously.

Fisher's (1911) quantity theory of money proposition states,

$$P_t Q_t = M_t V_t \quad (6)$$

It implies that **money supply has a direct, proportional relationship with the price level**, where P_t stands for the price index, Q_t is an index of the real value of final expenditures, M_t is the total amount of money in circulation every period, and V_t is the average velocity of money in the market.

Proposition 4: On the verge condition

Suppose that for $\alpha, \beta \in H$, $b_t^h > 0$, for $l \in L$, $\lambda_t^h \in [0, 1)$ and some state of nature defined by the set of shocks at t . We have that at a **FSMLD**, the on-the-verge condition for default penalties, for agents α, β and bank θ , respectively, is given by

$$\frac{1}{1+r_t^c} \frac{\partial u(c_{1,t}^\alpha, c_{2,t}^\alpha)}{\partial c_{2,t}^\alpha} \frac{1}{\tilde{p}_{2,t}} = \beta \mathbb{E}_t \left(\frac{\tau_{t+1}^\alpha}{\pi_{t+1}} \right) \quad (7)$$

$$\frac{1}{1+r_t^c} \frac{\partial u(c_{1,t}^\beta, c_{2,t}^\beta)}{\partial c_{1,t}^\beta} \frac{1}{\tilde{p}_{1,t}} = \beta \mathbb{E}_t \left(\frac{\tau_{t+1}^\beta}{\pi_{t+1}} \right) \quad (8)$$

$$\frac{\partial u(\pi_t^\theta)}{\partial \pi_t^\theta} = \tau_t^\theta \quad (9)$$

These conditions imply that the optimal amount of default is defined when the marginal utility of defaulting equals the marginal dis-utility from incurring in default.

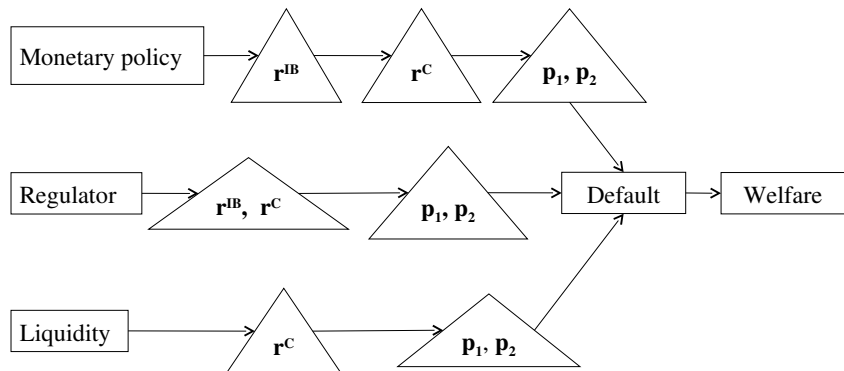
Calibration and Steady State

Parameter	Basic model	$\lambda^\alpha = 0.5, \lambda^\beta = 0.4$	$\lambda^\alpha = 0.5, \lambda^\beta = 0.5$
$\bar{\eta}^{CB}$	1	1	1
$\bar{\tau}^\alpha$	2.023	1.106	1.011
$\bar{\tau}^\beta$	2.023	1.121	1.011
$\bar{\tau}^\theta$	150	150	150
\bar{e}_1^α	2	2	2
\bar{e}_2^β	2	2	2
β^{CB}	0.97	0.97	0.97
$\hat{\beta}^{CB}$	0.98	0.98	0.98
ρ^{CB}	0.5	0.5	0.5
ρ_e^α	0.5	0.5	0.5
ρ_e^β	0.5	0.5	0.5
ρ_e^θ	0.5	0.5	0.5
\bar{M}	1	1	1



