I would like to thank the organisers for the kind invitation to speak at this prestigious conference. I am delighted and honoured to be in such distinguished company.

The question I would like to address today is whether a more pluralistic international monetary system – one with more international currencies on a more equal footing – would enhance global monetary, financial and macroeconomic stability.

This is a perennial question. It was, for instance, just as prominent under the Bretton Woods system as under the arrangements that have followed – which some regard as a “non-system” (eg Padoa-Schioppa and Saccomanni (1994)). And it presupposes the answer to another, more fundamental, question: what is the Achilles heel of the international monetary and financial system (IMFS)?

Note that I am choosing my words carefully. For, the “financial” dimension is just as important as the “monetary” one, although the shorthand “international monetary system” is much more common. This tendency perhaps harks back to post-war arrangements in which, for quite some time, finance played a subordinated role owing to constraints on capital flows and foreign exchange transactions. As we all know, that world is long gone.

There are three takeaways from my presentation.

First, there is no doubt that the dominance of one currency creates challenges for the IMFS. Fundamentally, the domestic interests of the country of issue need not coincide with those of the system as a whole.

Second, it is less clear, though, whether a more pluralist system, even if it was achieved, could help address the IMFS’s main weakness. To my mind, that weakness is its inability to prevent the build-up and unwinding of hugely damaging financial imbalances, or outsize financial cycles, thereby amplifying weaknesses in national arrangements (Borio (2014a)). This is what, with a colleague, Piti Disyatat, we have termed its “excess (financial) elasticity” (Borio and Disyatat (2011)). Think of an elastic band that you can stretch out further and further but that, as a result, snaps back more violently.

Third, addressing this weakness would require stronger anchors at national and international level. Some progress has been made, especially at national level. But much more needs to be done.

In what follows, I will first recall some basic facts to illustrate the US dollar’s dominance in the IMFS. Here I will consider the dollar’s three familiar roles, as a means of payment, a store of value and a unit of account. I will then explore the possible problems that this can create and put forward three propositions. I will finally turn to possible solutions and make three observations.
Objectives

- Study the transmission channels of capital and liquidity regulations
  - Trade-offs, interactions, synergies/conflicts, general equilibrium (unintended?) effects

- Derive the net welfare gain from stacking multiple regulations on the top of each other
  - Optimal regulatory mix, guidance for the coordination of those regulations

- Quantitative dynamic deterministic general equilibrium model
Main Takeaways

1. Stacking liquidity regulation on the top of capital regulation improves welfare

2. Most of the time, tightening one regulation makes the other more effective. Tensions between the two regulations may arise, if there is a shortage of liquid assets in the economy

3. Quantitative insights:
   - Optimal regulatory mix: a 17% leverage ratio combined with a 12% liquidity ratio
   - The elasticity of capital requirements to liquidity requirements is -0.2
Model

Transaction Costs: \( \chi_{et} \), \( \chi_{dt} \), \( \chi_{st} \), \( \chi_{bt} \)

Success probability: \( \Omega_{te} \), \( \Omega_{td} \), \( \Omega_{st} \), \( \Omega_{bt} \)

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Model

Transaction Costs: $\chi^e_t, \chi^d_t, \chi^s_t, \chi^b_t$

Households $a_t$

Banks

Firms $x_t$

Government $\bar{s}$
Model

Transaction Costs: $\chi_t^e, \chi_t^d, \chi_t^s, \chi_t^b$

Success probability: $\Omega_t$

Households $a_t$

Banks

Firms $x_t$

Government $s_t$

Transaction Costs: $\chi_t^e, \chi_t^d, \chi_t^s, \chi_t^b$
Banking Sector

- **2nd stage decisions:**
  - Banks draw their individual financial intermediation skills, $q^\ell \in [0, 1]$
    - Firms that borrow from bank $q^\ell$ succeed with probability $q^\ell$
  - Banks invest $n_t \equiv d_t + e_t - s_t^b$
  - Interbank transactions help to migrate savings from low-$q^\ell$ to high-$q^\ell$ banks
  - Frictions on the interbank market:
    - Banks can divert cash for private benefit $\gamma$, and abscond
    - Skills $q^\ell$ are private information
The bank maximizes its expected profit:

