Corporate Investment

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Modigliani- Miller and the neoclassical model

- Convergence of different theories and philosophies:
  - In 1958, Modigliani and Miller irrelevance theorem: under certain conditions, firms' financial structure is irrelevant for the total market value of the firm
  - Neoclassical theory of investment is based on this fundamental idea, (developed by Dale Jorgenson (1967) among others):

    "the firm's inter-temporal optimization problem could be solved without reference to financial factors; namely, firms' cost of capital is set in a centralized securities market and is not dependent on the firm's particular financial structure."

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But, theory deviated from Modigliani- Miller theorem

- A common prediction of many models developed in the 70s in corporate theory:
  - Investment increases with internal cash. Why?
    - In asymmetric info. models, equity is costly, thus internal cash helps with underinvestment.
    - In agency models, managers are empire builders and have different objectives from the shareholders, thus internal cash exacerbates overinvestment.
  - Two very different predictions of why investment is sensitive to cash:
    - either because the manager has now the ability to invest closer to the optimum (asymmetric information)
    - or because he can now deviate more from the optimum (agency models)

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Can we test this empirically?

- Empirical analyses of investment studied the question by estimating an investment regression:
  - I = a + b Q + c CF
  - Studies typically find that investment is much more strongly related to cash flow than it is to (average) q.
- Where Q is what?
- And CF?

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Challenges

- Fundamental empirical difficulties:
  - Cash flows are endogenous.
    - High cash flow proxies for profitability, investment prospects.
    - Hard to get a good control for investment prospects with q
      - i.e., cash flow may be better measure of marginal investment prospects than q.
      - q measures risk? past success?
  - **Problem 1: if regress I on q and CF, may get positive coefficient on CF even absent financing constraints.**
  - Problem 2: interpretation: If CF coeff is positive, is it overinvestment or underinvestment?

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Fazzari Hubbard Petersen (1988)

- Fazzari, S.M., R.G. Hubbard and B.C. Petersen (1988), "Financing Constraints and Corporate Investment,"
  - Argue that investment in financially constrained firms should vary more with cash flow than in non-financially constrained firms.
    - I = a + b Q + c CF
      - For non-financially constrained firms, only q should matter.
        - » i.e., c = 0.
      - Any non-zero CF coefficient, c, in unconstrained regression indicates a bias.
      - If bias is same across two groups, can net it out
    - For financially constrained firms, the constraint prevents firms from investing in a value maximizing way.
      - Every extra dollar of cash can be invested in positive present value projects.
      - I.e., c > 0.

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Fazzari Hubbard Petersen (1988)

- They test this conjecture dividing their sample of firms into three sub-samples according to the level of firms' retention of internal funds
  1) the low dividend-income ratio (firms that retain a lot: dividend-income ratios of less than 0.1 for at least 10 years),
  2) the medium dividend-income ratio (firms that retain a bit: dividend-income ratios greater than 0.1 but less than 0.2 for at least 10 years), and
  3) the high dividend-income ratio (firms that retain less: dividend-income ratios greater than 0.2).
- More retention (or less dividends) and investment from firms' internal income is a proxy for firms that are likely to face relatively high costs of external finance, i.e. a proxy for financial constraints.

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Fazzari Hubbard Petersen (1988)

Intuition:

Firms pay low dividends because they require investment finance that exceeds their internal cash flow and retain all of the low-cost internal funds they can generate

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Fazzari, Hubbard and Petersen (1988)

Empirical specification:

$$(I/K)_{it} = \mu_{it} + \mu_1 Q_{it} + \mu_2 (CF/K)_{it} + u_{it}$$

- Dependent variable: investment – capital ratio
  - I: investment in PPE
  - K: capital stock at the beginning of the period
- Independent variables:
  - Tobin's Q: Value of equity and debt less the value of inventories, divided by the replacement cost of the capital stock adjusted for corporate and personal taxes → control for growth opportunities
  - CF/K: cash flow – capital ratio
- Regressions also include firm and year fixed effects (not reported)

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Fazzari, Hubbard and Petersen (1988)

