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Cash Flow and Investment: Evidence from Internal Capital Markets

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ABSTRACT

Using data from the 1986 oil price decrease, I examine the capital expenditures of nonoil subsidiaries of oil companies. I test the joint hypothesis that 1) a decrease in cash/collateral decreases investment, holding fixed the profitability of investment, and 2) the finance costs of different parts of the same corporation are interdependent. The results support this joint hypothesis: oil companies significantly reduced their nonoil investment compared to the median industry investment. The 1986 decline in investment was concentrated in nonoil units that were subsidized by the rest of the company in 1985.

SUPPOSE THAT A COMPANY'S cash flow or collateral value falls, but the profitability of its investment opportunities stays constant (or rises). Would this company reduce its investment? In this article I try to answer this question by examining how different parts of the same firm reacted to the 1986 oil price decline, which reduced the cash flow and collateral value of oil firms. Using the COMPUSTAT database, I identify a group of firms that have corporate segments both in the oil extraction industry and in nonoil industries, where "non-oil" is defined as an industry with profits that are not (positively) correlated with the price of oil. I then test the hypothesis: do large cash flow/collateral value decreases to a corporation's *oil* segment decrease investment in its *nonoil* segment?

I focus on the 1986 oil shock, in which oil prices fell by 50 percent, because this dramatic economic event seems unambiguously exogenous to any individual firm. Looking within firms, rather than across firms, I test the joint hypothesis that 1) the oil shock affected the costs of finance for oil segments, and 2) the cost of finance in the oil segment affected the cost of finance in the nonoil segment of the company. This joint hypothesis would be true if both external capital markets were imperfect (so that financial slack matters for investment) and if internal capital markets allocated capital within firms (so that the different parts of the firm are interdependent). It is of interest both to macroeconomics, because investment is an important part of the business

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cycle, and to corporate finance, because the financing of investment is a central purpose of corporate capital structure.

To preview the main results, I compare the nonoil segments owned by oil companies with similar segments owned by companies that are less dependent on oil. The empirical tests reject the null hypothesis: oil companies significantly reduced their nonoil investment in 1986. Although the sample size is fairly small, the results appear moderately robust. The findings are consistent with previous research that suggests that diversified companies tend to subsidize and overinvest in poorly-performing segments.

Section I discusses the two parts of the joint hypothesis. Section II describes the episode studied here, while Section III discusses the data and sample selection issues. In Section IV, I perform statistical tests with the data, examining medians and means. In Section V, I show the investment reductions were concentrated in segments which were not self-financing in 1985. Section VI briefly discusses possible extensions, and Section VII presents conclusions.

I. Liquidity, Investment, and Internal Capital Markets

A. Liquidity and Investment

A large literature in corporate finance and macroeconomics documents the relationship between liquidity and investment (see Fazzari, Hubbard, and Petersen (1988); Hoshi, Kashyap, and Scharfstein (1991)). Although a strong correlation between cash (whether measured as a flow, a stock, or both) and investment is a well-documented fact, the causal connection between the two has been harder to establish, since both investment and cash flow are driven by underlying shocks to profitability. Existing studies have attempted to control for the profitability of investment by including a measure of Tobin's q in the estimated equation, but since current profitability may well be a better measure of the future profitability of investment than stock market data, the estimated coefficients may be biased.

Since exogenous instruments for cash that are uncorrelated with the profitability of investment are difficult to find, researchers instead have focused on examining the differences in cash-investment correlations between groups of firms hypothesized to have different dependence on internal finance. Studies typically use panel data on firms to estimate:

$$I/K = a + bQ + c\ \mathrm{CASH}/K + \mathrm{YEARDUMMY} + \mathrm{FIRMDUMMY} \quad (1)$$

where I is investment, K is capital stock at the beginning of the period, q is Tobin's q, and CASH is a measure of cash flow or cash stock. To test the hypothesis that two groups of firms face different finance constraints, the coefficient c on cash is compared across different firms, with firms categorized according to dividend payout ratios (Fazzari, Hubbard, and Petersen (1988)), bond rating (Whited (1992)), or membership in a Japanese keiretsu (Hoshi, Kashyap, and Scharfstein (1991)). Another test is to compare the coefficient c

across different time periods with different macroeconomic-credit conditions (Gertler and Hubbard (1988), Kashyap, Lamont, and Stein (1994)).

However, looking at differences in cash-investment correlations may still be a less than perfect test. It may be that innovations in cash have different implications for the profitability of investment in small and large firms (Gilchrist and Himmelberg (1996)). Alternatively, it may be that q is more poorly measured for small firms (as noted in Poterba (1988)).

This article takes a different route, and seeks to find an exogenous instrument for cash. By focusing on a small group of corporate units, I can unambiguously identify shocks to cash that are not correlated (or at least, not positively correlated) with the returns to investment. The basic idea is to find a natural experiment in which one can identify specific changes in the cost of finance. A similar strategy is used by Blanchard, Lopez-de-Silanes, and Shleifer (1994), who examine a small (eleven) group of firms that experience a cash windfall. In contrast, this study examines a somewhat larger group of firms that experience a cash shortfall, and compares their investment with a control group of similar companies that do not experience a cash shortfall.

The innovation in the present article is the use of corporate *segment-level* data. In the United States, publicly-owned firms are required to report certain data disaggregated into corporate segments, with a segment for each different industry in which the company participates. The new data set used here brings new issues (both econometric and conceptual), and by focusing on the 1986 episode I choose a different balance in the trade-off between sample size and econometric bias. Thus the data presented here are useful but imperfect evidence on the connection between finance costs and investment.

A simple perfect capital markets model implies that when a company's oil segment cash flow falls, the same company's nonoil segment should be unaffected if the net present value of nonoil investment is unaffected. An imperfect capital markets model implies, in contrast, that when financial constraints tighten, the shadow cost of investment rises for all projects, so that the amount of investment (ceteris paribus) falls for all divisions of the firm.

B. Internal Capital Markets

Internal capital markets are a major channel of capital allocation in modern industrial economies. In any firm, managers must allocate capital across different projects. External finance is sometimes earmarked for particular parts of the firm or secured by specific assets (e.g., project finance). Internal funds can be more fungible, and finance the bulk of investment. For example, between 1981 and 1991, internal funds accounted for more than three quarters of capital outlays for U.S. nonfinancial corporations.

Internal capital markets may differ from external capital markets due to differences in information, incentives, asset specificity, control rights, or transactions costs (see Alchian (1969), Grossman and Hart (1986), Gertner, Scharfstein, and Stein (1994), and Stein (1997)). Corporations may own multiple assets due to product market synergies, increases in managerial efficiency, or improvements in capital allocation.