\[
\max_{s_t^b, d_t, e_t} \Psi_{t-1,t} \int_0^1 \max_{\phi_t, 1_t} \left( r_t^s s_t^b - r_t^d d_t - r_t^e e_t + 1_t r_t^m n_t + (1 - 1_t) \left( q^\ell r_t^\ell (1 + \phi_t) - r_t^m \phi_t \right) n_t \right) d\mu(\ell) (q^\ell)
\]

s.t. the incentive compatibility constraint:

\[
\gamma (1 + \phi_t) n_t - r_t^e e_t \leq r_t^s s_t^b - r_t^d d_t - r_t^e e_t + r_t^m n_t
\]

→ Deposits are subject to moral hazard
The bank maximizes its expected profit:

$$\max_{s_t^b, d_t, e_t} \Psi_{t-1,t} \int_0^1 \max_{\phi_t, 1_t} \left( r_t^s s_t^b - r_t^d d_t - r_t^e e_t + 1_t r_m n_t + (1 - 1_t) (q^t r_t^\ell (1 + \phi_t) - r_t^m \phi_t) n_t \right) d\mu_\ell(q^t)$$

s.t. the incentive compatibility constraint:

$$\gamma (1 + \phi_t) n_t - r_t^e e_t \leq r_t^s s_t^b - r_t^d d_t - r_t^e e_t + r_t^m n_t$$

→ The opportunity cost of absconding increases with the interbank rate
**Banking Sector**

The bank maximizes its expected profit:

$$\max_{s^b_t, d_t, e_t, \phi_t, \gamma_t} \Psi_{t-1,t} \int_0^1 \max_{\phi_t, \gamma_t} \left( r^s_t s^b_t - r^d_t d_t - r^e_t e_t + \mathbb{1} r^m_t n_t + (1 - \mathbb{1}_t) (q^\ell r^\ell_t (1 + \phi_t) - r^m_t \phi_t) n_t \right) d\mu(q^\ell)$$

s.t. the incentive compatibility constraint:

$$\gamma(1 + \phi_t)n_t - r^e_t e_t \leq r^s_t s^b_t - r^d_t d_t - r^e_t e_t + r^m_t n_t$$

→ Deposits are subject to moral hazard
The bank maximizes its expected profit:

$$\max_{s_t^b, d_t, e_t} \psi_{t-1,t} \int_0^1 \max_{\phi_t, \ell_t} \left( r_t^s s_t^b - r_t^d d_t - r_t^e e_t + \mathbb{1}_t r_t^m n_t + (1 - \mathbb{1}_t) \left( q^\ell r_t^\ell (1 + \phi_t) - r_t^m \phi_t \right) n_t \right) \, d\mu(\ell)$$

s.t. the incentive compatibility constraint:

$$\gamma(1 + \phi_t) n_t - r_t^e e_t \leq r_t^s s_t^b - r_t^d d_t - r_t^e e_t + r_t^m n_t$$

→ Equity is not subject to moral hazard
The bank maximizes its expected profit:

$$\max_{s^b_t,d_t,e_t} \Psi_{t-1,t} \int_0^1 \max_{\phi_t,1_t} \left( r_s^b s^b_t - r^d_t d_t - r^e_t e_t + 1_t r^m_t n_t + (1 - 1_t) (q^\ell t^e_t (1 + \phi_t) - r^m_t \phi_t) n_t \right) d\mu^e (q^\ell)$$

s.t. the incentive compatibility constraint:

$$\gamma (1 + \phi_t) n_t - r^e_t e_t \leq r^s_t s^b_t - r^d_t d_t - r^e_t e_t + r^m_t n_t$$

→ Government bonds are seizable (i.e. they are “liquid”)
- High-\(q^\ell\) banks' interbank funding:

\[
\phi_t = \frac{r^d_t \frac{e_t}{d_t+e_t} + \left( r^s_t - r^m_t \right) \frac{s^b_t}{d_t+e_t} + r^m_t - r^d_t}{\gamma \left( 1 - \frac{s^b_t}{d_t+e_t} \right)} - 1
\]
Externalities and Capital Regulation

