Collateral and Capital Reallocation

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Role of Collateral in Macro Finance

- **Macro finance**
  - Interaction between finance and macro economy
  - Needed: Tractable dynamic microfounded model of financing

- **Collateral**
  1. Model of collateralized finance based on limited enforcement
     - Insight: Fixed (esp. tangible) assets determine capital structure
  2. Collateral assets key for secured and unsecured debt
     - Insight: Unsecured debt claim on unencumbered assets
  3. Durability of collateral assets affects ability to finance
     - Insight: More durable (and new) assets harder to finance

- **Capital reallocation**
  4. Reallocation of less durable, old assets to more constrained firms
     - Insight: Distributive effects of collateral price exceed collateral effects
Papers on Collateral and Capital Reallocation

- **Collateral**
  1. Model of collateralized finance based on limited enforcement
     - Rampini/Viswanathan (2013) Collateral and capital structure
  2. Collateral assets key for secured and unsecured debt
     - Rampini/Viswanathan (2022) Collateral and secured debt
  3. Durability of collateral assets affects ability to finance
     - Rampini (2019) Financing durable assets

- **Capital reallocation**
  4. Reallocation of less durable, old assets to more constrained firms
     - Lanteri/Rampini (2023) Constrained-efficient capital reallocation

- **More related (and selected) literature**
  - Collateral: Rampini/Viswanathan (2019, 2022b), Lanteri/Rampini (2023b)
(1) Model of Dynamic Collateralized Finance

- **Model** (essentially stochastic growth model)
  - Environment: discrete time; infinite horizon: $t = 0, 1, \ldots$
  - Preferences: linear; discount factor $\beta \in (0, 1)$; limited liability
  - Endowment: $w_0$ at time 0
  - Technology:
    - Production function $f(k)$ with decreasing returns, Inada condition
    - Capital $k$ depreciates at geometric rate $\delta \in (0, 1)$

- **Limited enforcement** – Rampini/Viswanathan (2010, 2013)
  - Limited enforcement without exclusion implies collateral constraints
  - Firms can abscond with
    - all cash flows and fraction $1 - \theta$ of (depreciated) assets (distinction!)
  - No exclusion from future borrowing – unlike Kehoe/Levine (1993)
  - Implication: Optimal long-term contract can be implemented with
    - one-period ahead borrowing subject to collateral constraint

- Nature of assets matters – (in)tangibility; durability; repossessability
Dynamic Collateralized Firm Financing

- **Firm’s (recursive) problem**: Given $w$ and interest rate $R$, solve

  \[ v(w) \equiv \max_{\{d,k,b,w'\} \in \mathbb{R}_+^2 \times \mathbb{R}^2} d + \beta v(w') \]

  subject to budget constraints

  \[ w + b \geq d + k \]
  \[ f(k) + k(1 - \delta) \geq Rb + w' \]

  and collateral constraint

  \[ \theta k(1 - \delta) \geq Rb \]

- **Tractability**: One-period ahead claims are sufficient
  - Extends to stochastic case – one-period ahead Arrow securities

- Similar: Kiyotaki/Moore (1997)
Collateral vs. Net Worth

- **State variable is net worth** \( w' = f(k) + k(1 - \delta) - Rb \)
  - Assets (incl. current cash flow) minus liabilities
  - Net worth matters *because* of collateral constraints

- **Collateral is endogenous**
  - *Inside collateral*: assets acquired for use in production
  - *Not*: *Outside collateral*: additional pledgeable assets (\( \approx \) net worth)
  - See, e.g., Bernanke/Gertler
    - Agency costs, collateral, and business fluctuations (1986)
    - Agency costs, net worth, and business fluctuations (AER 1989)

- Related: Scheinkman/Weiss (1986)
Investment with Collateral Constraints

- **Investment Euler equation**

\[
1 \geq \beta \frac{\mu'}{\mu} f_k(k) + (1 - \theta)q(1 - \delta)
\]

and \(\nu_w(w) = \mu\) (using Benveniste/Scheinkman (1979))

- **Down payment**

\[
\phi = 1 - R^{-1}\theta(1 - \delta) \quad [= R^{-1}(r + \delta) + R^{-1}(1 - \theta)(1 - \delta)]
\]

- Internal funds required per unit of capital
- Debt per unit of capital \(R^{-1}\theta(1 - \delta)\)
- Investment of constrained firm: \(k = \frac{1}{\phi}w\)
- Nature of assets determines collateralizability \(\theta\)

- Stochastic version of model quantitatively plausible
  - Li/Whited/Wu (2016)

- Dynamic model allows analysis of
  - risk management; insurance; intermediation; rental markets/leasing
(2) Collateral vs. Secured Debt

- **So far:** No distinction between secured and unsecured debt

- **Recent puzzles on secured debt**
  - Secured debt acyclical/countercyclical – Azariadis/Kass/Wen (2016)
  - Limited use of secured debt by large firms – Lian/Ma (2021)
  - Secular decline in secured debt – Benmelech/Kumar/Rajan (2022)
  - Need to consider other cash-flow or earnings based constraints?