These issues are not explored here; instead, I simply outline the hypothesis to be tested. The alternative hypothesis is a joint hypothesis that both external markets are imperfect and that corporate segments are financially interdependent; internal capital markets play a nontrivial role in allocating capital.[1] Under this hypothesis, combining diverse businesses into a corporate whole would alter the investment and financing behavior of the component companies. Of course, it need not be true that the financing of the company's segments is perfectly integrated; that is, the possible imperfections of the external capital market may be mirrored in the internal capital market.

The null hypothesis is that corporate segments operate as stand-alone units; there are no internal capital markets, and each segment finances its investment from its own internal finance or from external finance secured by its own collateral. Corporations operate multiple lines of business for reasons of product market synergy, or because scarce managerial talent is best used supervising a wide range of activity.

If different corporate segments are financially interdependent, then a financial shock to one segment affects the cost of finance in another segment. In the case of the oil shock, financial constraints tightened in two related ways. First, the internal finance available to the company—its cash flow generated by oil—fell. Second, the value of the petroleum-related collateral owned by the company also fell, so external finance may have been more difficult to obtain.

Note that internal capital markets may have macroeconomic implications. Existing macroeconomic research emphasizes the role of banks, securities markets, and other external capital markets in the transmission of business cycles. Internal capital markets (in diversified firms) also provide a channel through which shocks can be transmitted from one sector to another.

II. The Oil Shock of 1986

In late 1985, Saudi Arabia changed its petroleum policy, and increased production. Figure 1 shows the result: crude oil prices responded dramatically, falling from $26.60 per barrel in December 1985 to $12.67 in April 1986. Table I shows the effect this plunge had on major US oil companies: profit rates for petroleum fell markedly. Table I also shows that oil and gas production was hit much harder than other petroleum-related segments. Therefore, this article focuses largely on the shock to oil and gas production/extraction industries (as opposed to refining or transportation).

Evidence on whether the oil price crash was anticipated is mixed. On one hand, oil prices had been declining slowly in real terms throughout the mid-1980s and were weak in 1985, and many observers predicted a decline in oil

[1] By "imperfect external markets" I mean corporate structure and financial market equilibrium that results in suboptimal investment. This includes agency costs, in the sense that external markets are imperfect if they are unable to prevent misallocation of resources within the firm.

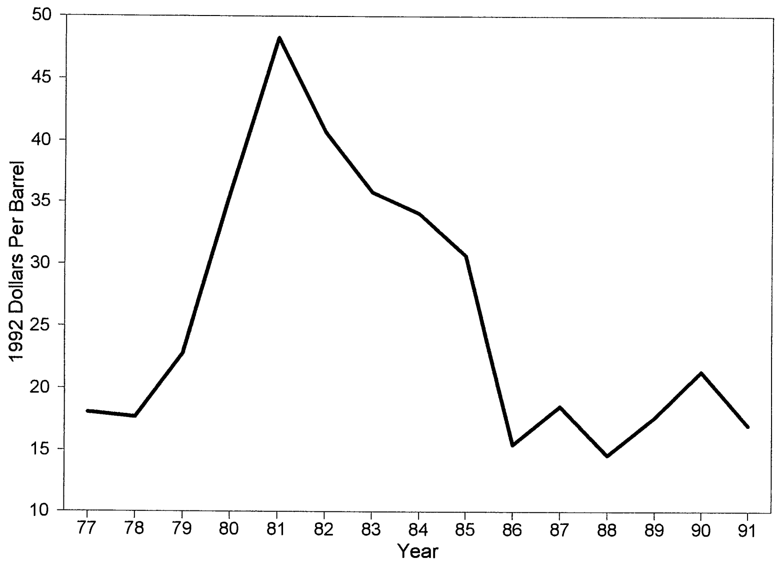

Figure 1. Real crude oil prices 1992 dollars per barrel.

prices due to OPEC's continuing internal turmoil. On the other hand, contemporary press accounts indicate that the depth and rapidity of the oil price decline surprised many participants.

Oil companies certainly dramatically altered their plans in the first quarter of 1986. According to a Department of Commerce survey conducted in October 1985, petroleum companies planned a 3.4 percent increase in (predominantly oil-related) capital expenditures in 1986 compared to 1985. By April 1986, the same survey indicated a planned 24.4 percent fall in capital expenditures in 1986.[2] For the companies that comprise the dataset, downward revisions of total planned 1986 investment ranged from 20 percent (Unocal) to 51 percent (Homestake Mining Company).[3] Unfortunately, most companies did not report the industry details of their expected and revised 1986 investment plans, which would have been ideal for the hypothesis test in this article.

For at least one company in the sample, company officials explicitly stated that they were cutting nonoil investment as a result of the oil price crash:

> Chevron Corp. cut its planned 1986 capital and exploratory budget by about 30 percent because of the plunge in oil prices . . . A Chevron spokesman said that spending cuts would be across the board and that no particular operations will bear the brunt.

[2] In contrast, industries that are major consumers of petroleum and energy as inputs revised their projected investment upwards. The three most energy-intensive manufacturing industries (chemicals, paper, and primary metals) all raised their projected 1986 capital spending between October and April, consistent with the fact that their investment returns rose as a result of the oil price decline.

[3] *Oil & Gas Journal,* 5/19/86.

Table I

Profit Rates and Operating Statistics for Petroleum Companies, 1980–1990

FRS Companies are a set of major petroleum companies that are tracked by the Department of Energy's Financial Reporting System.

	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 Marine	2.4	−1.1	−6.3	−13.2	−14.0	−19.0	5.3	−3.6	6.8	12.4	11.7
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
Panel B: Operating Statistics for FRS Firms and for US Petroleum Industry											
Net Production, Crude Oil, And Natural Gas Liquids (Billion barrels)											
FRS Companies	2.09	2.07	2.08	2.06	2.09	2.12	2.09	2.07	2.10	1.91	1.81
U.S. Industry	3.71	3.69	3.67	3.75	3.81	3.81	3.71	3.57	3.32	3.24	3.27
Refinery Output (Million barrels/day)											
FRS Companies	12.22	11.28	10.63	10.38	11.00	10.92	11.46	11.71	12.03	11.41	11.31
U.S. Industry	15.35	14.66	14.01	13.69	14.27	14.19	14.93	15.09	15.43	15.65	15.91
Net Wells Completed											
Exploratory	926	1,159	625	513	597	539	258	356	224	363	347
Development	1,917	2,081	1,580	1,586	1,982	1,776	647	911	822	922	1,164

> About 65 percent of the $3.5 billion budget will be spent on oil and gas exploration and production—about the same proportion as before the budget revision.
>
> Chevron also will cut spending for refining and marketing, oil and natural gas pipeline, minerals, chemicals, and shipping operations. (*Wall Street Journal*, 3/14/86)

In the terminology of this article, Chevron's chemical segment is classified as a "nonoil" segment. Note that Chevron's actions appear to be consistent with Shin and Stulz (1996) who look for "bureaucratic rigidity" in the allocation of capital in diversified firms.