- High-\( q^\ell \) banks' interbank funding:

\[
\phi_t = \frac{r^d_t \frac{e_t}{d_t+e_t} + (r^s_t - r^{m*}_t) \frac{s^b_t}{d_t+e_t} + r^{m*}_t - r^d_t}{\gamma \left( 1 - \frac{s^b_t}{d_t+e_t} \right)} - 1
\]

- Pecuniary externalities:

\[
\frac{d\phi_t}{d \left( \frac{e_t}{d_t+e_t} \right)} = \frac{\partial\phi_t}{\partial \left( \frac{e_t}{d_t+e_t} \right)} + \frac{\partial\phi_t}{\partial r^{m*}_t} \times \frac{\partial r^{m*}_t}{\partial \Phi_t} \times \frac{\partial\Phi_t}{\partial \left( \frac{E_t}{D_t+E_t} \right)}
\]
Externalities and Capital Regulation

- High-$q^\ell$ banks' interbank funding:

$$
\phi_t = \frac{\frac{r^d_t e_t}{d_t + e_t} + (r^s_t - r^m_t) \frac{s^b_t}{d_t + e_t} + r^m_t - r^d_t}{\gamma \left(1 - \frac{s^b_t}{d_t + e_t}\right)} - 1
$$

- Pecuniary externalities:

$$
\frac{d\phi_t}{d \left(\frac{e_t}{d_t + e_t}\right)} = \frac{\partial \phi_t}{\partial \left(\frac{e_t}{d_t + e_t}\right)} + \frac{\partial \phi_t}{\partial r^m_t} \times \frac{\partial r^m_t}{\partial \Phi_t} \times \frac{\partial \Phi_t}{\partial \left(\frac{E_t}{D_t + E_t}\right)}
$$

\[\Rightarrow \] Regulatory capital constraint: \(\frac{e_t}{d_t + e_t} \geq \tau_C\)
Externalities and Liquidity Regulation

- High-\(q^\ell\) banks' interbank funding:

\[
\phi_t = \frac{r^d_t e_{t_d} + (r^s_t - r^m_{t*}) \frac{s^b_t}{d_{t+e_t}} + r^m_{t*} - r^d_t}{\gamma(1 - \frac{s^b_t}{d_{t+e_t}})} - 1
\]

- Pecuniary externalities:

\[
\frac{d\phi_t}{d\left(\frac{s^b_t}{d_{t+e_t}}\right)} = \frac{\partial \phi_t}{\partial \left(\frac{s^b_t}{d_{t+e_t}}\right)} + \frac{\partial \phi_t}{\partial r^m_{t*}} \times \frac{\partial r^m_{t*}}{\partial \Phi_t} \times \frac{\partial \Phi_t}{\partial \left(\frac{S^b_t}{D_{t+E_t}}\right)}
\]

\[\implies\] Regulatory liquidity constraint: \(\frac{s^b_t}{d_{t+e_t}} \geq \tau_L\)
Liquidity regulation “mechanically” reduces the volume of risky assets per unit of equity

\[
\frac{\partial^2 \phi_t}{\partial \left( \frac{e_t}{d_t+e_t} \right) \partial \left( \frac{s^b_t}{d_t+e_t} \right)} > 0
\]

\[\implies \text{In this sense, liquidity and capital requirements mutually reinforce each other}\]
Figure 1: Banks’ Leverage Ratio with Liquidity Requirements (at SS)
Tensions: General Equilibrium Effects and Portfolio Re-balancing

Bank balance sheet

<table>
<thead>
<tr>
<th>Ass.</th>
<th>Lia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n_t$</td>
<td>$e_t$</td>
</tr>
</tbody>
</table>

$\uparrow s_t^b \quad \uparrow d_t \quad s_t^b + s_t^h = \bar{s}$

Household balance sheet

<table>
<thead>
<tr>
<th>Ass.</th>
<th>Lia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$e_t$</td>
<td>$d_t$</td>
</tr>
</tbody>
</table>

$\uparrow d_t \quad \downarrow s_t^h \quad b_t$
Figure 2: Regulatory Frontiers ("Best Response Functions")
# Steady State Welfare Gains

