Debt Financing, Used Capital Markets and Capital Reallocation

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Outline

1 Introduction

2 Model

3 Calibration

4 Results

How do used capital markets and financial frictions affect business cycles?

- Small and young firms contribute to employment, productivity, and growth (Haltiwanger et al., 2013; Haltiwanger, 2021)
- They mainly invest in old capital, and subject to limited borrowing capacity (Ma et al., 2022; Gertler and Gilchrist, 1994)
  - They are willing to exchange higher user cost for current growth (Eisfeldt and Rampini, 2007)
- This paper: examine two channels regarding used capital markets and financial frictions
  1. User cost of capital directly fluctuates with the used capital prices
  2. Borrowing capacity depends on the resale value of the pledged collateral (Banerjee and Blickle, 2021; Ioannidou et al., 2022)
- Take away:
  - Used capital markets is beneficial in the long-run but amplify recessions from financial shocks
  - User cost channel is three times larger than the collateral channel

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Overview

I consider a heterogeneous firm model with real and financial friction:

- **Used investment market**: trade price q is determined by the supply (downward-adjust) and the demand (upward-adjust)

- **Households:** own firms $\Rightarrow$ firms discount as HH.

- **Firms:** states (k, b, ε)
  - DRS production function; i.i.d. exit shock π_d
  - Upward-adjusting firms: purchase effective capital at cost Q.
    - Combine both new and used investment goods in a CES aggregator into capital stock
  - Downward-adjusting firms: sells used investment goods at price q.
  - Collateral constraint: $b' \leq q\zeta k$.

Production and Value Function ▸ v^u ▸ v^d

- Firms experience exogenous exit π_d:

$$v_0(k,b,\varepsilon,\mu) = \pi_d \max_n [x^d(k,b,\varepsilon)] + (1-\pi_d) v(k,b,\varepsilon,\mu),$$

- Conditional on survival, firm chooses upward- or downward-adjusting:

$$v(k,b,\varepsilon,\mu) = \max\{v^u(k,b,\varepsilon,\mu), v^d(k,b,\varepsilon,\mu)\}.$$

- Upward-adjusting firms maximizes dividend and continuation value subject to
  - Budget constraints: $0 \leq D \leq x^u(k,b,\varepsilon) + q_b b' - Qk'$
  - Collateral constraints and cash $x^u(k,b,\varepsilon) = z\varepsilon F(k,n) - w(\mu)n - b + Q(1-\delta)k$
  - Capital process for upward-adjusting firms (Lanteri (2018)):

$$k' = (1-\delta)k + \left[\eta^{\frac{1}{s}} (i_{new})^{\frac{s-1}{s}} + (1-\eta)^{\frac{1}{s}} (i_{used})^{\frac{s-1}{s}}\right]^{\frac{s}{s-1}},$$

leads to $\frac{i_{used}}{i_{new}} = \frac{1-\eta}{\eta}(q+\gamma)^{-s}$, and purchasing price of capital $Q = [\eta + (1-\eta)q^{1-s}]^{\frac{1}{1-s}}$

User cost of capital

- Following Jorgenson (1963), the user cost of capital is the current purchase cost of capital, net of its resale value, accounting for depreciation and discounting,

$$c(q) = Q(q) - \beta(1-\delta)q = \left[\eta + (1-\eta)q^{1-s}\right]^{\frac{1}{1-s}} - \beta(1-\delta)q$$

- When q is sufficiently high (> 0.7), decreasing used capital price increases user cost
  - Firms' user cost of capital is higher during recession (procyclical used capital price)

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Calibration Strategies

- **Externally assign** a subset of macro parameters from literature/data
  - Kauffman Firm Survey $\rightarrow$ entrants leverage
  - BDS $\rightarrow$ firm exit rate
  - Khan and Thomas (2013) $\rightarrow$ relative size of entrants
  - Edgerton (2011) & slope of demand $\rightarrow$ Investment CES parameter
- **Internally calibrate** the rest to match aggregate and investment rate moments
  - capital share $\rightarrow$ capital-output ratio
  - credit parameter $\rightarrow$ debt-capital ratio
  - depreciation rate $\rightarrow$ investment-capital ratio
  - disutility of labor $\rightarrow$ one-third of labor
  - Persistence/volatility of idio. productivity shock $\rightarrow$ serial correlation/std of investment rate
  - Share of new investment $\rightarrow$ share of firms undertaking negative investment