III. Data

For corporate segments that constitute at least 10 percent of total sales and which are in a different industry from the rest of the corporation, accounting standards require corporations to report five annual variables on a segment-level basis: sales, operating profit, capital expenditures, depreciation, and identifiable total assets. Operating profit is usually reported on a pretax basis. The COMPUSTAT database reports these five items, along with a pair of Standard Industrial Classification (SIC) codes, for each segment. After examining various documents supplied by the company, COMPUSTAT assigns a primary 4-digit SIC industry code to each segment, corresponding to the industry classification of the majority of the segment's sales. If the segment engages in business in more than one 4-digit industry, COMPUSTAT assigns a secondary SIC code for the next largest part of the segment.

Segment-level accounting data are far from perfect, and may well contain more noise than firm-level accounting data. In particular, firms must (perhaps arbitrarily) divide overhead costs and assets that may provide benefits to more than one segment. I focus primarily on (appropriately normalized) *changes* in segment-level capital expenditure data, so that any noise that is constant over time (such as different accounting practices used by different firms) may be alleviated. Since the 1986 shock is quantitatively and economically very large, the size of the effect should be large enough to be discerned despite possible measurement errors in the data.

To gather a sample of firms likely to be affected by the oil price decrease of 1986, I extract every firm that in 1985 had a segment with either primary or secondary SIC codes in the oil and gas extraction sector (2-digit SIC code 13). I then select only those firms that I classified, based on 1985 data alone, as being oil-dependent; that is, to have a high ex ante probability of receiving a large decrease in their oil cash flow (relative to their nonoil cash flow) in 1986. I classify firms as being oil-dependent if at least 25 percent of their cash flow in 1985 came from the oil and gas extraction industry (see the Appendix for more details).

I then select those firms that had a nonoil segment, as identified by COMPUSTAT's SIC codes for the segment and using my own judgment about which industries were oil-related.[4] I restrict attention to segments that were not in the financial or services industries, as is standard.[5] I define a nonoil industry as any industry that was not involved in the extraction of or exploration for oil and gas (or by-products of oil and gas extraction); did not primarily involve refining, transporting, or selling petroleum products; did not supply services or equipment to the oil and gas industry; and did not produce a product that was a substitute for petroleum.[6] This meant that, for example, in addition to excluding gas pipelines, retail gasoline distributors, and oilfield services, I also exclude the coal and uranium industries; manufacturing of valves and other pipeline-related equipment; manufacturing of construction and mining equipment; and sulfur mining (since sulfur is sometimes produced as a by-product of oil extraction). When in doubt, I exclude suspect industries.

After carefully checking the line-of-business descriptions of every segment, I exclude those that I judge likely to be adversely affected by the oil price shock, either because they provided services for the oil and gas extraction industry or operated in a region heavily dependent on oil (a complete list is given in the Appendix). For example: I exclude Rowan Companies "Aviation Operations" (a charter aircraft business) because after checking the company documents, I find it operates principally in two oil-related regions, Alaska and the Gulf of Mexico. Conversely, I am happy to include as nonoil industries those that used oil as an input, since these segments were likely to experience an increase in profitability as a result of the decline in oil prices.

As a check on this judgmental classification procedure, I also examine industry-level data on profits and investment for the nonoil industries with available data. Using data from the Annual Survey of Manufacturing from 1961–1985, I examine the time-series correlation of profits and investment with real oil prices. I am unable to reject the hypothesis that for this group of industries, profits and investment were not positively correlated with the price of oil.[7]

Lastly, as detailed in the Appendix, I delete segments with incomplete information and segments that were very small.

[4] A complete list of excluded industries is presented in the Appendix.

[5] I.e., those segments with primary SIC code less than 6000. This is standard because these industries have complex accounting variables.

[6] I made one exception in deleting companies with an SIC code that indicated refining. COMPUSTAT assigned Fina, Inc.'s Chemicals segment a secondary SIC code indicating petroleum refining. After reading Fina's 1986 annual report and related documents, I did not agree with this classification, so I included this segment in the sample.

[7] Of the 55 primary and secondary SIC codes of nonoil segments listed in Table III, I was able to find data for 29 of the industries. For each of these 29 industries, I ran a simple time-series regression with either I/K or π/K as the dependent variable (where π is profits). Each regression had on the right hand side the real price of oil, a time trend, and the lagged dependent variable. For I/K, the coefficient on oil was negative in 19 of the 29 regressions (it was never significant when positive, but was significant twice when negative). For π/K, the coefficient on oil was negative in 22 of the 29 regressions (it was never significant when positive, but was significant 5 times when negative).

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

The resulting sample of 26 diversified, multi-segment firms is shown in Table II. The main activity of most of these firms fell into one of five main areas: extracting, refining, and distributing petroleum products; railroads; mining; chemicals; and miscellaneous manufacturing. Most of these firms are quite large (the average annual sales is $15 billion, far larger than the typical COMPUSTAT firm). A standard result in the cash/investment literature is that liquidity matters less for large firms than for small firms. Fazzari, Hubbard, and Petersen, for example, find that small firms have much higher cash/investment correlations than large firms.[8] Thus it may be difficult to reject the null hypothesis with this sample of firms.

These 26 firms owned 40 segments, which are presented in Table III. Chemicals and plastics is the largest single industry (with 17 segments) with railroad, mining, agriculture, and paper/lumber products also represented.

A. Survivorship Bias

There is likely a substantial survivorship bias in the data that probably decreases the ability to reject the null hypothesis when it is false. Under the alternative hypothesis that the oil shock increased the cost of finance, financially constrained firms are likely to sell their nonoil segments.

One strand of the imperfect capital markets/financial constraints literature would predict that, as a result of the adverse cash flow shock of 1986, oil-dependent companies would underinvest in their nonoil subsidiaries. One way to mitigate this inefficiency, and at the same time to raise cash, is for the firm to sell off some of its divisions. This is precisely what occurred in 1986. Figure 2 shows that nonenergy asset disposals in companies tracked by the Department of Energy peaked in 1986.[9] This process decreases the sample size since this article includes only nonoil divisions with continuous data; i.e., those that were owned by the same parent company in both 1985 and 1986. Further, because the firms that were most constrained were the ones most likely to sell divisions, it may bias the results in favor of accepting the null hypothesis.