<table>
<thead>
<tr>
<th>Perm. cons. gain (%)</th>
<th>Regulation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. St.</td>
<td>τ_C</td>
</tr>
<tr>
<td>Incl. Transition</td>
<td></td>
</tr>
<tr>
<td>NR → ORM</td>
<td>0.6591</td>
</tr>
<tr>
<td></td>
<td>17.35</td>
</tr>
</tbody>
</table>

**Note:** NR → ORM: Permanent Consumption gain (in percent) from the non-regulated (NR) economy to the economy with the optimal regulatory mix (ORM).
Other Points of Discussion in the Paper

- Risk–weighted capital requirements can improve welfare almost as much as both leverage and liquidity requirements combined.

- The leverage ratio is useful as a backstop if banks mis–report their risk–weights by more than 12%.

- Financial dis–intermediation acts as a “safety valve”, and reduces the cost of regulations.

- Regulation reduces banks’ total cost of funding.

- Sterilization of liquidity requirements.
THANK YOU
### Risk–weighted Capital Requirements

#### Bank balance sheet

<table>
<thead>
<tr>
<th>Ass.</th>
<th>Lia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>([risky] cash) $n_t$</td>
<td>$d_t$ (deposits)</td>
</tr>
<tr>
<td>(gvt bonds) $s^b_t$</td>
<td>$e_t$ (equity)</td>
</tr>
</tbody>
</table>

#### Leverage:

$$\frac{e_t}{d_t + e_t} \geq \tau_C$$

#### Liquidity:

$$\frac{s^b_t}{d_t + e_t} \geq \tau_L$$

#### RW capital:

$$\frac{e_t}{n_t} \equiv \frac{e_t}{d_t + e_t} \frac{s^b_t}{d_t + e_t} \geq \tau_W$$
# Risk–weighted Capital Requirements

## Table 1: Welfare Analysis

<table>
<thead>
<tr>
<th>Perm. cons. gain (%)</th>
<th>Regulation (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\tau_W$</td>
<td>$\tau_C$</td>
</tr>
<tr>
<td>NR $\rightarrow$ RW</td>
<td>0.6576</td>
<td>19.81</td>
</tr>
<tr>
<td>NR $\rightarrow$ ORM*</td>
<td>0.6591</td>
<td>19.83</td>
</tr>
<tr>
<td>RW $\rightarrow$ ORM*</td>
<td>0.0014</td>
<td></td>
</tr>
</tbody>
</table>

Note: NR $\rightarrow$ RW: Permanent Consumption gain (in percent) from the non-regulated (NR) economy to the economy with the risk–weighted capital requirements (RW). RW $\rightarrow$ ORM: Permanent Consumption gain (in percent) from the risk–weighted capital requirements (RW) economy to the economy with optimal regulatory mix (ORM). $\star \tau_W \equiv \tau_C / (1 - \tau_L)$. 


Dis–intermediation as a Safety Valve

Households $a_t$ → Banks $m_t$ → Firms $x_t$

Households $a_t$ → Government $\bar{s}$ → Banks $m_t$ → Firms $x_t$

Government $\bar{s}$ → Banks $m_t$ → Firms $x_t$

$e_t, d_t$ → Banks $m_t$ → Firms $x_t$
<table>
<thead>
<tr>
<th>Permanent Consumption Gain (%)</th>
<th>Regulation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR → ORM+TCBR</td>
<td>0.6604</td>
</tr>
<tr>
<td>ORM → ORM+TCBR</td>
<td>0.0013</td>
</tr>
<tr>
<td></td>
<td>$\tau_C$</td>
</tr>
<tr>
<td></td>
<td>17.38</td>
</tr>
<tr>
<td></td>
<td>$\tau_L$</td>
</tr>
<tr>
<td></td>
<td>12.55</td>
</tr>
<tr>
<td></td>
<td>$\tau_B$</td>
</tr>
<tr>
<td></td>
<td>-0.33</td>
</tr>
</tbody>
</table>