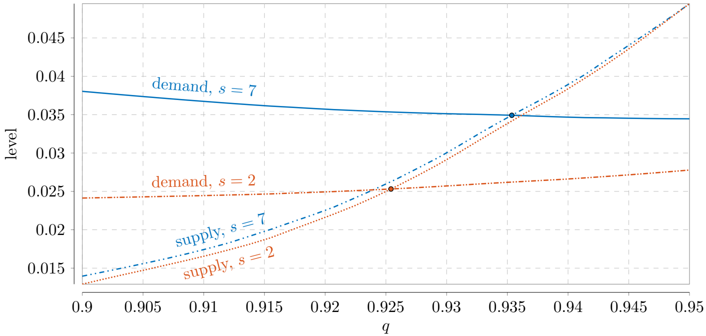
▸ Table

Calibrated Moments

	model	data
First moments		
Capital/Output, K/Y	2.3	2.3
Debt/Capital, B/K	0.353	0.370
Labor share, wN/Y	0.6	0.6
Investment/Capital, I/K	0.069	0.069
Second moments		
standard deviation of investment rate, $\sigma(i/k)$	0.338	0.337
serial correlation of investment rate, $\rho(i/k)$	0.043	0.058
frequency of negative investment	0.117	0.104
Untargeted moments		
average investment rate, $\mu(i/k)$	0.107	0.122
frequency of inaction region ($abs(i/k) < 1\%$)	0.504	0.081
frequency of lumpy investment ($i/k > 20\%$)	0.143	0.186
frequency of lumpy disinvestment ($i/k < -20\%$)	0.051	0.018

▸ Distribution

Choose CES s to ensure downward-sloping secondary market demand



Higher q leads to substitution effects (through $Q(q)$) and income effects (through $q\zeta k$)

A sufficiently high CES parameter s is needed for the substitution effect to dominate

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Overview of Counterfactural Experiments

I compare three scenarios in the comparison of long-run equilibrium,

- *Baseline*: with used capital markets clear
- *Fix Irreversibility*: fix the degree of irreversibility the same as the *Baseline*
  - Let $Q = 1$ and $q = \frac{q}{Q}$ without clearing used capital markets
- *Cost channel*: fix the q in $q\zeta k$ at the *Baseline* level, allow used capital markets clear

In the short-run dynamics, I compare three transitional dynamics under productivity and financial shocks,

- *Baseline*: with used capital markets clear
- *Partial Equilibrium*: fixing q at the steady-state level without clearing used capital markets
- *Cost channel*: fix the q in $q\zeta k$ at the steady-state level, allow used capital markets clear

Comparisons of Long-run Consequence of Counterfactual Experiments

	Description	Baseline	Fix irreversibility	Cost channel
Aggregates (in percentage of baseline)				
Y	output	(0.567)	-1.202	-0.000
C	consumption	(0.476)	-0.108	-0.000
N	labor	(0.332)	-1.095	-0.000
K	capital	(1.311)	-2.004	-0.000
I	investment	(0.228)	-2.079	-0.000
$B > 0$	debt	(0.464)	-1.704	-0.000
$\hat{z}$	measured TFP	(1.021)	-0.002	-0.000
Distribution				
$\mu_{\text{unc}}K$	unconstrained capital	2.156	2.057	2.156
$\mu_{\text{con}}K$	constrained capital	1.251	1.204	1.251
μ_{binding}	firms with binding $q\zeta k$	0.280	0.284	0.280

