Financial Frictions, Investment and Tobin's q

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The problem

Investment model with CRS and convex adjustment costs:

- Tobin's q = marginal q
- q sufficient statistic for investment

Empirical implementation:

$$\left(\frac{I}{K}\right)_t = a_0 + a_1 q_t + a_2 \left(\frac{\text{Cash Flow}}{K}\right)_t$$

usually rejected.

Question

Can financial frictions help explain the empirical result?

Answer

Gomes (2001) and Cooper and Ejarque (2003): **No**
$\longrightarrow$ Despite financial frictions, q is "almost" sufficient statistic

This paper: **Yes**

Methodology

Same approach

- Set up dynamic model with financial constraints
- Define q in the model corresponding to q in financial markets
- Solve and calibrate the model
- Run investment regression on simulated output

Differences

- Micro-founded financial friction: limited enforcement
- CRS: clarify connection to Hayashi (1982)

Main findings

1. Financial constraint $\longrightarrow$ **wedge** between marginal q and average q

2. Wedge varies over time, weakens correlation between q and investment

Also useful

- Tractable model with aggregate shocks and long term contracts
- Linear model $\longrightarrow$ easy aggregation

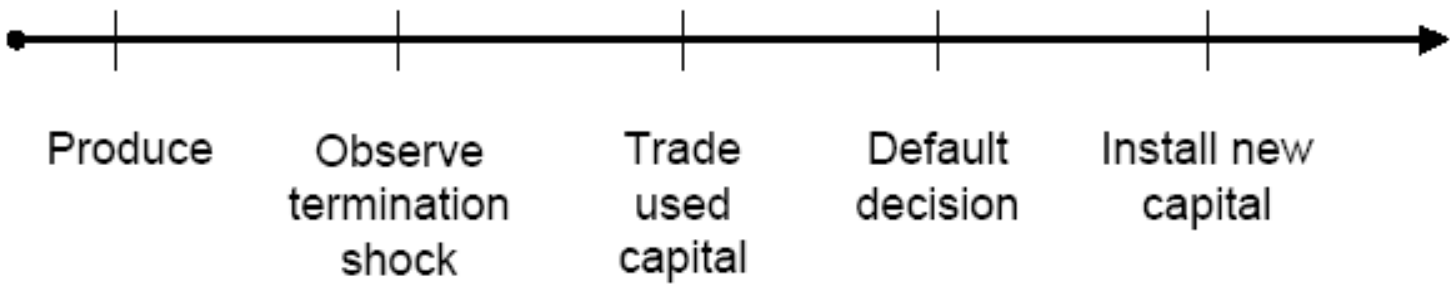
Preferences

Two groups: consumers and entrepreneurs

- consumers infinitely lived, risk-neutral
- discount factor β

- entrepreneurs also risk-neutral, but:
  - die with probability γ
  - discount factor $\beta_E < \beta$

Timeline


Produce
Observe termination shock
Trade used capital
Default decision
Install new capital

Technology

- Production function:

$$A_t F\left(k_t, l_t\right)$$

- Adjustment cost:
  Install k_{t+1} using k_t^o old capital and G consumption goods

$$G\left(k_{t+1}, k_t^o\right)$$

- Both CRS

Financial markets

- **Financial contract** (entrepreneur at t): sequence of state contingent transfers

$$\{d_\tau\}_{\tau=t}^{\infty}$$

- **Limited Enforcement**
  - Entrepreneur can default and divert fraction $(1-\theta)$ of liquidation value v
  - After default: the firm is liquidated, and the entrepreneur can start anew

Some results/definitions

- The **liquidation value** of a firm is

$$\begin{aligned} v_t &= R_t k_t \\ &= \max_l (A_t F(k_t, l) - w_t l) + q_t^o k_t \end{aligned}$$