**Note:** NR → ORM+TCBR: Permanent Consumption gain (in percent) from the non-regulated (NR) economy to the economy with both the optimal regulatory mix and the tax on corporate bond revenues (OMR+TCBR). ORM → ORM+TCBR: Permanent Consumption gain (in percent) from the economy with the optimal regulatory mix (ORM) to the economy with both the optimal regulatory mix and the tax on corporate bond revenues (OMR+TCBR).
Note: Transition path from the unregulated to the regulated equilibrium.
## Costs of Funding

<table>
<thead>
<tr>
<th>in pp</th>
<th>$r_t^e - r_t^m$</th>
<th>$r_t^d - r_t^m$</th>
<th>$r_t^f - r_t^m$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Regulated</td>
<td>10.72</td>
<td>0.00</td>
<td>0.73</td>
</tr>
<tr>
<td>Optimal Regulation</td>
<td>14.49</td>
<td>-2.44</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Note: $r_t^f \equiv \left( r_t^e e_t + r_t^d d_t + r_t^m (1 - \mu(\bar{q}_t)) \phi_t n_t \right) / \left( e_t + d_t + (1 - \mu(\bar{q}_t)) \phi_t n_t \right)$

denotes the representative bank’s overall cost of funding.
The Credit Quality Channel of Banking Regulation

Unreg. economy

Firms

Low quality banks

High quality banks

Household

$r_t^{m*}$

$q^e$

$r_t^e$
The Credit Quality Channel of Banking Regulation

Firms

Low quality banks

High quality banks

Household

\( r_t^m / r_t^\ell \)
The Credit Quality Channel of Banking Regulation

Firms

Low quality banks

High quality banks

Household

$q^\ell$

$r_t^m$, $r_t^{m*}$, $\tilde{r}_t^m$, $\tilde{r}_t^{m*}$
A competitive general equilibrium is:

- A sequence of prices \( \mathcal{P}_t \equiv \{r_{t+i}^s, r_{t+i}^m, r_{t+i}^d, \tilde{r}_{t+i}^b, \tilde{r}_{t+i}^\ell, r_{t+i}^e, w_{t+i}, \rho_{t+i}, p_{t+i}^x \}_{i=0}^\infty; \)
- A sequence of quantities \( \mathcal{Q}_t \equiv \{y_{t+i}, c_{t+i}, i_{t+i}, x_{t+i}, k_{t+i}, h_{t+i}, \tilde{a}_{t+i}, d_{t+i}, e_{t+i}, s_{t+i}^h, b_{t+i}, s_{t+i}^b, \ell_{t+i} \}_{i=0}^\infty \)

such that:

- For a given sequence of prices \( \mathcal{P}_t \), quantities \( \mathcal{Q}_t \) solve agents’ optimization problems
- For a given sequence of quantities \( \mathcal{Q}_t \), prices \( \mathcal{P}_t \) clear the markets.
Timeline

1. The government issues debt $\bar{s}$. Firms produce, pay the wages, pay the rent of physical capital, pay their debts; and die. Banks pay their debts, distribute dividends; and die.

2. The household consumes $c_t$, invests into $i_t$ units of physical capital goods, and saves $\bar{a}_{t+1}$.

3. The goods market clears and closes.

4. Household members draw their financial skills ($q_s^h, q_b^h, q_d^h, q_e^h$) and invest $\bar{a}_{t+1}$ into sovereign bonds $s^h_{t+1}$, corporate bonds $b_{t+1}$, bank deposits $d_{t+1}$, and bank equity $e_{t+1}$.

5. New banks are born and demand sovereign bonds, $s^h_{t+1}$, deposits, $d_{t+1}$, and equity $e_t$.

6. The sovereign bond, deposit, and equity markets clear and close.

7. Period $t + 1$ starts. New firms are born and issue corporate bonds $b_{t+1}$. Household members purchase corporate bonds. Bankers draw intermediation skills $q^\ell$, and invest $d_{t+1} + e_{t+1} - s^b_{t+1}$ into corporate loans, $\ell_{t+1}$, and interbank loans, $m_{t+1}$.

8. Firms hire labour $h_{t+1}$, rent physical capital $k_{t+1}$, demand loans $l_{t+1}$, and purchase material goods, $x_{t+1}$.