Major energy producers that sold off petrochemical operations in 1986 include Diamond Shamrock and Enron. Thus these two companies are not represented in our sample. Of the 26 oil firms examined here, at least five discontinued large nonoil operations: Canadian Pacific (airlines and mining); Homestake Mining (silver mining); WR Grace (agricultural chemicals and restaurants); Mobil (paperboard and packaging); and USX Corp (chemicals). For some of these discontinued segments, I was able to find at least partial capital expenditure data in 1986 (with data coming either from the buyer or successor company, or from the original owner). In each case, these data indicate that capital expenditures decreased in 1986 under the original owners, consistent with the hypothesis that investment decreased due to the oil shock. For example, one of the firms in the sample, USX Corp (formerly US Steel) spun-off its chemical segment in October, 1986. The financial statements of the resultant entity, Aristech Chemical, show that capital expenditure fell between 1985 and 1986, when it was (for most of the year) a unit of USX.

[8] More precisely, they group firms by dividend payout ratios; the oil companies used in our sample would largely fall into the high dividend payout ratio category.

[9] The sample of companies tracked by the Department of Energy (DOE) change over time, so this time series is affected by changes in composition.

Table III

Segment Data for Oil-dependent Firms

$\Delta I/S$ 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		

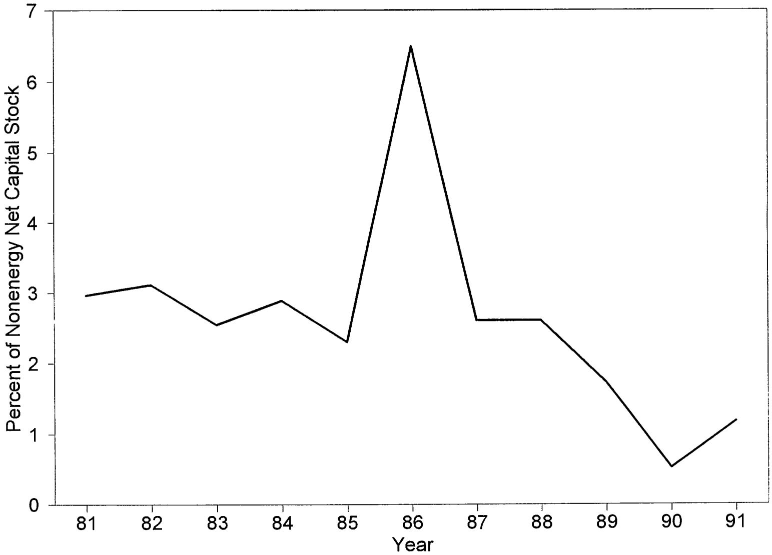

Figure 2. Nonenergy asset disposals. The book value of nonenergy asset disposals as a percent of the previous year's nonenergy property, plant, and equipment net of depreciation. The data are from a group of large energy companies tracked by the Department of Energy's Financial Reporting System.

IV. Results

I try to adhere to standard practice by using a dependent variable similar to the left hand side of equation (1). Unfortunately, I do not observe physical assets (K) for corporate segments. Further, since asset sales are likely to be a problem during this period, changes in the size of the segment could drive changes in capital expenditure. Therefore, I focus on the ratio of contemporaneous investment to contemporaneous sales, I/S.

The basic empirical strategy is to test the hypothesis in several ways. First, I impose few assumptions on the data, and look only at means and medians. Here I focus on the change in the investment to sales ratio between 1985 and 1986. In Section V, having established that investment fell in this period, I attempt to explain this fall by looking at the performance of these nonoil segments and the pattern of intersegment subsidization in 1985, looking at levels of investment in addition to changes in investment. Last, I come as close as possible to testing the standard equation (1) using oil cash flow and nonoil investment. However, with segment data it is impossible to observe Tobin's q for each segment, since individual corporate segments do not (usually) issue equity.[10] Because I cannot observe q, I pay particular attention to industry-adjusted data.

To be sure that the observed oil cash flow decrease is caused by an exogenous shock, and not by the firm's endogenous response to the shock, I look at both

[10] See Holmstrom and Tirole (1993).

Table IV

Raw segment I/S Level, 1985–1987

I is segment capital expenditure and S is segment sales. I/S expressed as percentage points.

	1985	1986	1987
No. of Observations	40	40	40
Mean	7.94	6.48	6.24
Median	6.91	6.13	5.84

the ex post magnitude of the cash flow decrease in the oil segment in 1986, and the ex ante likelihood that a large decrease would occur. In looking at ex ante data, I use only information on the industry composition of the firm in 1985, to avoid the possibility that firms that had a large ex post decrease in oil cash flow in 1986 were firms with particularly inept managers.

A. *Ex Ante Tests:* $\Delta\, I/S$

As can be seen in Table III, most of the nonoil segments experienced an increase in cash flow between 1985 and 1986, in sharp contrast to the performance of the oil industry. Cash flow is defined as the sum of segment operating income and segment depreciation. The average change in the cash flow to sales ratio from Table III is 2.43 percent (with a t-statistic of 2.76).

Table IV presents means and medians for the (normalized) levels in segment investment. Based on the evidence from Table III, one might have expected capital expenditures to increase in 1986, since cash flow increased. In fact, Tables III and IV show that just the opposite occurred: capital expenditures declined in 1986 for most of the 40 segments, with a mean and median decline of around one percent, compared to the 1985 level of the investment to sales ratio of around eight percent.[11]

Table V presents raw and industry-adjusted changes in investment, and displays some of the major results of this article. Industry-adjustment is necessary to control for industry-wide changes in the profitability of investment. The method used is fairly standard in the corporate finance literature.[12] For example, Kaplan (1989) uses an almost identical algorithm (except, as explained in the appendix, I use information about both the primary and secondary SIC industry codes assigned by COMPUSTAT). For each observation of $\Delta\, I/S$, I subtract the median value of $\Delta\, I/S$ 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. The algorithm for selecting the control group is detailed in the Appendix; there were matches for 39 of the 40 observations.

[11] I/S declined for 27 of the 40 segments. As shown in Table V, the probability of flipping 40 coins and getting 27 heads or 27 tails is 0.04.

[12] In a previous version of this article (Lamont (1994)), I find that using a different method of industry-adjustment does not change the results.

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)

Table V shows that, for both means and medians, both raw and industry-adjusted investment fell in 1986. The mean and median fall are significant at the five percent level, and again equal to about one percent of the investment to sales ratio.[13] Following convention, the table reports two-sided *p*-values, although I am really trying to test a one-sided hypothesis; thus the *p*-values in the table are quite conservative.