- **Terminology**
  - **Collateral (law):** Assets pledged to secure loan
  - **Collateral (economics):** Assets that facilitate enforcement

- **Insight:** Collateral restricts both secured and unsecured debt
  - Unsecured debt backed by unencumbered assets
  - Collateral essential to understanding firm financing
Trade-off between Secured and Unsecured Debt

- Model as before but distinction between secured and unsecured debt

- Capital can be financed with secured and unsecured debt
  - Encumbered capital $k_s$ explicitly pledged to secured lender
  - Unencumbered capital $k_u = k - k_s$ backs unsecured debt

- **Benefits of secured debt – enforcement of payment** $\theta_s > \theta_u$
  - Pledging assets explicitly facilitates enforcement
    - “increases the lender’s ability to collect the debt forcibly through liquidation of the collateral” – Mann (1997)

- **Costs of secured debt – (direct) cost** $\kappa > 0$
  - Alternative: indirect cost – operating flexibility
    - Encumbered capital less efficient: $k = k_u + \phi k_s$ with $\phi < 1$
    - “you just don’t have the same flexibility of dealing with your properties as if you owned them unencumbered” – Mann (1997)

- **Trade-off**: cost of encumbering assets vs. ability to lever
Firm Financing with Secured and Unsecured Debt

Firm’s problem

\[ v(w) = \max \{ d, k_s, k_u, w', b_s, b_u \} \in \mathbb{R}_+^4 \times \mathbb{R}^2 \]

subject to budget constraints for current and next period

\[ w + \sum_{j \in \mathcal{J}} b_j \geq d + \sum_{j \in \mathcal{J}} k_j + \kappa k_s \]

\[ f(k) + \sum_{j \in \mathcal{J}} k_j (1 - \delta) \geq R \sum_{j \in \mathcal{J}} b_j + w' \]

collateral constraints on secured and unsecured borrowing

\[ \theta_j k_j (1 - \delta) \geq R b_j, \quad \forall j \in \mathcal{J} \]

where \( k = \sum_{j \in \mathcal{J}} k_j \) and \( \mathcal{J} \equiv \{ s, u \} \).

Borrower incurs cost of secured debt; not reflected in interest rate
Choice between Secured and Unsecured Debt

- **Constrained firms use secured debt**

  **Panel A:** Secured debt/Total debt – Data

  **Panel B:** Secured debt/Total debt – Model

- **Unconstrained firms have unsecured debt in model and data**
  - but nevertheless face collateral constraints
  - as unencumbered assets back unsecured debt
(3) Effect of Durability of Assets

- Nature of assets matters – one aspect: **durability**
  - New assets have longer useful life than old assets
  - Alternative: different quality assets depreciate at different rates

- **New and old capital**
  - Suppose capital lasts for two periods (one-horse shay depreciation)
  - **New, durable assets** $k_N$ last two periods; price $q_N \equiv 1$ (exogenous)
  - **Old, non-durable assets** $k_O$ one period of useful life left; price $q_O$
  - Perfect substitutes in production: $k \equiv k_N + k_O$
  - Price of old capital $q_O \equiv q$ determined in (stationary) equilibrium

- Otherwise economy as before but OLG with two-period lived firms
  - For simplicity; more generally stochastic over-lapping generations
  - Firms born with stochastic net worth $w$
Firm’s Problem with Two-Period Assets

- Given net worth $w$, entrepreneur solves

$$ v(w) \equiv \max_{\{d, k_N, k_O, b, w'\} \in \mathbb{R}^3_+ \times \mathbb{R}^2} d + \beta w' $$

subject to budget constraints for current and next period

$$ w + b \geq d + k_N + qk_O $$
$$ f(k) + qk_N \geq Rb + w' $$

and the collateral constraint

$$ \theta qk_N \geq Rb $$

and $k \equiv k_N + k_O$

- Note: only new assets can serve as collateral
Choice between New and Old Capital