Variable	Basic model	$\lambda^\alpha = 0.5$	$\lambda^\alpha = 0.5$
		$\lambda^\beta = 0.4$	$\lambda^\beta = 0.5$
p_1	0.513	0.920	1.012
p_2	0.513	0.922	1.012
r^c	0.05	0.05	0.05
r^{IB}	0	0	0
R	0.952	0.953	0.952
μ^α	0.525	0.486	0.525
b_2^α	0.500	0.915	1.000
v^α	0.952	0.928	0.952
q_1^α	0.976	0.981	0.988
$\eta_{1\alpha}$	-1.94	-1.074	-0.982
$\eta_{2\alpha}$	-2.000	-1.093	-1.000
μ^β	0.525	0.563	0.525
b_1^β	0.500	0.902	1.000
v^β	0.952	0.974	0.952
q_2^β	0.976	0.992	0.988
η_1^β	-1.964	-1.088	-0.982
η_2^β	-2.000	-1.108	-1.000
Π^θ	0.007	0.007	0.007
μ^θ	1	1	1
l^θ	1	1	1
v^θ	0.993	0.993	0.993
η_1^θ	-150	-150	-150
η_2^θ	-143	-143	-143
M	1	1	1
e_1^α	2	2	2
e_2^α	2	2	2
τ^α	2.023	1.106	1.011
τ^β	2.023	1.121	1.011
τ^θ	150	150	150
η^{CB}	1	1	1
π	0.03	0.03	0.03

Transmission mechanism



Results overview

a) Asset Prices:

- i. $\Delta^{-\lambda} \rightarrow \Delta^{+r^c}$.
- ii. $\Delta^{+\tau} \rightarrow \Delta^{-r^c}$.

b) Inflation:

- i. Δ^{-M} , $\Delta^{+\tau}$ or $\Delta^{-\lambda} \rightarrow \Delta^{-\pi}$, but they overshoot in medium run.
- ii. The impact of household default penalties shocks on prices is reduced in liquid markets.

Results overview

c) Repayment rates:

- i. $\Delta^- M$, or $\Delta^- \lambda \rightarrow \Delta^- R$ (with a peak in the medium run).
- ii. $\Delta^+ \tau \rightarrow \Delta^+ R$ and $\Delta^+ v^\theta$ in the medium run, respectively.
- iii. Shocks have a reduced response in v^θ .
- iv. It is important to mention that bank repayment rate's response to shocks is asymmetric to liquidity and default penalty shocks depending on the liquidity of the goods of the agent shocked.

d) Welfare:

- i. $\Delta^- \lambda \rightarrow \Delta^- U^h$, for $h \in \{\alpha, \beta\}$
- ii. It is important to mention that bank utility response to shocks is asymmetric to liquidity and household default penalty shocks depending on the liquidity of the goods of the agent shocked.
- iii. Again, the effect of shock on the bank is much lower than in the household's utility case (e.g. a negative shock in M)

On resilience

- Resilience in this paper is considered as the ability of the economy to respond to shocks. It also could consider the speed of adjustment to shocks.
- We have just analyzed the response of the variables to shocks. In the case of speed of adjustment, one alternative is to try to calibrate the AR(1) parameter for all processes.
- We did not calibrate. Instead, we let the parameter to be the same across shocks. Still, we have found interesting interesting results.
- As an example, asset prices and financial stability (i.e. repayment rates) are more affected (magnitude) than price stability by monetary shocks. In the short run inflation respond to the negative shock in M by decreasing its level. However in the medium run, inflation as well as repayment rates follow a negative trajectory. That is, **inflation grows and repayment rates decrease in the medium run**. They adjust in the long run.
- There are more results to be analyzed in this context.



