Investment and Credit Constraints
Part 1: Cash shortfalls

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Question

- Are firms credit constrained in their investment?
- Important question:
  - Foundation for macro-finance models
  - Public policies – financial development
  - Misallocation of capital – role for taxation

Neo-classical theory of investment

- To address the question, start from a normative, frictionless benchmark
- Neo-classical theory of investment: Abel & Eberly (1994, AER).
- <u>Bottom-line</u>: Under certain assumptions, M/B ratio should be a sufficient statistics for investment:
  - Another form of M&M proposition 1: firms invest in NPV>0 projects only; financing is irrelevant.

Neo-classical theory in the data

- Neoclassical theory suggests under certain assumptions:

$$\frac{I_t}{K_t} = \frac{1}{\lambda} q_t = \frac{1}{\lambda} \frac{V(K_t, \epsilon_t)}{K_t}$$

- Empirically:

```
. reg inv q if year==2003,r

Linear regression                                      Number of obs =    4360
                                                       F(  1,  4358) =   92.96
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.0428
                                                       Root MSE      =  .33278
```

inv	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
q	.0326955	.003391	9.64	0.000	.0260473	.0393437
_cons	.1792207	.0078856	22.73	0.000	.1637608	.1946805

Is this really a rejection?

- M/B ratio has low explanatory power, but:
  - Strong parametric assumptions
  - Measurement error: markets are noisy; market cap is a poor proxy for true average Q.

How to reject the neo-classical null?

- First idea in the literature:
  - Variables related to the availability of financing should not explain investment.
    - Only NPV (i.e. marginal q) of investment matters.
- Cash-flows (internally generated funds) are the main mode of financing for corporations.
- High cash flows should not predict more investment, controlling for Q

I/cash-flow sensitivity

- Let's run this:

```
. reg inv q cash if year==2003,r

Linear regression                                      Number of obs =    4350
                                                       F(  2,  4347) =   72.65
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.0591
                                                       Root MSE      =  .33006

------------------------------------------------------------------------------
             |               Robust
         inv |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           q |   .0403279   .0034428    11.71   0.000     .0335782    .0470776
        cash |   .0226522   .0041899     5.41   0.000     .0144378    .0308666
       _cons |   .1643259    .007991    20.56   0.000     .1486595    .1799922
------------------------------------------------------------------------------
```

- Cash is significant, but:
  - (Still a very low R^2) – not the point.
  - Why is this wrong?

I/cash-flow sensitivity

- Typical case of endogeneity and measurement error:
  - M/B measures only approximately the true marginal q.
  - Cash-flows are likely correlated with marginal q, part of which is in the residual (because of measurement error)
- Both issue likely to lead to upward-bias in estimation of cash coefficient.
  - A >0 and significant coefficient **does not** tell you that financing factors affect investment decision.

Differential I/cash-flow sensitivity

- Fazzari et al. (1988) had the following idea:
  - Construct bucket of ex ante likelihood of being constrained/poor access to outside finance: e.g., dividend payments
    - Later in the literature: size, credit rating, indices
  - Compare I/cash-flow sensitivity for this different groups
  - Intuition:
    - Bias should be the same across groups
    - Difference should thus be the unbiased coefficient.
  - Why is this wrong?

Results from Estimation (Fazzari et al. 1988)

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

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

Source: Authors' estimates of equation 3 based on a sample of firm data from Value Line data base. See text and Appendix B.

a. The dependent variable is the investment-capital ratio $(I/K)_{it}$, where I is investment in plant and equipment and K is beginning-of-period capital stock. Independent variables are defined as follows: Q is the sum of the 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 (see Appendix B); $(CF/K)_{it}$ is the cash flow–capital ratio. The equations were estimated using fixed firm and year effects (not reported). Standard errors appear in parentheses.

a. Firms with dividend-income ratios of less than 0.1 for at least 10 years.
b. Firms with dividend-income ratios greater than 0.1 but less than 0.2 for at least 10 years.
c. Firms with dividend-income ratios greater than 0.2.

Note on the specification

- Relative to what we have seen so far, regression is run on a ***panel*** of firms.
- Regression includes year fixed effects. Why?
- Regression includes firm fixed effects. Why?
- How is this model identified/estimated?

Compustat 1982-2006

```
. xi: areg inv q cash i.year, a(gvkey) r
i.year            _Iyear_1981-2006    (naturally coded; _Iyear_1981 omitted)
note: _Iyear_2006 omitted because of collinearity

Linear regression, absorbing indicators          Number of obs   =     104452
                                                 F(  26,  92013) =     262.21
                                                 Prob > F        =     0.0000
                                                 R-squared       =     0.3861
                                                 Adj R-squared   =     0.3031
                                                 Root MSE        =     0.3873

------------------------------------------------------------------------------
             |               Robust
         inv |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           q |   .0444884   .0015158    29.35   0.000     .0415175    .0474593
        cash |   .0338352   .0016285    20.78   0.000     .0306433    .0370272
 _Iyear_1982 |   .2862664   .0099891    28.66   0.000     .2666879     .305845
 _Iyear_1983 |   .2866646   .0103518    27.69   0.000     .2663751    .3069541
 _Iyear_1984 |   .3337589   .0104765    31.86   0.000     .3132251    .3542927
 _Iyear_1985 |   .2491213   .0098831    25.21   0.000     .2297506    .2684921
 _Iyear_1986 |   .2424319   .0100384    24.15   0.000     .2227568     .262107
 _Iyear_1987 |   .2456422   .0099128    24.78   0.000     .2262132    .2650712
 _Iyear_1988 |   .1834503   .0095126    19.29   0.000     .1648058    .2020948
 _Iyear_1989 |   .1568977   .0093242    16.83   0.000     .1386223    .1751731
 _Iyear_1990 |   .1463196   .0093791    15.60   0.000     .1279367    .1647024
 _Iyear_1991 |   .0944785   .0093334    10.12   0.000     .0761851    .1127719
 _Iyear_1992 |   .1392512   .0095675    14.55   0.000      .120499    .1580034
 _Iyear_1993 |   .1649948   .0096929    17.02   0.000     .1459967    .1839929
 _Iyear_1994 |   .2031545   .0096067    21.15   0.000     .1843254    .2219836
 _Iyear_1995 |   .1669894   .0093272    17.90   0.000     .1487082    .1852705
 _Iyear_1996 |   .1890897   .0093588    20.20   0.000     .1707466    .2074328
 _Iyear_1997 |   .1473413   .0091875    16.04   0.000     .1293339    .1653487
 _Iyear_1998 |   .1201909   .0091325    13.16   0.000     .1022913    .1380905
 _Iyear_1999 |   .0832187   .0091322     9.11   0.000     .0653196    .1011177
 _Iyear_2000 |   .1677038   .0096789    17.33   0.000     .1487332    .1866743
 _Iyear_2001 |  -.0173977   .0090142    -1.93   0.054    -.0350656    .0002701
 _Iyear_2002 |  -.0739467    .008755    -8.45   0.000    -.0911064   -.0567869
 _Iyear_2003 |  -.1044114   .0087412   -11.94   0.000     -.121544   -.0872788
 _Iyear_2004 |  -.0224148   .0091135    -2.46   0.014    -.0402773   -.0045523
 _Iyear_2005 |   .0076475   .0093684     0.82   0.414    -.0107144    .0260095
 _Iyear_2006 |          0  (omitted)
       _cons |   .1787136   .0077124    23.17   0.000     .1635974    .1938299
-------------+----------------------------------------------------------------
       gvkey |   absorbed                                    (12413 categories)
```

Why is this wrong? More.

- Kaplan and Zingales also show that the premise of the Fazzari et al. (1988) analysis is flawed from a theoretical perspective.
  - In the simplest model of investment under cost of outside finance, I/cash-flow sensitivity does not decrease with initial liquidity
  - Of course, a positive and *** I/cash-flow sensitivity, if estimated properly, would still constitute a rejection of Neo-classical model of investment.

Why is this wrong? Even more.

- Kaplan and Zingales (1997) also shows empirically that I/cash flow sensitivity is not related to *actual* credit constraints.
- Sample: 49 low-dividend paying firms from Fazzari et al. (1988).
  - i.e. those firms more likely to be constrained.
- Then, use both hard and soft information to classify firms according to *real* (?) credit constraints.

