Econ 234C – Corporate Finance
Lecture 2: Internal Investment (I)

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1 Corporate Investment

1.1 A few basics from last class

Baseline model of investment and financing

- Three-periods, firm has existing assets A and s shares outstanding.
- Ass. 1: financing with internal cash or equity issuance; no debt
  Ass. 2: zero interest rate
- Timeline
  - $\mathbf{t = 0}$: return function $R(I)$ becomes known to CEO + investors; R defined on $[0, \infty)$, $R' > 0$, $R'' < 0$, $R'(I) > 1$ for some I.
  - $\mathbf{t = 1}$: cash flow C is realized (firm's new net worth $A + C$); CEO chooses I.
  - $\mathbf{t = 2}$: $R(I)$ realized.

CEO's optimization problem

CEO maximizes shareholder value subject to the financing constraint:

$$\max_I \ \frac{s}{s+s'}(A+R(I))$$

$$\text{s.t. } \frac{s'}{s+s'}\cdot(A+R(I)) = I - C \quad \text{if } I > C$$

$\Longrightarrow$ First-order condition: $R'(I) = 1$.

Digression: We are assuming that a CEO (in a world without incentive problems, without asymmetric information) maximizes $s/(s+s') \cdot (A + R(I))$. What does this mean? What alternative assumption would make sense (i.e., is consistent with 'shareholder-vaue maximization')? How does the maximization problem look like now?

Would it make a difference? If so for what?

1.2 Empirical Evidence on Investment

- Theory: In a frictionless world, investment $\perp$ cash flow. (Firm can borrow at market interest rate.)

- Baseline empirical test:

$$I_{k,t} = \alpha + \beta C_{k,t} + X'_{k,t}\Gamma + \mu_k + \nu_t + \varepsilon_{k,t}$$

  where C is cash-flow of company k in year t,
  $X_{k,t}$ includes a proxy for investment opportunities ($Q_{k,t}$)

- Much of the empirical evidence is about testing whether coefficient β significantly different from 0.

Remark:

- What bigger question are we trying to address here (indirectly)?
- Why don't we ask it directly?
- Can you think of ways of asking directly?
- Can you think of OTHER ways of asking this question indirectly?

Identification of Investment-Cash Flow Sensitivity

- Model: $I_{k,t} = \alpha + \beta C_{k,t} + X'_{k,t}\Gamma + \mu_k + \nu_t + \varepsilon_{k,t}$

- Identification: Need exogenous shock to $C_{k,t}$

  1. Unexpected gains from law-suits (Blanchard, Lopez-de-Silanes, Shleifer, *JFE* 1994): windfall gains used for acquisitions.

  2. Oil price shocks (Lamont, *JF* 1997): impact on investment in non-oil segments of oil companies.

  3. Hurricanes (Froot-O'Connell, 1997): reinsurers supply less earthquake coverage after post-hurricane payments.

  4. Non-linearities in pension fund requirements (Rauh, *JF* 2006).

Identification using Oil Price Shocks (Lamont, JF 1997)

- **Idea:**
  - **Step 1**: exogenous shock to cash flow available to a firm
    $\Longrightarrow$ oil price exogenously determined + affects CF of oil firms

