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Increased debt and industry product markets An empirical analysis

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Abstract

This paper tests for changes in firms' production and pricing decisions in four industries in which firms have sharply increased their financial leverage. The analysis of product price and quantity data shows that industry product market decisions are associated with capital structure. In three industries, output is negatively associated with the average industry debt ratio. In the one industry which shows a positive association between output and debt ratios, rival firms have low financial leverage and entry barriers are relatively low. Analysis of executive compensation data supports the hypothesis that managers' incentives to maximize shareholders' wealth increase following recapitalization.

Key words: Capital structure; Product markets; Strategic interaction
JEL classification: G32; L22

1. Introduction

The financial press has frequently conjectured that a firm's capital structure influences both the firm's and competitors' output and pricing decisions.[1]

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[1]See, for example, *Forbes*, October 16, 1989, pp. 38–39, *Marketing News*, March 5, 1990, p. 12, and *Mergers and Acquisitions*, November/December 1986, p. 78.

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Industrial organization economists tend to focus on the effects of production and pricing decisions on firm and industry profits and have not typically considered the effects of capital structure. Until recently, financial economists have ignored the interaction between capital structure and product market decisions. Harris and Raviv (1991) make this point and discuss recent theoretical work which models product market and capital structure interactions. Ravid (1988) also surveys the literature on the interaction between capital structure and product market decisions. Both of these surveys identify two types of interaction: the effect on firm product market strategy and the effect on a firm's product choice. Titman (1984) and Maksimovic and Titman (1991) show how capital structure can affect a firm's choice of product quality and the viability of its products' warranties.

Recent theoretical models by Brander and Lewis (1986), Maksimovic (1988), Gertner, Gibbons, and Scharfstein (1988), Glazer (1989), Poitevin (1989), Bolton and Scharfstein (1990), and Phillips (1992) have formalized the ways in which industry product markets may both influence, and be influenced, by corporate financing decisions. Theoretical models have shown that output by a firm and its competitors can be affected by the use of increased debt financing. However, empirical evidence on this relationship has not previously been presented.[2]

This paper empirically considers whether a firm's capital structure decision has an effect on its own *and* on competitors' output and product pricing decisions in four industries: the fiberglass, tractor trailer, polyethylene, and gypsum industries. These four industries lend themselves to investigation because they have limited numbers of producers and multiple firms that have sharply increased their debt financing; the largest firms have used leveraged recapitalizations to increase their debt ratios by more than 25 percentage points.

Researchers in corporate finance have argued that capital structure changes can decrease agency costs. Agency costs can affect both input and output efficiency. Kaplan (1989) provides evidence that operating cash flows increase and capital expenditures decrease following management leveraged buyouts. Lichtenberg and Siegel (1990) examine total factor productivity, or the amount of inputs per unit of output at the plant level, before and after leveraged buyouts. This paper provides evidence that financial leverage interacts with product markets.

Firms may also change their product market behavior in anticipation of changes in a competitor's investment and output decisions. Any decreases in

[2]Recently, in a working paper following this paper, Chevalier (1992) presents evidence consistent with this paper which shows that firms which undertake leveraged buyouts invest less than their unleveraged competitors. While not considering product market behavior, Spence (1985) does consider cross-sectional determinants of corporate financial structure including concentration ratios among other variables for a set of 403 four-digit SIC code industries.

output can increase producer or output efficiency if the industry was previously characterized by excess investment or excess production. This type of efficiency change differs from changes in total factor productivity which Lichtenberg and Siegel investigate. The analysis in this paper is designed to test whether industry product markets, and specifically industry output, are affected by changes in firms' capital structures. Market structure summary statistics and data on plant closings provide initial evidence that firms adjust capacity following financial recapitalizations.

The empirical framework for examining the effects of capital structure on product markets is adapted from intra-industry industrial organization studies described in Bresnahan (1989). These studies of price and quantity decisions exploit the fact that price and quantity respond differently to exogenous demand shocks, depending on whether the industry is perfectly competitive. Supply relationships and industry demand equations are estimated at the industry level using detailed price and quantity data.[3]

The results using individual firm product sales and cost data indicate that market share does change following increases in financial leverage. In the first three industries: the fiberglass insulation, the tractor trailer, and the polyethylene chemical industries, firms that increase their financial leverage either lose market share or fail to gain market share when smaller rivals exit the industry. Results using firm-level accounting data show that operating margins increase and sales decrease for the recapitalizing firms in these three industries. Results examining quantity and price data for each of these industries show that industry output is negatively associated with the average industry debt ratio. In the supply relationships, product price is positively associated with the debt ratio. This result is consistent with price increasing as output decreases, controlling for changes in input prices. In these industries, rival firms have high financial leverage, and entry is relatively difficult. The results are consistent with models by Glazer (1989) and Phillips (1992) in which debt commits the leveraged firms to behave less aggressively and decrease output, as well as with decreased agency costs and decreased inefficient investment. The results are also consistent with a revised form of Telser's (1963) deep purse model in which the rival cannot or does not have sufficient resources to force exit of the leveraged firm. Rival firms gain market share, but the leveraged firm's margins also increase.

In the gypsum industry, however, firm-level data show that the largest firms increased their market share at the expense of small firms and operating margins decrease. At the industry level, price decreases as output increases, after controlling for changes in input prices. Industry output is positively associated with the

[3]Schmalensee (1989) discusses measurement and identification problems associated with using accounting data in industrial organization structure–conduct–performance studies. As Bresnahan (1989) discusses, using price and quantity data solves many of these problems.

industry debt ratio. The increased output is consistent with models by Brander and Lewis (1986) and Maksimovic (1988) which predict that increased debt will cause firms to increase output. The gypsum industry is different on several accounts from the other three industries. Several major competitors did not increase their leverage, the minimum efficient scale of the plants is small compared to the size of the market, and the technology is simple with no identifiable potential barriers to entry. I attribute differences in the association of capital structure with product market price and quantity to whether rival firms are also highly leveraged and the ease of entry and expansion in the industry.

As noted by Jensen (1986), agency costs can affect the level of investment and the size of the firm as well as operating efficiency. Donaldson (1984) and McConnell and Muscarella (1985) provide evidence that managers expand investment and sales beyond the optimal level. If the increase in debt financing increases incentives for managers to maximize shareholder wealth or forces managers to pay out free cash flow, managers may reduce investment. Murphy (1985) shows that changes in executive compensation are positively related to growth in sales and stock returns.

Given the evidence that the relationship between industry output and capital structure changes after firm recapitalizations, I look for changes in the relationship between executive compensation, stock returns, and sales at the firm level. Results show that changes in executive compensation are significantly related to changes in stock returns after, but not before, the recapitalization. Sales growth is significantly associated with changes in executive compensation before the recapitalization. These results are consistent with the hypothesis that the recapitalization increases the incentives of the firms' managers to maximize shareholder wealth and that managers had incentives to expand the size of the firm before the recapitalizations. The results are also consistent with decreases in agency costs that cause excess investment and output. While the industry-level tests cannot separate changes in recapitalizing versus rival firms' output decisions, the firm-level tests are evidence that the recapitalizing firms' managers have increased incentives to choose the level of output that maximizes shareholder returns.

One caveat must be noted. Given that capital structure is a decision variable by the firm, other exogenous changes in the industry environment may be responsible for changes in the *ex post* association between capital structure and product market variables. I control for many of these exogenous factors by explicitly including demand variables and prices of inputs used in making these products. Smith and Watts (1992) consider exogenous changes in regulation and investment opportunities. A structural model which explicitly considers optimal reactions to exogenous shocks is left for future research.

The paper proceeds as follows. Section 2 discusses how the capital structure of firms can affect firm output decisions and industry product markets. Section 3

describes the industries and the data analyzed, presenting evidence on changes in individual firm market share. Section 4 presents the results of firm-level accounting measures of performance. Section 5 provides a framework that shows how detailed price and quantity data can identify changes in industry product markets. The framework illustrates how industry product markets and output can be affected by capital structure. The results of the product market and capital structure interaction tests follow. Section 6 tests for changes in the relationship between executive compensation and shareholder wealth changes for the largest recapitalizing firm in each industry. Section 7 concludes.

2. How capital structure can affect industry product markets

Capital structure can affect industry product markets because financial instruments alter the ownership of residual cash flows and the ability of a firm to invest. These changes affect the beliefs and expectations a competitor forms about a firm's potential actions. A debt-for-equity recapitalization or an equity-for-debt recapitalization provides a natural experiment to examine whether product markets are affected by changes in capital structure.

There are three major theories regarding how industry product markets can be affected by capital structure. According to 'the output and limited liability effect' of Brander and Lewis (1986), firms compete by choosing output, as in Cournot models. In a firm with higher financial leverage, managers who maximize shareholders' wealth have an incentive to increase output when marginal profit increases with a random shock. Second, there is the 'strategic bankruptcy effect' or 'long purse' (also called the 'deep purse') of Telser (1963), whereby rivals may increase output in order to drive down price and cause the highly-leveraged firm to exit the industry. This theory assumes that the firm cannot recapitalize and reduce leverage. Finally, capital structure can change the ability of the firm to invest, causing rivals to realize that the highly-leveraged firm will decrease output. Changes in agency costs are also important for this effect, which I call the 'investment and capital structure effect'. Each of these theories are now discussed in more detail.