Defining credit constraints

- Data source: letters to shareholders, management discussions of operations and liquidity, financial statements with notes (10-K filings)
- Non-financially constrained:
  - firm initiated or increased cash dividends, repurchased stock
  - explicitly indicated in annual report that it had more liquidity than needed for investment in the foreseeable future
- Financially constrained:
  - mention having difficulties in obtaining financing -- postponing an equity or convertible debt offering due to adverse market conditions.

First, show that the sample is comparable to original Fazzari et al. (1988) paper

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.

Then show that I/cash flow sensitivity does not increase with 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

Opposite to results found in Fazzari et al. (1988). Why?

A possible interpretation

- Constrained firms use their cash flows to repay their creditors and reduce financial distress.

Insights from Kaplan and Zingales (1997)

- Payout policy is not a good proxy for financial constraints (yet still widely used in the literature).
- The median NFC firm could have paid out large dividends (58\% of investment) without permission from current lenders.
- Financial constraints do not explain I/CF sensitivity. Never-constrained firms have the highest I/CF sensitivity.

Kaplan and Zingales (KZ) index

- Kaplan and Zingales (1988) run ordered logit regressions for predictability of financing constraint status
- Extended in Lamont, Polk and Saa-Requejo, 2001:

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

- Typical use: quintiles, double lagged.
- People use KZ index as measure of likelihood of financing friction. Is it a good idea?

Now what?

- If I/cash flow is not a valid measure of financing frictions, estimating a >0 and *** I/cash flow sensitivity would still reject the neo-classical model.
- Going back to bias formula: need to find a proxy/ shock to cash that is orthogonal to q.
  - i.e. orthogonal to firms' investment opportunities.
  - Simply replace cash by Z where cov(Z,q)=0 and cov(Z,cash)≠0
  - Not even an IV – a simple reduced form is enough to reject the neo-classical null. (but need an IV to quantify properly I/cash flow sensitivity).

Rauh (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.
- Definition of funding status:
  - Funding assets – funding liabilities (Market Value)
- Mandatory contribution depends on size of funding deficits – and vary through time.

Administrative rule for funding requirement.

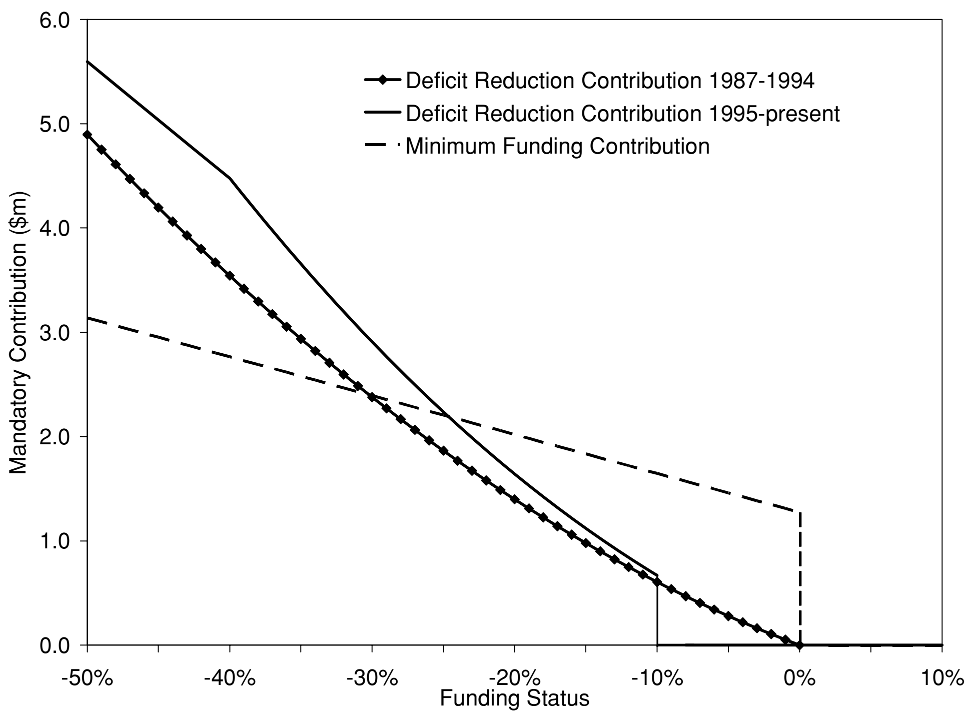


Figure 2. Mandatory pension contributions. A firm's required pension contribution is the maximum of two components: The minimum funding contribution (MFC) and the deficit reduction contribution (DRC). The graph shows mandatory contributions in dollar terms for a firm with sample mean characteristics (liabilities of $37.3m and "normal cost" of $1.3m). The DRC as a percentage of firm funding is given by $min\{0.30, [0.30 - 0.25 * (\textit{funding status} - 0.35)]\}$ for 1987 to 1994 and $min\{0.30, [0.30 - 0.40 * (\textit{funding status} - 0.60)]\}$ for 1995 and later. The minimum funding contribution is defined as the "normal cost" plus 10% of the ERISA underfunding. The "normal cost" differs on a firm-by-firm basis depending on the accounting cost method and the rate of liability accrual.

- Sample period: 1990-1998
- Mandatory contribution formula changes during sample period.
- Is this a problem?

Distribution of funding status in the data

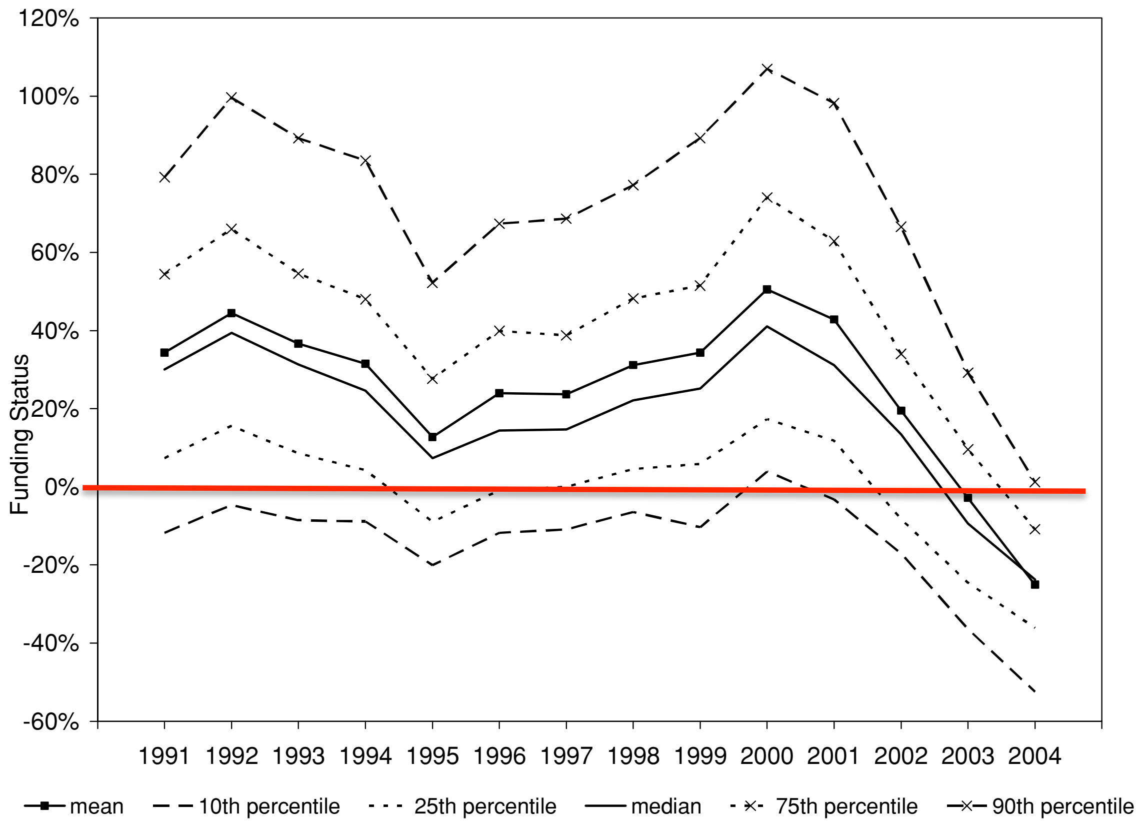


Figure 1. Distribution of beginning-of-year funding status. This figure shows the distribution of the firm-level pension funding status as of the start of the fiscal year for Compustat firms during 1991 to 2004. The funding status is defined as pension assets minus pension liabilities divided by pension liabilities. The data are from the annual filings of companies in the Compustat database, with pension liabilities on a projected benefit obligation (PBO) basis.