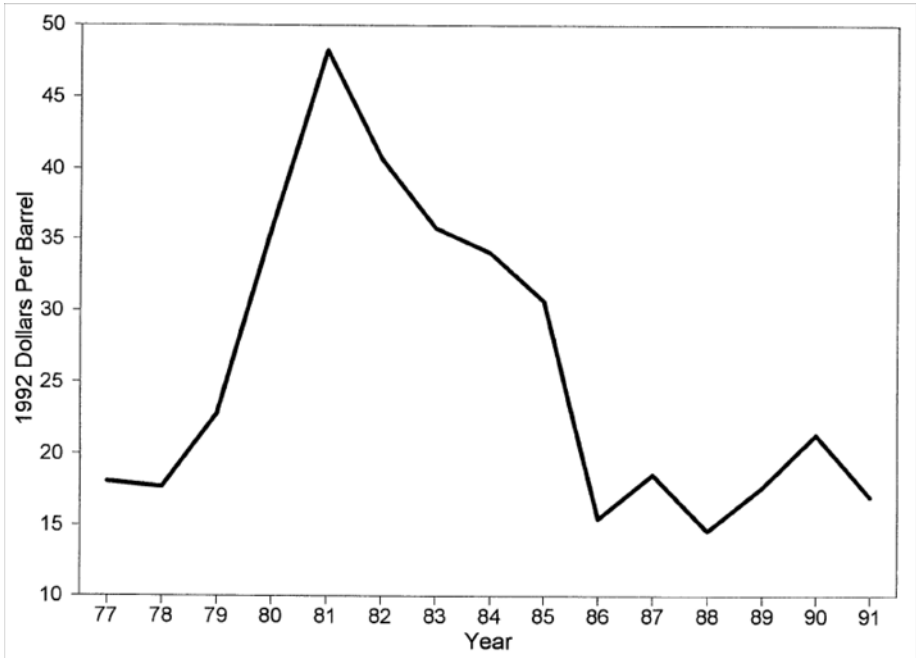


Figure 1. Real crude oil prices 1992 dollars per barrel.

  - **Step 2**: exogenous shock needs to be orthogonal to investment opportunities (quality of investment projects)
    $\Longrightarrow$ non-oil subsidiaries of oil companies

- **Caveat:** joint hypothesis test with financial frictions
  + internal capital markets ("corporate socialism")

- **Data:**
  - Focus on 1986 oil price decrease.
    Argument 1: size of price change: -50%
    (from \$26.60/barrel in 12/1985 to \$12.67/barrel in 4/1986).
    Argument 2: unanticipated
    (What is otherwise the problem?)

  - Def. oil company: primary or secondary SIC as oil/gas extraction
    AND $\geq 25\%$ of $C_{k,1985}$ from oil/gas extraction.

  - Def. non-oil-segment: ρ(profit, oil price) ≤ 0.

- Final sample: 26 firms, 40 segments

- Note:
  * "Exclusion of financial or services industry as it is standard (because of complex accounting variables)"
  * Concrete examples; quotes from newspapers, annoual reports!
  * Appendix with full listing, including the *excluded* firms.

- **Results**: Table III ($\Delta =' 86 -' 85$) :'eye-ball test'

