Bond Finance, Bank Credit, and Aggregate Fluctuations in an Open Economy

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Extremely preliminary
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Motivation

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- Shin (2013): new phase in global liquidity, with a broader change in the way private corporations fund themselves, where traditional bank financing is substituted with increased funding through capital markets.
Corporate debt in Latin America, bln USD

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- What is the role of net worth (both of firms and of financial intermediaries)?

- How does the observed growing reliance on debt issuance interact with the business cycle?
This Paper

- Builds a model where firms can borrow directly (bond issuance) or with the participation of intermediaries (bank finance) in world capital markets.

Extends the static, partial equilibrium framework of Holmström-Tirole (1997), into a dynamic stochastic small open economy framework.

We then use this framework to study the dynamic behavior of both direct and indirect finance when unexpected shocks occur. Particularly, a large and persistent drop in world interest rates.
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- Particularly, a large and persistent drop in world interest rates.
Main Results (for now)

The model can generate an increase in both direct and indirect finance following a drop in world interest rates.

A key driver: evolution of net worth. As their net worth builds up, firms are able to access more (cheaper) direct finance. Access to (more costly) indirect finance also increases because some firms, that were previously absent from the market due to their low net worth, now have enough equity to participate in credit markets. As in HT, the net worth of banks can substitute for the net worth of firms, and its evolution is critical for dynamics.
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  - Final good producers
  - Households
  - Financial intermediaries (banks)
  - Foreigners
  - Holdings of investment good producers
Usual, competitive sector, with production function

\[ Y_t = A_t K_t^\alpha H_t^{1-\alpha} \]

Cost minimization:

\[ \alpha Y_t = r_t^K K_t \]
\[ (1 - \alpha) Y_t = w_t H_t \]
Households

- Households own productive factors, including capital
- Capital accumulation is subject to adjustment costs:

\[ K_{t+1} = (1 - \delta)K_t + X_t - \frac{\varphi}{2}K_t \left( \frac{K_{t+1}}{K_t} - 1 \right)^2 \]
Budget constraint:

\[ C_t + Q_t X_t + B_{t+1} = w_t H_t + r_t^K K_t + \Psi_t R^*_t B_t \]

where

\[ \Psi_t = \Psi - \phi(e^\bar{B} - B - 1) \]

Note that the price of investment goods (new capital), \( Q_t \), is variable
Optimal Labor Supply

- Preferences are GHH

- Labor supply only depends on the wage:

\[ w_t = \kappa H_t^{\tau-1} \]
The FOC for savings is standard:

\[
\lambda^c_t = \beta^h E_t \left( \lambda^c_{t+1} \Psi_{t+1} R^*_{t+1} \right)
\]

with

\[
\lambda^c_t = \left( C_t - \kappa \frac{H^\tau}{\tau} \right)^{-\sigma}
\]
Capital accumulation is given by the Euler equation

\[
Q_t \left[ 1 + \varphi \left( \frac{K_{t+1}}{K_t} - 1 \right) \right] = \beta h E_t \frac{\lambda_{t+1}^c}{\lambda_t^c} \left[ r_{t+1}^K + Q_{t+1} (1 - \delta) + \varphi \left( \frac{K_{t+2}}{K_{t+1}} - 1 \right) \frac{K_{t+2}}{K_{t+1}} - \frac{\varphi}{2} \left( \frac{K_{t+2}}{K_{t+1}} - 1 \right)^2 \right]
\]

This would be a standard model if \( Q_t \equiv 1 \)
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A representative holding arrives to period $t$ with equity $K_t^f$
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The holding’s equity is then split: a firm $i$ is given equity $A_t^i$, according to some distribution $G_t(\cdot) = G(A; \mu_t)$, so that

$$K_t^f = \int_0^\infty A_t^i dG_t(A_t^i)$$
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Each firm $i$ is charged with financing and executing a project, which takes $l_t$ units of the final good as input, and returns a random amount of new capital goods.
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Each firm $i$ is charged with financing and executing a project, which takes $I_t$ units of the final good as input, and returns a random amount of new capital goods.