- Distribution quite stable during sample period → good.
- Only small fraction of firms have <0 funding status → problem?

The main specification

$$\frac{I_{it}}{A_{i,t-1}} = \alpha_i + \alpha_t + \beta_1 Q_{i,t-1} + \beta_2 \frac{NonPensionCashFlow_{it}}{A_{i,t-1}} + \beta_3 \frac{Z_{it}}{A_{i,t-1}} + \mathbf{x}_{it}\gamma + \varepsilon_{it}, \qquad (3)$$

$$NonPensionCashFlow = \underset{data18}{NetIncome} + \underset{data14}{DA} + \underset{data43}{PensionExpense}.$$

- Should Z be actual contributions to pension plan?

The main specification

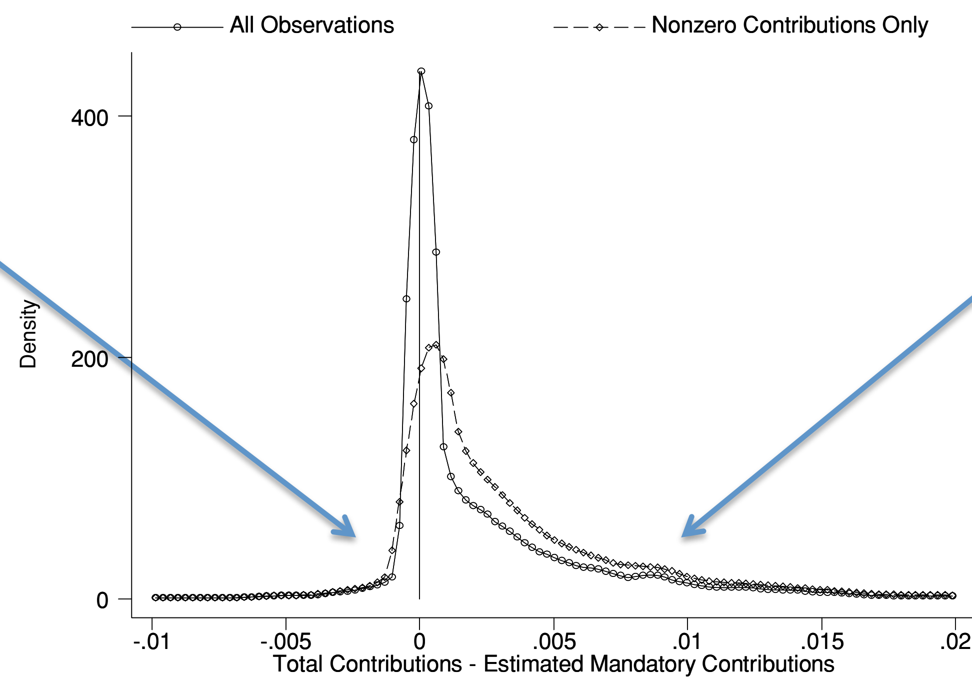
$$\frac{I_{it}}{A_{i,t-1}} = \alpha_i + \alpha_t + \beta_1 Q_{i,t-1} + \beta_2 \frac{NonPensionCashFlow_{it}}{A_{i,t-1}} + \beta_3 \frac{Z_{it}}{A_{i,t-1}} + \mathbf{x}_{it}\gamma + \varepsilon_{it}, \tag{3}$$

$$NonPensionCashFlow = \underbrace{NetIncome}_{data18} + \underbrace{DA}_{data14} + \underbrace{PensionExpense}_{data43}.$$

- Should Z be actual contributions to pension plan?
  - No, voluntary contributions likely correlated with q (or unobserved heterogeneity in investment)
  - Instead, use **mandatory contributions** (computed from administrative formula) or simply a **dummy for funding status**>0.

Significant fraction of firms give more than they have to. Endogeneity of funding status?

Errors



Voluntary contributions

Figure 3. Probability density of the difference between actual total contributions and estimated mandatory contributions. Kernel density estimation of the difference between reported total contributions and estimated mandatory contributions is performed using the Epanechnikov kernel with optimal bandwidth based on the formula of Silverman (1986).

Validity of the approach

- Argument in the paper:
  - Variations in funding status come from:
    - Variations in value of pension funds' assets.
    - Variations in liabilities (mostly changes in discount rates).

    → Exogenous to investment opportunities

    → Hard to manipulate?
- Are you convinced?

Validity of the approach

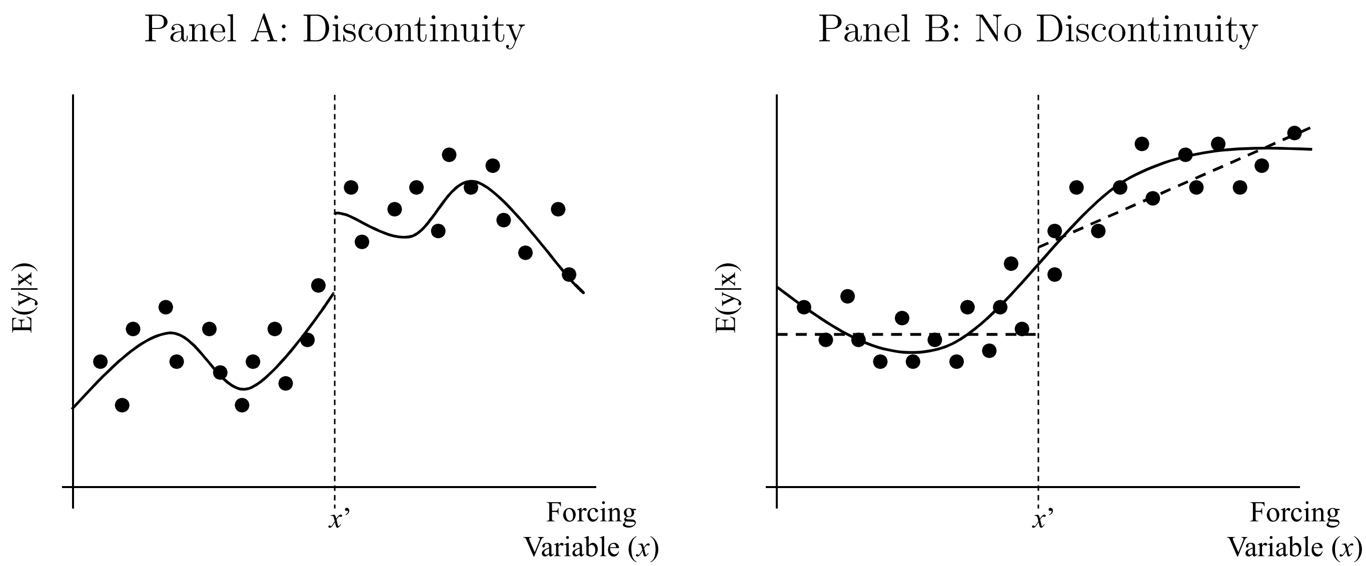
- Is this source of (<0) cash flows really exogenous to unobserved investment opportunities?
  - No. Firms that are financially strong (temporarily) manage their pension fund to avoid underfunding.
    - Effect of pension cash shock on investment is **upward-biased**
  - No. Firms that have a strong investment opportunities coming up may try to manipulate their pension fund returns.
    - Again, **upward bias**.
  - No. At least in the cross-section, required contribution might be correlated with age structure of employees, which itself is correlated with investment opportunities. Maybe less important with Firm FE?

Almost an RD design

- Two arguments in the paper for these issues:
  - Control for non-pension cash flows (basically operating cash flows) should capture investment opportunities not soaked up by Tobin's Q.