2.1. Output and the limited liability effect

Brander and Lewis (1986) and Maksimovic (1988) focus on the ability of capital structure to alter the payoffs to stockholders. In their models, there is no separation between managers and stockholders. In Brander and Lewis, two firms compete by choosing output after first choosing capital structure, in a one-period Cournot model. Marginal profit is influenced by a random shock that increases profits with good realizations of the shock and decreases profits with bad realizations of the shock. Increased debt leads firms to choose

strategies that increase profits with good realizations of the random shock and lower profits with bad, as stockholders are residual claimants to the firm's profits. By increasing the variance of the firm's profits, stockholders increase the value of their option-like claims on the firm's future profits. An increase in debt causes the firm to expand its output at its rival's expense. However, the availability of debt financing tends to lead to prisoners' dilemma-like behavior. Both firms add debt and produce more than they would if debt financing were restricted. The result is that aggregate industry profits are reduced. Glazer (1989), however, shows that the prediction that output increases is changed if firms issue long-term debt. He shows that the number of periods before debt repayment influences the output decision.

Maksimovic (1988) extends Brander and Lewis' by focusing on the strategic effects of the limited liability of equity and by considering multiple periods of interaction. Maksimovic shows that increases in debt make it more difficult for firms to maintain collusive outcomes. This prescription is tempered somewhat by introducing explicit dependence of profits on demand and cost functions. The maximum debt capacity that is consistent with decreased output depends on the elasticity of demand, the number of firms, and the discount rate. The prediction remains that as the proportion of debt increases, stockholders have an increasing incentive to produce more than the Cournot equilibrium output level without debt, because they receive the residual cash flow after debt payments today.

2.2. Strategic bankruptcy and the deep purse

'Strategic bankruptcy' or 'deep purse' models have a long background, beginning with Telser (1963) and continuing with Benoit (1984), Brander and Lewis (1988), and Bolton and Scharfstein (1990). The models postulate that a rival might increase its output to increase the probability of driving a high-debt firm into insolvency. A deep purse, in these models, represents greater access to funds, enabling the firm to sustain losses and still remain solvent. A deep purse has value when the capital markets are closed to the firm; otherwise, a firm can borrow when faced with 'predatory' behavior by rivals. Bolton and Scharfstein (1990) endogenize a firm's financial constraints. In their model, financial constraints occur because second-period financing is contingent upon first-period profits. This contingency is a solution to first-period agency problems. This second-period contingency provides a competitor with an opportunity to drive down the high-debt firm's profits, in anticipation that banks might not extend second-period financing to the high-debt firm. The difference between these models and the limited liability model is that in the deep purse models, it is the unleveraged firm which has the incentive to increase output to drive the other firm out of the market.

2.3. Capital structure and the investment effect

In contrast to the previous models, Phillips (1992) shows how industry output may decrease with increases in debt.[4] Increased debt is a commitment not to invest in the future because the percentage of free cash flow to be paid out each period is increased. Since debt payments must be made regularly, the residual remaining as retained earnings is reduced by high debt levels. It is assumed that firms have agency problems or asymmetric information problems which increase the cost of additional external financing in equity or debt markets. If retained earnings and free cash flow are a cheaper source of funds for investment than external funding, a commitment to a high debt level is a commitment to a higher cost of output expansion, investment, or advertising. Similar to the deep purse model, a rival may want to increase output to decrease the highly-leveraged firm's profits in order to prevent the firm from investing, but only when it expects that the highly-leveraged firm can still obtain necessary financing to invest. A rival behaves less aggressively and does not attempt to make up all of the decreased output from the leveraged firm when the leveraged firm's capital structure commits the firm to decrease future investment. By focusing on the effects of the investment decision instead of current product market profits, capital structure can be shown to decrease output both at the firm and the industry level. A higher cost of external finance because of agency costs or asymmetric information is important for this effect; otherwise, the firm or its rival could simply obtain outside financing and increase investment and output.

Standard agency explanations, which focus only on the recapitalizing firm's output decision, can also predict decreased industry output. If managerial compensation is a function of sales growth and firm size, as Jensen (1986) notes, managers may have incentives to expand the firm's sales beyond the level that maximizes shareholder value, consistent with evidence provided by Donaldson (1984) and McConnell and Muscarella (1985). If the recapitalization aligns managerial incentives with stockholders or reduces free cash flow, the managers will set investment and sales at the optimal level. This change in investment and sales can have two effects: agency costs which affect a firm's efficient use of inputs and assets may be reduced, and increases in operating margins will result from changes in production decisions.

The notion that managerial incentives change following recapitalization does not preclude an effect on rival firms' output decisions. Given the structure of the industries examined in this study, in which the top four firms representing at least 50% of the market, a change in the leveraged firm's output should have

[4]This paper considers output choices or Cournot strategies by firms. Kreps and Scheinkman (1983) shows that when investment is chosen in the first period, price or Bertrand competition can produce similar results as Cournot output competition.

effects on other firms' production decisions. It should be noted that the industry-level tests cannot separate the relative effect on industry output of changes in the recapitalizing firm's versus competitors' output. To further investigate managerial incentives to expand output, the relationship between compensation, sales growth, and shareholder wealth is examined at the firm level in Section 6. The firm-level tests provide evidence on whether managers have greater incentives to choose the level of output that maximizes stockholders' wealth.

3. Data and industry descriptions

In the four industries analyzed in this study – the fiberglass insulation, tractor trailer, polyethylene, and gypsum industries – there have been large discrete increases in debt-to-value ratios. Firms in these industries have recapitalized using leveraged recapitalizations and leveraged buyouts reducing retained earnings and free cash flow, as large sums of cash were paid to existing stockholders at the time of the recapitalizations.

The industries were chosen on the basis of four criteria: (1) a discrete increase of at least 25% in debt-to-market value by the firm with the largest sales, (2) a limited number of producers in each industry, with the top four firms comprising at least 50% of the market, (3) product homogeneity within the industry, and (4) the leading firm producing at least 50% of its sales in the same four-digit SIC code. The sharp shift in capital structure increases the likelihood that any effect of capital structure on product markets can be identified. The second criterion increases the likelihood that price can actually deviate from marginal cost. The third criterion improves the measurement of price data and reduces problems of differential product quality across firms. The fourth criterion decreases the possibility that the firm has different competitors for different products and thus increases the effects of industry firms' actions on each other.

Table 1 presents summary statistics showing the market shares of individual firms and their rivals before and after the largest firms' recapitalizations. Table 1 shows that in the insulation and tractor trailer industries, firms that sharply increased their debt ratios have lost market share. In the polyethylene industry, the highly-leveraged Quantum Chemical failed to pick up market share when a major competitor lost its capacity because of an industrial accident. In the gypsum industry, the highly-leveraged USG gained market share. One cannot, however, extract changes in industry profitability from these numbers. Product market tests are conducted at the industry level using industry product price and quantity data.

Table 2 presents summary statistics for the price and quantity series used in the product market tests. Industry price and quantity data were gathered for the primary product and the variable inputs in each of the four industries. Monthly data from 1980 to 1990 are used. Means are presented for each series from

January 1980 to the recapitalization announcement and after the recapitalization announcement to December 1990 as summary statistics to describe changes in product and input prices. Table 2 shows the importance of considering changes in input prices when controlling for marginal cost. Wages also vary significantly before and after the recapitalization for every industry. In industries that are perfectly competitive and have constant or decreasing marginal cost, an increase in input prices should be matched by an increase in the product price. The variable inputs of the product were identified using the input–output tables of the Bureau of Labor Statistics. Unless stated otherwise, the price data are from the Bureau of Labor Statistics. All price data are deflated by the wholesale price index. The general demand variables – industrial production, new construction, and shipments of manufactures – were obtained from the Federal Reserve Board's *Industrial Production.* Insulation quantity data are from *Industrial Production.* Tractor trailer price data were obtained from the *U.S. Department of Commerce: Current Industrial Reports,* while tractor trailer quantity sales data were obtained from R.L. Polk & Co. Polyethylene price data are from the Bureau of Labor Statistics, while polyethylene quantity data are from McGraw Hill Data Resources Institute (DRI). Gypsum price and quantity data are from the Bureau of the Mines. The paper also considers accounting measures of performance using data obtained from COMPUSTAT. Each industry is now described in more detail to provide a background for the analysis in Sections 4 through 6. This section concludes by providing some limited evidence on plant closings to assess changes in fixed investment decisions following the recapitalizations.

3.1. The fiberglass roofing and insulation industry

Fiberglass insulation, roofing shingles, and reinforced plastic products are produced by combining glass fibers and plastic resins. Owens–Corning Fiberglas (OCF) is the industry's largest firm, and Manville Corporation, Certainteed Corporation, and PPG Industries are the other three primary firms. These four firms account for almost 75% of industry sales. OCF used a leveraged recapitalization to increase its debt-to-market value by 50 percentage points in 1986. The recapitalization occurred in early 1986, about the time of large decreases in energy prices.

Table 1 presents firm market share data for the three years before and after Owens-Corning's recapitalization in November 1986. The individual firm data are line-of-business sales data reported in each firm's annual reports. Data for the recapitalization year, 1986, are excluded from the averages. Fiberglass total market size data were obtained from the U.S. Census Bureau *Annual Survey of Manufactures.* Table 1 shows that OCF's three-year average market share decreased from an average of 30.5% to 26.5% for the three years following the leveraged recapitalization. Including fiberglass specialty products that OCF

Table 1
Market descriptions

Pre-recap figures are the means for three years prior to the leading firm's recapitalization announcement. Post-recap figures are means for three years after the recapitalization, or until the 1990 fiscal year-end. The exact years used in each of the pre- and post-recap numbers for each firm are given in the footnotes. Debt-to-value ratios are one-year pre- and post-recapitalization book value of debt divided by the book value of debt plus the market value of equity. MES stands for minimum efficient scale; low versus high is according to industry self-descriptions.