Table 4. Effects of Q and Cash Flow on Investment, Various Periods, 1970–84ᵃ

Independent variable and summary statistic	Class 1	Class 2	Class 3
		1970–75	
Q_{it}	−0.0010	0.0072	0.0014
	(0.0004)	(0.0017)	(0.0004)
$(CF/K)_{it}$	0.670	0.349	0.254
	(0.044)	(0.075)	(0.022)
$\bar{R}^2$	0.55	0.19	0.13
		1970–79	
Q_{it}	0.0002	0.0060	0.0020
	(0.0004)	(0.0011)	(0.0003)
$(CF/K)_{it}$	0.540	0.313	0.185
	(0.036)	(0.054)	(0.013)
$\bar{R}^2$	0.47	0.20	0.14
		1970–84	
Q_{it}	0.0008	0.0046	0.0020
	(0.0004)	(0.0009)	(0.0003)
$(CF/K)_{it}$	0.461	0.363	0.230
	(0.027)	(0.039)	(0.010)
$\bar{R}^2$	0.46	0.28	0.19

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Fazzari, Hubbard and Petersen (1988)

- <u>Results:</u>
- Firms that do not pay dividends have greater investment-cash flow sensitivity than firms that pay dividends.
- Interpreted as evidence of underinvestment due to financial constraints.
- the cash flow coefficient is largest for firms in class 1, then for class 2, and the lowest for class 3.
- Moreover, the differences between the estimated coefficients across classes are always statistically significant at very high confidence levels. Robustness checks lead to similar results
- <u>Interpretation:</u>
  - Investment is two or three times more sensitive to cash flow fluctuations in the first class of firms than it is in the third.
- <u>Conclusion:</u>
  - class 1 firms (the ones that retain more earnings) have a higher cash flow sensitivity effect on investment due to financial constraints.
  - → Negative relationship between investment - cash flow sensitivities and financing constraints

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Fazzari, Hubbard and Petersen (1988)

- Some questions for FHP approach:
  - Is measurement error in q worse for young, “constrained” firms?
  - Are profits more informative about investment prospects?
- Both objections could explain the results

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Fazzari, Hubbard and Petersen (1988)

- Follow up papers:
  - Several papers after FHP88 investigated this link, using different hypothesis of which firms would be financially constrained
    - e.g small firms vs. large firms, firms in a conglomerate vs stand alone firms
- How the paper became influential:
  - The empirical strategy became a "technique" to identify firms that were financially constrained, e.g. to prove some theoretical hypothesis regarding which firms were more likely to be financially constrained.

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How influential was FHP?

Financing constraints and **corporate investment**
S Fazzari, RG Hubbard, BC Petersen - 1988 - nber.org
Most empirical models of **investment** rely on the assumption that firms are able to respond to
prices set in centralized securities markets (through the" cost of capital" or" q"). An alternative
approach emphasizes the importance of cash flow as a determinant of **investment ...**
Cited by **5042** Related articles Library Search BL Direct All 24 versions

[PDF] The **cost** of **capital**, **corporation finance** and the **theory** of investment
F Modigliani, MH Miller - The American economic review, 1958 - JSTOR
What is the" **cost** of **capital**" to a firm in a world in which funds are used to acquire assets
whose yields are uncertain; and in which **capital** can be obtained by many different media,
ranging from pure debt instruments, representing money-fixed claims, to pure equity **...**
Cited by 12456 Related articles Library Search All 32 versions

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Example of papers following FHP

- Hoshi, Takeo, Anil Kashyap and David Scharfstein (1991), "Corporate Structure, Liquidity, and Investment: Evidence from Japanese Industrial Groups,"
  - Divided Japanese firms into those that were part of keiretsu / bank group and those that were not.
    - Hypothesis: keiretsu involves close ties to a bank, eases info and agency problems.
  - Firms in keiretsu / bank group have lower I-CF sensitivity.
  - Conclude that bank relationships reduce financial constraints.
    - I.e., conclude banks reduce underinvestment.
    - Downplayed alternative explanation:
      - » bank relationships allow for non-economic investment, i.e., allow overinvestment.
  - **But, notice that non-keiretsu firms have lots of cash and look very financially healthy.**

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Example of papers following FHP

- Whited (1992): Firms with lower-than-average leverage interpreted, a priori, as relatively unconstrained firms.
- Kashyap, Lamont, and Stein (1994): firms with unusually high cash holdings are sometimes classified, a priori, as relatively unconstrained.
- All papers find investment-cash flow sensitivity greater for more constrained firms!
- A bit suspicious. What other effect can be going on?