9. The markets for labour, capital goods, material goods, corporate bonds, corporate loans, and interbank loans clear and close.
Calibration

- Unregulated economy
- Standard for the real sector
- Nine financial parameters and nine financial variables to match:
  - Two interest rates (interbank, corporate loan)
  - Five balance sheet ratios (households and banks)
  - Proportion on non–performing loans
1. $r^m = r^d = r^s = 1.0167$. The real returns on interbank loans, deposits, and government bonds match the Federal Fund Rate, and are equal to 1.67%;

2. $\tilde{r}^b = 1.0465$. The contractual real corporate bond yield matches Moody’s 3–month Seasoned Baa Corporate Bond Yield and is equal to 4.65%;

3. $e/d = 0.1190$. Banks’ equity to deposit ratio is equal to 11.90%;

4. $b/a = 0.0658$. The share of corporate bond holding in households’ financial wealth is equal to 6.58%;

5. $s^h/a = 0.0910$. The share of sovereign bonds in households’ financial wealth is equal to 9.10%;

6. $d/\ell = 1.0310$. The bank deposit to loan ratio is equal to 103.10%.

7. $\phi n/d = 1.7086$. The ratio of no–core liabilities to core liabilities is equal to 170.86%;

8. $\Omega = 0.9841$. The proportion of non–performing loans is 1.58%.
Table 2: Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply of sovereign bonds $\bar{s}$</td>
<td>$0.131$</td>
</tr>
<tr>
<td>Private benefits $\gamma$</td>
<td>$0.045$</td>
</tr>
<tr>
<td>Distribution $- \mu_d(q^d)$ $\lambda^d$</td>
<td>$456.341$</td>
</tr>
<tr>
<td>Distribution $- \mu_e(q^e)$ $\lambda^e$</td>
<td>$0.967$</td>
</tr>
<tr>
<td>Distribution $- \mu_b(q^b)$ $\lambda^b$</td>
<td>$5.062$</td>
</tr>
<tr>
<td>Distribution $- \mu_{sh}(q^{sh})$ $\lambda^{sh}$</td>
<td>$55.128$</td>
</tr>
<tr>
<td>Distribution $- \mu_\ell(q^\ell)$ $\lambda^\ell$</td>
<td>$0.387$</td>
</tr>
<tr>
<td>$Lower \ bound$ $\theta$</td>
<td>$0.959$</td>
</tr>
</tbody>
</table>
\[ \mu_j(q) = (q)^{\lambda_j} \]

- \( \mu_e(q) \)
- \( \mu_b(q) \)
- \( \mu_{sh}(q) \)
- \( \mu_d(q) \)
Welfare Effect of Regulations

Figure 3: Welfare Effect of Regulations

Welfare when the regulator imposes a liquidity requirement $\tau_L$ only (left panel) or a capital requirement $\tau_C$ (right panel) only.
Leverage Ratio as a Backstop: Welfare Gains

- Banks may mis-report their risk-weights (IRB approaches) and undermine risk-weighted capital regulation

- \[ \frac{e_t}{\xi n_t} \geq \tau_W \] instead of \[ \frac{e_t}{n_t} \geq \tau_W, \] with \( \xi \in [0, 1) \)

- What is the welfare gain of using a leverage ratio as a backstop?

- Compare welfare with \((\tau_W, \tau_C)\) and welfare with \((\tau_W, \cdot)\)
Leverage Ratio as a Backstop: Welfare Gains

The risk-weighted capital constraint (RWCC) binds, with or without backstop.

The RWCC is slack with or without backstop.