  → Does this deal with the endogeneity of the funding status?
  - Non-parametric controls (linear (+ square+ cube)) for funding status in under- and over-funding region. "like" an RD Design. But is it? (what is an RD design?)

RD design: importance of non-parametric control



RD design

- Important to test (Mc Crary test) for continuity of the forcing variable at the threshold
  - If not, sign of manipulation. Manipulation can violate continuity of unobserved heterogeneity assumption
- No need to include covariates X as long as these covariates are also continuous at the threshold.
  - Just think X is in the residual.
  - Otherwise, can also repeat RD experiment with X as an outcome variable – should not find significant results.
  - Also can include f(X) in the RD and check it does not affect the results.
- Falsification test/ placebo

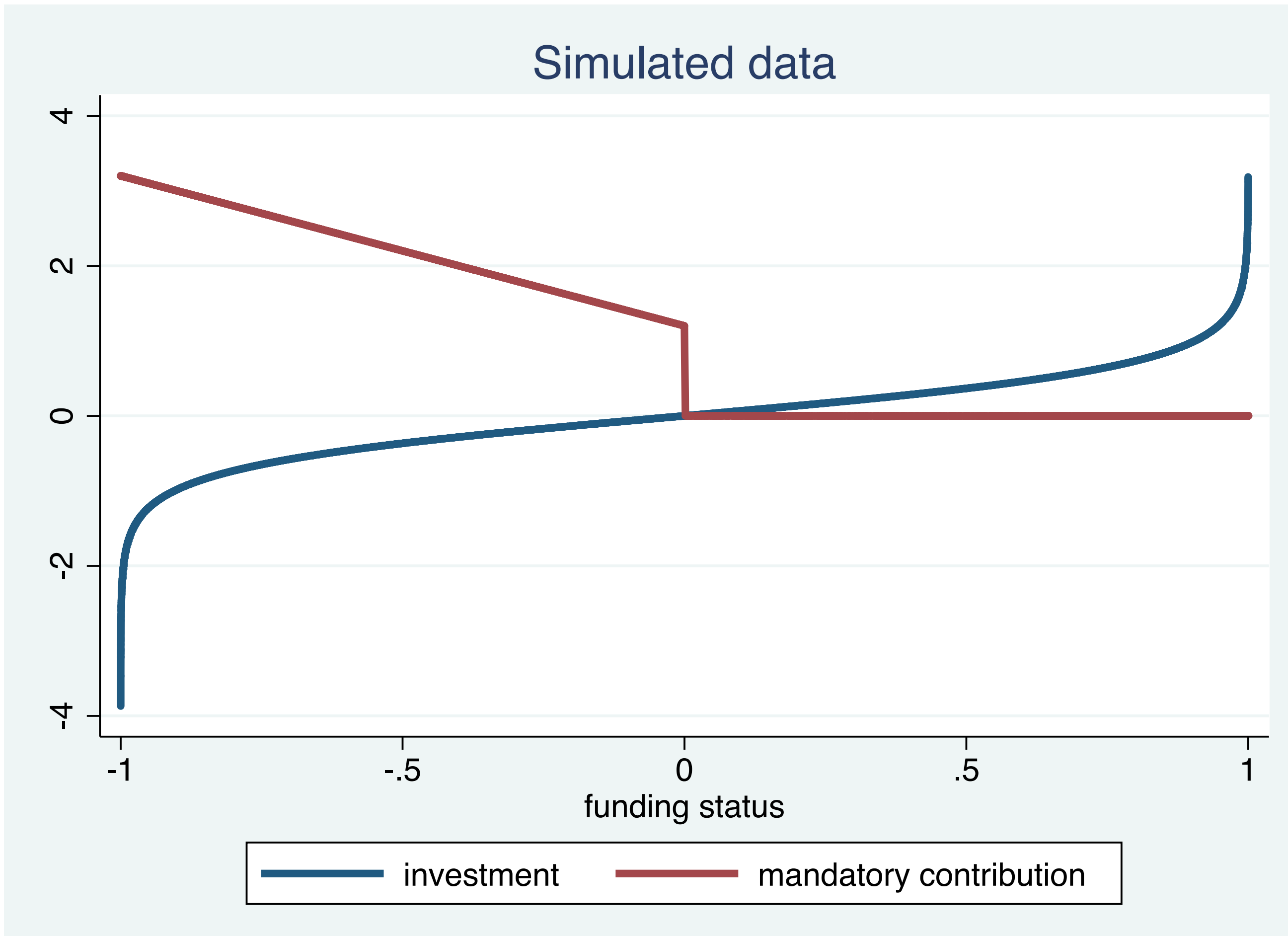
RDD?

- Say we are ok with assumption that investment opportunities are continuous at the discontinuity.
- However, must be careful when using full sample to estimate effects:
  - Even with 3rd order polynomials, might fail to detect highly non-linear relations between unobserved heterogeneity and forcing variable (i.e. funding status).
  - Important to check what happens for samples around the discontinuity.

Failing to detect non-linear effect: simulation

- Simply simulate the following statistical model:
  - Investment opportunities y are normal.
  - Funding gap is $x=2*(1/(1+e^{-3y})-.5)$. Highly non-linear at top/bottom of investment distribution.
  - Mandatory contribution is non-linear function of funding gap. (but does not affect the data generating process for investment)

Simulated data



Simulated regression

	investment
mandatory contribution	0.368
	(16.30)**
(funding gap)^1 * (funding status>0)	4.487
	(24.85)**
inter1	-0.620
	(2.87)**
(funding gap)^2 * (funding status>0)	8.990
	(28.34)**
inter2	-18.273
	(40.62)**
(funding gap)^3 * (funding status>0)	7.212
	(37.54)**
inter3	0.213
	(0.78)
Constant	-0.228
	(11.80)**
R2	0.97
N	5,000

* p<0.05; ** p<0.01

- Even with cubic controls for funding status on each side of the cut-off, regression picks up (wrong) effect of mandatory contribution on investment.
- The non-linear function of funding gap helps pick up some of the non-linearity in investment.

Back to Rauh (2006): mandatory contributions are small.

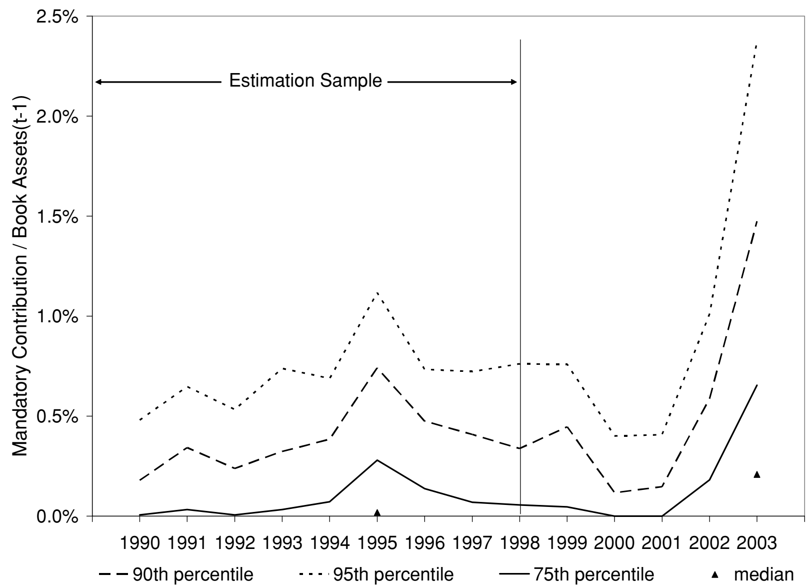


Figure 4. Estimated mandatory contributions. Estimates of the mandatory contribution for the period 1990 to 1998 are calculated based on data from the IRS 5500 plan-level filings and aggregated to the firm level. Simulated values of mandatory contributions for 1999 to 2003 are based on Compustat data for firms that are also in the IRS 5500 sample for the earlier period, with a series of correction steps applied for the differences between the two reporting regimes. In particular, ratios of Compustat to IRS pension variables (assets, liabilities and costs) are calculated for 1990 to 1998, and within-firm medians of these ratios are applied to Compustat data, between 1999 and 2003 with observations excluded if the deviation is larger than 10%. These simulated values for 1999 to 2003 are not used in this paper's empirical specifications due to the potential for introducing systematic error via this procedure, though the results are robust to their inclusion.