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Example of papers following FHP

- R&D and cash flow sensitivities
- Firms in conglomerated groups and not
- Firms that have access to the bond market and firms that do not
- Cross-sectional regressions: Firms in countries with better corporate governance
- And so on… till…

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A really strong critique

- Kaplan and Zingales criticize the FHP approach saying that cash flow sensitivities do not provide useful measures of financing constraints.
  - They developed a very simple model explaining why
  - They asked FHP the original dataset of FHP (1988)
  - They totally overturned the results in FHP (1988)

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In details

Kaplan and Zingales (1997):

The empirical approach implicit in these paper rely on one fundamental hyp: that investment-cash flow sensitivities increase monotonically with the degree of financing constraints.

Two critiques:

1) Theoretical -- the relationship between investment – cash flow sensitivities and financing constraints is non-monotonic
2) Empirical --- let's analyze the specific sorting done by FHP and verify whether the firms classified as "constrained" are indeed as such

Kaplan and Zingales (1997):

Theoretical model:

FIRST BEST:

In the FB there are no financial frictions and each firm chooses I to maximize

$$Max\ F(I)-I$$

F(I) is the production function of investment with F'>0 and F''<0

The FOC is: $$F_1(I^{FB})=1$$

Kaplan and Zingales (1997):

SECOND BEST:

In the SB there are financing frictions: deadweight costs associated with funds raised externally.

Each firm chooses I to maximize

$$Max\ \ F(I)-C(E,k)-I$$
$$s.t.\quad I=W+E$$

W is the amount of internal funds, E are external funds

C(E,k) is an additional cost of external funds, with k the extent of information problems or agency costs. C increases in E and k.

The FOC is: $$F_1(I^{SB})=\left[1+C_1(I^{SB}-W,k)\right]$$

Kaplan and Zingales (1997):

SECOND BEST. Properties:

1) $I^{SB}(W,k) \leq I^{FB}$

By implicit differentiation of the FOC, we obtain the sensitivity of investment due to internal resources and to financing frictions:

2) $dI^{SB}/dW = \dfrac{C_{11}}{C_{11}-F_{11}} \geq 0$

3) $dI^{SB}/dk \leq 0$

Kaplan and Zingales (1997):

Theoretical model (continued):

Looking at the cross-sectional differences in the investment – cash flow sensitivity across groups of firms (FHP 88), corresponds to looking at differences in *dI/dW* as a function of W or k:

$$\frac{d^2I}{dW^2} = \left(\frac{F_{111}}{F_{11}^2} - \frac{C_{111}}{C_{11}^2}\right)\frac{F_{11}^2C_{11}^2}{(C_{11}-F_{11})^3}$$

Given that the second term is always positive, $\frac{d^2I}{dW^2}$ is negative only if the term in brackets is negative.

→ This need not be the case, it rather depends on the curvature of the cost function and of the production function at the optimal level of investment.

Kaplan and Zingales (1997):

Theoretical model (continued):

Similarly, one cannot in general sign the sensitivity of investment to cash flows with respect to *k:*

$$\frac{d^2I}{dkdW} = \frac{C_{112}F_{11}^2 - C_{112}C_{11}F_{11} + C_{12}C_{111}F_{11} - C_{12}C_{11}F_{111}}{(C_{11}-F_{11})^3}$$

It is easy to construct examples in which this derivative is positive and in which it is negative depending on the cost and production functions.

The **important message for empirical work** is that one has to be careful in using measures of cash flow sensitivity to investment as proxies for financing constraints.

→ *In comparing two firms, it is not necessarily true that the one with the higher empirically-measured sensitivity of investment to internal cash flow should be thought of as the one facing the more severe financing frictions*

Kaplan and Zingales (1997):

Empirical strategy:

- KZ then test crucial assumption that dI/dW increases with financial constraints / higher costs of external finance.
  - Strategy: Use direct observation.
    - Start with firms likely to face high costs of external finance.
      - Preferably firms with high investment-cash flow sensitivities.
    - Directly observe any problems in access to external funds.
  - KZ use 49 **non-dividend** paying firms used by FHP!
  - Key questions:
    - What is nature of financial constraints?
    - Are they really financially constrained?
    - Does variation in financially constrained status explain investment-cash flow sensitivity?

Kaplan and Zingales (1997):

- They classify each firm-year into 5 sub-groups depending on the degree of financial constraints, following a *different criteria* from FHP 88 for assessing their level of financial constraints:
  - Letters to shareholders, management discussions of operations and liquidity, financial statements
  - Wall Street Journal Index entries
  - Standard accounting variables from Compustat and annual reports
- They run the same regressions that FHP 88

Kaplan and Zingales (1997):

Results:

- Unconstrained firms exhibit greater investment - cash flow sensitivity than constrained firms
- Opposite to FHP 88!