B. Robustness Checks

This section presents some basic robustness tests on the industry-adjusted results of Table V. First, I checked to see if the results are driven by any single observation. They aren't.[14] Next, Table VI measures the dependent variables in a variety of different ways. In each case, the variables are industry-adjusted in the same manner as before. The first three columns normalize the change in investment by a constant 1985 denominator instead of looking at the change in the contemporaneous investment to sales ratio. Looking at the change in investment relative to 1985 sales and 1985 total assets does not change the

[13] Using a different definition of oil-dependent does not alter the qualitative conclusions. Looking only at the twenty-one segments whose companies have more than 50 percent (instead of 25) of 1985 cash flow coming from oil, the means and medians for 1985–1986 in Table V are slightly higher, while the test statistics are about the same size.

[14] The lowest *t*-statistic for the industry-adjusted mean in Table V that I could generate by eliminating a single observation was 1.77.

Table VI

Alternative Measures of Industry-Adjusted ΔI, 1985–1986

All variables industry-adjusted and expressed as percentage points. *Alternative measures:* $(\Delta I)/S_{85}$ is the change in investment normalized by 1985 segment sales. $(\Delta I)/A_{85}$ is the change in investment normalized by 1985 segment total assets. $(\Delta I)/I_{85}$ is the percentage change in investment between 1985 and 1986. $\Delta(I\text{-}\delta)/S$ is the change in the net investment ratio (capital expenditures minus depreciation divided by sales) between 1985 and 1986. 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. *Alternative sample:* Uses both the base sample of 39 nonoil segments and an additional group of 36 nonoil segments. These 36 segments are owned by 17 firms who have an oil segment in 1985 but which are not oil-dependent in 1985 (less than 25 percent of the firm's cash flow comes from oil). Mean: the coefficient on the dummy variable for oil-dependent firms in a regression including only a dummy and a constant. Constant term not shown. Median: the difference between the medians of the oil-dependent and not-oil-dependent sample. The Z-statistic is the Wilcoxon-rank sum test, which tests the hypothesis that the two samples have the same iid distribution. The reported 2-sided p-values are two sided.

	Alternative Measures				Alternative Sample
	$(\Delta I)/S_{85}$	$(\Delta I)/A_{85}$	$(\Delta I)/I_{85}$	$\Delta\ (I\text{-}\delta)/S$	$\Delta\ I/S$
No. of Obs.	39	39	39	39	75
Mean	−1.54	−1.09	−6.34	−1.74	−2.56
t-statistic	(2.31)	(2.26)	(0.48)	(2.47)	(2.49)
p-value	(0.02)	(0.02)	(0.63)	(0.02)	(0.01)
Median	−1.02	−1.32	−14.96	−1.25	−1.53
Z-statistic	(2.20)	(2.20)	(2.20)	(2.56)	(2.57)
p-value	(0.03)	(0.03)	(0.03)	(0.01)	(0.01)
Number positive	15	15	15	12	NA
p-value	(0.20)	(0.20)	(0.20)	(0.02)	NA

conclusions: there was a significant decrease in 1986. The percentage change in investment, in the third column, appears quite skewed but the median is also significantly negative. The fourth column shows net segment investment (capital expenditures minus depreciation), as in Shin and Stulz (1996). Net investment to sales ratios fell significantly in 1986.[15]

One potential objection to the evidence in the first four columns of Table VI is that the nonoil segment data may somehow be contaminated because the parent company also owns an oil exploration segment. This objection might be valid even though I carefully screen the companies and read each segment's line-of-business description. For example, it could be that Burlington North-

[15] In a previous version of this article (Lamont (1994)), I perform additional robustness tests, examining the effect of multiple observations from the same firm and different methods of normalizing investment. I find that in general the results are robust.

ern's railroad division is more heavily involved in oil transportation compared to the control group of railroad divisions. There may be synergies between oil and nonoil segments (although it is difficult to imagine for segments such as Mobil's Montgomery Ward retail division). Perhaps tax changes in this period affected oil companies more than other companies. Also, it could be that companies that own oil extraction segments are concentrated in oil-producing states.[16]

Although I cannot control for all of these factors, a different control group may address some of these concerns. To provide a better control group, I use a group of 17 firms that owned an oil segment in 1985 but were not oil-dependent (by my methodology using ex ante data; less than 25 percent of their cash flow came from oil). These 17 firms owned 36 nonoil segments. There is substantial overlap in the industries owned by the oil-dependent firms and this control group, with both groups including chemicals, mining, railroads, and agriculture. If there is some hidden dependence on oil in these industries, then one might expect it to be reflected in the segments owned by nonoil-dependent oil firms. Of course, this control group is only useful to the extent that the hidden dependence is a function of the *existence* of an oil segment rather than its quantitative size. If there is some hidden synergy that is a function of the size of the oil segment, I have no hope of controlling for it.

The last column in Table VI shows evidence using both means and medians for industry-adjusted data. Both the mean and the median change in investment were significantly lower for the oil-dependent oil firms compared to the control group of diversified, oil-owning firms.[17]

V. Why Did Nonoil Investment Fall?

The previous section documented that oil-dependent firms decreased their nonoil investment in 1986. Why do we observe this relation between liquidity/collateral and investment? First, I attempt to disentangle the fall in collateral from the reduction in cash flow. Second, and more broadly, I examine whether the decrease in nonoil investment is likely to help or hurt the shareholders of oil companies. Last, I examine cash-flow investment correlations at the segment level.

A. Cash Flow Versus Collateral

Was the proximate cause of the decline in investment the decline in collateral, the decline in cashflow, or both? Since for this sample of oil-dependent companies the two are highly correlated, this is a difficult question. I address

[16] Of course, this possible regional effect could work both ways. It could be that nonoil industries that sold their products nationally but were located in oil-related regions benefit, as wages, rents, and other business costs fell in those regions.

[17] In a previous version of this article (Lamont (1994)), I explore the differences between these two groups of segments in more detail. Using a more precise way to compare the two groups, I reject the hypothesis that the two groups experienced the same change in investment in 1986.

Table VII

Ex Post Regression Evidence on Δ *I/S*: Cash Flow vs. Bond Ratings

The dependent variable is industry-adjusted Δ *I/S*, the change in the ratio of capital expenditures to sales for nonoil segments between 1985 and 1986. Downgrade is a dummy variable equal to 1 for the 17 segments whose parent firms had their debt downgraded by Moody's between 1985–86. Expostshock is a dummy variable equal to one for the 20 segments whose parent firms experienced a decline in oil cash flow between 1985 and 1986 that was greater than 4.3 percent of their 1985 sales. Δ CF/*S* is the industry-adjusted change in the cash flow to sales ratio between 1985 and 1986. (Δ*S*)/*S* is the industry-adjusted percent change in segment sales between 1985 and 1986. I_{85}/S_{85} is the industry-adjusted level of the ratio of capital expenditures to sales. N = 39. *t*-statistics in parentheses.