Industry	Three-year % industry sales		Capital structure changes	Technology/ Barriers to entry
	Pre-recap	Post-recap		
Fiberglass roofing and insulation				
Leading firm: Owens–Corning Fiberglas (OCF)[a]	30.5%	26.5%	OCF debt/value: Pre-recap = 34%, post = 71%	High MES Large fixed costs
2nd firm: Manville	22.3%	21.8%		
Manville before bankruptcy	27.1%			
Next 2 'unleveraged' firms	22.1%	25.7%		
Tractor trailers				
Leading firm: Fruehauf[b]	22.4%	16.5%	Fruehauf debt/value: Pre-recap = 22%, post = 72%	Job shop Distribution network
Top 5 leveraged firms	48.1%	41.6%	Five of top six firms involved in leveraged recaps/LBOs.[b]	
Top 5 'unleveraged' firms	19.7%	24.8%		
Polyethylene				
Leading firm: Quantum[c]	21.8%	21.9%	Quantum debt/value: Pre-recap = 36%, Post = 76% Union Carbide debt/value: Pre-recap = 37%, Post = 55%	High MES Large fixed costs
2nd firm: Union Carbide[d]	14.2%	13.2%		
3rd firm: Cain Inc.[d]	6.3%	7.9%		
Top 4 'unleveraged' firms	32.1%	34.8%		

Gypsum				
Leading firm: USG[e]	47.7%	51.1%	USG debt/value:	Low MES
2nd firm: National Gypsum	22.1%	21.6%	Pre-recap = 35%, Post = 90%	Low fixed costs
Next 2 'unleveraged' firms	15.7%	22.1%	National Gypsum: 1984 LBO.	

Individual firm data are obtained from industry segment data from firm annual reports for fiberglass and gypsum. Total market size data are from the U.S. Bureau of Mines and the Census Department *Annual Survey of Manufactures* for fiberglass and gypsum. Data for tractor trailers are from R.L. Polk & Co. and represents actual unit quantity sales. Data for polyethylene represents rated capacity of plants and are from *Modern Plastics*, January annual issue.

[a]Owens–Corning Fiberglas' recapitalization was announced 8/28/86 and completed in November 1986. The three-year averages exclude 1986, representing 1983–1985 for the pre-recap period and 1987–1990 for the post-recap period. The market share for Owens–Corning Fiberglas rises to 35% before the recapitalization if some specialty fiberglass products that were sold off are included. The market share decrease would then rise to 8.5 percentage points if the market size of these products were included in the denominator.

[b]Fruehauf's recapitalization was announced 6/24/86 and completed in December 1986. The pre-recap period represents 1983–1985. The post-recap period represents 1987–1989. Four other firms (Dorsey, Great Dane, Monon, Trailmobile) recapitalized using LBOs from 1985 to early 1987. The Fruehauf pre- and post-recap periods are used for the market share numbers for the combined five firms.

[c]Quantum Chemical's recapitalization was announced 12/27/88 and completed in January 1989. The pre-recap period represents years 1986–1988. The post-recap period for Quantum Chemical only represents two years, 1989 and 1990, given that 1991 capacity data was not yet available.

[d]The pre-recap period for Union Carbide represents 1983–1985, three years before its recapitalization in 1986. Cain Inc. was formed by an LBO of DuPont high-density polyethlyene plants in 1987. Complicating identification of the post-recap period for Cain, Occidental Petroleum bought these plants nine months later. Thus the same years as Quantum Chemical are used. If the pre-recap period is defined as 1984–1986 for Cain, its market share number would be 5.92%.

[e]USG's recapitalization was announced in 5/2/88 and completed in July 1988. The pre-recap period represents 1985–1987. The post-recap period represents 1989–1990. The market share numbers for USG are overstated because USG has sales in some specialty gypsum products which are not separated from general gypsum sales, while the market size from the Bureau of the Mines does not include these products. This overstatement should primarily affect the level and not the change in market share.

exited following its recapitalization, OCF's prior market share was approximately 35%, implying a decline of 8.5 percentage points following the recapitalization. This additional decrease is imprecise, as these specialty fiberglass businesses are not in the total market size measurements reported by the census. Manville Corporation was also financially constrained over this period. Manville filed bankruptcy under Chapter 11 in 1983 and did not emerge from bankruptcy until late 1988. Manville lost five percentage points of market share relative to its average in 1979–1982. Over the years surrounding OCF's recapitalization, Manville's market share remained constant, while other smaller,

Table 2
Industry product market data: Summary statistics

Pre- and post-recap periods are months in the 1980s surrounding Owens–Corning Fiberglas', Fruehauf's, Quantum Chemical's, and USG's announcements of leveraged recapitalizations, with exact years given in the footnotes. Unless otherwise indicated, the price and quantity series are indices. All indices are normalized for presentation purposes only so that the pre-recap mean equals 1.0. All price data are deflated by the wholesale price index.

Industry	Pre-recap mean	Std. error of mean	*N*	Post-recap mean	Std. error of mean	*N*
Fiberglass insulation[a]						
Insulation price (Index)	1.0	0.006	75	0.99	0.006	50
Quantity	1.0	0.009		1.18[c]	0.007	
Real input prices						
Glass	1.0	0.004		1.02[c]	0.006	
Wage: SIC 3296 ($)	8.60	0.054		9.28[c]	0.040	
Oil	1.0	0.024		0.57[c]	0.019	
Electricity	1.0	0.006		1.04[c]	0.006	
Tractor trailer[b]						
Price tank trailers ($000)	31.31	0.203	77	34.4 [c]	0.197	55
Quantity tank trailers	1.0	0.028		0.79[c]	0.013	
Real input prices						
Aluminum	1.0	0.032		1.16[c]	0.029	
Steel	1.0	0.003		1.02[c]	0.006	
Wage: SIC 3215 ($)	8.28	0.068		8.74[c]	0.060	
Electricity	1.0	0.009		1.05[c]	0.007	
Polyethylene chemical[c]						
High-density poly. price	1.0	0.015	97	1.17[c]	0.031	25
Quantity (mil. lbs)	452.0	10.778		638.2 [c]	12.027	
Low-density poly. price	1.0	0.002		1.14[c]	0.039	
Quantity (mil. lbs)	620.2	9.49		709.3 [c]	23.930	
Real input prices						
Oil	1.0	0.029		0.71[c]	0.038	
Wage: SIC 2821 ($)	11.66	0.120		12.82[c]	0.034	

Table 2 (continued)

Industry	Pre-recap mean	Std. error of mean	N	Post-recap mean	Std. error of mean	N
Gypsum[d]						
Gypsum board price	1.0	0.013	100	0.75[e]	0.009	29
Quantity (mil. sq. feet)	1432	26.960		1724[e]	21.160	
Real input prices						
Electricity	1.0	0.008		1.01	0.007	
Natural gas	1.0	0.014		0.73[e]	0.006	
Wage: SIC 327 ($)	9.02	0.056		9.38[e]	0.027	
Paper sheeting	1.0	0.003		1.69[e]	0.018	

[a]The pre-recap period for the fiberglass industry is from April 1980 to July 1986, the months before Owens–Corning Fiberglas' recapitalization announcement on 8/28/86. The post-recap period is from August 1986 to October 1990.

[b]The pre-recap period for the tractor trailer industry is from January 1980 to May 1986, the months before Fruehauf's recapitalization announcement on 6/24/86. The post-recap period is from June 1986 to December 1990.

[c]The pre-recap period for the polyethylene industry is from November 1980 to November 1988, the months before Quantum Chemical's recapitalization announcement on 12/27/88. The post-recap period is from December 1988 to December 1990.

[d]The pre-recap period for the gypsum industry is from January 1980 to April 1988, the months before USG's recapitalization announcement on 5/2/88. The post-recap period is from May 1988 to September 1990.

[e]Significantly different from the pre-recap mean at the 1% level.

unleveraged firms increased their market share. Large plant sizes in this industry also provide some barriers to smaller, unleveraged rivals expanding or new firms entering the market. In this industry, major firms have had large increases in debt or have been financially constrained by bankruptcy.

Table 2 presents summary statistics of the monthly industry data used in the product market tests. The industry price and quantity series in the product market tests are for mineral wool and roll insulation. The series that proxy for changes in demand for this industry are new residential and commercial construction, industrial production, and auto production. The input series used for this industry are glass fibers, electricity, oil, and the average hourly wage series for SIC code 3296, while the proxy for the substitute price is gypsum wallboard. To give an indication of the movements in end-of-month prices surrounding the changes in leverage in the industry, means for each series are presented for April 1980 to July 1986, the period before OCF's recapitalization announcement on August 28, 1986, and for the period after the recapitalization announcement, from August 1986 to December 1990. Real insulation prices were stable during the years examined, although two of the real input prices, electricity and oil, fell drastically in early 1986. The price of oil decreased over 50%, falling from $30 to

$10 a barrel. During this period, no major changes occurred in the real wage and glass fiber prices. Insulation prices decreased somewhat during 1989, but remained above levels that seem justified by real input price changes. Quantity sold was on a slight upward trend throughout this period. The fact that product and input prices did not move in the same direction is initial evidence that the industry is not a perfectly competitive industry with constant marginal cost.