Conclusion:

Investment – cash flow sensitivities are not useful measures of f[illegible]

	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

Kaplan and Zingales (1997):

Remarks:

- FHP 88 and KZ 97 show opposite results!

Where might the differences between the two empirical results come from?

1. The data set is the same
2. Empirical strategy is the same: OLS
3. Classification of firms? Not the same!
   1. FHP total investment includes fixed investment, inventories and accounts receivable. KZ only include fixed investment. Firms appear more constrained in KZ
   2. Unused lines of credit and cash stock may come from precautionary savings of financially constrained firms (FHP) or from pure financial slack (KZ)
   3. Financially distressed firms may use a lot of cash to enhance liquidity and avoid bankruptcy although they are financially constrained, then sensitivity appears low (KZ and FHP agree)
   4. Leverage effect: firms with more liquid assets borrow more and thus are more sensitive to profitability shocks. Then, less financially constrained firms may exhibit more sensitivity than more financially constrained firms.

   → Classification matters!!

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Example of classification

- *"Our financial position is sound ... Most of the company's funds are generated by operations and these funds grew at an average annual rate of 29% [over the past 3 years]. Throughout the company's history this self-financing concept has not been a constraint on the company's growth. With recent growth restrained by depressed economic conditions, the company's net cash position has grown substantially." Hewlett-Packard 1982 Annual Report.*

- H-P does not pay a dividend during sample period.
  - According to FHP, H-P is financially constrained!
- According to KZ, H-P is not financially constrained.
  - H-P has enough cash to finance large additional capital expenditures.

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Results

- On average, firms do not appear contemporaneously liquidity or financially constrained - 85% of firm-years.
  - E.g., Hewlett-Packard is not unusual.
- Firms **least** financially constrained have **highest** investment-cash flow sensitivity.
  - Sensitivity decreases with degree of financial constraint! But why?
  - Entire difference in FHP among dividend vs. non-dividend is driven by least financially constrained non-dividend payers.

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Epilogue

- Cannot interpret I-CF sensitivities as evidence of financial constraints.
  - Has substantially reduced the number of papers that use I-CF sensitivities to infer financial constraints.
- Does not say that financial constraints do not affect (reduce) investment. KZ is inconclusive about this, but provided an alternative measure of financially constrained firms.

- People stopped using the Fazzari-Hubbard-Petersen and started using the KZ index as a measure of financial constraints.
- The first paper is Lamont, Polk, and Saa-Requejo (1997)

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Lamont, Polk, and Saa-Requejo (1997)

"Kaplan and Zingales classify firms into discrete categories of financial constraint and then use an ordered logit regression to relate their classifications to accounting variables. We use the regression coefficients to construct an index consisting of a linear combination of five accounting ratios, which we call the KZ index"

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Extrapolating from KZ

Table 9	
Ordered logit from Kaplan and Zingales	
Discrete categories of financial constraints on	
Cash Flow/K	-1.002
	(0.234)
Q	0.283
	(0.078)
Debt/Total capital	3.139
	(0.449)
Dividends/K	-39.368
	(6.097)
Cash/K	-1.315
	(0.289)
Log likelihood	-699.2
Pseudo Rsquare	0.134

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KZ Index

- Based on Table 9, the KZ index is:

KZ INDEX= -1001909[(Item 18+Item 14)/8]+

.2826389*[(Item 6+ CRSP December Market Equity- Item 60 – Item 74)/Item 6]

+3.139193*[(Item9+Item34)/(Item9+Item34+Item 216)]

39.3678*[(Item21+Item19)/Item8]-1.314759*[Item1/Item8]

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Impact of KZ

Do investment-cash flow sensitivities provide useful measures of financing constraints?
SN Kaplan, L Zingales - The Quarterly Journal of Economics, 1997 - qje.oxfordjournals.org
Abstract No. This paper investigates the relationship between **financing** constraints and **investment-cash flow sensitivities** by analyzing the firms identified by Fazzari, Hubbard, and Petersen as having unusually high **investment-cash flow sensitivities**. We find that firms **...**
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Summary until now:

- If one runs an investment regression on Q and CF finding is that CF is correlated with investment (Problem set two)
- Interpretation? Still a mistery.