Peak-to-Trough Comparisons: Four-period Credit shocks

Table: Peak-to-Trough Declines: Credit Shock

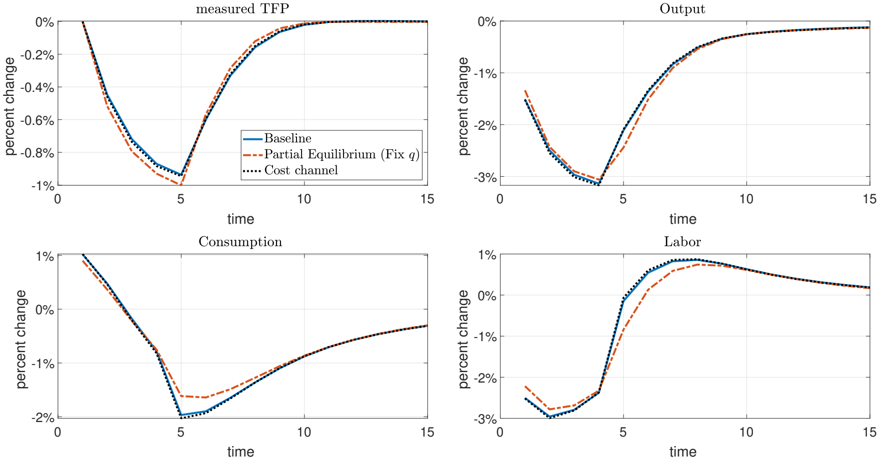
	TFP	Y	C	N	I	Debt
Data	2.18	5.59	4.08	6.03	18.98	25.94
Baseline	0.94	3.14	1.97	2.96	10.51	25.63
Partial Equilibrium	1.00	3.06	1.64	2.79	11.97	25.57
Cost channel	0.95	3.17	2.03	3.00	10.67	26.01

- From *Baseline* to *Cost channel*: size of collateral channel is -0.03 pp
- From *Cost channel* to *Partial Equilibrium*: size of user cost channel is 0.11 pp
- Rising user cost deepens the trough by a factor of three than collateral value adjustment

▸ TFP

Response to a four-period credit crisis

Price adjustments amplify the severity and duration of recessions triggered by financial shocks



▸ TFP

Conclusion

- Equilibrium model to quantify the business cycle implications of used capital markets
  - Price adjustment in used capital markets amplifies the severity and duration of recessions
  - User cost channel is three times larger than collateral channel
- What's next:
  - Price fluctuations under aggregate uncertainty
  - Firm dynamics: how endogenous entry and exit affects the used capital markets

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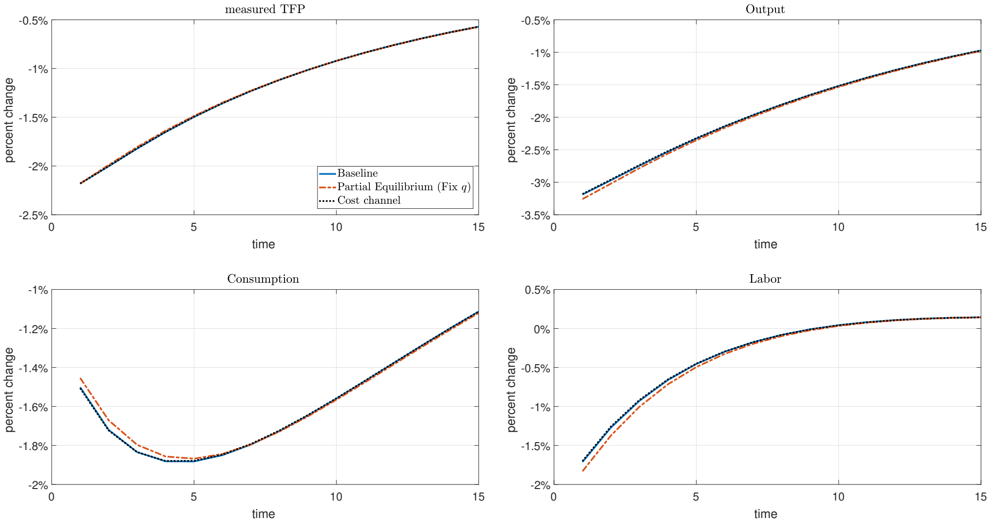
Peak-to-Trough Comparisons: TFP shocks

Table: Peak-to-Trough Declines: TFP shock

	TFP	Y	C	N	I	Debt
Data	2.18	5.59	4.08	6.03	18.98	25.94
Baseline	2.18	3.19	1.88	1.71	5.54	2.69
Partial Equilibrium	2.18	3.26	1.87	1.83	4.77	2.67
Cost channel	2.18	3.18	1.88	1.70	5.51	2.66