3.2. *The tractor trailer industry*

Tractor trailers are the trucking equivalent of the railroad car. The technology used to build tractor trailers is simple. Firms that produce tractor trailers do not build the engines and 'rigs' that pull the trailers. According to industry trade publications, tractor trailers have become commodity products. Industry participants, however, claim that a tractor trailer firm's dealer network and its factory service network do provide some barriers to entry (*Commercial Carrier Journal*, February 1990, pp. 66–73). Prior to the recapitalizations, the top four firms in the industry accounted for over 50% of industry sales. All of the top five firms have experienced sharp changes in capital structure. Fruehauf, the market share leader, used a leveraged recapitalization to increase its debt-to-market value ratio by 50 percentage points during 1986.

Table 1 presents firm market share data for the periods before and after Fruehauf's recapitalization in December 1986. The data for tractor trailers were obtained from R.L. Polk & Co. and represent actual unit quantity sales. The table shows that the market share of Fruehauf decreased from 22.4% to a three-year average of 16.5%, following its recapitalization. The four other firms which were the major competitors of Fruehauf (Dorsey, Monon, Trailmobile, and Great Dane) were privatized in leveraged buyouts between late 1985 and early 1988. The market share of these five leveraged firms decreased from the three-year pre-recapitalization mean of 48.1% to the three-year post-recapitalization mean of 41.6%, a loss of 6.5 percentage points.

Table 2 presents summary statistics of the industry data used in the product market tests. Industry price and quantity series in this study are for tank tractor trailers. The proxies for general demand-shifts are new construction and shipments of manufactured goods. The input price series used are steel prices, electricity prices, aluminum prices, and the average hourly wage for SIC code 3715, while the proxy for the substitute price is small truck and bus bodies (SIC code 3713). Means from January 1980 to May 1986, the period before Fruehauf's recapitalization announcement on June 24, 1986, and for the period after the announcement from June 1986 to December 1990, are presented to illustrate that input price and tractor price movements are not perfectly correlated. Following the recapitalization of Fruehauf, real prices for tank trailers were on an upward trend, while quantity produced was on a downward trend.

3.3. The polyethylene chemical industry

Polyethylene products are oil-based plastics used in almost every industry. Firms manufacture polyethylene chemicals in a continuous-flow process, using large plants dedicated to producing individual chemicals. These plants cannot generally be reconfigured to produce other chemicals. Quantum Chemical, the largest manufacturer in this industry, has only polyethylene plants. Other major producers generally also produce additional chemicals. Quantum Chemical recapitalized in 1988 and paid out a large special dividend. Its debt-to-firm value ratio increased by 40 percentage points. Union Carbide, the second largest producer of polyethylene, recapitalized in 1986, increasing its debt-to-firm value ratio by 18 percentage points. A third smaller competitor, Cain Inc., was formed by a leveraged buyout of DuPont high-density polyethylene plants in 1987. Complicating identification of the post-recapitalization period for Cain, Occidental Petroleum bought these plants nine months later. The post-recapitalization years used for Quantum Chemical, 1989–1990, are also used for Cain.

Table 1 presents firm market share data for the periods before and after Quantum Chemical's recapitalization in December 1988. The numbers in Table 1 represent percentage firm capacity of total industry capacity, as individual firm sales numbers for polyethylene are not available. Firm capacity data were obtained from the January annual issue of *Modern Plastics*. In this industry several major firms had low debt ratios. Large plant sizes provide some barriers to entry.

Table 2 presents summary statistics of the industry price and quantity data. The industry price and quantity series in the study are for high-density polyethylene. The demand-shift instruments used for this industry are construction, auto production, and shipments of manufactures. The input series used for this product are oil, electricity, and the hourly wage. To give an indication of the movements in end-of-month prices surrounding the changes in leverage in the industry, means for each series are presented for November 1980 to November 1988, the period before Quantum's recapitalization announcement on December 27, 1988, and for the period after the recapitalization announcement from December 1988 to December 1990. Means (before and after) are presented to examine whether large changes in the input prices are also matched by large changes in product price. Prices increased drastically for polyethylene approximately one year prior to the recapitalization announcement, while quantity sold was on a slight upward trend throughout the period, yet the price of oil, the primary input, fell sharply from about \$30 to \$10 a barrel in 1986.

3.4. The gypsum industry

Gypsum products are used primarily in the construction and home building market. The principal product in this industry is gypsum wallboard. In the

gypsum industry, the major companies are highly integrated in all stages of the production process. The industry has two principal firms that account for over 50% of the market: U.S. Gypsum (USG) and National Gypsum. Both firms have had sharp changes in their capital structure. USG recapitalized using a leveraged recapitalization, increasing its debt-to-market value by 50 percentage points in 1986. National Gypsum recapitalized using a leveraged buyout in 1984.

Table 1 presents firm market share data for the periods before and after USG's recapitalization, announced in May 1988 and completed in July 1988. The three-year average before and after market share numbers exclude 1988, the year of the recapitalization. The individual firm sales data for gypsum are line-of-business sales from the firms' annual reports. Total market size data are from the Bureau of the Mines. This industry is different from the previous three industries in several ways. First, the largest firm's market share has increased.[5] Second, two major rivals in the industry have low debt; these firms also gained market share. Finally, the minimum efficient scale is low in the industry, and barriers to entry are minimal.

Table 2 presents summary statistics of the industry data used in the product market tests. The industry price and quantity series in the study are for one-half inch gypsum sheetrock or wallboard. The proxy for demand for this industry is new residential and commercial construction. The primary input prices for this industry are natural gas, electricity, and the average hourly wage for SIC code 327, while the proxy for the substitute price is wood sheeting. To give an indication of the movements in end-of-month prices surrounding the changes in leverage in the industry, means for each series are presented for January 1980 to April 1988, the period before USG's recapitalization announcement on May 2, 1988, and for the period after the recapitalization announcement from May 1988 to September 1990. Product and input prices have not been moving in the same direction, which is evidence that factors other than input price movements and the amount produced are contributing to gypsum price movements. There has been a strong downward trend in the real price of gypsum following the recapitalization, while quantity produced has been relatively stable. The gypsum price series has a mean of 1.16 prior to the recapitalization and 0.87 after. Input prices have, however, been relatively stable over the entire period.

[5]The level of the market share numbers for USG in Table 1 are higher than actual, as USG also has specialty product sales which are not broken out of its basic gypsum sales. The total market size in the denominator does not include the market size of these products, thus producing a high market share level. However, there is no indication that USG's specialty product sales have increased relative to their basic gypsum sales. General market share changes are strong enough that any changes not reflected in the market size should be of second order.

3.5. Plant closing decisions and capacity utilization

This section presents evidence of actual plant closings to assess changes in fixed investment decisions for the firms in these four industries. Capital expenditure data is presented in the next section, along with accounting measures of firm performance. I gathered plant closing decisions to verify that capacity actually was withdrawn from the market for the industries studied in this paper. To locate plant closing decisions, I examined firm annual reports and industry association journals for the fiberglass industry and the tractor trailer industry. For polyethylene, plant closing decisions were identified using *Modern Plastics*, which reports plant capacities and industry shipments in their January issue. For gypsum, initial identification of plant closings was made using *Annual Mineral Surveys* published by the U.S. Department of the Interior, Bureau of the Mines. I also electronically searched the Dialog information service for news releases of plant closings in these industries. For one industry, polyethylene, I was able to gather capacity utilization data. I also used the Trinet plant-level database from 1980–1988 as an initial indication of changes in the number of plants and to identify plant locations and companies producing in the industry. The Trinet plant-level database is a survey of plant locations undertaken every two years, although the Trinet database is limited in that some exits may be missed and plants with less than 20 employees are not covered.

In the fiberglass insulation industry, I identified six plants that closed over the years 1983–1990. Of these six plants, only one closed prior to OCF's recapitalization. Subsequent to OCF's recapitalization, five plants closed in the industry, one of these by OCF in 1988 (out of the seven plants OCF operated in fiberglass insulation and roofing in 1988). The other plant closings were by unleveraged rivals in 1987, 1988, and 1990. In OCF's 1986 annual report (p. 30), the company states that they were reducing excess production capacity through the closing and consolidation of certain existing facilities and sections of facilities in order to generate funds required to make scheduled interest and principal payments on debt incurred in the recapitalization.

In the tractor trailer industry I identified ten plant closings over the years 1983–1990. Fruehauf closed five plants from 1985–1990, one of these in 1985 and the other four since its recapitalization (out of a total of eleven plants that Fruehauf operated in 1984). I was able to verify two other plant closings by two other leveraged firms, one by Trailmobile and one by Dorsey. Three plant closings were by unleveraged firms that were also among the top ten firms. In the tractor trailer industry, accounts published in the trade press indicate that industry participants clearly believe that changes in leverage affected industry investment. The Trailmobile CEO stated (*Commercial Carrier Journal*, February 1990, p. 68): 'In the past, capacity may have changed hands (through acquisition or merger), but rarely was removed. We finally are seeing some moves toward capacity reduction. This will be positive for the industry as

a whole, because it will help relieve depressed margins.' Capacity has decreased by more than 50% at Trailmobile since the early 1980s. At Fruehauf, the CEO maintains that capacity is being reduced by approximately 50%, or 35,000 units, a number which is supported by the five plant closings. Several smaller firms have increased their capacity, changing the relative positions of firms.