The RWCC binds without backstop, but is slack with the backstop.
Related Literature

- **Link between finance and aggregate productivity**
  - Finance and growth literature (Greenwood and Jovanovic (1990); Greenwood et al. (2013); Hsieh and Klenow (2009))
  - Venture capital and relationship lending literature: VCs/banks improve firm productivity with market knowledge, strategic planning, mentoring, etc (Kortum and Lerner (2000); Hellman and Puri (2000), Bolton et al. (2016))
  - Allocative efficiency and the recent crisis (Gopinath et al. (2015); Cuñat and Garicano (2009))

- **Macroeconomic models with financial frictions**
  - Frictions between banks and depositors (Gertler and Karadi (2012), Martinez-Miera and Suarez (2014))
  - Frictions on wholesale funding markets (Boissay, Collard, Smets (2016))

- **Banking regulation in macroeconomic models**
  - Capital requirements only (Clerc et al. (2015); Begeneau (2015))
Households and Firms

- **Households:**

\[
\begin{cases}
\max_{\{c_t, h_t, i_t\}} \sum_{s=0}^{\infty} \beta^s \mathbb{E}_q \left[ \max_{\{d_{t+1}, e_{t+1}, s_{t+1}^h, b_{t+1}\}} \left( u(c_{t+s}) - v(h_{t+s}) \right) \right] \\
\text{s.t.: } c_t + i_t + d_{t+1} + e_{t+1} + s_{t+1}^h + b_{t+1} + \chi_t^d + \chi_t^e + \chi_t^s + \chi_t^b = r_t^d d_t + r_t^e e_t + r_t^s s_{t+1}^h + r_t^b b_t + \rho_t k_t + w_t h_t + \Pi_t - T_t
\end{cases}
\]

- **Firms:**

\[
\begin{cases}
\max_{k_t, h_t, x_t, b_t, l_t} \pi_t^f \equiv \Omega_t \left( x_t \right) \\
\text{s.t.: } l_t + b_t = x_t
\end{cases}
\]
\[ x_t = \frac{1}{\varsigma} f(k_t, h_t) \]  \hspace{1cm} (1)

\[ \tilde{r}_t^\ell = \tilde{r}_t^b \]  \hspace{1cm} (2)

\[ x_t = l_t + b_t \]  \hspace{1cm} (3)

\[ \tilde{\rho}_t = \left( z - \frac{\tilde{r}_t^\ell p^x_t}{\varsigma} \right) f'_k(k_t, h_t) \]  \hspace{1cm} (4)

\[ \tilde{w}_t = \left( z - \frac{\tilde{r}_t^\ell p^x_t}{\varsigma} \right) f'_h(k_t, h_t). \]  \hspace{1cm} (5)

Note: \[ \rho_t \equiv \Omega_t \tilde{\rho}_t ; \quad r_t^b \equiv \Omega_t \tilde{r}_t^b ; \quad w_t \equiv \Omega_t \tilde{w}_t. \]
- **2\textsuperscript{nd} Stage**: Household member with draw \((q^d, q^e, q^s^h, q^b) \in [0, 1]^4\) gets net unit returns \(q^d r^d_t, q^e r^e_t, q^s^h r^s_t,\) and \(q^b r^b_t,\) and invests in \(d_t\) if

\[
q^d r^d_{t+1} > q^j r^j_{t+1} \forall j \neq d
\]

- **1\textsuperscript{st} Stage**: Representative household works, invests, and saves

\[
v'(h_t) = u'(c_t)w_t
\]

\[
\Psi_{t,t+1} r_{t+1} = 1, \text{ where } \Psi_{t,t+1} = \beta \frac{u'(c_{t+1})}{u'(c_t)}
\]

\[
r_{t+1} = \rho_{t+1} + 1 - \delta
\]
1st Stage solution: Choice of $d_t$, $e_t$, and $s_t^b$:

\[
\begin{align*}
    r_t^s &= r_t^m \\
    r_t^d &= r_t^m \\
    r_t^e &= (1 + \Delta_t)r_t^d
\end{align*}
\]

Equity frees up borrowing capacity ex post ("Shadow value of equity")
2\textsuperscript{nd} Stage solution: Choice of $\mathbb{I}_t$ and $\phi_t$ knowing $q^\ell$:

Bank $q^\ell$ borrows funds ($\mathbb{I}_t = 0$) iff $q^\ell > q^\ell_t \equiv \frac{r^m_t}{r^\ell_t}$, and lends otherwise \hfill (6)

and

$$\phi_t = \frac{r^s_t s^b_t - r^d_t d_t + r^m_t n_t}{\gamma n_t} - 1$$