

Econ 234C – Corporate Finance

Lecture 5: External Investment (I)

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Outline

1. Organization etc.
2. Excursion: Tobin's Q
3. External Investment (I): Stylized Facts
4. Homework 2

1 Organization

- Updated notes on the course webpage
http://emlab.berkeley.edu/users/webfac/malmendier/e234C_s07/e234C.shtml
- Information Sheets
- Ross Levine research sheet
- Homework 1

2 Tobin's Q

James Tobin (1969), "A general equilibrium approach to monetary theory," *Journal of Money, Credit, and Banking* 1 (February), pp. 15-29.

2.1 Model of Investment with Adjustment Costs (q-Theory of Investment)

Assumptions

1. **Profits** $\pi(K_t)\kappa_t$ with $\pi'(\cdot) < 0$.

$\kappa_t \equiv$ firm capital at t

$\pi_t \equiv$ real profits per capital unit

$K_t \equiv$ industry-wide capital

—→ Firm's profit proportional to capital stock

Justification?

- Constant returns to scale (production function)
- Perfect competition (output market)
- Perfectly elastic supply (all other production factors)

—→ Firm's profit decreasing in industry-wide capital

Justification?

- downward-sloping demand

2. **Adjustment cost** $C(\cdot)$ function of change in capital $d\kappa$
convex ($C''(\cdot) > 0$, $C(0) = 0$, $C'(0) = 0$)
→ capital increase and decrease are costly

3. **Price of capital** = 1

4. **Depreciation rate** = 0

$$\longrightarrow d\kappa_t = I_t$$

Discrete-Time Version

$$\max_{\{I_t, \kappa_{t+1}\}_t} \sum_{t=0}^{\infty} \frac{1}{(1+r)^t} [\pi(K_t)\kappa_t - I_t - C(I_t)]$$

$$\text{s.t. } \kappa_{t+1} = \kappa_t + I_t \quad \forall t$$

Lagrangian

$$\begin{aligned} \mathcal{L} = & \sum_{t=0}^{\infty} \frac{1}{(1+r)^t} [\pi(K_t)\kappa_t - I_t - C(I_t)] \\ & + \sum_{t=0}^{\infty} \lambda_t (\kappa_t + I_t - \kappa_{t+1}) \end{aligned}$$

\implies Lagrange multiplier λ_t

= marginal value of relaxing the κ_{t+1} / κ_t constraint

= marginal impact of an exogenous increase in κ_{t+1} fson NPV profits

$$\implies q_t = (1 + r)^t \lambda_t$$

= value of 1 additional unit capital at $t + 1$ in time- t dollars

Thus

$$\mathcal{L} = \sum_{t=0}^{\infty} \frac{1}{(1 + r)^t} [\pi(K_t)\kappa_t - I_t - C(I_t) + q_t (\kappa_t + I_t - \kappa_{t+1})]$$

F.o.c. w.r.t. I_t

$$\frac{\partial \mathcal{L}}{\partial I_t} = \frac{1}{(1+r)^t} [-1 - C'(I_t) + q_t] = 0$$

or

$$1 + C'(I_t) = q_t$$

Interpretation:

- cost of acquiring capital = value of capital
- price of capital (= 1) + marginal adjustment cost = value of capital

F.o.c. w.r.t. κ_t :

$$\frac{\partial \mathcal{L}}{\partial \kappa_t} = \frac{1}{(1+r)^t} [\pi(K_t) + q_t] - \frac{1}{(1+r)^{t-1}} q_{t-1} \stackrel{!}{=} 0$$

or

$$\pi(K_t) = (1+r)q_{t-1} - q_t$$

or

$$\pi(K_t) = rq_t - \Delta q_t - r\Delta q_t$$

Interpretation:

- MR capital = opportunity cost of capital
- MR capital + capital gain (Δq_t) = cost of forgoing real interest rq_t
(neglect interaction term)

Additional Condition (Transversality Condition)

$$\lim_{t \rightarrow \infty} \frac{1}{(1+r)^t} q_t \kappa_t = 0$$

Interpretation:

- Value of capital $\longrightarrow 0$.
- Else, the firm is holding valuable capital forever; could do better by reducing capital.