- R_t gross return on invested capital

- Marginal q equal across entrepreneurs and given by

$$q_t^m = \frac{\partial G(k_{t+1}, k_t^o)}{\partial k_{t+1}}$$

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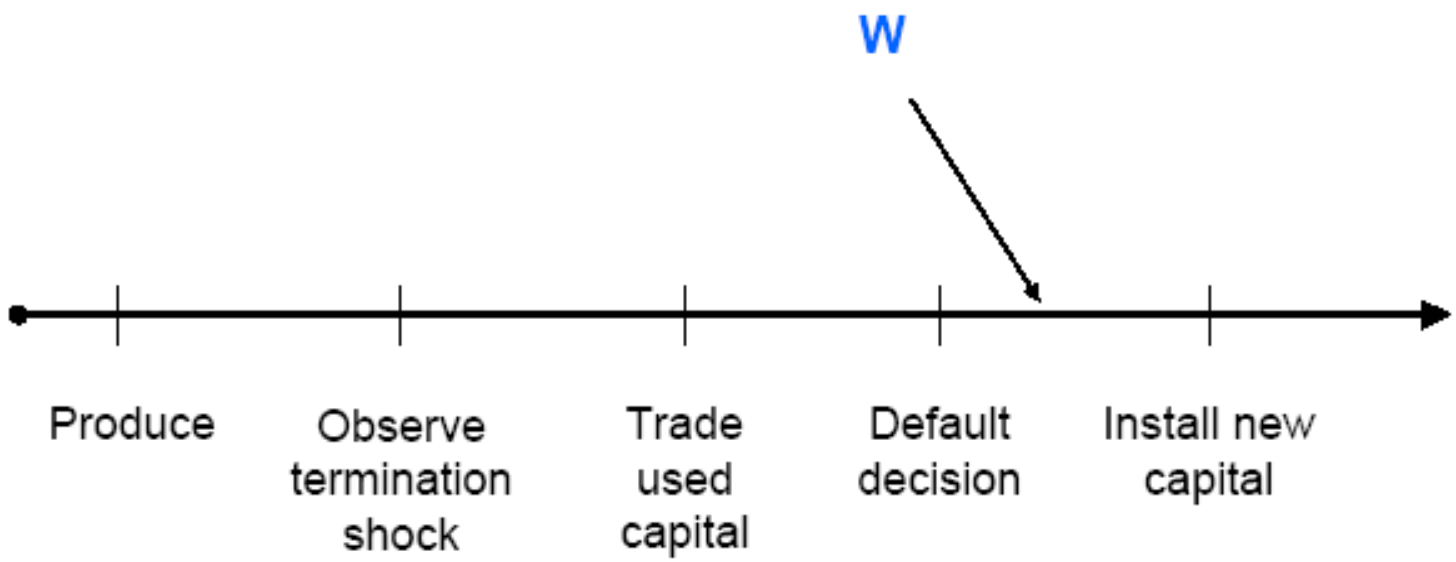
w
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Entrepreneur problem

- $W_t(v, b)$ value function
- b present (market) value of promised transfers
- Choose c^E, d, k' and b' subject to:
  1. Promise keeping constraint

$$b = d + \beta b'$$

  2. No-default constraint (next period)
  3. Resource constraint

$$c^E + d + q^m k' \leq v$$

Results

- W_t is linear

$$W_t(v, b) = \phi_t(v - b)$$

- No-default constraint

$$W_{t+1}(v', b') \geq W_{t+1}((1-\theta)v', 0)$$

equivalent to:

$$b \leq \theta v$$

Definition of q

Value of the firm

sum of **future claims** by insiders and outsiders:

$$p_t = W_t(v, b) + b - d - c^E$$

Average q

$$q_t \equiv \frac{p}{k'}$$

Result (Hayashi(1982))

Large θ

$$\phi_t = 1$$

$$p_t = (v - b) + b - d - c^E$$

and, using the resource constraint:

$$p_t = v - d - c^E = q^m k'$$

$$\text{average } q = \text{marginal } q$$

Result

Small θ

$$\phi_t > 1$$

$$p_t = \phi_t(v - b) + b - d - c^E$$

and, using the resource constraint:

$$p_t > q^m k'$$

$$\text{average } q > \text{marginal } q$$

More on ϕ

Forward looking measure:
average future tightness of the financial constraint

$$\phi_t = \frac{\beta_E \mathbb{E}_t \left[\left(\gamma + (1-\gamma) \phi_{t+1} \right) (1-\theta) R_{t+1} \right]}{q_t^m - \beta\theta \mathbb{E}_t \left[R_{t+1} \right]}$$