  - increase in CF in nonoil segments

  - decrease in investment in nonoil segments

	Company	Segment	Δ I/S	Δ CF/S	1985 Size (Mil $)	SIC Codes	
1	Amoco Corp	Chemicals	3.46	5.88	2905	2860	2820
2	Atlantic Richfield	Spec & Int. chemicals	2.38	1.97	2155	2869	2865
3	Burlington Northern	Forest products	−1.60	1.55	258	2411	2421
4	Burlington Northern	Railroad	−6.63	−4.27	4098	4011	6519
5	Canadian Pacific Ltd	Forest products	1.66	1.61	1546	2621	2421
6	Canadian Pacific Ltd	Railroad	−3.40	−1.38	2408	4011	
7	Chevron Corp	Chemicals	−1.30	6.05	2246	2869	2865
8	Dekalb Energy Co	Agricultural seed	−2.85	−13.16	201	115	119
9	Du Pont	Ag-Ind. chemicals	−0.67	10.72	3388	2879	2819
10	Du Pont	Biomedical products	0.19	3.08	1016	3844	3841
11	Du Pont	Fibers	1.43	10.77	4483	2824	2297
12	Du Pont	Indus.-cons. products	0.02	−0.65	2780	3861	3679
13	Du Pont	Polymer products	−0.69	3.53	3379	2821	3081
14	Fina Inc	Chemicals	−0.95	9.36	405	2821	2821
15	Grace (W.R.) & Co	Specialty business	−0.91	0.42	787	2066	5192
16	Grace (W.R.) & Co	Specialty chemicals	−1.21	−1.01	2254	2800	3086
17	Homestake Mining	Gold	−16.64	12.11	169	1041	
18	Imperial Oil Ltd	Chemicals	0.81	4.08	542	2860	2870
19	Kerr-McGee Corp	Chemicals	−2.33	5.22	483	2812	2816
20	Litton Industries	Adv. electronic	2.84	−5.65	1863	3812	3679
21	Litton Industries	Marine engin. & prodtn	−0.32	0.05	975	3731	3663
22	Mobil Corp	Chemical	−0.40	4.86	2266	3081	2821
23	Mobil Corp	Retail merchandising	−0.88	2.57	6073	5311	5961
24	Nova Corp of Alberta	Petrochemicals	6.92	2.09	541	2869	2821
25	Occidental Petroleum	Agribusiness	0.40	0.37	6510	2011	6512
26	Occidental Petroleum	Chemicals	−1.19	2.87	1621	2812	2874
27	Phillips Petroleum	Chemicals	0.72	8.65	2266	2869	2821
28	Placer Dome Inc	Mining	−0.43	1.10	221	1041	1021
29	Royal Dutch/Shell Grp	Chemicals	−1.09	8.52	8583	2800	2820
30	Schlumberger Ltd	Measurement & systems	0.51	0.13	1619	3820	7373
31	Southdown Inc	Cement and concrete	−4.54	−0.29	265	3241	6519
32	Tenneco Inc	Automotive parts	0.77	1.65	1074	3714	5531
33	Tenneco Inc	Chemical	−1.87	2.34	841	2819	2800
34	Tenneco Inc	Packaging	−0.72	0.25	851	2631	3089
35	Tenneco Inc	Shipbuilding	−1.80	−0.00	1801	3731	3610
36	Union Pacific Corp	Transportation	−4.39	6.87	3786	4011	4213
37	Unocal Corp	Chemicals	−2.39	0.44	1217	2873	2999
38	Unocal Corp	Metals	−9.41	−3.42	129	1099	1061
39	USX Corp	Steel	−1.44	−8.72	6263	3312	1011
40	Zapata Corp	Marine protein	−10.29	16.45	93	2048	2077
	Average		−1.46	2.43	2109		

Table V

Change in I/S, 1985–1986

Dependent variable: Δ *I/S*, where I is segment capital expenditure and S is segment sales. Expressed as percentage points. Median: The *Z*-statistic is the Wilcoxon signed-rank test, which tests the hypothesis that the observations are iid and symmetrically distributed around zero. Number positive: the 2-sided *p*-value is the probability of observing at most this number of positive or negative values, under the null hypothesis that the observations are independent and prob[positive] = 0.5. Industry-adjustment: For each observation of Δ *I/S*, I subtract the median value of Δ *I/S* from a control group of COMPUSTAT segments that were in the same industry, but were owned by companies that did not have an oil extraction segment.

	Raw	Industry-Adjusted
No. of Observations	40	39
Mean	−1.46	−1.41
t-statistic	(2.34)	(2.06)
p-value	(0.02)	(0.05)
Median	−0.90	−0.80
Z-statistic	(2.51)	(2.18)
p-value	(0.01)	(0.03)
Number positive	13	12
p-value	(0.04)	(0.02)

- Limits:
  - Mere time-series identification. $\Longrightarrow$ What is the problem?
    See Table I, Panel A:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Panel A: Profit Rates for Lines of Business for FRS Petroleum Companies											
Consolidated	15.3	12.4	7.7	7.4	6.9	5.5	3.0	3.6	7.2	6.4	6.8
Petroleum	19.2	16.6	12.5	11.3	10.4	10.5	5.5	6.2	7.3	6.7	9.5
US Petroleum	17.5	16.1	12.7	10.3	9.4	9.4	3.0	4.9	6.3	5.8	7.9
Oil and Gas Production	20.9	20.2	14.0	11.3	10.8	9.5	0.8	4.1	2.8	2.9	8.5
Refining and Marketing	9.8	4.4	6.0	4.8	0.3	6.5	4.5	2.9	14.7	11.5	5.2
Pipelines	15.1	15.6	20.8	16.6	20.8	15.0	13.2	12.8	9.6	10.2	11.2
Foreign Production	23.0	17.7	11.8	14.1	13.3	13.8	12.8	9.5	9.9	8.7	12.5
Oil and Gas Production	25.1	25.5	17.4	19.6	18.8	20.0	11.6	12.4	9.2	8.9	13.1
Refining and Marketing	26.4	9.0	4.7	7.7	4.5	3.3	16.3	4.7	11.6	8.0	11.2
International	2.4	−1.1	−6.3	−13.2	−14.0	−19.0	5.3	−3.6	6.8	12.4	11.7
Marine											
Coal	5.6	6.1	4.4	5.0	6.2	4.6	2.7	5.1	6.7	5.0	3.3
Nuclear and Other Energy	−0.7	−6.8	−5.2	0.5	−1.8	−8.4	−0.8	0.5	−2.5	−2.3	1.9
Nonenergy	5.9	3.5	0.6	2.9	4.8	4.2	5.1	12.2	20.3	17.3	7.8