Continuous-Time Version

$$\begin{aligned} & \max_{\{I_t, \kappa_t\}_t} \int_{t=0}^{\infty} e^{-rt} \{ \pi[K(t)]\kappa(t) - I(t) - C[I(t)] \} dt \\ & \text{s.t. } \frac{d\kappa(t)}{dt} = I_t \quad \forall t \end{aligned}$$

Hamiltonian (*“Lagrangian for dynamic optimization in continuous time”*):

$$\mathcal{H}[\kappa(t), I(t)] = \pi[K(t)]\kappa(t) - I(t) - C[I(t)] + q_t \left(I_t - \frac{d\kappa(t)}{dt} \right)$$

with $q(t) = \lambda(t)e^{rt}$ = value of 1 additional unit capital at $t + 1$ in time- t dollars.

I “freely controlled” (*control variable*), κ determined by past decisions (*state variable*), q shadow value of state variable (*co-state variable*).

F.o.c. w.r.t. control variable $I \forall t$

$$\frac{\partial \mathcal{H}}{\partial I(t)} \stackrel{!}{=} 0$$

or

$$1 + C'[I(t)] = q(t)$$

Interpretation:

- cost of acquiring capital = value of capital
- price of capital ($= 1$) + marginal adjustment cost = value of capital

F.o.c. w.r.t. state variable κ_t

$$\frac{\partial \mathcal{L}}{\partial \kappa_t} \stackrel{!}{=} 0$$

or

$$\pi[K(t)] = rq(t) - \frac{dq(t)}{dt}$$

Interpretation:

- MR capital = opportunity cost of capital
- MR capital + capital gain $(dq(t)/dt)$ = cost of forgoing real interest $rq(t)$.

Additional Condition (Transversality Condition)

$$\lim_{t \rightarrow \infty} e^{-rt} q(t) \kappa(t) = 0$$

From

$$\pi[K(t)] = r q(t) - \frac{dq(t)}{dt}$$

follows

$$q(t) = \int_{\tau=t}^T e^{-r(\tau-t)} \pi[K(\tau)] d\tau + e^{-r(T-t)} q(T)$$

for all $T > t$.

Applying the transversality condition, we can further simplify $e^{-r(T-t)}q(T) \xrightarrow{T \rightarrow \infty} 0$. Thus

$$q(t) = \int_{\tau=t}^{\infty} e^{-r(\tau-t)} \pi(K(\tau)) d\tau$$

Interpretation

- market value 1 unit capital (q) = NPV of future MR
- q shows how an additional dollar of capital affects the NPV of profits
 - invest if q higher than capital replacement cost
 - divest if q lower than capital replacement cost
- “market value 1 unit capital” = “total value of firm with one more unit of capital minus total value of the other firm (without the additional unit of capital)”

- Tobin's q = market value over replacement cost of capital

SUMMARY: Tobin (1969) suggests that the rate of investment is related to q = market value of installed capital / replacement cost of installed capital, with $q = 1$ in equilibrium.

Marginal q (MV of marginal unit of capital/replacement cost of capital) determines investment; not *average q* (MV firm/replacement cost total capital stock).

But *average q* easier to measure.

2.2 Hayashi (1982)

Assumptions:

- The firm is a price taker;
- The production function displays constant returns to scale
- **key new assn:** Adjustment costs, per unit of I only depend on the ratio of I/K .

Then:

$\implies q$ determines growth rate capital, independent of initial capital

$\implies \Pi$ is proportional to initial capital

$\implies \text{marginal } q = \text{average } q \quad (\text{Hurrah!})$

3 Mergers and Acquisitions: Introduction

Andrade-Mitchell-Stafford, *JEP* 2001; Holmstroem-Kaplan, *JEP* 2001; Moeller, Schlingemann, Stulz, *JF* 2006

Why do CEOs make acquisitions?

1. Synergies (e.g. economies of scale).
2. Attempt to create market power (e.g. forming monopolies)
3. Incompetent target management → market discipline
4. Self-serving attempts to overexpand (empire-building, hubris).
5. Advantages of diversification (e.g. internal capital market; diversification for undiversified managers)

6. Mergers = reaction to unexpected shocks to industry structure (Explanation for wave/cluster structure in Mitchel and Nulherin, *JFE* 1996, and Andrade, Mitchell, Stafford, *JEP* 2001; could also be the “trigger” in the informational cascades literature.)
- E.g. technological innovation (creates excess capacity, need for consolidation).
 - E.g. financial innovation.
 - E.g. supply shock (oil prices; foreign competition).
 - E.g. deregulation.
 - 1973: airlines.
 - 1984 and 1996: broadcasting.
 - 1984: entertainment.
 - 1978: natural gas.
 - 1980: trucking.
 - 1994: banks and thrifts.
 - 1992: utilities.
 - 1996: telecommunications.