Non-parametric “first-stage”: problem?

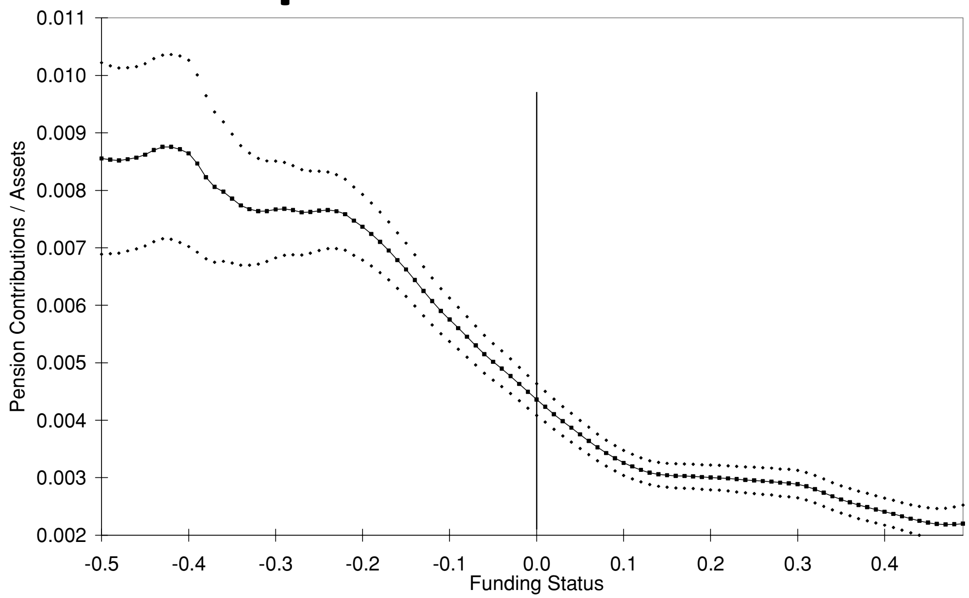
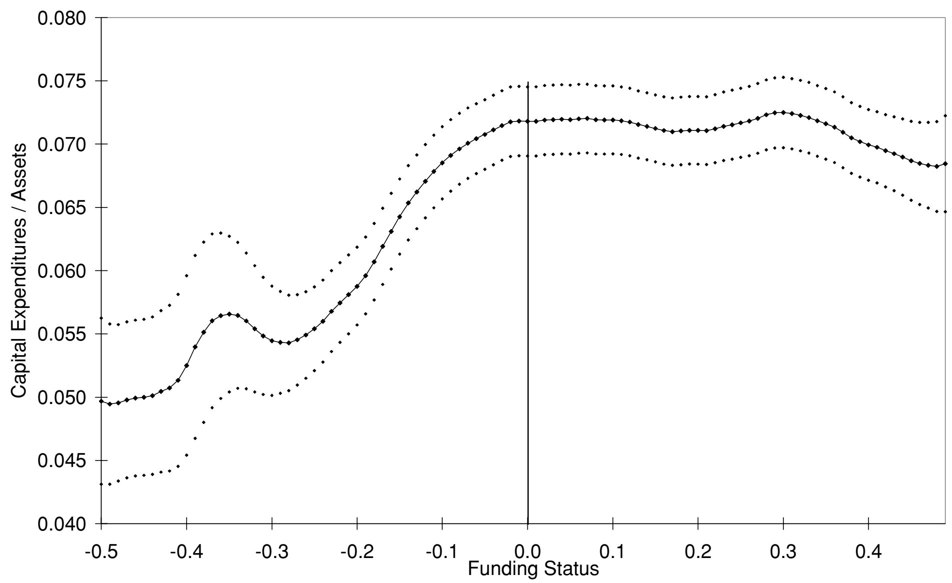


Figure 5. Kernel regressions of capital expenditures and pension contributions on funding status. Kernel regression estimation is performed on pooled data using the Epanechnikov kernel. The funding status is aggregated to the firm level. The top graph shows the relationship between funding status and pension contributions. The bottom graph shows the relationship between funding status and capital expenditures. The error bounds are 95% confidence intervals (±1.96 standard deviations). The bandwidth of 0.1 is validated using a cross-validation algorithm that minimizes the sum of squared residuals (Härdle (1990), p. 159). The error bounds are pointwise confidence intervals, calculated using an algorithm that is based on the variance of the estimate (Härdle (1990), p. 100).

Non-parametric evidence: problem?



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Regression evidence

Table II

Panel Regressions of Capital Expenditures on Pension and Nonpension Cash Flows

Each column presents estimates from a regression of the form:

$$\frac{I_{it}}{A_{i,t-1}} = \alpha_i + \alpha_t + \beta_1 Q_{i,t-1} + \beta_2 \frac{NonPensionCashFlow_{it}}{A_{i,t-1}} + \beta_3 \frac{Z_{it}}{A_{i,t-1}} + \mathbf{x}_{it}\gamma + \varepsilon_{it},$$

where I_{it} is capital expenditures, Z_{it} is (mandatory) pension contributions, and $\mathbf{x}$ is a vector of controls. Variables are scaled by beginning-of-year balance sheet assets ($A_{i,t-1}$). In specifications (1a), (2a), and (3a), nonpension cash flow and contributions are aggregated into one cash flow variable. In (1b), (2b), and (3b), the contributions variable is total contributions; in (1c), (2c), (3b), and (3c), it is mandatory contributions. In specifications (2a)–(2c), the funding status is controlled for linearity by including the funding status (pension assets minus pension liabilities scaled by firm assets) as an explanatory variable. In the specifications (3a)–(3b) the funding variable controls are underfunding and overfunding, separately, and in (3c) the first three powers of these variables are included (squares and cubes not shown). The sample size is 8,030 observations on 1,522 firms.

	Dependent Variable: Capital Expenditures$_{i,t}$ / $A_{i,t-1}$								
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
Contributions (mandatory)$_{i,t}$ / $A_{i,t-1}$			-0.830^{***}			-0.738^{***}		-0.607^{**}	-0.597^{**}
			(0.289)			(0.284)		(0.296)	(0.300)
Contributions (total)$_{i,t}$ / $A_{i,t-1}$		0.109			0.188				
		(0.162)			(0.158)				
Cash flow$_{i,t}$ / $A_{i,t-1}$	0.111^{***}								
	(0.012)								
Nonpension cash flow$_{i,t}$ / $A_{i,t-1}$		0.111^{***}	0.112^{***}	0.111^{***}	0.110^{***}	0.111^{***}	0.111^{***}	0.111^{***}	0.111^{***}
		(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
$Q_{i,t-1}$	0.019^{***}	0.019^{***}	0.019^{***}	0.019^{***}	0.019^{***}	0.019^{***}	0.019^{***}	0.019^{***}	0.019^{***}
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Funding status$_{i,t-1}$ / $A_{i,t-1}$				0.042^{*}	0.050^{**}	0.026			
				(0.024)	(0.024)	(0.023)			
Underfunding$_{i,t-1}$ / $A_{i,t-1}$							-0.164^{**}	-0.075	-0.040
							(0.065)	(0.066)	(0.256)
Overfunding$_{i,t-1}$ / $A_{i,t-1}$							0.020	0.021	0.148^{*}
							(0.025)	(0.024)	(0.088)
Powers of funding variables	0	0	0	1	1	1	1	1	1, 2, 3
R^2 (within)	0.098	0.098	0.100	0.100	0.101	0.101	0.100	0.101	0.101
Adjusted R^2	0.609	0.609	0.610	0.609	0.610	0.610	0.609	0.610	0.610
Alternate standard errors for mandatory contributions coefficient:									
Clustering by year			0.238			0.232		0.329	0.232
AR(1) model w/panel correlations			0.243			0.251		0.337	0.244

Standard errors are in parentheses. ***Significant at 1%; **significant at 5%; *significant at 10%.
All models contain firm-fixed effects and year-fixed effects. Standard errors in parentheses are heteroskedasticity-robust and clustered by firm.

Very (too?) large results: for each $1 of MC, 60 cents decrease in investment.

Non-parametric evidence from Bakke and Whited: problem(s)?