No polyethylene plants were closed from 1980–1989 by the top five firms in the industry. In 1990, Quantum did close a 40-year-old plant. In 1991, faced with a decline in demand, Quantum mothballed two other plants. However, in 1990, because of capacity expansions, none of the top five producers had a decrease in capacity. It is important to note that it is not merely the closing of plants that is important, but rather the capacity relative to demand growth in the industry. Polyethylene was the only industry for which I was able to calculate capacity utilization data at the industry level. Capacity utilization averaged 85.49% over 1980–1988, increasing from 82.24% in 1980 to 89.98% in 1988, as plant shipments increased sharply from 1986–1988. In 1989, capacity utilization increased to 93.0%. Quantity shipments of polyethylene grew at an annual rate of 5.43% over the 1980–1988 period, while capacity only grew at a 4.25% rate. Over the 1986–1988 period, quantity shipments grew by an annual rate of 5.76%. Although industry reports indicate that there was a supply shortage at the time of Quantum's recapitalization, announced in 1988, Quantum Chemical still recapitalized and paid out a large special dividend. In 1989, when most plants were running at capacity, an explosion at a large Phillips' Petroleum plant removed approximately nine percentage points of capacity from the market. In 1989, with demand already high, the Phillips' explosion provided an opportunity for firms to expand. Quantum Chemical maintained its share of capacity, Union Carbide lost almost two percentage points of the market share of capacity, while four smaller unleveraged firms expanded, gaining three percentage points of the market share of capacity.

In the gypsum industry, I identified six plant closings over the years 1983–1990. Four of these plants closed since the recapitalization of USG in 1988. Of these four plants, two were closed by USG and one by National Gypsum. In 1990, USG still operated 22 plants and National Gypsum operated 19 plants. An unleveraged firm closed the other two plants in 1988. While some smaller firms exited the market, the production plants were purchased by unleveraged rivals such as Domtar Inc., a Canadian firm which entered the U.S. market. Industry participants have realized that industry strategic interaction has changed in this market; in this case, output has increased and prices have decreased. USG states in a 1989 10-K: 'Growing competition and an overall weaker construction market, have had a significant adverse effect on domestic gypsum prices.' During 1988–1991, there has been low capacity utilization in the industry. Both major firms are in financial difficulty: National Gypsum is in Chapter 11, while USG was close to filing.

Overall, plant closings occurred at a much higher rate following the recapitalizations and many were closed by the firms which recapitalized and increased their financial leverage. Although no tests are conducted on these data, they do serve to illustrate the adjustment in capacity that is occurring in these industries. Section 5 below examines price and industry quantity decisions more directly.

4. Accounting measures of performance

This section examines whether the changes in market share are also accompanied by firm and industry changes in performance. Three accounting measures are examined: the annual change in sales, operating price-cost margins, and capital expenditures as a percentage of sales. The accounting measures are examined to check consistency with the more direct product market tests in Section 5. As evidenced by their similarity with measures used in studies by Kaplan (1989) and Smith (1990) of *ex post* performance of leveraged buyouts, some of these accounting measures are consistent with increased *input* efficiency. Changes in these measures are, however, also consistent with changes in producer efficiency from price and output changes. Operating margins, for example, can increase because of price increases as well as from cost decreases. Increases in these measures may be evidence not of increased input efficiency but rather of decreased output and increased prices. Changes at the industry level can help identify changes in output, but only if the matched industry firms sell similar products. For these industries, exact matching at the product level by firm is very difficult. These numbers, therefore, must be interpreted with caution.[6] The product market price and quantity tests in the next section allow separation of these input and output effects.

Table 3 presents these accounting measures and industry benchmarks of the measures for the primary recapitalizing firms in the four industries. Industry numbers represent medians for at least three firms at the three- or four-digit SIC code level. The annual sales change provides a measure of output changes for the highly-leveraged firm. The operating price–cost margin (PCM) is: $(S - CGS + \Delta INV)/(S + \Delta INV)$, where S = sales, CGS = cost of goods sold,

[6]Schmalensee (1989) and Bresnahan (1989) discuss problems that arise when using accounting data. One of the problems with accounting data is the difficulty of measuring marginal cost. Without constant returns, given that the level of production may change, it is difficult to ascertain whether it is changes in price or cost that cause changes in performance. This problem is not as serious for the industries in this study as they are reported to have essentially constant marginal cost. Cost figures reported by firms will, however, include sunk and fixed costs, thus distorting the measurement of marginal cost. As discussed in the next section, the use of price and quantity data can overcome these measurement problems.

Table 3
Accounting measures of performance

Common measures of firm performance using accounting data. Years are relative to the firm's announcement of a recapitalization. Year 0 is the year of the announcement. The announcement date is given under the firm's name. Thus, for Owens-Corning Fiberglas, years 1–3 are 1987–1989. All data are obtained from firm annual reports. Industry numbers represent industry medians for at least three firms at the four- or three-digit SIC code. Industry data are obtained from COMPUSTAT. Sales change is the annual percentage change (not multiplied by 100). Operating price–cost operating margin is sales − cost of goods sold + change in inventories divided by sales + change in inventories. This margin is also called the Lerner Index.

		Year − 2	Year − 1	Year 1	Year 2	Year 3	Wilcoxon test Before vs. after: p-value[a]
Owens–Corning Fiberglas (announcement date: 8/28/86)							
Sales change	Own	0.097	0.094	− 0.125	− 0.021	0.060	0.05
	Industry ($N = 12$)	0.090	0.010	0.156	0.068	0.034	
Price–cost margin (Lerner index)	Own	0.322	0.328	0.335	0.381	0.381	0.02
	Industry	0.300	0.290	0.351	0.344	0.343	
Capital expend./Sales	Own	0.043	0.059	0.034	0.045	0.042	0.06
	Industry	0.053	0.065	0.049	0.063	0.041	
Fruehauf Corporation[b] (announcement date: 6/24/86)							
Sales change	Own	− 0.080	0.047	− 0.269	0.068		0.06
	Industry ($N = 12$)	− 0.013	0.020	0.017	0.085		
Price–cost margin (Lerner index)	Own	0.143	0.083	0.190	0.161		0.20
	Industry	0.397	0.272	0.258	0.184		
Capital expend./Sales	Own	0.039	0.031	0.028	0.025		0.02
	Industry	0.035	0.043	0.030	0.019		

Quantum Chemical[b] (announcement date: 12/27/88)							
Sales change	Own	0.113	0.554	− 0.086	− 0.006		0.15
	Industry (N = 10)	0.196	0.151	0.045	0.033		
Price–cost margin	Own	0.173	0.220	0.311	0.255		0.06
(Lerner index)	Industry	0.339	0.384	0.378	0.366		
Capital expend./Sales	Own	0.070	0.068	0.221	0.175		0.02
	Industry	0.057	0.075	0.090	0.099		
USG Corporation (announcement date: 5/2/88)							
Sales change	Own	0.078	0.064	− 0.224	− 0.025	− 0.126	0.48
	Industry (N = 7)	0.035	0.068	0.04 5	0.117	0.067	
Price–cost margin	Own	0.376	0.341	0.290	0.309	0.272	0.00
(Lerner index)	Industry	0.322	0.336	0.304	0.307	0.305	
Capital expend./Sales	Own	0.072	0.062	0.038	0.036	0.033	0.61
	Industry	0.041	0.038	0.059	0.042	0.075	

[a]Observations are separated into before and after sets. The year of the recapitalization is excluded. The Wilcoxon signed-rank test is a nonparametric test. The null hypothesis is that the before and after measures are from populations with the same distribution and the same medians. The Wilcoxon signed-rank test for the own row includes *all* firms in the industry. Results were similar in tests excluding the recapitalizing firm. Separate tests for firm versus the industry are not conducted because of the limited number of observations.

[b]Year 3 is unavailable for Fruehauf because it was acquired by another corporation in the third year following the recapitalization. Year 3 was unavailable for Quantum because of the late date of its recapitalization.

and Δ INV = the change in inventories. Changes in inventories are added back into the operating margin to capture changes in input prices not yet captured by current sales. This measure follows Domowitz, Hubbard, and Petersen (1987). Inclusion of the change in inventories helps control for mismatching of current-period product and input prices that may result from inventory buildups. Changes were similar when the change in inventories was not included. For industries producing undifferentiated commodities, the *PCM*s can be related to theories of industry structure and demand conditions. Following Waterson (1984), a firm's price–cost margin can be more directly expressed as: $(P - MC_i)/P = s_i(1 + v_i)/\varepsilon$, where P = price, MC = marginal cost, s_i = market share of firm i, ε is the industry elasticity of demand, and v_i is the firm's conjectural variation. The firm's conjectural variation is its estimate of the output response of other firms to its actions, capturing the strategic reaction of a firm to a rival's expected behavior. For a monopoly, $PCM = 1/\varepsilon$, while for an oligopoly under a Cournot outcome, $PCM = s_i/\varepsilon$. Multiplying this measure by the quantity sold, q_i, the calculated price–cost margin equals the actual price–cost margin when marginal cost equals average variable cost. This index is referred to as the Lerner index. A price–cost margin equal to zero is consistent with perfect competition.

The table also gives the firm's capital expenditures as a fraction of sales. This measure is presented because of the potential importance of capital expenditures to future output. Wilcoxon signed-rank nonparametric tests are conducted to evaluate the significance of changes in these measures. Observations are separated into before and after groups, including the primary recapitalizing firm. The null hypothesis is that the before and after measures are from populations with the same distribution and the same medians.