Increase in non-energy profit rate in 1986 supports identifcation.

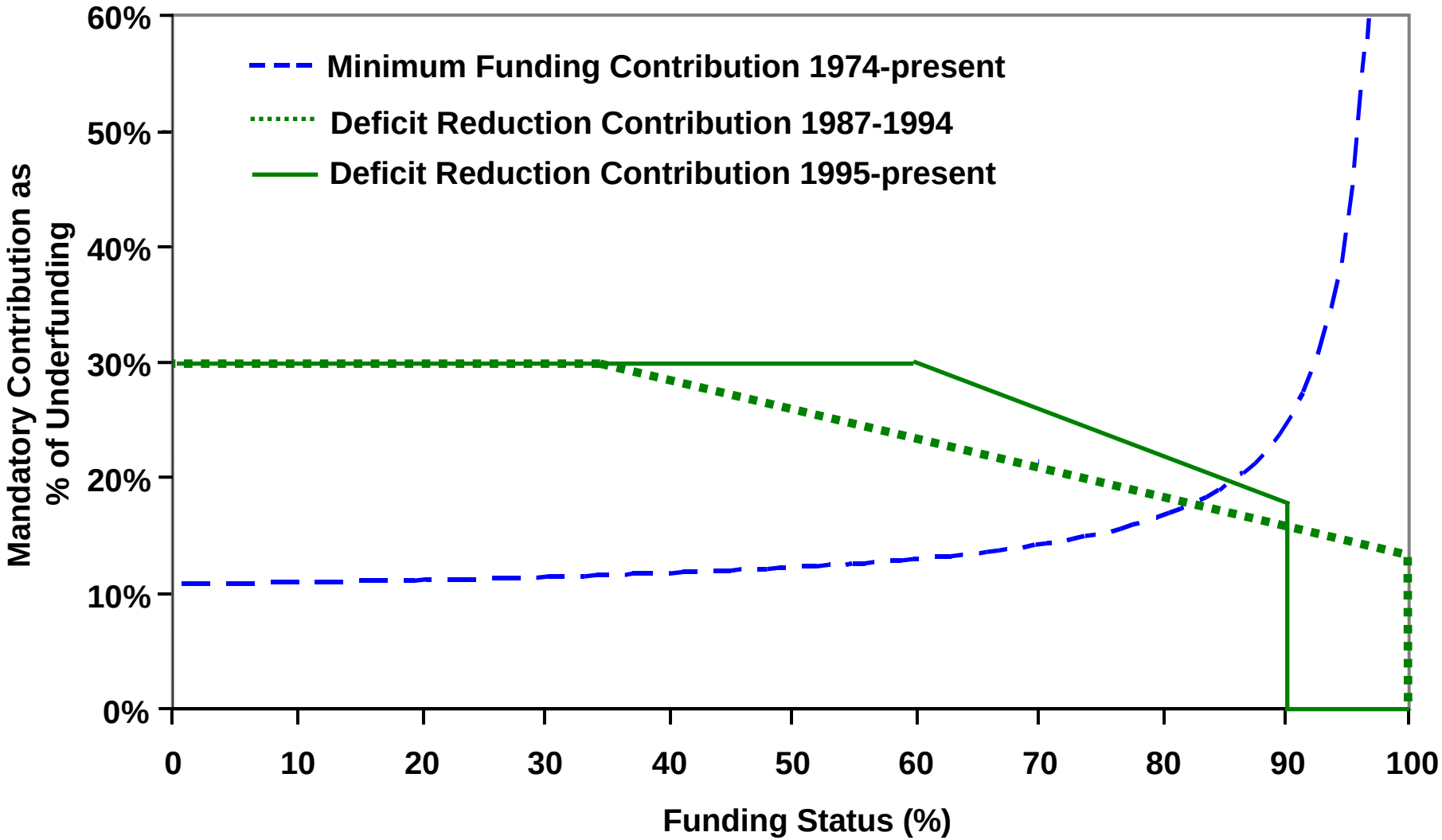
Explosion in 1987 casts doubt on identification. (Why?)