Panel B: Regressions to the left and right of zero funding status

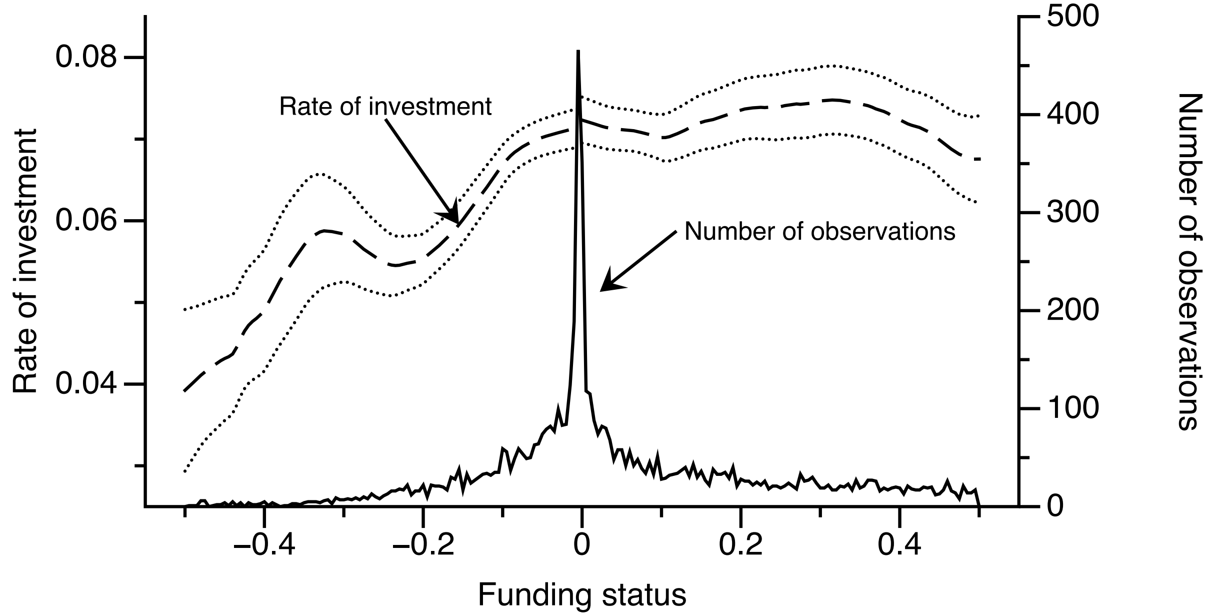


Figure 2. Kernel Regressions and Funding Status Histograms. Calculations are based on a sample of firms from Compustat from 1990 to 1998. Both panels plot the univariate relation between investment (vertical axis) and funding status (horizontal axis). Superimposed on these plots is a histogram of funding status. Funding status is defined as the sum of the plan surpluses minus the sum of the plan deficits. The kernel regression estimation is performed using an Epanechnikov kernel, with a bandwidth of 0.1. In panel A one regression is done for the full sample. In panel B separate regressions are performed for positive and negative funding statuses. Dotted lines indicate 5% confidence bounds. The results show a small discontinuity at the point of zero underfunding within the 5% confidence bounds.

Bakke and Whited (2012)

Rauh's result in column 2a.

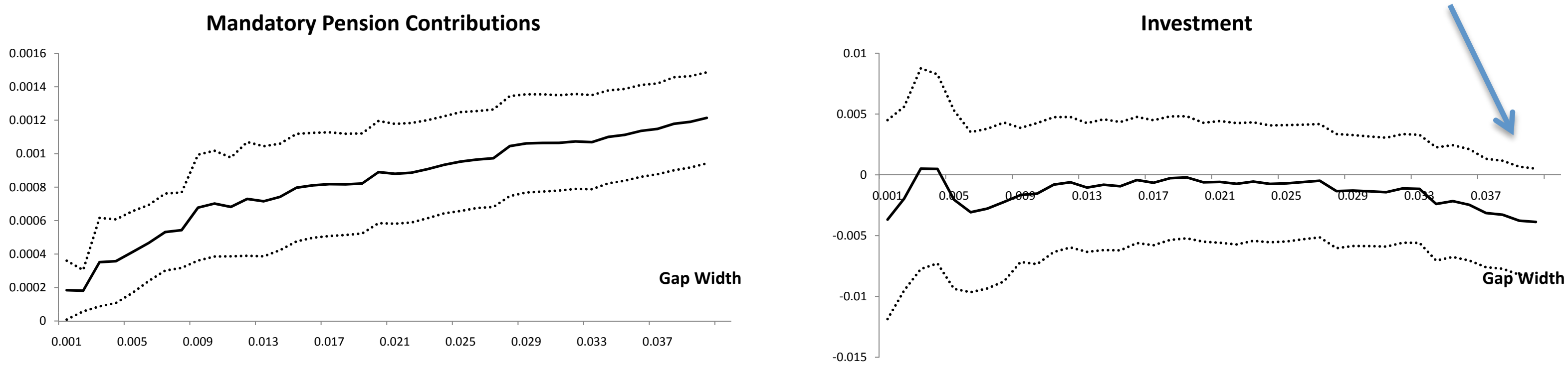
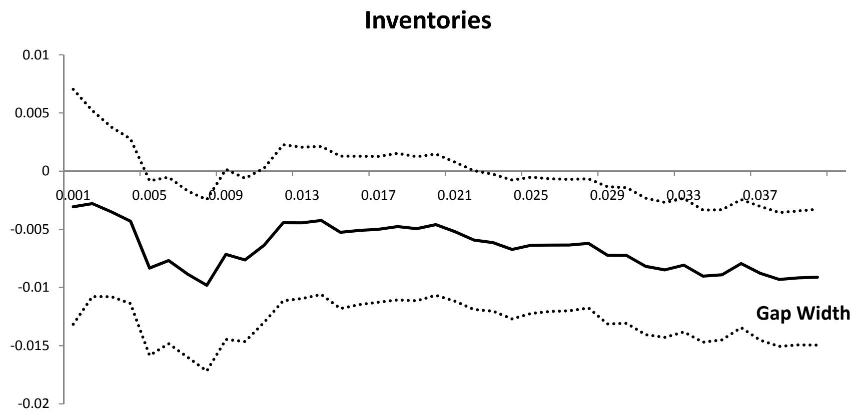
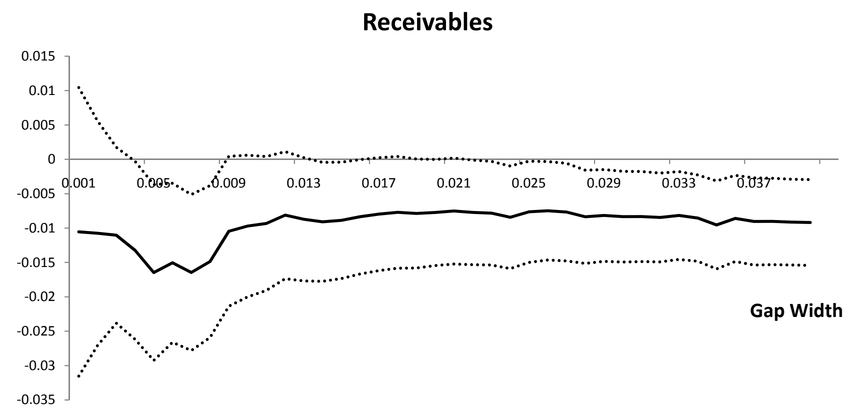


Figure 5. Local Responses to Funding Violations. Calculations are based on a sample of firms from Compustat from 1990 to 1998. Each panel in this figure plots regression coefficients from 40 regressions as a function of the sample used for the estimation. Each panel is labeled by the dependent variable in the regression. The regressors are a pension violation indicator and firm and time fixed effects, and the coefficient of interest is that on the violation indicator. On the horizontal axis is a measure of the sample used for estimation, which is the absolute value of the pension gap as a fraction of plan assets. The pension gap is defined as the minimum plan surplus if all of the plans in a firm have a surplus and as the sum of the deficits if at least one of a firm's plans has a deficit. The sample used for the calculation is all observations for which the absolute value of the pension gaps is less than the specified value on the horizontal axis. All dependent variables except employment are expressed as a fraction of total assets. Employment is measured as the natural log of millions of employees.