Table 3 presents the accounting measures of performance. The firms considered in this paper, except for USG in the gypsum industry, have increased margins following the recapitalizations. Similar results generally occur for the industry levels of these measures. Wilcoxon tests generally indicate that the before and after measures for these industries are not drawn from the same distribution.

Table 3 indicates an increase in Owens–Corning Fiberglas' price–cost margin and decreases in its sales and capital expenditures relative to the year prior to its leveraged recapitalization. Sales and capital expenditures divided by sales decline for both the firm and the industry. The results for Fruehauf indicate an increase in its price–cost margin relative to years -2 and -1. Sales and capital expenditures divided by sales decline for Fruehauf. The statistics for the industry do not indicate sharp increases in margins, but these numbers are for firms in the small truck and bus industry, SIC code 3713. This SIC code is used because all but one of Fruehauf's' major competitors were privatized through leveraged buyouts during this time. Quantum Chemical also shows an increase in its price–cost margin. Sales increased sharply in the year prior to the

recapitalization because Quantum purchased the polyethylene assets of a smaller firm. The statistics for the industry do not show similar increases, but these numbers are for diversified firms, like Dow Chemical, which produce many different chemicals. The results for U.S. Gypsum in Table 3 are sharply different. The cash flow price–cost margin also decreases relative to years -2 and -1. The industry median price–cost margins also decrease, suggesting that output has increased in the industry. Cash flow return on assets also shows similar results: increases in years 1 and 2 relative to the year before the recapitalizations for the first three recapitalizing firms and decreases for USG and the gypsum industry.

These accounting results are consistent with industry output decreasing relative to demand for the fiberglass insulation, tractor trailer, and polyethylene industries. Margins increase and sales decrease for the primary recapitalizing firm in the industry. Capital expenditures also decrease for fiberglass and tractor trailer industries. The decreases in sales and capital expenditures are consistent with the notion that the firms reduce investments which have the potential of decreasing margins throughout the industry. For the gypsum industry and USG, the opposite results occur. The gypsum results are consistent with increasing output and competition among firms, especially given the fact that the quantity produced did not decrease with declines in new construction over this period.

5. Industry level tests: Supply and demand in product markets

This section presents the methodology and results for the product market tests of the interaction between output and capital structure. These tests directly examine whether changes in industry supply contribute to the movements of product prices. The general framework follows Porter (1983) and Bresnahan (1989). The tests examine quantity and price movements, controlling for changes in input prices and the level of production. The tests separate price changes resulting from changes in marginal cost from those resulting from changes in output. This separation occurs because the tests involve estimating how prices respond to marginal cost, not sunk fixed costs. Prices will not change by reducing sunk or fixed costs in a perfectly competitive market, unless returns to scale in production change. Two factors help control for changes in returns to scale in production. First, the equations estimated include quantity, controlling for returns to scale. Second, the commodities are reported by industry firms to have a relative constant marginal cost of production for a plant of minimum efficient scale.

The analysis begins by specifying demand functions for products and marginal cost functions for firms. From these equations, an industry supply relationship is derived, aggregating from the firm level. General functional forms are

specified, capturing a variety of competitive outcomes, from monopoly to perfect competition. Initially, these functions do not incorporate any dependence on capital structure.

The general form of the (inverse) demand function is

$$P_t = D(Q_t, Z_t, Y_t, \alpha, \varepsilon_t), \tag{1}$$

where P is price, Q is industry quantity, Z is the price of a substitute product, and Y is a vector of exogenous variables shifting demand, observed by all firms in the industry contemporaneously. The alphas (α) are parameters of the demand system, while ε represents unobserved shocks to demand that are econometric error in the estimation. The general form of the firm's cost function can be written

$$C_{it} = C(Q_{it}, W_t, \beta, \mu_{it}), \tag{2}$$

where W is a vector of input prices and β is a vector of parameters of the cost function. The last term, μ, represents a random cost shock from such items as input price shocks. Firm-level marginal cost follows from (2) and is written as

$$MC_{it} = c(Q_{it}, W_t, \beta, \mu_{it}). \tag{3}$$

Individual firms maximize profits by choosing quantity as in a Cournot model. The firm picks the level of output that sets 'perceived' marginal revenue equal to marginal cost. Generally, an individual firm's supply function cannot be explicitly obtained, as supply and demand are simultaneously determined. Quantity-setting conduct will follow the more general supply relationship

$$P_t = MC_{it} - \theta_{it} D'^{q}(Q_t, Y_t, Z, \alpha, \varepsilon_t) Q_{it}, \tag{4}$$

where $D'^{q}(Q, Z, Y, \alpha, \varepsilon)$ represents the derivative with respect to output of the inverse demand function. Presented in this manner, the supply relationship's two primary components are highlighted. The first component represents marginal cost and the second represents the perception of firm i of its output on industry price. The parameter θ indicates the intensity of competition. When $\theta = 1$, the firms in the industry jointly produce the monopoly level of output, and Eq. (4) reduces to the standard monopoly condition, marginal cost = marginal revenue. When $\theta \in (0, 1)$, the firms produce at a level such that price is higher than marginal cost, as in an oligopoly. When $\theta = 0$, the industry is perfectly competitive with price equal to marginal cost.

Eq. (4) is not estimated in this study at the firm level. Given specific functional forms for demand and marginal cost, Eq. (4) is aggregated to the industry level, with $c(Q_t, W_t, \beta, \mu)$ being carefully interpreted for these functional forms. The general form of the industry supply relationship to be estimated is

$$P_t = c(Q_t, W_t, \beta, \mu) - \theta D'^{q}(Q_t, Z_t, Y_t, \alpha, \varepsilon_t) Q_t. \tag{5}$$

Shocks and shifts to product demand allow identification of the effect of quantity produced on the industry price. The exogenous variables, which are the general demand variables and substitute prices, rotate and shift the demand curve. Under perfect competition, rotations in the demand curve will have no effect on the industry equilibrium point. Price equals marginal cost before and after any rotation. With constant marginal cost and perfectly competitive markets, shifts in the demand curve also will not affect product prices. Without perfect competition, rotations in the demand curve will cause the firms output decisions to change as the elasticity of demand changes. Any changes in the perceived optimal response of competitors because of capital structure changes will also cause a firm's output decisions to change.

5.1. *Estimation of capital structure and product market interaction*

Demand equations and supply relationships incorporating capital structure are estimated for the four industries at the industry level. These equations incorporate capital structure by allowing parameters to depend on the average debt ratio of the industry. The industry supply and demand equations are estimated in a simultaneous equation framework, using two-stage instrumental variable techniques. Reduced-form equations are also estimated, regressing quantity on the exogenous variables in the system.

To test the interaction of price and quantity with capital structure, the industry supply relationship is derived by assuming a specific form for the industry demand functions and the firm production function. The exact form of the production and demand functions are not as crucial as one might first surmise. The derivatives, the marginal cost functions and the derivative of the demand equation with respect to quantity, are the equations that are estimated that contain the parameters of interest. This flexibility of not having to estimate average cost functions is one of the advantages of the tests. Alternative specifications of the demand and supply relationships provide tests for the robustness of the results. To allow for more efficient uses of inputs in the production process, one specification estimates input price coefficients before and after the recapitalization. The supply relationship also includes quantity controlling for changes in returns to scale. Because of the simultaneity of quantity and price, actual quantity is not used in this equation. The exogenous demand variables from the demand equation are used as instruments for quantity. Other changes in marginal cost are captured by changes in input prices.

Total industry demand is assumed to be a loglinear function of price as follows:

$$q_t = \alpha_0 + \alpha_1 p_t + \alpha_2 y_t + \alpha_3 r_t + \varepsilon_t\,, \tag{1'}$$

where lower case variables indicate log transformations. In the equation, r is a relative price term with $r_t = \ln(P_t/Z_t)$, where Z is the price of a substitute

product. (In the linear case, the relative price term, r_t, provides the identification of θ. In the loglinear case, the relative price term does not appear in the final equation, as Z is not part of the derivative with respect to quantity.) q is quantity, p is price, y is a demand shift variable, such as industrial production, and ε represents econometric error. Rearranging Eq. (1'), the inverse demand function is

$$p_t = (q_t - \alpha_0 - \alpha_2 y_t + \alpha_3 z_t + \varepsilon_t)/(\alpha_1 + \alpha_3)\,.$$

Marginal cost is specified by assuming that firms produce using N inputs, according to a Cobb–Douglas production function (a flexible production function): $Q_{it} = A_i * L_1^{a_{1i}} L_2^{a_{2i}} \ldots L_N^{a_{Ni}}$; the quantity $L_j^{a_{ji}}$ $(j = 1, \ldots, N)$, denotes the quantity of input j used in production for firm i. A_i represents a firm specific technology shift parameter, and $a_i = \sum_{j=1}^{N} a_{ji}$ indexes returns to scale. Under constant returns to scale, $a_i = 1$; under increasing returns to scale, a_i is greater than one. Taking input prices as given and minimizing cost for any level of output, marginal cost is (lower case again refers to log transformations)

$$mc_{it} = \beta_{i1} q_{it} + \sum_{j=1}^{N} (a_{ji}/a_i)\, w_{ji} - \frac{1}{a} * \log(A_{it}) + v_{it}\,, \tag{3'}$$

where mc is log marginal cost, q denotes log output, w_j are the logs of input prices, and v represents a random cost shock. In this specification, $\beta_{i1} = (1 - a_i)/a_i$ indexes returns to scale for the firm. This equation thus directly controls for changes in returns to scale and changes in input prices. A_{it} represents a technological shift parameter, assumed constant across time and firms, given the mature industries examined.