Other Evidence

- Windfall gains from law-suits
  (**Blanchard, Lopez-de-Silanes, Shleifer, JFE 1994**)
  - Problem: $N = 11$

- Non-linearities in pension fund requirements (**Rauh, JF 2006**)
  - Firms that sponsor defined benefit (DB) pension plans must make financial contributions to their pension funds.
    * If underfunded, mandatory contributions.
    * If overfunded, contributions only up to a limit.
  - Contributions affect internal financial resources.
  - If a firm is financially constrained, contributions thus affect ability to invest.

Mandatory Contributions (%)



Minimum funding contribution drawn for a firm with sample mean characteristics: liabilities of $37.3m, a normal cost of $1.3m, and prior credits of $0.5m.

- Issues (many of which explored by Rauh himself in follow-up papers!)
  - Claim: Required contributions exogenous relative to investment opportunities.
  - But: investment & hiring / age structure / turnover etc?
  - Manipulation similar to earnings manipulation?
  - As with Lamont: investment further before and further after.
  - Does not exploit (much) the discontinuity between funded and underfunded. (Only within underfunded)

Broad conclusions from above papers:

- I/CF sensitivity exists
- It remains hard to put a $$ amount on it.
- It remains hard to understand generalizability.

1.3 Why is Investment Sensitive to Cash Flow?

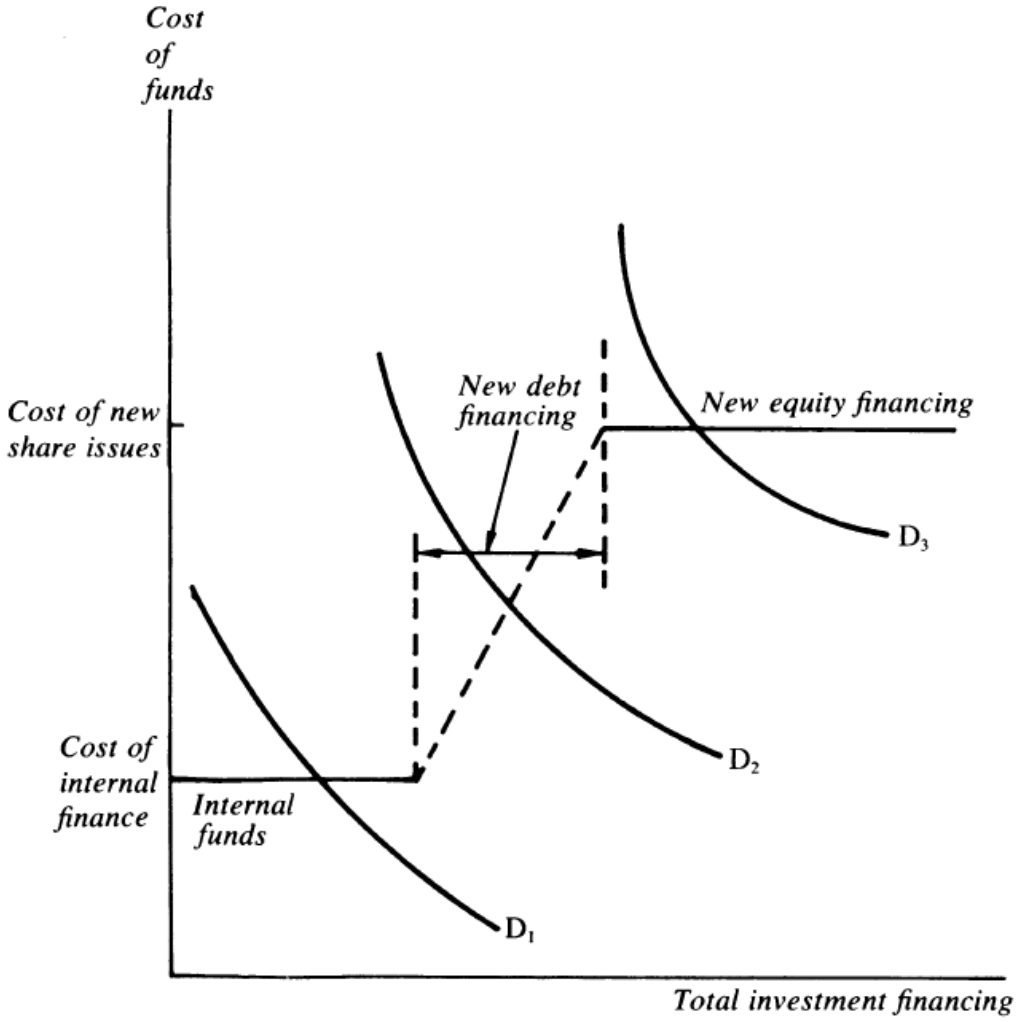
- Prime hypothesis: financial constraints.