Constant	−0.99	−1.06	−0.46	−0.48	−1.16
	(1.07)	(1.06)	(0.37)	(0.37)	(1.42)
Downgrade	−0.97		−1.13	−1.56	−0.86
	(0.70)		(0.79)	(0.99)	(0.85)
Expostshock		−0.69	−0.89	−0.75	1.21
		(0.50)	(0.63)	(0.47)	(1.17)
Δ CF/*S*				0.00	−0.03
				(0.02)	(0.30)
(Δ *S*)/*S*				−0.04	0.01
				(0.72)	(0.35)
I_{85}/S_{85}					−0.68
					(7.24)
Adj R^2	−0.01	−0.02	−0.03	−0.07	0.57

the question by collecting data on bond rating changes for the parent companies. Of the 39 segments for which industry-adjusted data is available, 17 had their parents' bond-rating downgraded by Moody's between May 1985 and May 1986.[18] For these segments, the cost of external finance presumably rose.

The first column of Table VII uses regression evidence to show that these 17 segments had a fall in investment that was larger than the segments that did not have their debt downgraded. This difference, while quantitatively large at about one percent, is statistically insignificant. Is this relationship driven by the fact that downgrades are correlated with the 1986 reduction in oil cash flow? To control for the ex post change in oil cash flow, I split the sample in half based on the size of the decline in oil cash flow. The variable Expostshock is equal to one for the 20 segments whose parent firm had the largest decline in oil cash flow relative to 1985 firm sales.

As can be seen in Table VII, both the downgrade and ex post shock variable do a poor job of explaining the cross-section of investment changes, whether entered separately, together, or with other segment-level control variables (industry-adjusted changes in segment cash flow and sales). Adding the industry-adjusted 1985 level to the regression, in the last column, does not help clarify matters. I conclude from Table VII that it is impossible, in this sample, to untangle the effects of cash flow and collateral value changes.

[18] I am unable to find ratings for parent companies for 6 of the 39 segments.

Table VIII

The Level of Investment

I/S is segment capital expenditure divided by segment sales, industry-adjusted, and expressed as percentage points. The last column is the difference in the first two columns. 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.

I/S	1985	1986	Δ 1985–1986
Mean	0.62	−1.05	−1.66
t-statistic	(0.75)	(1.95)	(2.50)
p-value	(0.46)	(0.06)	(0.02)
Median	−0.18	−1.49	−1.06
Z-statistic	(0.15)	(1.91)	(2.79)
p-value	(0.88)	(0.06)	(0.01)
Number positive	17	17	13
p-value	(0.52)	(0.52)	(0.05)

B. Underinvestment Versus Overinvestment

The literature on imperfect information suggests that underinvestment (relative to what would take place in perfect capital markets) may result from costly external finance, so that the fall in oil cash flow may have resulted in (increased) underinvestment in nonoil activities. On the other hand, principal-agent models (such as Jensen (1986)) stress that managers may overinvest free cash flow, so that the fall in oil cash flows may have prevented wasteful expenditure. Indeed, the oil industry was often cited as a possible case of overinvestment and an example of the salutary effects of hostile takeovers on corporate discipline. Blanchard, Lopez-de-Silanes, and Shleifer (1994) also conclude that agency problems may explain firms' use of cash flow. Both the underinvestment/information and overinvestment/agency approaches imply that when internal finance falls, investment falls.

In the context of diversified firms, previous research points in the direction of overinvestment. Lang and Stulz (1994) document that diversified firms have lower market values compared to less diversified firms. Berger and Ofek (1995) explain this negative effect of diversification using COMPUSTAT segment data similar to that used in this article. They find that diversified firms tend to invest more than undiversified firms, tend to invest more in low q industries, and tend to have below-average profits and cash flow. In sum, Berger and Ofek's evidence indicates that diversified firms tend to overinvest in and to subsidize money-losing segments.

Table VIII investigates these issues by examining industry-adjusted *levels* of nonoil investment to sales ratios, in 1985 and in 1986. In 1985, nonoil investment by oil firms was insignificantly different from industry levels; in 1986, nonoil investment was more than one percent below industry levels. Conse-

Table IX

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		
Mean	−2.05	−0.96	1.09
t-statistic	(2.00)	(0.88)	(1.38)
p-value	(0.05)	(0.39)	(0.17)
Median	−0.24	−0.20	0.48
Z-statistic	(1.63)	(0.61)	(1.31)
p-value	(0.10)	(0.54)	(0.19)
Number positive	17	18	21
p-value	(0.52)	(0.75)	(0.75)

quently, investment to sales ratios fell significantly.[19] The level of investment in 1986 was below industry norms at marginal significance.[20] Based on this table alone, one might conclude that oil companies were investing optimally in their nonoil businesses in 1985, but were forced to underinvest in 1986. The next table, however, tells a different story.

Table IX shows industry-adjusted levels of profitability and cash flow. Berger and Ofek (1995) find that segments owned by diversified firms had profit to sales ratios about two percent below similar segments owned by

[19] Note that the last column of Table VIII reports the change in the industry-adjusted levels, while Table V reports the industry-adjusted change in the levels. This slightly different procedure produces highly similar results.

[20] Results are similar using capital expenditures net of depreciation.

undiversified firms.[21] As one might expect from Berger and Ofek's findings, nonoil segments owned by oil companies underperformed their industry peers in 1985, with profit to sales ratios about two percent lower than industry median (this difference is marginally significant). In 1986, these nonoil segments performed about as well as the industry standard; thus industry-adjusted profitability rose significantly. One possible explanation for the improvement in performance in 1986 is that the oil cash shortfall gave managers newfound incentives to squeeze out more nonoil profits, just as LBOs and MBOs cause profits and cash flow to increase (Kaplan (1989)).

Although there could be several explanations for Tables VIII and IX, the industry-adjusted levels of investment and profitability seem quite consistent with the free cash flow hypothesis. In 1985, oil companies were investing industry-average amounts of capital expenditures into below-average segments. In 1986, oil companies cut back on this (possibly) wasteful expenditure, because they no longer had cash to (possibly) waste. Although Tables VIII and IX cannot *prove* that the nonoil segments were negative-NPV projects in 1985, they are certainly consistent with this idea and with the findings of Lang and Stulz (1994) and Berger and Ofek (1995).