in frictionless case

$$\beta \frac{E_t[R]}{q_t^m} = 1 \implies \phi_t = 1$$

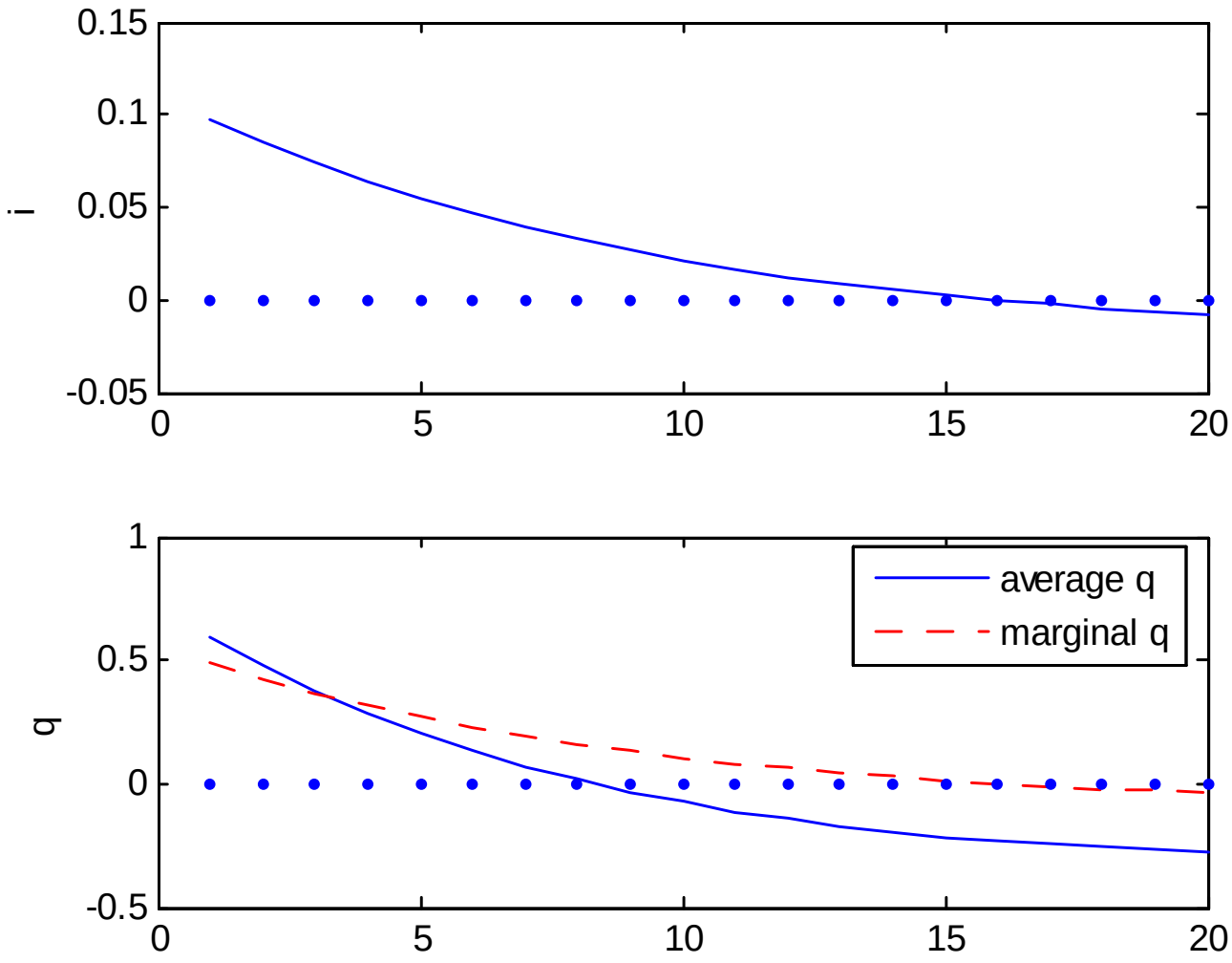
ϕ_t, and therefore the wedge, reflects the tension between

1. **Future profitability** of investment (future productivity, adjusted for capital stock)
2. **Availability of funds** (current and past productivity)

Calibration

β	0.97	
α	0.33	capital share
δ	0.05	depreciation
ξ	5	adjustment cost
θ	0.6	conservative
		30% of manuf. investm. financed ext.
γ	0.12	outside finance premium 3%
l_E	0.3	outside finance premium 3%

Response to persistent shock, ρ=.95



Two effects

Amplified response of q

- early on
  - high $E[R]$
  - constrained investment, low k
  - ϕ captures high rents in early periods$\longrightarrow$high wedge

Breaks $q - i$ relationship

- later on
  - firm has high k
  - future productivity a not so high
  - low $E[R]$
  - low $\phi \longrightarrow$low wedge

Investment regressions

- **Coefficient on q** (a_1)

$$\underbrace{.20}_{\text{frictionless } (1/\xi)} > \underbrace{.08}_{\text{univariate}} > \underbrace{.016}_{\text{controlling for CF}}$$

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  - Result very robust to parameter changes
  - Can match GH exactly if add temporary shocks or "expectation shocks"

Summary

- Limited enforcement creates a wedge between marginal q and average q
- The wedge reflects the tension between **future profitability** of investment and **availability of funds**
- Time-variation in the wedge breaks the link between average q and investment

Key conclusion: Financial constraints can help in replicating the empirically observed relationship between i, q and cf.

Appendix - entrepreneur's problem fully specified

$$W(v, b; X) = \max_{\substack{c^E, d \\ k', v'(.), b'(.)}} c^E + \beta_E \mathbb{E}[W(v', b'; X') | X]$$

$s.t.$

$$c^E + d + q^m(X) k' \leq v,$$

$$b = d + \beta \mathbb{E}[b'(X') | X],$$

$$v'(X') = R(X') k' \quad \forall X',$$

$$W(v'(X'), b'(X'); X') \geq W((1-\theta) v'(X'), 0; X') \quad \forall X',$$

Related literature

- Macro literature on financial constraints:
  - Bernanke & Gertler (1989)
  - Carlstrom & Fuerst (1997)
  - Kiyotaki & Moore (1997)
  - Cooley, Marimon, & Quadrini (2004)
- Financial contracts with limited enforcement:
  Albuquerque & Hopenhayn (2004)
- Empirical:
  Fazzari, Hubbard, Petersen (1988), Gilchrist & Himmelberg (1995)
- Recent work on q-theory:
  Gomes (2001), Cooper and Ejarque (2003), Abel and Eberly (2005)

IRF to temporary shock