- User cost of new and old assets for unconstrained firms

\[ u_N \equiv 1 - R^{-1}q \quad \text{[} = R^{-1}(r + (1 - q))\text{]} \]
\[ u_O \equiv q \quad \text{[} = R^{-1}q(r + 1)\text{]} \]

- Down payment on new and old assets

\[ \varphi_N \equiv 1 - R^{-1}\theta q \quad \text{[} = u_N + R^{-1}(1 - \theta)q > u_N \text{]} \]
\[ \varphi_O \equiv q \]

- Investment Euler equation (multiplier on collateral constraint \( \lambda' \))

\[ u_j + \lambda' \varphi_j \geq \beta f_k(k) \]

- Basic trade-off: In equilibrium,

- \( \varphi_N > \varphi_O \) — new assets require higher down payment
- \( u_N \leq u_O \) — new assets have lower user cost

- (Un)constrained firms buy old (new) assets
(4) Capital Reallocation and Efficiency

- **Constrained-efficient allocation?**

- **Model**
  - Economy as before
  - Stochastic firm net worth $w$ with distribution $\pi(w)$
  - Firms can pay negative dividends to raise funds at cost
    \[ d_0 - \phi(-d_0) + \beta d_1 \]
    where cost of equity issuance $\phi(-d)$, increasing and convex for $d < 0$

- **Planner**
  - Choose allocation and prices subject to same constraints as firms
  - Note: no redistribution except through induced price of old assets
Constrained-Efficient Price

- First-order condition w.r.t. price \( q \) (in current period)

\[
\int k_O(w) (1 + \phi_d(w)) \ d\pi(w) = \int k_N^{-}(w) (1 + \theta \lambda^{-}(w)) \ d\pi(w)
\]

or

\[
\int k_O(w) (1 + \phi_d(w)) \ d\pi(w) - \int k_N^{-}(w) \ d\pi(w) = \int \theta k_N^{-}(w) \lambda^{-}(w) d\pi(w)
\]

- Using market clearing for capital goods (\( \int k_O d\pi = \int k_N^{-} d\pi \))

\[
\int k_O(w) \phi_d(w) d\pi(w) = \int \theta k_N^{-}(w) \lambda^{-}(w) d\pi(w)
\]

and note that \( \phi_d(w) = \lambda(w) \)
Externalities at Competitive Equilibrium

- At stationary competitive equilibrium
  - Distributive externality is larger than collateral externality
    \[
    \int k_O(w)\phi_d(w)d\pi(w) > \theta \int k_N(w)\phi_d(w)d\pi(w)
    \]
- CE price of old capital is **higher** than constrained-efficient one
- Intuition: constrained firms are net buyers of old capital

![Graphs showing the relationship between net worth and capital allocation with different values for different scenarios.](image)
Essential Role of Heterogeneity and Reallocation

- **Distributive externality hinges on reallocation in equilibrium**
  - Stationary equilibrium with reallocation

- **Representative entrepreneur in steady state – Kiyotaki/Moore (1997)**
  - Assets in fixed supply (land)
  - Entrepreneur has constant amount of land in steady state
  - Misallocation, but no reallocation
  - Change in price of land has no effect on budget constraints
  - Only collateral externality

- **Result obtains with assets in fixed supply and OLG firms**
  - Heterogeneity between young and old firms
  - Reallocation of land from old to young firms
  - Distributive externality dominates collateral externality
Financing Adoption of Clean Technology

- New paper: Lanteri/Rampini (2023b)

- **Choice between clean and dirty technologies**
  - Capital requires energy to operate
  
  \[
  x_j \equiv \min \left\{ \frac{e_j}{\gamma_j}, k_j \right\}
  \]
  
  where \( e_j \) is energy input for type \( j \) capital
  - Two types of capital: clean and dirty \( \gamma_C < \gamma_D \)
  - Production \( f(x) \) where \( x = \sum_{j \in J} x_j \)

- **Insight: (Un)constrained firms adopt dirty (clean) technologies**
  - Clean capital is expensive reflecting lower energy costs
  - Key: collateral only partially pledgeable
Conclusion

- **Collateral central to finance and hence macro finance**
  - Collateralizable assets matter for financing, not just secured debt
  - Focus on firms but also applies to households

- **Useful laboratory for macro finance**
  - Models as laboratories – Lucas
  - Model is quantitatively and empirically plausible
  - Strength: tractability

- **Applications** *(today)*
  - Choice between new (durable) vs. old (less durable) capital
  - Choice between clean vs. dirty technologies