On resilience: Example inflation and repayments after a negative (5%) shock in M

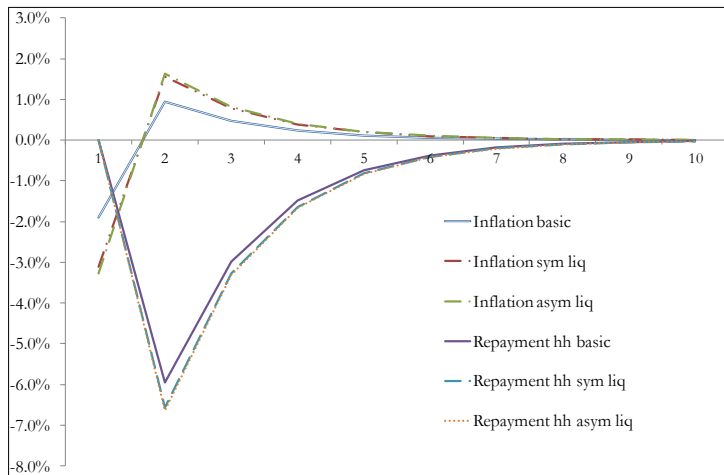


Figure: Inflation and Repayment rates after a negative monetary shock

Conclusions

- Our framework can assess financial and economic consequences of monetary and regulatory policy.
- Micro-founded financial frictions are included in the model.
- **Our results suggest that liquidity and default in equilibrium should be studied contemporaneously.**
- As a result, liquidity should be considered when designing metrics for financial stability.
- Possible extensions are: to micro-found liquidity of assets as a result of the endogenous interaction with the liquidity of goods or as the response of asymmetric information on the quality of the goods or assets. It also can be extended to address further questions.

Selected simulation results - Asset Prices

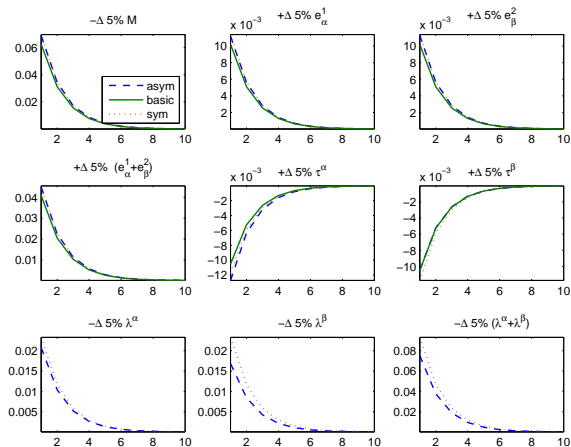


Figure: Impulse responses on commercial bank interest rate (r_t^C)

Selected simulation results - Inflation

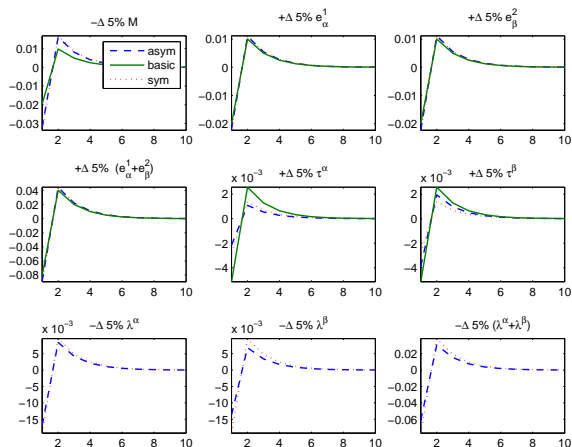


Figure: Impulse responses on inflation (π_t)

Selected simulation results - Repayment Rates

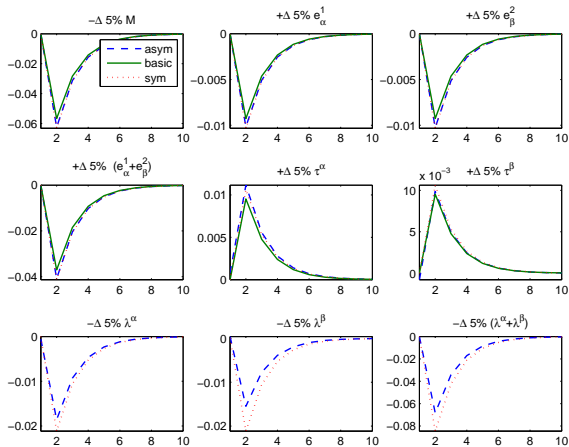


Figure: Impulse responses on average repayment rate (R_t)