Assuming that the products produced by firms are of homogeneous quality, all firms charge equal prices in equilibrium. Substituting the derivative of the inverse demand function (1') into Eq. (4), taking into account the log transformations, the supply relationship for individual firm i is

$$P_t = MC_{it} - \theta_{it} * P_t/(\alpha_1 + \alpha_3) + v_{it}\,. \tag{4'}$$

The first term in this equation represents marginal cost, the second is the effect on marginal revenue from the expected price change on existing sales, and v represents the combined cost and demand shocks, assumed to be independent of input prices and demand shift variables. If firms choose to price competitively, price will equal marginal cost, and $\theta_{it} = 0$ for all i and t. Under perfect collusion, the monopoly outcome will result: $\theta_{it} = 1$ for all i and t. In an oligopoly, with Cournot competition, θ_{it} equals s_{it} which equals q_{it}/q_t, the market share of firm i in period t.

Allowing θ to depend on and interact with the firm's debt ratio incorporates capital structure in the model. In empirical work by Porter (1983), θ is a function of unobservable demand shocks to the industry. As demand shocks occur,

industry collusion breaks down as cartel members suspect that a rival has cheated, deviating from the collusive outcome. In this paper, capital structure is incorporated in several ways. The average industry debt ratio is included as an independent variable, and a variable is included that interacts marginal revenue with a dummy variable that equals one following the recapitalization. The model thus captures whether price movements also depend on the capital structure of firms. If low amounts of free cash flow act as a credible bond that decreases investment and industry output, the coefficient on the debt ratio will be positive. A negative coefficient will result when a firm increases output subsequent to the recapitalization, as in Brander and Lewis (1986) and Maksimovic (1988). The tests in this paper also differ from Porter (1983) in that they test for structural change, in addition to the dependence of the change on the debt ratio.

In the estimation, the industry debt ratio varies by time and θ is a weighted function of individual firm θ_i's weighted by their market shares, $\theta_t = \sum s_i \theta_{it}$. Solving Eq. (4') for price, taking logs and substituting in Eq. (3'), yields firm-level supply equations for the specified cost function. Adding up these firm-level supply equations, weighted by firm market shares, gives an industry-level supply relationship that can be estimated with industry price and quantity data.[7] Given the functional forms for the market demand and cost functions, the industry supply relationship can be written as:

$$p_t = \beta_0 + \beta_1 q_t + \beta_j w_t + \gamma * (Debt\ ratio_t) + v_t\,, \tag{5'}$$

where j indexes the vector of inputs. The fourth term, $\gamma * (Debt\ ratio_t)$, indicates the dependence of the industry supply relationship on the average industry debt ratio. The partial derivative with respect to the debt ratio, γ, will be greater than zero if prices increase, controlling for demand and input prices, and less than zero if prices decrease. The parameters on the terms in the marginal cost function are weighted indices of individual firm cost function parameters. Eq. (5') and the demand equation (1') are estimated at the industry level.

From Eqs. (1') and (4'), the dependence of γ on the underlying parameters can be derived. In the loglinear specification, $\gamma = -\log(1 + \theta/(\alpha_1 + \alpha_3))$. Whether θ (and thus γ) is affected by the debt ratio tests whether capital structure influences the industry supply relationship. If no structural change occurs, or the firms have no market power, this term will be zero. There are additional terms involving θ that enter the equation, but they are part of the constant term. Under any theory of oligopoly, changes in the elasticity of demand shift the perceived marginal revenue of firms. If capital structure changes affect their

[7]Aggregating the supply equations follows Porter (1983). Porter also shows that marginal cost can still differ by firm. The coefficients on quantity and input prices in Eq. (5') are then weighted functions of individual firm cost parameters.

perceived marginal revenue, firms will make different output decisions. Firms' responses to changes in relative prices and demand shocks will vary depending upon capital structure. Increased debt can cause firms to credibly commit to changing output decisions. Industry output is affected by capital structure as the firm and its rivals adjust their output.

5.2. *Tests of capital structure and product market interaction*

The tests involve estimating the demand equation (1′) and the supply relationship (5′). Both linear and loglinear forms of the demand and supply equations are estimated. The text and tables contain the derivation and results of the loglinear specification.[8] Reduced-form equations are also estimated, regressing quantity on the input prices and general demand variables, as well as the average industry debt ratio. It should be noted that these equations would not be appropriate if the input prices or demand shocks were endogenous to industry competition. In these industries, the large shocks to oil, other input prices, and general demand shift variables such as new construction, should be exogenous to industry prices.

The first panel of Tables 4a–4d contains the demand equations, the second panel contains the supply relationships, and the final panel contains the reduced-form. In Tables 4a–4d, the supply relationships in the second panel and the reduced-form equation in the third panel contain the debt ratio variables which test the influence of capital structure on product markets. Two different specifications in the second panel for the supply relationship are estimated. The first supply relationship in the middle panel of Tables 4a–4d includes the average weighted debt ratio of public companies to test the influence of capital structure on prices. The second supply relationship in the middle panel includes a financial change dummy variable that identifies the period after the recapitalization announcement and also allows the coefficients on the independent variables to change subsequent to the recapitalization. Given the postulated importance of the largest recapitalizing firm this dummy variable equals one after the largest firm's recapitalization announcement and zero before, irrespective of other industry firms' leverage changes. Alternate specifications such as setting the dummy variable equal to one when two or more firms have high leverage make no difference in the significance or the sign of this variable. Using the weighted-average debt ratio also controls for different recapitalizing dates.

[8]The results from estimating linear forms of these equations are similar and are available in a previous working paper version of the paper. The linear specification contains an interaction variable whose coefficient can be used to identify the differential product market response as $D'(Q)$ does not contain Q and thus it does not cancel in the supply function. In this interaction variable, the debt ratio is interacted with quantity multiplied by the relative price.

Several additional variables are included, and different specifications are estimated to control for changes in other exogenous factors. The coefficient on instrumented quantity in the supply relationship controls for returns to scale. A negative coefficient is consistent with increasing returns to scale and a positive coefficient with decreasing returns to scale. Quantity can also proxy for other variable inputs omitted from the estimation. Differences in the relationship between input and industry prices before and after the recapitalizations also help control for possible input substitution. The residuals from the demand equation are also included as an independent variable to control for demand shocks. In a competitive industry, with no capacity constraints and with constant returns to scale, demand shocks should not affect price. Rotemberg and Saloner (1986) model how these shocks increase the incentive to increase output in an imperfectly competitive industry, predicting a negative coefficient. Alternatively, Green and Porter (1984) predict that a negative demand shock will decrease price as firms cannot distinguish between negative demand shocks and 'cheating by firms'. They predict a positive coefficient.

Tables 4a–4d present results on estimating the demand and supply relationships using monthly data from 1980 to 1990. Results presented are for the entire period, and allow the slope coefficients to change before and after the recapitalization announcement. Monthly dummy variables and a time trend are also included. Results are similar without the inclusion of the monthly dummies. Given that most of the data are in indices, all remaining data are converted to indices.

In order to control for the simultaneity of supply and demand, equations are estimated using two-stage simultaneous equation methods with instruments for price in the demand equation and for quantity in the supply relationship. The instruments for the supply relationships are the exogenous variables from the demand equation. The same instruments from the demand equation are used for both of the supply relationships. The input prices are the instruments for the product price in the demand equation. The last regression, presented in the third panel, estimates the reduced form of the structural equations, substituting the exogenous variables from the supply equation for price in the demand equation. Standard errors are adjusted for autocorrelation and heteroskedasticity given that the Durbin–Watson test indicates the presence of serial correlation in nearly all of the regressions and the Ljung–Box Q test indicates higher-order serial correlation for several of the regressions, while White tests indicate the presence of heteroskedasticity. The adjustment for the standard errors follows Newey and West (1987), providing a consistent estimate of the covariance matrix without imposing a specific structure on the form of heteroskedasticity and autocorrelation. [The Newey–West correction extends the White (1980) heteroskedasticity correction to allow for autocorrelation.] The significance of the coefficients on the capital structure interaction variables is the same as when estimated using ordinary least squares or a Cochrane–Orcutt AR(1) correction.

Table 4a

Industry product market analysis: Fiberglass insulation industry

Supply relationships and the reduced-form equation test whether capital structure interacts with industry product markets. The linear (loglinear) form of the industry demand equation in the first panel is estimated with the linear (loglinear) supply relationship in the second panel using two-stage simultaneous equations. The before/after rows for the loglinear supply relationship are estimated in one equation. The before/after periods are months in the 1980's surrounding Owens–Corning Fiberglas' announcement of a leveraged recapitalization on 8/28/86. The reduced-form of the loglinear demand and supply equations in the last panel is estimated in one step. Figures in parentheses are Newey–West heteroskedastic and autocorrelation consistent standard errors.