Working capital management





Other interesting ideas from Rauh (2006)

- Dynamics: maybe current cash shortfall simply delays investment to next period. (or follows periods of large investment).

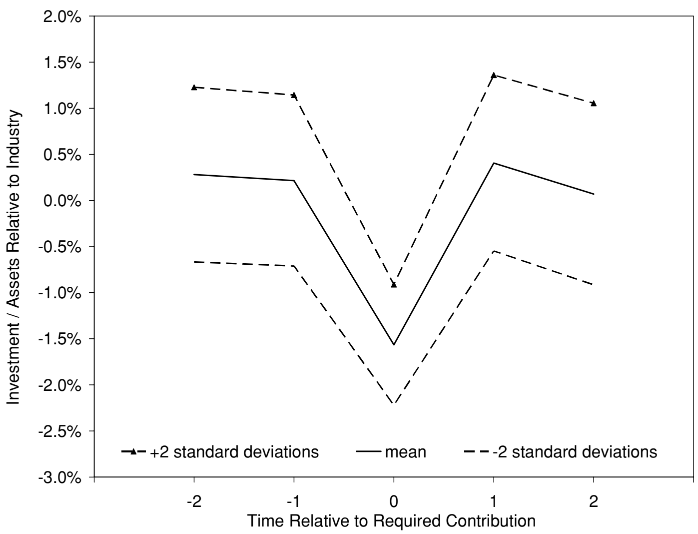


Figure 6. Investment around the time of large required pension contributions. This figure shows the distribution of investment relative to the average investment within each firm's industry-year cell, around the time of large required contributions. The figure is drawn for a sample of 131 firms which satisfy two criteria: 1.) the firm had a required contribution of at least 0.1% of assets in one and only one year during the sample period; and, 2.) the firm shows a decline in investment in that year relative to the previous year. The vertical axis shows the difference between the firm's investment scaled by book assets and industry investment scaled by book assets in the observation year. Industries are defined according to the 48-industry categorization of Fama and French (1997).

Are you convinced?

What have we learned?

- This is a very clever and empirical setup.
  - DB plan underfunding is a real policy issue.
  - Potential discontinuity could help in identifying a “big” question
- However:
  - Identification strategy is not a smoking gun
  - When looking at actual discontinuity, no effect.
  - Identification comes from (few) observations far from the cutoff:
    - External validity?
    - Spurious?

Bottom-line

- Literature has not yet found the perfect setting.
- But people are getting tired of the question.
- Room for papers only with top-notch identification.

Other approaches in the literature

- Early paper by Lamont (1997) in Journal of Finance.
- Idea:
  - Oil prices shocks are cash flow shocks to oil companies. (cash-flows ➚ when oil prices ➚)
  - But of course, oil price shocks are also investment opportunities shocks for oil companies. (investment opportunities ➚ when oil prices ➚)
  - What can we do?

Lamont 1997

- Old finance literature on conglomerates:
  - <u>Corporate socialism</u>: Internal capital markets channel funds from profitable divisions to non-profitable divisions.
  - Look at non-oil divisions in oil conglomerates.
  - Oil price shocks affect non-oil divisions cash-flows through internal capital markets
  - <u>Identifying assumption</u>:
    - Oil price shocks are not correlated with investment opportunities of non-oil divisions.
    - $Cov(cash^{oil}, I^{non\text{-}oil})=0$ →what do you think?

The oil price shocks

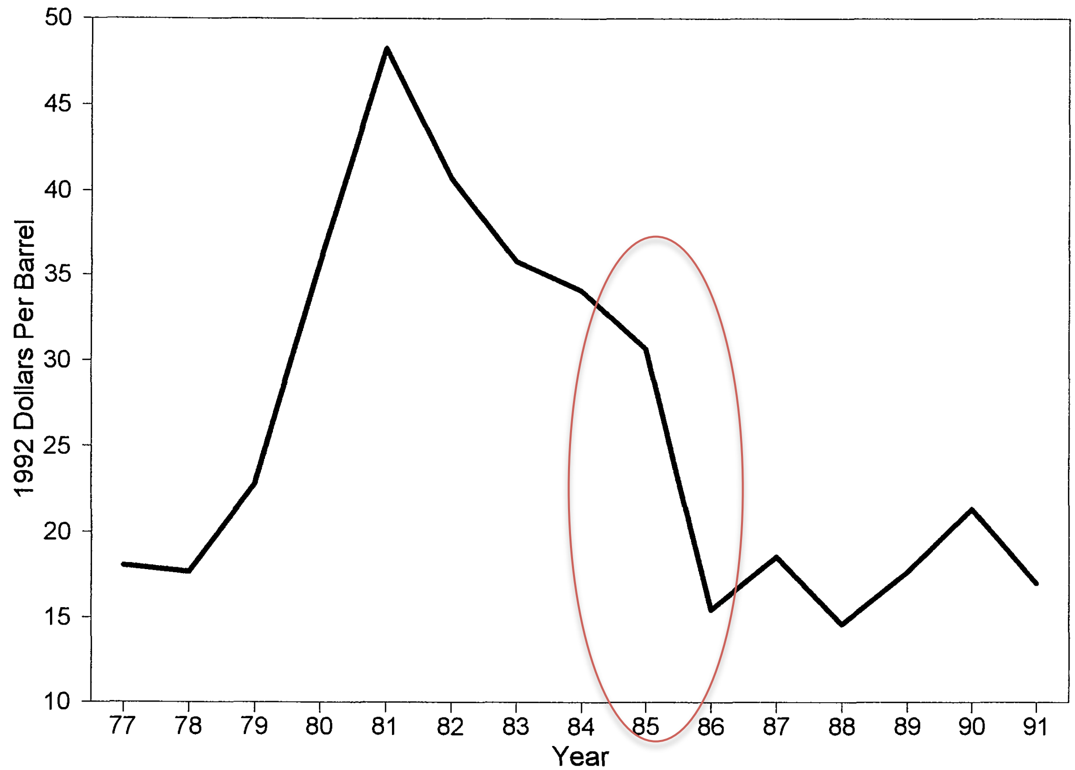


Figure 1. Real crude oil prices 1992 dollars per barrel.

Late 85: counter-oil shocks. Saudi Arabia increases in production.
Prices are divided by 2 in a quarter. Is that a good cash flow shock?

Lamont (1997): data construction

- Data: COMPUSTAT Segment files
  - corporate segment >10% of total sales in ≠ industry reports segment-level sales, profit and CAPX.
  - Sample selection:
    - All firms with a segment in oil or gas extraction sector.
    - Oil-dependent firms=at least 25% of cash-flows come from oil and gas extraction industry.
    - Select firms with non-oil related segments (some industry screens (e.g., refining, supplier to oil industry, etc.)+ judgment)
    - Exclude segments that mostly operate in oil-dependent regions.
    - Delete small segments or those with missing data.

26 (!) oil conglomerates

Table II

Firm Data: 1985–1986

Ex ante cash flow and sales share are the percent of cash flow and firm sales that are derived from the petroleum extraction industry. The share of cash flow (sales) derived from the petroleum extraction industry is computed by dividing the total oil cash flow (sales) by the sum of the cash flow (sales) of all firm segments. Ex post change in net income and cash flow are the 1986–1987 dollar changes in firm net income and cash flow, divided by 1985 firm sales.