Importance / Significance of mergers

- Reallocation of resources within and across industries
- 1995: Value of M&A's = 5% GDP and = 48% nonresidential gross investment
- For a firm an “extraordinary event” often doubling its size within months; large organizational uncertainty; movement of human capital

==> Extremely large literature (in finance, IO, macro; also relevant for labor, public).

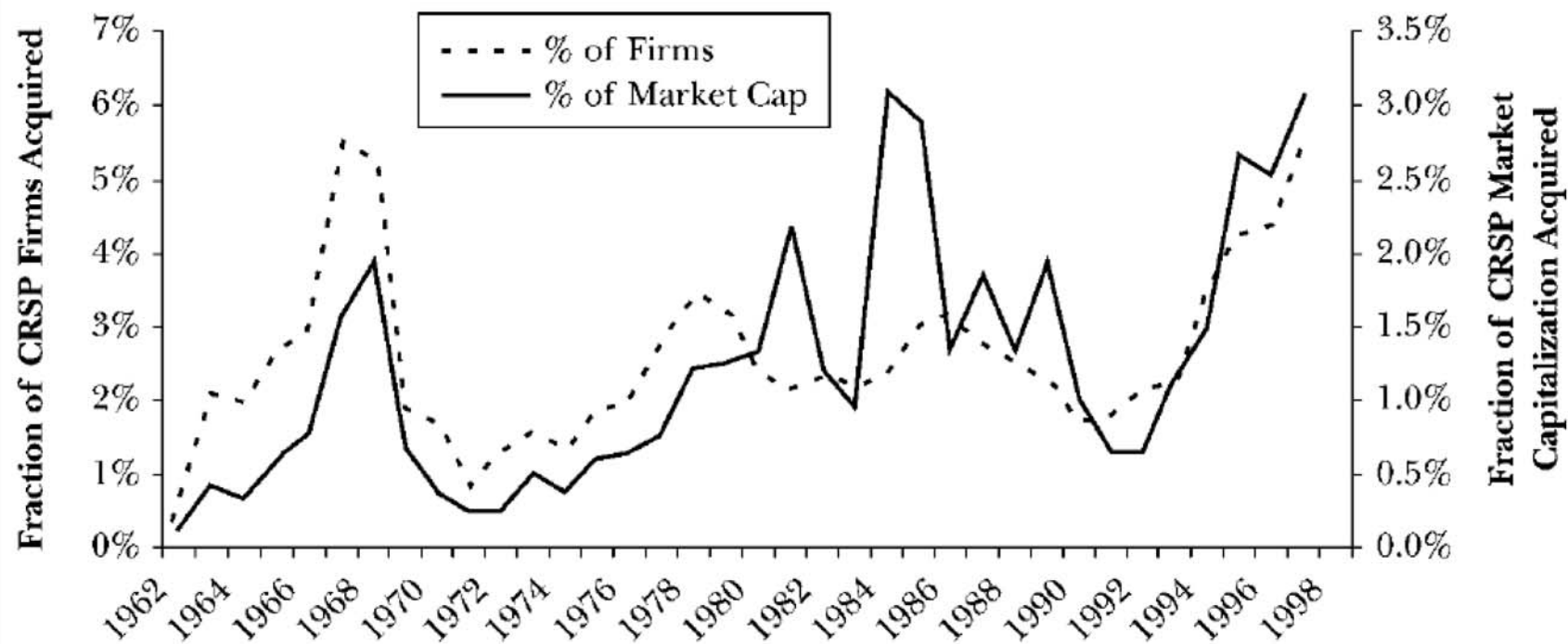
Stylized facts

1. Mergers occur in waves.

- 1920s/1930s: Mergers for market power.
- 1960s: Mergers for diversification (def.: 2-digit SIC).
 - Decreasing since 1960s.
(1970s: 70%, 1980s: 60%, 1990s: 52%)
 - Ultimately failures.
- 1980s: Mergers for market discipline.
 - 1980s: Half of all major US corporations received a takeover offer.
 - 14% hostile (only?); 4% in 1990s. (*hostile* = target publicly rejects or acquirer describes it as unsolicited and unfriendly)
- late 1980s and 1990s: Mergers of deregulation.
 - three major waves
 - large multi-billion dollar deals