- Cost of external equity finance
  $>$ cost of external debt finance
  $>$ cost of internal finance.
  (Pecking order)

- Illustration from **Fazzari, Hubbard and Petersen (1988)**

  – $D_1/D_2/D_3 =$ low/medium/high level of investment demand (depending on Q)

Figure 1. Investment and Financing Decisions



$$I_{k,t} = \alpha + \beta C_{k,t} + X'_{k,t}\Gamma + \mu_k + \nu_t + \varepsilon_{k,t}$$

Fazzari, Hubbard and Petersen (1988) sort on a priori measures of constraint (dividends) and interpret β.

Kaplan and Zingales (1997) show that β is not higher for firms that truly appear constrained.

Sample: 49 low-dividend paying firms from FHP (1988)

Data source: letters to shareholders, management discussions of operations and liquidity, financial statements with notes (from annual report / 10-K filings); COMPUSTAT instead of VALUELINE data

Establish comparability of sample

TABLE I

COMPARISON OF REGRESSION OF INVESTMENT ON CASH FLOW AND Q WITH FAZZARI, HUBBARD, AND PETERSEN RESULTS

Regression of investment on cash flow and Q for 49 low-dividend firms from Fazzari, Hubbard, and Petersen [1988], (hereinafter FHP [1988]), from 1970 to 1984 compared with estimates in FHP. KZ refers to our estimates. Investment is capital expenditures (COMPUSTAT item 128). Cash flow equals the sum of earnings before extraordinary items (COMPUSTAT item 18) and depreciation (COMPUSTAT item 14). Investment and cash flow are deflated by beginning of year capital (K_{t-1}) which we define as net property, plant, and equipment (COMPUSTAT item 8). Q equals the market value of assets divided by the book value of assets (COMPUSTAT item 6). Market value of assets equals the book value of assets plus the market value of common stock less the sum of the book value of common stock (COMPUSTAT item 6) and balance sheet deferred taxes (COMPUSTAT item 74). All regressions include firm fixed effects and year effects. Standard errors are in brackets.

	KZ 1970–84	KZ 1970–84	FHP 1970–84	KZ 1970–79	KZ 1970–79	FHP 1970–79	KZ 1970–75	KZ 1970–75	FHP 1970–75
CF_t/K_{t-1}	0.395	0.500	0.461	0.477	0.578	0.540	0.558	0.634	0.670
	[0.026]	[0.023]	[0.027]	[0.035]	[0.030]	[0.036]	[0.040]	[0.034]	[0.044]
Q_{t-1}	0.039		0.0008	0.030		0.0002	0.021		−0.0010
	[0.005]		[0.0004]	[0.006]		[0.0004]	[0.006]		[0.0004]
Adj. R^2	0.584	0.548	0.46	0.649	0.627	0.47	0.764	0.753	0.55
N obs.	719	719	N.A.	476	476	N.A.	280	280	N.A.