The size of the investment project, $I_t$, is chosen by the manager of the holding and common to every firm.
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Need finance, but there is moral hazard problem

If project is executed, it returns $Rl_t$ with probability $p_H$ and zero otherwise
Typical Firms’s Problem

- Follow HT (1997): consider a firm with $A^i_t < I_t$
- Need finance, but there is moral hazard problem
- If project is executed, it returns $Rl_t$ with probability $p_H$ and zero otherwise
- But, to gain a private benefit $B$, the firm can choose a ”bad” project that reduces success probability to $p_L < p_H$
Incentive Compatibility Constraint (ICC):

\[ p_H R_{t,i}^f \geq p_L R_{t,i}^f + B_l_t \]

or, with \( \Delta = p_H - p_L \),

\[ R_{t,i}^f \geq \frac{B_l_t}{\Delta} \]
• Incentive Compatibility Constraint (ICC):

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• Lenders’ Participation Constraint:

\[ p_H (Q_t R_l_t - R_t^{f,i}) \geq l_t - A_t^i \]
Conditions for Direct Finance

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- Lenders’ Participation Constraint:
  \[ p_H (Q_t R l_t - R^{f,i}_t) \geq I_t - A^i_t \]

- Combining the two:
  \[ A^i_t \geq \bar{A}_t = l_t \left[ 1 - p_H (Q_t R - \frac{B}{\Delta}) \right] \]
If a firm $j$ does not have enough equity, it can seek the help of financial intermediaries or "banks"
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A bank can reduce the private benefit of the bad project to $b < B$ at a cost $c_l_t$. 
ICC for firm $j$:

$$p_H R_{t}^{f,j} \geq p_L R_{t}^{f,j} + b l_t$$
Conditions for Bank Finance

- ICC for firm $j$:

$$p_H R^f_{t,j} \geq p_L R^f_{t,j} + bI_t$$

- ICC for bank:

$$p_H R^m_{t,j} - cI_t \geq p_L R^m_{t,j}$$

so $R^m_{t,j} \equiv R^m_t$
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- ICC for bank:
  \[ p_H R_t^{m,j} - c l_t \geq p_L R_t^{m,j} \]
  so $R_t^{m,j} \equiv R_t^m$

- Outsiders’ participation constraint:
  \[ p_H (Q_t R_l - R_t^{f,j} - R_t^{m,j}) \geq I_t - I_t^{m,j} - A_t^j \]
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  \[ p_H (Q_t R_l - R_{t}^{f,j} - R_{t}^{m,j}) \geq I_t - I_{t}^{m,j} - A_t^j \]

- Bank’s participation constraint:
  \[ p_H R_t^m \geq \beta_t I_{t}^{m,j} \]
  so $I_{t}^{m,j} \equiv I_t^m$
Combining, firm $j$ will have access to bank finance if it has enough equity: $A^j_t \geq A_t$, where

$$A_t = l_t \left[ 1 - p_H \frac{c}{\Delta \beta_t} - p_H \left( Q_t R - \frac{b + c}{\Delta} \right) \right]$$
Project Size

The holding’s manager chooses $I_t$ to maximize profits:

$$
\Pi_t^f = p_H Q_t R I_t \left[ 1 - G_t(A_t) \right] + \int_0^A A_t d G_t (A_t) \\
- \int_{A_t}^\infty (I_t - A_t) d G(A_t) - \int_{A_t}^{\bar{A}_t} \left( I_t - p_H \frac{c I_t}{\Delta \beta_t} - A_t \right) d G(A_t) \\
- p_H \frac{c I_t}{\Delta} \left[ G(\bar{A}_t) - G(A_t) \right]
$$
We have assumed that $G_t(A) = G(A; \mu_t)$ for some parameter $\mu_t$. In particular, if

$$A_t^i = K_t^f z_t^i$$

where $z_t^i$ is i.i.d. across agents and time, with cdf $F(z)$, mean one, and some variance

$$G_t(A) = \Pr \{ A_t^i \leq A \} = \Pr \{ K_t^f z_t^i \leq A \} = F \left( \frac{A}{K_t^f} \right) \equiv G(A; \mu_t)$$