Figure 1

Aggregate Merger Activity



**2. Within a wave,
mergers occur in industry clusters.**

- 1970s: Metal Mining, Real Estate, Oil & Gas, Apparel, Machinery
- 1980s: Oil & Gas, Textile, Misc. Manufacturing, Non-Depository Credit, Food
- 1990s: Metal Mining, Media & Telecommunication, Banking, Real Estate, Hotels

3. Merger financing

- 1970s, 1980s: less stock financing
 - 45% any stock
 - 37% or 32% all stock
- 1990s: stock-financing
 - 70% any stock
 - 58% all stock

Why?

... under/overvaluation?

... overconfidence?

... investment bankers?

4. Announcement Effects

- Methodology: Event Study
 - Average abnormal stock market reaction at announcement as measure of value creation / destruction.
 - Hypothesis: efficient capital market (immediate incorporation of expected value change into stock price).
 - Event windows: (a) short: 3 days (-1 to +1) and (b) long: several days prior to announcement to close of merger. **[Problem with (b)?]**
 - Software: Eventus (WRDS)

- AR 1973-1998

[both acquirer and target publicly traded!]

[mixing NYSE, NASDAQ, AMEX]:

value creation (?),

entirely accruing to target shareholders (!!)

- Target:

positive, **significant** (16%) for -/+1

positive, **significant** (24%) for -20/close

- Acquirer:

negative, **insignificant** (-0.7%) for -/+1

negative, **insignificant** (-3.8%) for -20/close

- Combined:

positive, **significant** (1.8%) for -/+1

positive, **insignificant** (1.9%) for -20/close

- Magnitude
 - Median target value \$230m \implies 16% = \$37m
 - Average annual return publicly traded companies = 12% \implies 16% normally over 16 months
- Effect much more striking in \$\$ than in % \rightarrow Moeller et al.