Next step:Split firms in quintiles of 'severity of being financial constrained' and show that I/CF sensitivity is *not* increasing in financial constraints.

TABLE V

REGRESSION OF INVESTMENT ON CASH FLOW AND Q BY FINANCIALLY CONSTRAINED STATUS OVER ENTIRE SAMPLE PERIOD

Regression of investment on cash flow and Q for 49 low-dividend firms from FHP [1988] from 1970 to 1984. Variables are defined in Table I. Regressions are estimated for total sample and by financially constrained status where 19 firms are never financially constrained over the entire period (NFC or LNFC in every year), 8 firms are possibly financially constrained at some time (PFC in some year), and 22 firms are likely financially constrained at some time in the period (LFC or FC). Overall status is based on firm financing constraint status for each year of not financially constrained (NFC), likely not financially constrained (LNFC), possibly financially constrained (PFC), likely financially constrained (LFC), and financially constrained (FC). All regressions include firm fixed effects and year effects. Standard errors are in brackets.

	All firms N = 49	Firms never constrained N = 19	Firms possibly constrained N = 8	Firms likely constrained N = 22	Firms never/possibly constrained N = 27	Firms possibly/likely constrained N = 30
CF_t/K_{t-1}	0.395	0.702	0.180	0.340	0.439	0.250
	[0.026]	[0.041]	[0.060]	[0.042]	[0.035]	[0.032]
Q_{t-1}	0.039	0.009	0.016	0.070	0.033	0.059
	[0.005]	[0.006]	[0.049]	[0.018]	[0.006]	[0.017]
Adj. R^2	0.584	0.793	0.240	0.410	0.655	0.358
N obs.	719	279	113	327	392	440

Main insights:

1. 'Dividends' is not a good proxy for financial constraints. The median firm in the highest quintile coud have paid large dividends (58% of investment) without seeking additional funding / permission from current lenders.

2. Financial constraints do not explain I/CF sensitivity. Nver-constrained firms have the hightes I/CF sensitivity.

Side product: KZ index as a measure of financial constraint.

$$\begin{aligned} KZ_{it} &= -1.001909 * \frac{CF_{it}}{K_{it-1}} + 0.2826389 * Q_{it} + 3.139193 * Lev_{it} \\ &\quad -39.3678 * \frac{Dividend_{it}}{K_{it-1}} - 1.314759 * \frac{C_{it}}{K_{it-1}} \end{aligned}$$

$==>$ Typical use: quintiled.

$==>$ Often double-lagged (endogeneity).

(**Other ex-ante measures of financial constraints**: age, debt-rating)

Theories relating to I/CF sensitivity

- Asymmetric information
  - Implies underinvestment (external financing more costly than internal financing)
  - Myers and Majluf (1984)
- Manager-shareholder agency problems
  - Tendency to over-invest; (internal resources easier to divert)
  - Jensen and Meckling (1976), Stulz (1990), Hart and Moore (1995)
- Overoptimism/overconfidence
  - Tendency to over-invest; but perceived undervaluation may lead to underinvestment in the case of equity-financing
  - Heaton (2002); Malmendier and Tate (2005)

1.4 Required reading for next class:

- Myers, Stewart and N. Majluf (1984), "Corporate Financing and Investment Decisions when Firms Have Information that Investors Do Not Have," Journal of Financial Economics 13, pp. 187-222.

- Jensen, Michael and William Meckling (1976), "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure," Journal of Financial Economics 3, pp. 305-360.

- Jensen, Michael (1986), "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers," American Economic Review 76, pp. 323-329.

1.5 Take away & Research Ideas

- If your main field is not finance:
  - Clean estimates of the phenomenon (in education economics, development economcis).
  - Exploring explanations other than financial constraints in areas where financial constraints is the typical explanation (e.g. firm-level growth data in development).
  - Use investment-CF sensitivity where you are 'really' interested in investment quality (as a measure of the 'degree of suboptimality').

- If your field is finance:
  - My guess (my personal taste?): little room for yet another identification / criticism (despite lack of the perfect paper).

- Direct measures of investment quality?

- Look at frictions *other* than sensitivity to cash flow, e.g. over-/underadjustment to demographic trends.