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Corporate Investment 2

Summary of investment cash flow regressions

- Empirically financial slack seems correlated with investment
- The correlation between cash flows and investment is strong
- Is it really true?
- Attack comes from two fronts
  - Macro literature has generally being loyal to the Lucas' idea that finance does not matter. If financial slack matters this is an implicit statement that the neoclassical model – q-theory of investment- fails then?
  - Econometrics – finance papers have been weak at proving the results – lots of econometrics problems.

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Critiques to the investment cash-flow sensitivities literature:

1st problem: Endogeneity

- Since CF is related to profitability and profitability may well be a better measure of investment opportunity than q, then estimated coefficients may be biased

Solutions:

1st solution: "Natural Experiments"

Isolate shocks to firms' financial positions that appear obviously unrelated to their investment opportunities (Blanchard et al. 1994, Lamont 1997, Rauh 2006)

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Critiques to the investment cash-flow sensitivities literature:

2nd problem: Measurement Error

→ Erickson and Whited (2002) explain that measurement error in q can lead to inconsistent estimators

→ Solution: check q-theory with measurement error-consistent generalized method of moments.

3rd problem: Misspecification

- Cash-flow effects can be generated by deviations from the assumptions of the neoclassical model. Do cash-flow effects persist even when there are no financing constraints?
- Solution (not really one): Study a model of investment with different assumptions and/or without financing constraints: Gomes (2001), Abel and Eberly (2002, 2005), Eberly, Rebelo and Vincent (2007).

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1st problem: endogeneity

- Three important papers that exploit the existence of "exogenous" shocks (unrelated to investment opportunities) to cash flow
  - Blanchard et al. (1994)
  - Lamont (1997) – MIT Job market paper 1994
    →University of Chicago GSB
  - Josh Rauh – MIT Job market paper 2004
    →University of Chicago GSB

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"Natural experiments"

Blanchard et al. (1994): "What do firms do with cash windfalls?"

They study the changes in investment and other factors of firms that receive windfalls coming from lawsuits that do not change the firms' investment opportunities (or their marginal q's).

Exogenous shock: windfalls come from lawsuits that

i) Affected lines of product already discontinued by the firm

ii) Concerned past events no longer affecting operations

Data and empirical strategy:

- Firms in the sample are unprofitable and with poor investment opportunities (low q)
- Event study with a 3, 10 and 100 days window around the windfall

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Blanchard et al. (1994):

Results:

- The market value of the firms does not increase as much as the value of the net award. Two interpretations: i) the award was already anticipated by the market, ii) the market anticipates a waste of the money by the managers
- Investment does not change. This is consistent with low investment opportunities.
- Firms raise the pace of retirement and discontinuances of assets (some of them massive) after the award compared to the previous two years. This is also consistent with low investment opportunities → these firms must disinvest.
- Sharp rise in asset acquisitions after the award, either in a new (for the lowest q), or in the same line of business (for less worse q's)
- Increase in long term debt. Firms borrow more after the windfall instead of returning it to debtholders (the agency model is supported)

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Blanchard et al. (1994):

- Executive compensation increases: managers redistribute some windfall to themselves (agency model is supported)

Conclusion:

- The evidence supports the agency model of managerial behavior, in which managers strive to ensure the long-run survival and independence of their firms with themselves at the helm. They do this by keeping the resources inside and investing them in unattractive projects just to avoid giving up cash or having an outsider lay a claim on it, this enables the firm to stay independent.
- But…. How much can we generalize this result? Small size sample, selected sample, cute idea, but would apply to all?

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Lamont, Owen (1996):

- Studies the effect of exogenous shock is the oil price decline in 1986.
- The objective is to look at the effects of a decline in cash flows and collateral value of oil firms on corporate segments in the non-oil industries.

Joint hypothesis test:

i) the oil shock affected the costs of finance for oil segments

ii) the cost of finance in the oil segment affected the cost of finance in the non-oil segment of the company

Why is this helpful to answer the question about cash and investment? What is he assuming?