C. Subsidization and Self-Financing

To further explore the issue of subsidization of nonoil segments by oil segments, I examine the intersegment flow of cash in 1985. Five of the thirty-nine segments had capital expenditures in 1985 which exceeded their (pretax) cash flow; in some sense, their investment was subsidized using oil cash flow.[22] Table X shows that these segments were dramatically different from the rest of the sample; they cut their industry-adjusted investment to sales ratios by a whopping eight percentage points more in 1986. This difference in means is highly significant, even controlling for changes in industry-adjusted segment cash flow and sales, and for the 1985 level of investment. Evidently, companies who were subsidizing their nonoil segments in 1985 slashed their investment in 1986.[23]

Last, I examine the relationship between segment investment and both segment cash flow and oil cash flow, in regressions similar to equation (1). I examine 1985 and 1986 separately to see how the change in the fortunes of the oil industry affected the allocation of capital across segments.

Table XI shows the results, regressing industry-adjusted levels of investment against own cash flow and oil cash flow. The variables are normalized by firm sales. In 1985, oil cash flow has a strong and statistically robust effect: for every dollar in oil cash flow, nonoil investment rises 12 or 13 cents. The

[21] In contrast, here I compare segments owned by oil companies to the entire universe of segments not owned by oil companies (which includes both diversified and undiversified parent firms).

[22] This calculation is done on raw data, without industry-adjusting.

[23] The number of "subsidized" segments in this sample of 39 fell from five in 1985 to two in 1986.

Table X

Subsidies and Δ *I/S*

The dependent variable is industry-adjusted change in investment to sales ratios for non-oil segments between 1985 and 1986. CF is segment cash flow = $\pi + \delta$. Subsidy is a dummy variable equal to one for the 5 segments which had CF < I in 1985, where neither I nor CF have been industry-adjusted. Δ CF/S is the industry-adjusted change in the cash flow to sales ratio between 1985 and 1986. (Δ S)/S is the industry-adjusted percent change in segment sales between 1985 and 1986. I_{85}/S_{85} is the industry-adjusted level of the ratio of capital expenditures to sales. $N = 39$. t-statistics are in parenthesis.

Constant	−0.37	−0.46	−0.58
	(0.65)	(0.76)	(1.22)
Subsidy	−8.10	−8.32	−4.04
	(5.07)	(5.13)	(2.64)
Δ CF/S		−0.01	0.01
		(0.12)	(0.12)
(Δ S)/S		−0.04	0.01
		(1.16)	(0.19)
I_{85}/S_{85}			−0.50
			(4.91)
Adj R^2	0.39	0.38	0.63

coefficient on the segment's own cash flow appears imprecisely estimated; it is 0.35 in one specification but zero in another.

In 1986, in contrast, nonoil investment appears to be decoupled from oil cash flow: the coefficient on oil-cash flow is zero. The segment's own cash flow now has a coefficient that is higher, highly significant, and robust across specifications. In summary: oil cash flow mattered for nonoil investment in 1985, but only own cash flow mattered in 1986.

Table XI is consistent with the following story. In 1985, oil companies were awash in cash, and subsidized underperforming nonoil businesses. In 1986, the parent companies stopped subsidizing their nonoil segments; these segments therefore relied only on their own cash flow to finance investment.

These results are comparable to existing estimates of equation (1). Using firm (not segment) data, Fazzari, Hubbard, and Petersen (1988) estimate a coefficient of 0.23 on cash flow for a similar group of companies 1970–1984.[24] However, there are important differences between this regression and standard firm-level versions of equation (1). One difference is that, for consistency, I have industry-adjusted both the nonoil investment and the nonoil cash flow. Thus the estimates on the segment's own cash flow are intended to capture only the idiosyncratic component of the segment's cash flow.

[24] This estimate is for companies that pay high dividends. Most of the companies in the sample would fall into this category.

Table XI

Levels of Investment and Segment and Oil Cash Flow, 1985 vs. 1986

FS is total firm sales. The dependent variable is $I/\text{FS} = I/S * S/\text{FS}$ for nonoil segments, where I/S is industry-adjusted. S/FS measures the relative size of the segment by taking the ratio of segment sales to total firm sales. $\text{CF/FS} = \text{CF}/S * S/\text{FS}$ where CF/S is the industry-adjusted nonoil cash flow to sales. OILCF/FS is the (unadjusted) oil cash flow to firm sales ratio. $N = 39$. t-statistics are in parentheses.

	1985		1986	
Constant	−1.21	−2.61	−1.11	0.06
	(1.52)	(3.24)	(0.30)	(0.11)
CF/FS	0.35	−0.04	0.40	0.43
	(1.83)	(0.19)	(3.55)	(3.26)
OILCF/FS	0.13	0.12	−0.00	−0.01
	(2.40)	(2.62)	(0.09)	(0.24)
S/FS		0.07		−0.00
		(3.46)		(0.42)
Adj R^2	0.17	0.35	0.23	0.21

Obviously, some caution should be exercised in interpreting multivariate regressions with only 39 observations. This is especially important since all the tables are based on the same 39 observations. Again, Tables X and XI cannot prove that the 1985 level of nonoil investment was excessive. Nevertheless, all the data appear consistent with previous research on the nature of value-reducing diversification during this period.

D. Caveats

The most significant departure from the existing literature is that the cash flow observed is pretax operating income, since aftertax net income is not generally available. Thus OILCF and CF do not represent true internal finance available to the firm. This problem may well be particularly acute for oil companies, for two reasons. First, U.S. tax laws (which were changing or anticipated to change during this period) are a substantial factor in investment in capital-intensive industries like petroleum. Second, much of the income tax payment made by the large international oil companies in the sample was paid to foreign governments (e.g., Saudi Arabia). These payments to host countries were sometimes structured to ensure fixed profit margins for oil companies regardless of price. Thus, looking at pretax income would overstate the effect of the 1986 oil price crash for some companies.[25] Using aftertax income would

[25] For example, Mobil (which did report both before- and aftertax segment income) had a fall in pretax oil income as shown in Table II, but aftertax net oil income was essentially flat. Due to growth in chemicals and merchandising, Mobil's net income actually rose between 1985 and 1986, as can be seen from Table II.

decrease the magnitude of the cash flow variable, and thus increase the magnitude of the coefficients.

Another potential way that taxation might affect our ability to make inferences from the results is by affecting the cost of capital. Companies with lower profits (or losses) may lose certain tax benefits and thus face a higher after tax cost of capital. Thus the cash/investment correlation might reflect changes in the cost of finance due to the tax code, not financial market imperfections. This problem is also present in the existing literature using firm-level data. So while the use of segment data improves on the existing literature by avoiding the profitability signaling component of cash flow, it does not avoid the tax signaling component.

A problem more specific to the 1986 episode is that major tax legislation was passed during this period; this legislation contained several provisions with differing effects on the cost of capital (portions of the law were implemented in 1986, with the bulk of the effect in 1987). If tax reform raised the cost of capital for oil firms more than other firms, then this may be driving the results.

VI. Future Extensions

In principle, the approach used here can be used for many other episodes with financial shocks to diversified firms, for example exchange rate fluctuations (and other region-specific shocks for geographically diverse firms), commodity price movements, and business cycles.