For $G_t(.)$ to be lognormal with mean $\mu_t$ and variance $\sigma_G^2$,

$$\mu_t = \log K_t^f - \frac{\sigma_G^2}{2}$$
The FOC’s are:

\[(p_H Q_t R - 1) [1 - G_t (A_t)] - p_H \frac{c}{\Delta \beta_t} (\beta_t - 1) [G(\bar{A}_t) - G(A_t)]\]

\[= \lambda_{1t} \left[1 - p_H (Q_t R - \frac{B}{\Delta})\right] + \lambda_{2t} \left[1 - p_H \frac{c}{\Delta \beta_t} - p_H \left(Q_t R - \frac{b + c}{\Delta}\right)\right]\]

with

\[\lambda_{1t} = g_t(\bar{A}_t) I_t p_H \frac{c}{\Delta \beta_t} (\beta_t - 1)\]

\[\lambda_{2t} = g_t(A_t) I_t \left[p_H Q_t R - 1 - p_H \frac{c}{\Delta \beta_t} (\beta_t - 1)\right]\]
Temporary Equilibrium

- $\beta_t$ adjusts to equate demand for bank equity to its supply:

$$K_t^m = p_H \frac{c_l_t}{\Delta \beta_t} [G(\bar{A}_t; \mu_t) - G(A_t; \mu_t)]$$

The price of new capital, $Q_t$, adjusts to clear the new capital market:

$$X_t = p_H R I_t [1 - G(A_t; \mu_t)]$$
Temporary Equilibrium

- $\beta_t$ adjusts to equate demand for bank equity to its supply:

$$K^m_t = p_H \frac{cl_t}{\Delta \beta_t} \left[ G(\bar{A}_t; \mu_t) - G(A_t; \mu_t) \right]$$

- The price of new capital, $Q_t$, adjusts to clear the new capital market:

$$X_t = p_H R l_t \left[ 1 - G(A_t; \mu_t) \right]$$
Banks’ equity:

\[ K_{t+1}^m = \theta^m p_H \frac{c_l_t}{\Delta} [ G(\bar{A}_t; \mu_t) - G(A_t; \mu_t) ] \]
Dynamics of Equity

- Banks’ equity:

\[ K_{t+1}^m = \theta^m p_H \frac{cl_t}{\Delta} [G(\bar{A}_t; \mu_t) - G(A_t; \mu_t)] \]

- Holding’s (capital producers’) equity:

\[
K_{t+1}^f = \theta^f \Pi_t \\
= \theta^f \left\{ K_t^f + (p_H Q_t R - 1) l_t \left[ 1 - G(A_t; \mu_t) \right] - p_H \frac{cl_t}{\Delta \beta_t} (\beta_t - 1) \right\}
\[
\left[ G(\bar{A}_t; \mu_t) - G(A_t; \mu_t) \right]
\]
An important aspect of the parameterization concerns the distribution of equity supply which is assumed to be

\[ G(A; \mu) = 0.4 \]
\[ G(\bar{A}; \mu) = 0.8 \]
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi$</td>
<td>Cost of capital adjustment</td>
<td>4.602</td>
</tr>
<tr>
<td>$\Psi$</td>
<td>Risk premium elasticity</td>
<td>0.001</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Rate of return to bank equity</td>
<td>1.042</td>
</tr>
<tr>
<td>$p_H$</td>
<td>High prob. of project success</td>
<td>0.99</td>
</tr>
<tr>
<td>$p_L$</td>
<td>Low prob. of project success</td>
<td>0.96</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Cobb-Douglas capital share</td>
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<tr>
<td>$K/Y$</td>
<td>Capital-to-output ratio</td>
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<tr>
<td>$\beta^h$</td>
<td>Household’s discount factor</td>
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<tr>
<td>$\delta$</td>
<td>Depreciation rate</td>
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<tr>
<td>$A$</td>
<td>TFP</td>
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<tr>
<td>$H$</td>
<td>Hours</td>
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<tr>
<td>$C/Y$</td>
<td>Consumption-to-output ratio</td>
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<td>$R^*$</td>
<td>World interest rate</td>
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<td>$\tau$</td>
<td>Labor disutility</td>
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<tr>
<td>$\sigma$</td>
<td>Relative risk aversion</td>
<td>2</td>
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</tbody>
</table>
Drop in $R^*$ of 1% on impact, persistence 0.99

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Bond Finance, Bank Credit, and Aggregate Fluctuations
Increase in $A$ of 1% on impact, persistence 0.99
Increase in $R$ of 1% on impact, persistence 0.99