		Ex ante		Ex post		Firm Size
	Company	1985 Percent of Cash Flow	1985 Percent of Sales	Δ Net Income	ΔOil Cash Flow	1985 Sales (mil $)
				Normalized By Firm Sales		
1	Amoco Corp	81	15	−4	−7	26,922
2	Atlantic Richfield Co	74	47	4	−1	21,723
3	Burlington Northern	28	28	−17	−2	8,651
4	Canadian Pacific	28	7	−2	−1	10,754
5	Chevron Corp	101	94	−2	−3	41,742
6	Dekalb Energy Co	77	28	−12	−17	570
7	Du Pont	49	12	1	−4	29,314
8	Fina Inc	71	8	−1	−5	2,403
9	Grace (W.R.) & Co	28	10	−12	−8	5,193
10	Homestake Mining	32	19	−0	−6	298
11	Imperial Oil Ltd	49	9	−4	−8	6,197
12	Kerr-McGee Corp	57	16	−13	−9	3,345
13	Litton Industries Inc	34	29	−5	−4	4,585
14	Mobil Corp	94	83	1	−3	55,960
15	Nova Corp of Alberta	41	29	6	NA	2,393
16	Occidental Petroleum	88	31	−4	−9	14,534
17	Phillips Petroleum Co	80	21	−1	−11	15,636
18	Placer Dome Inc	43	27	9	−7	302
19	Royal Dutch/Shell Grp	82	19	−0	−4	81,562
20	Schlumberger Ltd	94	65	−39	−17	6,119
21	Southdown Inc	49	19	−12	−5	325
22	Tenneco Inc	57	10	−1	−4	15,270
23	Union Pacific Corp	41	48	−12	−2	7,798
24	Unocal Corp	70	10	−1	−2	10,738
25	USX Corp-Consolidated	78	52	−12	−4	18,429
26	Zapata Corp	103	68	−62	−12	289
	Average	63	31	−8	−6	15,040

Data construction (2)

- To be included in the sample, non-oil division must have non-missing data for 1985 (pre-oil shock) and 1986 (post-oil shock)
- Is this ok?

Data construction (2)

- To be included in the sample, non-oil division must have non-missing data for 1985 (pre-oil shock) and 1986 (post-oil shock)
- Is this ok?
  - No: survivorship bias.
  - More credit constrained conglomerates are:
    - More affected by the oil price shocks
    - More likely to divest their non-oil division.
    - Leads to an over-estimation of the <0 effect.
    - Still means the quantitative estimate is wrong.

40 non-oil divisions of oil conglomerates

Table III

Segment Data for Oil-dependent Firms

Δ I/S is the change in the segment investment to sales ratio between 1985 and 1986. Δ CF/S is the change in the segment cash flow to sales ratio between 1985 and 1986. Cash flow equals pretax operating profit plus depreciation. Expressed as percentage points. SIC is Standard Industrial Classification.

	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		

- Average change in I/S ratio is <0
- Change in I/S is <0 27 cases out of 40.
- Is this convincing?

Cash-flow of non-oil division

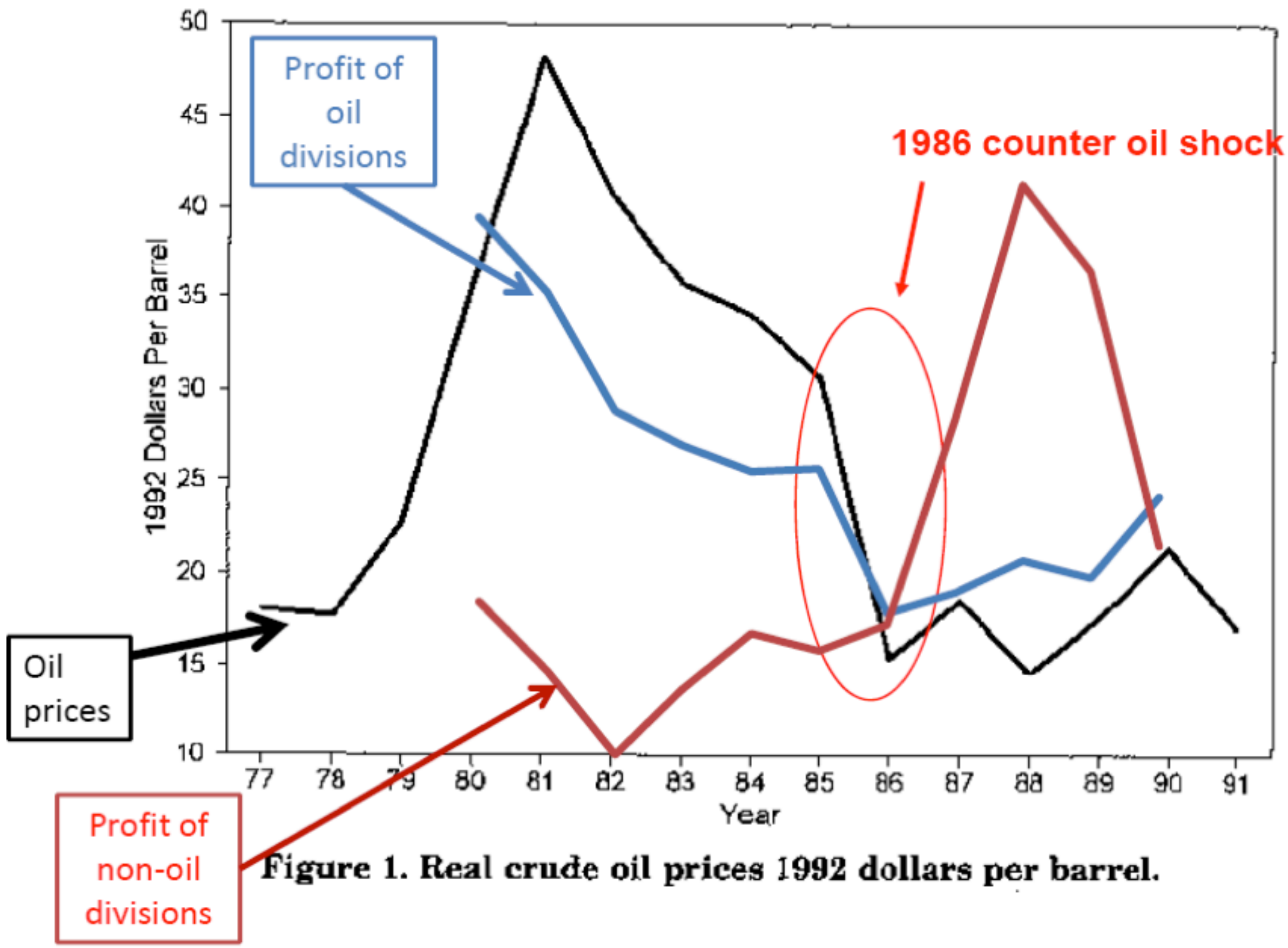


Figure 1. Real crude oil prices 1992 dollars per barrel.

Non-oil divisions could be in industries with cash-flows <0 correlated to oil prices.

→ Another upward bias to the <0 effect

→ Need a control group

Control group: rest of the industry

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)

Welfare

- First-order question / very hard question:
  - If firms investment is constrained by (inside) financing availability, is that necessarily welfare destroying?
  - In other words, what is the underlying theory of credit frictions?

Welfare (2)

- Two broad views on this question:
  - Moral hazard/limited commitment → Underinvestment
    - The entrepreneur/firm can't invest up to first best because it can only borrow up to collateral value (limited commitment) or because she needs to retain enough inside equity for incentive purposes.
  - Agency cost of free cash flows (Jensen 1986)→ Overinvestment.

Lamont's attempt at welfare analysis

Profitability

π/S is segment operating income divided by segment sales. CF/S $(= (\pi + \delta)/S)$ is segment operating income plus segment depreciation divided by segment sales. Variables are industry-adjusted and 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. N = 39.

	1985	1986	Δ 1985–86
	Panel A: π/S		
Mean	−1.82	0.29	2.11
t-statistic	(1.79)	(0.26)	(2.43)
p-value	(0.08)	(0.80)	(0.02)
Median	−2.58	0.82	2.34
Z-statistic	(1.69)	(0.53)	(2.75)
p-value	(0.09)	(0.60)	(0.01)
Number positive	16	22	28
p-value	(0.34)	(0.52)	(0.01)

Panel B: CF/S

Lamont: rise in performance consistent with agency cost explanation
→ Conglomerate managers with no FCF squeeze out profits from non-oil divisions / like in LBOs.
But: Mechanical – even within industries, firms in conglomerates selected to have <0 correlation with oil prices (diversification).
Robustness?

Other approach to welfare question

- Blanchard, Lopes-de-Silanes and Shleifer (1994), JFE:
  - Unexpected cash windfall from corporate lawsuits.
  - Sample Size: **N=11**.
  - **Question**: what do firms do with cash windfall?
  - **Answer:** mostly diversifying acquisitions and increase in executive compensations.
  - Again: evidence consistent with agency theory, but how persuasive?