These two hypothesis are true if:

1) external capital markets are imperfect (so that financial slack matters for investment)

2) internal capital markets allocate capital within firms (so that the different parts of the firm are interdependent)

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Lamont, Owen (1996):

Data and empirical strategy:

- Data set comes from Compustat
- Segment-level data
- Dependent variable is I/S (contemporaneous investment to contemporaneous sales), since it is not possible to observe physical assets for corporate segments.
- A trick to control for industry-wide changes in the profitability of investment is to use industry-adjusted changes in investment by subtracting the median value of the change in I/S from a *control group* of Compustat segments which are in the same industry but which are owned by companies that do not have an oil extraction segment.
- Strategy: 1st) means and medians comparisons
  2nd) OLS

Lamont, Owen (1996):

Results:

- Most of the non-oil segments experienced an increase in cash flow between 1985 and 1986, in sharp contrast to the performance of the oil industry
- However, capital expenditures in non-oil segments declined in 1986 for most segments compared to the 1985 level; and raw and industry-adjusted investment in non-oil segments fell in 1986:

Change in I/S 1985-1986		
	Raw	Industry-adjusted
N. obs.	40	39
Mean	-1.46	-1.41
t-statistic	2.34	2.06
p-value	0.02	0.05

Lamont, Owen (1996):

Results (cont.):

Why did non-oil investment fall? Two possible explanations:

1) The decrease in cash flow/collateral values explanation
2) The overinvestment and subsidization

Cash flow and collateral value decreases:

For 17 segments (out of 39), parents' bond-rating was downgraded by Moody's between 1985 and 1986, thus, the cost of external finance presumably rose. For these firms, the fall in investment was larger than for the segments which did not suffer downgrading. The difference is statistically insignificant and the author concludes that:

'it is impossible in this sample to untangle the effects of cash flow and collateral value changes'.

Lamont, Owen (1996):

Results (cont.):

Overinvestment and subsidization hypothesis:

- Investment to sales ratios in non-oil segments fell significantly
- Industry-adjusted profitability of non-oil segments rose significantly
- 5 non-oil segments had capital expenditures in 1985 which exceeded their (pre-tax) cash flow: subsidization!. These segments cut their investment by 8% more than the rest.
- In 1985, for every dollar in oil cash flow, non-oil investment rises 12 or 13 cents, whereas it is 0 in 1986. Moreover, the coefficient of own cash-flow for investment increases significantly from 1985 to 1986.

→ the author explains that in 1985 oil companies were pumping (overinvesting and subsidizing) average amounts of capital expenditures into below-average non-oil segments. In 1986, oil companies cut back on this wasteful expenditure, because they no longer had cash to waste.

Joshua D. Rauh (2006):

Examines the response of corporate capital expenditures to changes in internal financial resources by using the required contributions of firms to pension plans as an instrument :

- Firms are legally required to make contributions to their pension funds
- These contributions have a direct impact on a company's internal financial resources: if the firm is financially constrained, contribution requirements may affect its ability to invest.
- To the extent that required contributions (or the firm's pension funding status) can be separated from investment opportunities, they are a useful instrument for identifying the response of capital expenditures to changes in internal financial resources

Joshua D. Rauh (2006):

Some basic concepts:

The pension funding status equals the pension assets minus the pension liabilities:

- The firm pledges retirement benefits (in a DB pension plan) to its employees → this constitutes a financial liability
- The liability must be funded, by law, with dedicated assets

The fund is overfunded when the market value of pension assets is greater than the present discounted value of liabilities. It is underfunded otherwise.

Firms with overfunded plans do not have to make contributions to their pension funds (but they can do it voluntarily up to a certain limit)

Firms with underfunded pension plans are required by law to make contributions as given by a complex nonlinear function of the pension funding status of the firm.

As we will see, these sharp nonlinearities of pension funding requirements allow identification

Joshua D. Rauh (2006):

Some basic concepts (cont.):

The pension funding status depends on four factors:

1) The dedicated assets in the fund are generally invested in a range of financial securities chosen by the firm, and thus their performance varies from year to year and across firms
2) The required discount rate for pension liabilities is the 30-year Treasury rate. Thus changes in this rate affect the pension funding status
3) The funding status is affected by voluntary funding decisions which may be related to the financial strength of the firm
4) The firm may choose to make changes to the level and structure of benefits (voluntary contributions)

→ Be careful, several of these factors are endogenous to the firm's investment opportunities!!! E.g. voluntary contributions

Joshua D. Rauh (2006):

Identification:

- The *sharp nonlinearities* of pension funding requirements allow for *identification* of an effect of required contributions on investment that is purged of this endogeneity problem
- The function that relates the pension funding status to investment opportunities does not have precisely the same kinks, jumps, and asymmetries as the function that relates the pension funding status required pension contributions
- Rauh's empirical strategy resembles to the methodology of Regression Discontinuity Design more on this later….next week.