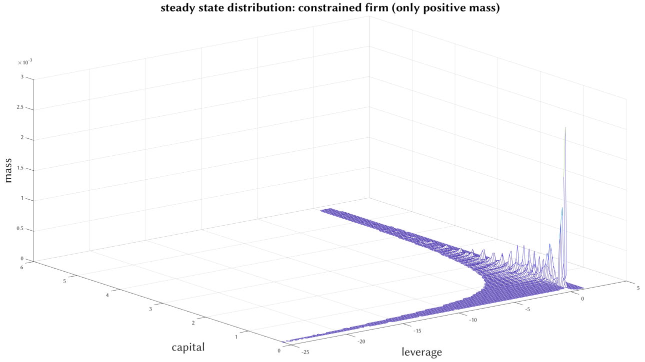
◂ Back

Almost no role of used capital market following a TFP shock



◂ Back

Steady State distribution: median productivity



- new firm k: 0.1311
- constrained mass: 93.4%
- average unconstrained k: 2.156
- average constrained k: 1.251
- firms with currently binding collateral constraints: 28%

Upward-adjusting Firm

$$v^u(k,b,\varepsilon;\mathbf{s}_f;\mu) = \max_{k',b',D} D + \sum_{g=1}^{N_s} \pi^{\mathbf{s}}_{fg} d_g(\mathbf{s}_f;\mu) \sum_{j=1}^{N_\varepsilon} \pi^{\varepsilon}_{ij} v_0(k',b',\varepsilon'_j;\mathbf{s}'_g;\mu'),$$

subject to

$$0 \leq D \leq x^u(k,b,\varepsilon_i;z_f) + q_b b' - Qk', \qquad \text{(Budget: Up)}$$

$$x^u(k,b,\varepsilon_i;z_f) = z_f \epsilon_i F(k,n) - w(z_f,\mu)n - b + Q(1-\delta)k \qquad \text{(Cash: Up)}$$

$$b' \leq q\zeta k, \qquad \text{(Collateral)}$$

$$k' \geq (1-\delta)k, \qquad \text{(K range)}$$

$$\mu' = \Gamma(z_f;\mu), \qquad \text{(Distribution)}$$

q_b: bond price; $d_g(z_f,\mu)$: SDF; ζ: efficiency of financial sector.
Downward-adjusting firms: replace all Q with q

Back

Downward-adjusting Firm ◂ Back

$$v^d(k, b, \varepsilon_i; \mathbf{s}_f, \mu) = \max_{k', b', D} D + \sum_{g=1}^{N_\mathbf{s}} \pi^{\mathbf{s}}_{fg} d_g(\mathbf{s}_f; \mu) \sum_{j=1}^{N_\varepsilon} \pi^{\varepsilon}_{ij} v_0(k', b', \varepsilon'_j; z'_g, \mu'),$$

subject to

$$0 \leq D \leq x^d(k, b, \varepsilon; z_f) + q_b b' - qk', \quad \text{(Budget: Down)}$$

$$x^d(k, b, \varepsilon; z_f) = z_f \epsilon_i F(k, n) - w(z_f, \mu)n - b + q(1-\delta)k \quad \text{(Cash: Down)}$$

$$b' \leq q\zeta k, \quad \text{(Collateral)}$$

$$k' \leq (1-\delta)k, \quad \text{(K range)}$$

$$\mu' = \Gamma(z_f; \mu), \quad \text{(Distribution)}$$

◂ Back ▸ Definition of *recursive equilibrium*, ▸ Rewrite in terms of $p(z_f; \mu)$

Calibrated Parameters

Parameter	Description	Value
Preferences and technology		
β	Subjective discount factor	0.960
ψ	Disutility from working	2.150
α	Capital share	0.270
ν	Labor share	0.600
δ	Depreciation rate	0.064
Shocks		
ρ_ε	Persistence idiosyncratic productivity shock	0.740
$\sigma_{\eta_\varepsilon}$	Volatility idiosyncratic productivity shock	0.100
Firm characteristic		
ζ	efficiency of the financial sector	1.250
π_d	exogenous exit probability	0.085
χ	relative size of entrants	0.100
ζ_0	entrants leverage	0.410
Investment technology		
η	new investment ratio	0.900
s	elasticity of substitution between new and used investment	7.000