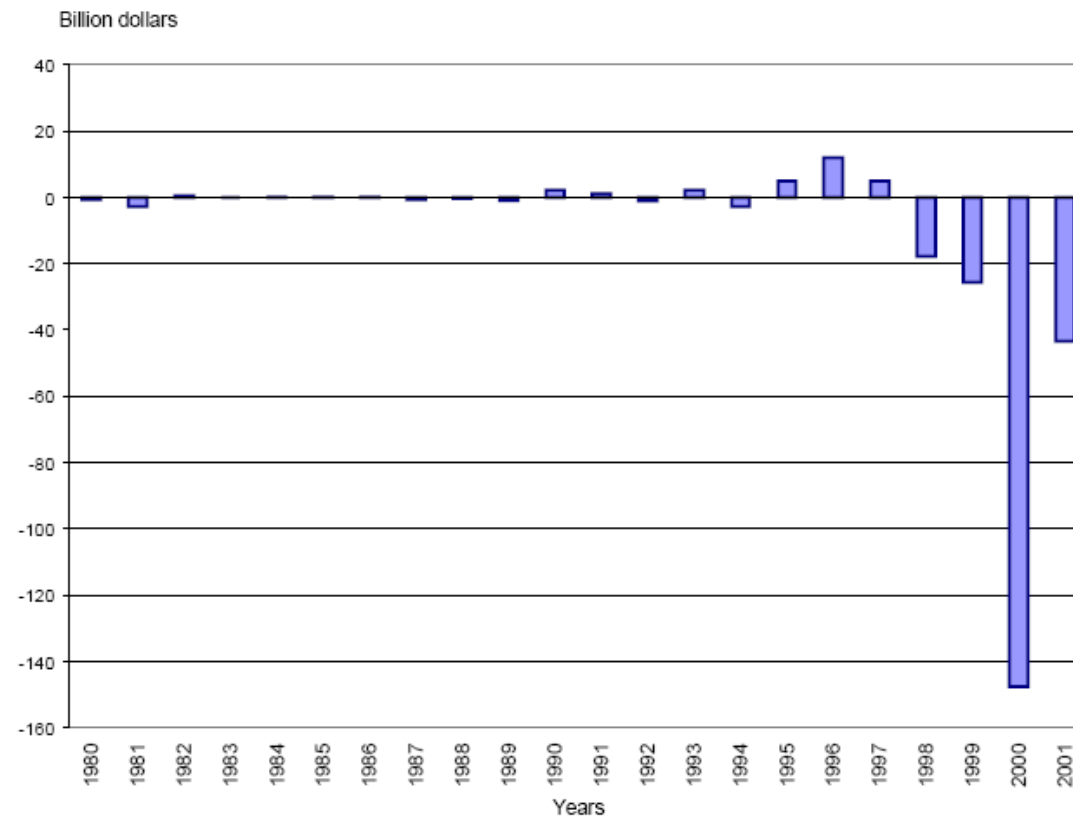


Figure 1. Yearly aggregate dollar return of acquiring-firm shareholders (1980 to 2001). Data are from the SDC Mergers and Acquisitions Database. The graph shows the aggregate dollar return associated with acquisition announcements for each sample year. The aggregate dollar return is defined as the sum of the product of the abnormal return of each announcement multiplied by the equity capitalization of the acquirer.

- Dollar loss of acquiring-firm shareholders = change in the acquiring firm's capitalization over the three days surrounding acquisition announcements (for transactions exceeding 1% of the market value of the assets of the acquirer)
- Sample: yearly aggregate losses to acquiring-firm shareholders for our sample of acquisitions of public firms, private firms, and subsidiaries from 1980 through 2001.
- From 1991 to 2001: acquiring firms' shareholders lost an aggregate \$216 billion (more than 50 times the \$4 billion lost 1980-1990)

- Most of the acquiring-firm shareholder losses took place from 1998 through 2001
 - -\$4 billion in the 1980s,
 - +\$24 billion 1991-1997
 - -\$240 billion 1998-2001.
- NOTE: even the aggregate combined value of acquiring and acquired firms falls by a total of \$134 billion (public firm acquisition announcements 1998-2001).

5. Announcement Effects and Financing

- Equity-financed mergers
 - Acquirer: -1.5%, significant (but insignificant over “-20/close”)
 - Target: 13%, significant
 - Combined: 0.6%, insignificant
- No-equity
 - Acquirer: 0.4%, insignificant
 - Target: 20%, significant
 - Combined: 3.6% significant (but insignificant over “-20/close”)

Link to asymmetric information (Myers-Majluf 1984)?

But: “double-signalling” (value of firm, value of merger)

But: variation over time?

But: combination stock/equity?

6. Long-Term Abnormal Returns

- If markets are not fully efficient ...
- *On average*: negative long-term AR acquirer; overwhelms positive combined stock-price reaction at announcements
- *Financing*: [Loughran and Vijh (1997)] five-year long-term AR 1970-89
 - Stock-Financed: -24.2%
 - Cash-Financed: +18.5%
- *Book-to-Market*: [Rau and Vermaelen (1998)] three-year long-term AR 1980-91
 - Value firms: + 7.6%
 - Growth/Glamour firms: -17.3%
 - Why?

- * Fama and French (1992, 1993): increased risk of value firms
- * Lakonishok, Shleifer, Vishny (1994): investors mistakenly estimate future performance by extrapolating from past performance
- But: methodological problems
 - Tests of long-term abnormal performance are joint tests of stock market efficiency and a model of market equilibrium (Fama 1970).
 - Abnormal returns are not independent across firms. (Clustering by industries.)

Next Question: Why and How?

We will think of M&A as “another type of investment” and go over the motivations (models) considered for internal investment.

$$V(c) = V_A + V_T + e - c$$

and

$$V^{old}(c) = \frac{s}{s + s'} [V_A + V_T + e - c].$$

4 Homework 2 (15 points)

Suppose you are interested in the question whether suboptimal investment is related to CEO incentives (CEO compensation). You decide to investigate the relationship between investment-cash flow sensitivity to equity compensation of CEOs using as large as possible a sample that Compustat and ExecuComp allow you to use.

1. Generate the sample of firms/CEOs for which you have all data necessary to analyze I/CF sensitivity AND compensation. Provide detailed summary statistics.
2. Replicate the result of investment-CF sensitivity for your sample (following the specification in previous literature).

3. Document the stylized features of CEO compensation for your sample.
4. Relate I/CF to compensation.
5. What do you conclude? What are the limits of what you can conclude from that type of exercise (endogeneity, data issues, ..)?
6. Do you have an idea how to overcome these limits?

On 1: Please include a detailed description of each step of the data generating process.

On 2-4: Use STATA. Provide a detailed description of your empirical steps (regression specification). I may ask for your do-files and dta-files.

Due: in 2 weeks in class (February 27, 2007)