2nd problem: measurement error

- In the formal optimization model of q theory, q is a sufficient statistic (the sole regressor) for the rate of investment
- Empirical observations show that q theory does not hold, other variables like output, sales and internal funds (specially cash flow) appear statistically significant when regressed against investment, *even after controlling for q*
- Why?

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Three sources of measurement error:

1. Marginal q may not equal average q: marginal q is the shadow value of capital, whereas average q is the manager's subjective valuation of the capital stock
2. Average q is different from Tobin's q: Tobin's q is the financial market's valuation of average q. The two may not be the same if the market and the manager attribute different valuations to the company (inefficient markets, overconfident managers). In other words, it is possible that temporary misvaluation in the stock market reflect incorrectly in the investment opportunities.

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Three sources of measurement error

3. Tobin's q may not be correctly measured. Tobin's q is usually calculated as (Debt+Equity-Inventories) / (Replacement value of capital stock)

   The numerator should equal the market valuation of the capital stock. Then, since D+E is the market value of debt and equity(=market value of the firm), to calculate the market value of the capital stock one should subtract not only inventories but also the value of non-physical assets such as human capital and goodwill.

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How to deal with measurement error?

– Instrumental variable technique (recall the qualities of a good instrument, what are those?)
  - Lagged values of measured *q*. What do you need to assume for this to be a good instrument?
  - Analysts' forecasts of earnings (e.g. Zacks, IBES dataset), e.g. Abel and Eberly (2002)

– How much do you trust these instruments?

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How to deal with measurement error?

– Developing a new estimator
  - Erickson and Whited (2000) "*Measurement Error and the Relationship between Investment and q*" develop a measurement error-consistent generalized method of moments estimators and find that most of the stylized facts produced by investment q cash flow regressions are artifacts of measurement error.
  - To account for measurement error, Erickson and Whited specify a errors-in-variables model and then compute consistent estimators with GMM
  - Their results go a long way towards rehabilitating q-theory.

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Erickson and Whited (2000)

Results:

- The GMM estimates are 1.4 to 2.5 times higher than the corresponding OLS R-squared, evidence that simple q theory explains investment considerably better than previously thought.

TABLE 4
BOND RATING INTERACTION MODEL: ESTIMATES OF ρ^2, POPULATION R^2 OF THE INVESTMENT EQUATION

	OLS	GMM3	GMM4	GMM5
1992	.228	.484	.417	.450
	(.034)	(.095)	(.089)	(.098)
1993	.211	.435	.385	.521
	(.042)	(.091)	(.074)	(.074)
1994	.219	.664	.459	.311
	(.041)	(.417)	(.071)	(.047)
1995	.201	.359	.271	.416
	(.036)	(.088)	(.085)	(.070)
Minimum distance	.215	.436	.405	.384
	(.025)	(.046)	(.046)	(.036)

NOTE.—We define the OLS estimate of ρ^2 to be the OLS R^2. Standard errors are in parentheses under the parameter estimates.

Erickson and Whited (2000)

Has become a standard in the literature, but…

Several criticism about this paper:

- Almeida, et al. (2010) use Monte Carlo simulations and real data to assess the performance of alternative methods that deal with measurement error in investment equations.
- individual-fixed effects, error heteroscedasticity, and data skewness severely affect the performance and reliability of methods found in the literature.
- Estimators that use higher-order moments are shown to return biased coefficients for (both) mismeasured and perfectly-measured regressors

Theoretical critique of the I/Q model

Main idea: may be the true model is not the neoclassical model, but it needs some modifications.

Can we twist the neoclassical model to deliver the empirical results in the literature (cashflow sensitivities) without introducing financial constraints?

Several recent examples of this line of reasoning. e.g. Eberly et al (2007): "Investment and Value: A Neoclassical Benchmark" propose and estimate a new neoclassical benchmark for the investment model.

The parameter estimates from their model imply three important deviations from the assumptions of the traditional neoclassical model introduced by Hayashi:

- returns to scale are decreasing instead of constant
- there is a fixed production cost
- productivity or demand shocks are also crucial

Eberly et al. (2007)

These authors also use their parameter estimates to simulate their model and create a panel of firm-level data.