For the case of oil firms, additional evidence could be gathered by moving in at least two directions. The first is to obtain plant-level data, for example from the Census Bureau's plant-level database. This would be useful both because it would supply more observations and because it would supply more information about the product of the individual plant. The second direction is to obtain more firm-level data for different periods of time. With a longer time series, we could begin to answer questions like: do negative shocks and positive shocks have the same effect on investment?

One desirable extension would be a more formal analysis of the profitability of investment. If a longer time series were available, forecasts of future profitability could be constructed in the tradition of Hall and Jorgenson (1967), Abel and Blanchard (1986), and Gilchrist and Himmelberg (1996).

Another extension would be to separate the effects of cash flow and collateral, perhaps by finding firms that have cash flow and collateral values that are not positively correlated.

VII. Conclusion

I conclude, based on the responses of oil companies' nonoil segments, that large decreases in cash flow and collateral value decrease investment. I confirm the findings from the literature on cash flow and investment: cash matters. Unfortunately, the sample size is fairly small, so that the investigation is fairly limited in scope; I feel confident only in testing relatively simple hypotheses. While statistical confidence levels are not extraordinarily high, they are moderately robust.

I also conclude that corporate segments are interdependent, so that combining different firms into a corporate whole has real consequences. Issues in the theory of the firm emerge naturally from this empirical investigation.

The sample of firms used in the article include some of the largest corporations in the world (the median annual sales of the firms in Table II is about eight billion dollars). If one does not believe that asymmetric information or access to capital markets is likely to be a problem for such firms, one must find other explanations for the correlation of oil cash flow with nonoil investment.[26] One explanation, suggested by previous research, is that large diversified companies overinvest in and subsidize underperforming segments. The evidence presented here is consistent with this explanation.

The segment data presented here are potentially important for two reasons. First, segment data can provide a useful tool for examining questions of traditional interest in corporate finance. For example, this article has explored the correlation of internal funds and investment, while Lang, Ofek, and Stulz (1996) use segment data to find the effect of leverage on investment and growth. Second, segment data will also be useful in exploring empirically novel issues in the theory of the firm, since it allows us to peer into the inner workings of the corporation.

Appendix

This appendix describes detailed information about the procedures used to select and check the baseline sample of 40 segments and the control group of 36 segments used in the last column of Table VI.

For calculating which firms were oil-dependent, I wanted to use segment data to determine how much of the firms' cash flow came from the oil and gas extraction industry (code 13). Unfortunately, companies sometimes lumped different industries together in the same segment. I use COMPUSTAT's system of assigning two SIC codes to each segment in order to get around this problem. If a segment's primary SIC code was in code 13, I count all of that segment as code 13; if only the secondary SIC code was code 13, I count only half the segment, since that is the highest possible proportion of the segment that could be in code 13. Some companies in the sample, for example Chevron, did not disaggregate their petroleum business into refining and extraction but instead reported it as a single unit, which was assigned primary SIC code 2911 (refining) and secondary SIC code 1311 (extraction) by COMPUSTAT. I treat these units as if they had a primary SIC code of 1311.

I also read the line of business description for each segment from the companies' 10K and annual reports. I exclude the following segments because I judged the segment to be adversely affected by the oil price shock: Freeport

[26] Kaplan and Zingales (1995) also find that financial constraint does not appear to be a plausible explanation of cash flow/investment correlations.

McMoran—segments including uranium and sulphur; Mitchell Energy—real estate segment in Houston, Texas; Nicor—marine service segment serving oil industry; Petrolite—chemicals used in oil production; Rowan Companies—operates airline in Alaska and Gulf of Mexico; Tidewater—marine service segment serving oil industry.

I then delete segments with incomplete data for the 1985–1986 period, segments from firms that were in bankruptcy between 1985–1986, segments whose segment name was OTHER (since I found these segments often contained only corporate overhead or discontinued operations data), segments that (according to COMPUSTAT footnotes) had significant merger and acquisition activity in 1985–1986 (because these accounting events could distort the variables of interest), and segments that had anomalous accounting data in 1985 (I remove segments that report zero depreciation and segments with 1985 capital expenditures greater than sales).

Last, because the resulting sample contains very small segments that seem to have more volatile accounting data, I exclude all segments with 1985 sales of less than $50 million, or identifiable assets or depreciation of less than $5 million in 1985.

I also check COMPUSTAT figures for accuracy. I find (apparently) typographical errors in the segment data for four companies: Amoco, ARCO, Occidental, and Schlumberger. COMPUSTAT's general policy was to report pretax operating income before special charges; however, for six companies (Burlington Northern, Canadian Pacific, Fluor, Goodyear, Union Pacific, and USX Corp), I find that COMPUSTAT includes special charges even though the company documents clearly state and quantify the impact of the accounting charges. I therefore correct the data so that cash flow is reported consistently for all companies.

For two companies I exclude subsidiaries companies; that is, to accept only one set of segment data from each corporate entity. These were: Occidental Petroleum (I exclude segment data from Canadian Occidental); and Royal Dutch/Shell (I include COMPUSTAT's computed Royal Dutch/Shell Group and exclude Royal Dutch, Shell Transport and Trade, and Shell Canada.)

All variables in COMPUSTAT are stated in U.S. dollars, so that when the original data are in Canadian dollars or pounds sterling, COMPUSTAT converts using end-of-year exchange rates. Exchange rate changes did not appear to have a large affect on ΔI.

I note that the inclusion of Placer Dome is slightly misleading, since Placer and Dome merged in 1987, so that the restated data reflects a corporate entity that did not exist in 1985–1986. However, the 1985–1986 ΔI, I, the oil share, and other variables from the original company, Placer, are virtually identical to the variables of the successor company. Therefore, in order to get a continuous set of variables from 1985–1987, I retain Placer Dome data as it exists in the COMPUSTAT database.

Industry-adjusting method: First, I screen on the size, data availability, and other criteria described previously. Then I try to find segments with matching four digit primary and secondary SIC codes. If I could find at least five such segments, I use them as the control group; otherwise, I loosen the required match on the secondary SIC code to the three digit level and then to the two digit level. If this did not supply at least five segments, I reduce the level of precision to a three digit match on both the primary and secondary SIC code, and so on down to the two digit level. Using this procedure, I was able to calculate industry-adjusted figures for 39 of the 40 observations (I find no match for Dekalb Energy's agricultural seed division).

In calculating the share of oil in total firm sales, I divide the total oil sales by the sum of the sales of all firm segments. This does not necessarily equal total firm-level sales reported by the company due to miscellaneous sales, discontinued operations, intersegment sales, or unclassified sales.

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