Selected simulation results - Repayment Rates

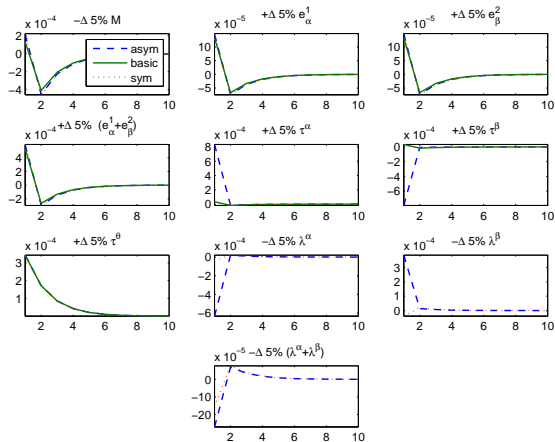


Figure: Impulse responses on commercial bank repayment rate (v_t^θ)

Selected simulation results - Welfare

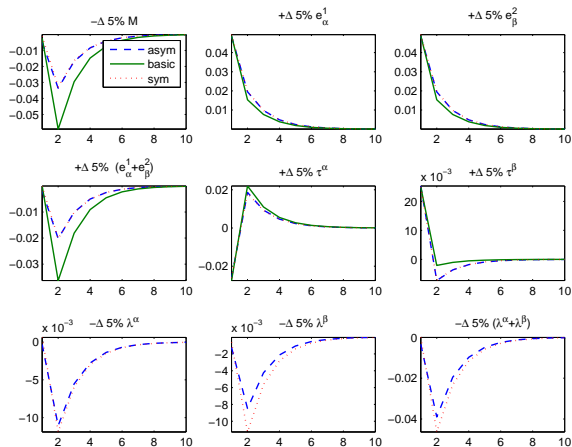


Figure: Impulse responses on utility of agent α (U_t^α)

Selected simulation results - Welfare

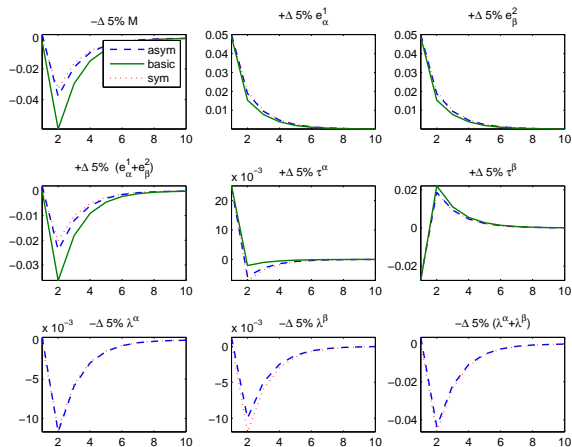


Figure: Impulse responses on utility of agent β (U_t^β)

Selected simulation results - Welfare

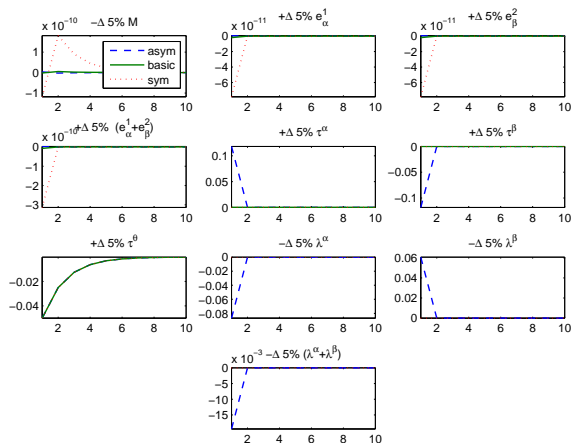


Figure: Impulse responses on utility of commercial bank $\theta(U_t^\theta)$