- When comparing the regressions from the simulated data to regressions from the Compustat sample, both regressions feature similar cash-flow effects
- This result suggests that cash-flow effects occur because the strong assumptions are necessary to make the investment-capital ratio depend only on ***average*** Q do not hold in the data
- Thus they conclude that ***average*** Q is not a sufficient statistic for the choice of the investment-capital ratio.

Eberly et al. (2007)

Model

Write the standard neoclassical model , simulate data that are consistent with the data. Estimate the simulated and actual data

Estimation

- The model is estimated with a panel of Compustat firms for the period 1981-2003.
- Simple regressions lead to the following coefficients for Tobin's Q and cash-flow:

$$i/k = 0.12 + 0.003Q + 0.17(cash - flow/k)$$

Standard errors are 0.0005 and 0.009 for q and cash-flow respectively. Adjusted R2 is 0.24.

- Both q and cash-flow are significant. The coefficient on Tobin's Q is quantitatively small.

Eberly et al. (2007)

Estimation

- The model is estimated using the simulated method of moments proposed by Lee and Ingram (1989):
  - First use the data to estimate the vector of moments
  - Next choose the vector of parameters to estimate
  - Next simulate the model and compute simulated moments

Simulated regression results:

Consists in regressing investment on its determinants: both the state variables that are only observable in the model, as well as Q and cash flow.

Eberly et al. (2007)

Results:

	Dependent variable I/K				
Regression	1	2	3	4	5
Constant	1.490 (0.003)	0.0058 (0.0002)	0.139 (0.0003)	0.299 (0.0006)	0.158 (0.0002)
ln(Q)		0.466 (0.0006)			
ln(Q+noise)			0.037 (0.0006)	0.009 (0.0004)	0.0081 (0.0004)
ln(Cash Flow/K)				0.079 (0.0003)	
ln(K)	-0.171 (0.0004)				
ln(z)	0.133 (0.0002)				0.109 (0.0003)
R^2	0.95	0.95	0.08	0.71	0.73

Eberly et al. (2007)

Conclusions and limitations:

→ Since there are no frictions in the model that would give a direct role to cash flow, the results strongly suggest that cash flow proxies for the impact of the shock.

→ A simple neoclassical model can generate a cash-flow effect even if the model was not designed to produce one.

→ More a theoretical exercise than a search for truth. In order to estimate which one is the right model, one needs to figure out how to nest the two models and structurally estimate one against the other.

Conclusions

- Investment-cash flow sensitivity probably some combination of overinvestment (agency), underinvestment (information), and Q mismeasurement.
  - More evidence on agency, but stronger emphaisis (theoretically) on information.
- Endogeneity problems, measurement errors, and theoretical disagreement have left many questions unanswered.

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Problem set 1/2

- **Exercise:**
- 1) The data set(s)
  - Provide a brief introduction on the panel data set you obtained: number of firms, number of firm-year observations, period…
  - Present a table with summary statistics on the variables of your data. Comment briefly.
- 2) Estimate the following regressions:
  - The capital-investment ratio on Tobin's Q
  - The capital-investment ratio on Tobin's Q and cash-flow
  - Repeat the two regressions above with a semi-log specification.
  - Repeat the two regressions above with and without firm fixed effects
  - Present the results of the four regressions in a single table (similar to table IV in Eberly et al. paper)
  - Briefly, comment on the results of the regressions

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Problem set 1/2

3) Since you are using a panel data set, it is likely that the residuals are correlated across firms or across time. This would lead to biased standard errors in your previous OLS estimations.

Read the paper (will be presented by Mitchell):

Mitchell A. Petersen (2007): "Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches"

- Apply the various techniques presented in the paper in order to correct the standard errors in the regressions run in (2).
- Present the results in a single table and comment briefly on the techniques you used and why you think you obtained different results with different corrections.

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Problem set 2

Some tips:

- Download only the variables that you will need for your study
- Note that, the description of the variables, with the corresponding numbers of their classification in Compustat, are specified at the appendix of the paper you are going to replicate. You need however to extract the data twice. First using the legacy data, then the new compustat.
- All the tables of results that you present must be self-contained, i.e. all the variables as well as symbols (like *, or numbers in brackets) should be explained in a text just above the table. The reader of your table should not go back to the text to understand what you have done in the tables. The notes of the table should be enough to understand your results. As an example of tables you can refer to:
- http://www.kellogg.northwestern.edu/faculty/sapienza/htm/HSVJ.pdf

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