Demand equations – Dependent variable: Quantity

	Price	Construction	Industrial production	Auto production	Relative price[a] (Gypsum board)	R^2
Linear	−0.81[e]	0.01[e]	1.04[e]	0.22[e]	0.02	0.87
	(0.11)	(0.002)	(0.21)	(0.08)	(0.03)	
Loglinear	−0.96[e]	0.32[e]	1.15[e]	−0.050	0.09[e]	0.86
	(0.10)	(0.06)	(0.20)	(0.06)	(0.03)	

Supply relationships – Dependent variable: Price

	Quantity	Electricity price	Glass abrasives price	Oil price	Wage	Demand shock[b]	Debt ratio[c]	Financial change dummy[d]	R^2
Linear	−0.071[e]	0.37[e]	−0.12	−0.03	0.37[e]	0.19[e]	0.013[f]		0.90
	(0.02)	(0.05)	(0.15)	(0.02)	(0.08)	(0.07)	(0.01)		
Loglinear	0.00	0.27[e]	−0.54[e]	0.01	0.60[e]	0.19[e]	0.021[e]		0.93
	(0.30)	(0.04)	(0.12)	(0.01)	(0.06)	(0.05)	(0.01)		

Loglinear									
Before	−0.15[e]	0.30[e]	0.29[f]	0.00	0.21[e]	0.15[e]		0.147[e]	0.93
	(0.04)	(0.04)	(0.17)	(0.01)	(0.07)	(0.07)		(0.03)	
After	−0.33[e]	0.21[e]	−0.31	−0.01	−0.24	0.06			
	(0.09)	(0.07)	(0.24)	(0.02)	(0.29)	(0.04)			

Reduced form – Dependent variable: Quantity

	Construction	Industrial production	Auto production	Relative price[a]	Electricity	Glass abrasives price	Oil price	Wage	Debt ratio[c]	R^2
Loglinear	0.32[e]	0.82[e]	−0.24[e]	0.02	−0.86[e]	0.88[e]	−0.24[e]	−0.51[e]	−0.09[e]	0.94
	(0.07)	(0.18)	(0.11)	(0.04)	(0.11)	(0.09)	(0.05)	(0.18)	(0.03)	

Data are monthly indices from 4/1980 to 10/1990. Price data were obtained from the Bureau of Labor and Statistics. Insulation quantity data and general demand shift data were obtained from the Federal Reserve Board's *Industrial Production*. Instruments for price in the demand equation are the omitted input prices. In the supply relationships, instruments for quantity and the quantity interaction are the demand variables and the omitted relative prices. To account for seasonality in demand, monthly dummies were included but are not reported. A time trend was also included and all price data are deflated by the wholesale price index.

[a]In the linear case the relative price is the price of gypsum board divided by the the price of fiberglass. In the loglinear case the relative price is the price of gypsum board.

[b]The demand shock variable is the residuals from the demand equation.

[c]Debt ratio is the weighted-average debt-to-market value ratio of the public firms, weighted by sales. In the linear case, the debt ratio variable is interacted with instrumented quantity divided by the substitute price.

[d]The financial change dummy variable equals one for the months following the capital structure change.

[e]Significant at the 5% level using a two-tailed test.

[f]Significant at the 10% level using a two-tailed test.

Table 4b
Industry product market analysis: Tractor trailer industry (tank trailers)

Supply relationships and the reduced-form equation test whether capital structure interacts with industry product markets. The linear (loglinear) form of the industry demand equation in the first panel is estimated with the linear (loglinear) supply relationship in the second panel using two-stage simultaneous equations. The before/after rows for the loglinear supply relationship are estimated in one equation. Before and after periods are months in the 1980's surrounding Fruehauf's announcement of a leveraged recapitalization on 6/24/86. The reduced-form of the loglinear demand and supply equations in the last panel is estimated in one step. Figures in parentheses are Newey–West heteroskedastic and autocorrelation consistent standard errors.

Demand equations – Dependent variable: Quantity

	Price	Construction	Shipments of manufactures	Relative price[a] (truck and bus)	R^2
Linear	−0.60[e]	0.18	3.54[e]	0.16	0.45
	(0.31)	(0.12)	(0.50)	(0.20)	
Loglinear	−0.71[e]	1.02[e]	3.81[e]	0.34	0.54
	(0.39)	(0.33)	(0.50)	(0.35)	

Supply relationships – Dependent variable: Price

	Quantity	Steel price	Electricity price	Aluminum price	Wage	Demand shock[b]	Debt ratio[c]	Financial change dummy[d]	R^2
Linear	0.26	−0.24	1.35[e]	0.15[f]	−0.10	−0.07	0.41[e]		0.58
	(0.27)	(0.35)	(0.59)	(0.09)	(0.44)	(0.10)	(0.16)		
Loglinear	0.23	−0.17	1.54[e]	0.104[f]	0.00	−0.04	0.203[e]		0.65
	(0.16)	(0.30)	(0.70)	(0.05)	(0.08)	(0.04)	(0.10)		

Loglinear								
Before	− 0.18	0.56	1.09[e]	0.03	− 0.43	− 0.02	0.359[e]	0.61
	(0.18)	(0.84)	(0.46)	(0.08)	(0.48)	(0.02)	(0.09)	
After	0.27[e]	0.77[e]	0.31	− 0.18[e]	− 0.41	− 0.07		
	(0.09)	(0.30)	(0.36)	(0.07)	(0.46)	(0.08)		

Reduced form Dependent variable: Quantity

	Construction	Shipments of manufactures	Relative price[a]	Steel price	Electricity price	Aluminum price	Wage	Debt ratio[c]	R^2
Loglinear	0.24	1.42[e]	0.15	− 0.02	1.16[e]	0.02	− 0.17	− 0.17[e]	0.58
	(0.30)	(0.34)	(0.20)	(0.38)	(0.45)	(0.10)	(0.58)	(0.06)	

Data are monthly indices from January 1980 to December 1990. Tractor quantity data were obtained from R.L. Polk. Tractor price data were obtained from *U.S. Department of Commerce: Current Industrial Reports*. All other price data were obtained from the Bureau of Labor and Statistics. Demand shift data, construction and shipments of manufactures, were obtained from the Federal Reserve *Industrial Production*. Instruments for price in the demand equation are the omitted input prices. In the supply relationships instruments for quantity and the quantity interaction are the demand variables and the omitted relative prices. To account for seasonality in demand, monthly dummies were included but are not reported. A time trend was also included and all price data are deflated by the wholesale price index.

[a]In the linear case the relative price is the price of small truck and bus bodies divided by the the price of tractor trailers. In the loglinear case the relative price is the price of tank tractor trailers.

[b]The demand shock variable is the residuals from the demand equation.

[c]Debt ratio is the weighted-average debt-to-market value ratio of the public firms, weighted by sales. In the linear case, the debt ratio variable is interacted with instrumented quantity divided by the substitute price.

[d]The financial change dummy variable equals one for the months following the capital structure change.

[e]Significant at the 5% level using a two-tailed test.

[f]Significant at the 10% level using a two-tailed test.

Table 4c
Industry product market analysis: Polyethylene industry (high-density polyethylene)

Supply relationships and the reduced-form equation test whether capital structure interacts with industry product markets. The linear (loglinear) form of the industry demand equation in the first panel is estimated with the linear (loglinear) supply relationship in the second panel using two-stage simultaneous equations. The before/after rows for the loglinear supply relationship are estimated in one equation. Before and after periods are months in the 1980's surrounding Quantum Chemical's announcement of a leveraged recapitalization on 12/27/88. The reduced-form of the loglinear demand and supply equations in the last panel is estimated in one step. Figures in parentheses are Newey–West heteroskedastic and autocorrelation consistent standard errors.

Demand equations – Dependent variable: Quantity

	Price	Consumer industrial production	Auto production	Shipments of manufactures	Relative price[a] (aluminum cans)	R^2
Linear	−0.71[e]	2.22[e]	0.11	−0.21	0.48[e]	0.91
	(0.24)	(0.96)	(0.16)	(0.33)	(0.22)	
Loglinear	−0.45[e]	1.19[f]	0.19[e]	−0.28	0.26	0.91
	(0.20)	(0.65)	(0.10)	(0.37)	(0.17)	

Supply relationships – Dependent variable: Price

	Quantity	Oil price	Electricity price	Wage	Demand shock[b]	Debt ratio[c]	Financial change dummy[d]	R^2
Linear	−1.12[e]	−0.47[e]	−0.84	0.22	0.08	0.33[e]		0.71
	(0.44)	(0.16)	(0.58)	(0.96)	(0.10)	(0.15)		
Loglinear	0.15	−0.23[e]	−1.23[e]	−0.64	0.12	0.15[f]		0.65
	(0.17)	(0.09)	(0.49)	(0.58)	(0.14)	(0.08)		

Loglinear

Before	0.46[e]	− 0.21[e]	− 1.52[e]	− 0.45[e]	− 0.10		0.94[e]	0.64
	(0.24)	(0.05)	(0.60)	(0.74)	(0.12)		(0.39)	
After	0.20	− 0.56[e]	− 1.91[f]	− 4.66[e]	− 0.47			
	(0.16)	(0.22)	(1.12)	(1.37)	(0.84)			

Reduced form – Dependent variable: Quantity

	Consumer industrial production	Auto production	Shipments of manufactures	Relative price[a]	Oil price	Electricity price	Wage	Debt ratio[c]	R^2
Loglinear	0.27	− 0.10	0.89[f]	0.17	0.03	− 0.85[e]	1.66[e]	− 0.19[f]	0.92
	(0.81)	(0.14)	(0.47)	(0.33)	(0.05)	(0.41)	(0.64)	(0.10)	

Data are monthly indices from October 1980 to December 1990. Polyethylene quantity data were obtained from McGraw Hill/Data Resources Institute (DRI). Price data were obtained from the Bureau of Labor and Statistics. Demand shift data, consumer industrial and auto production, were obtained from the Federal Reserve Board's *Industrial Production*. Instruments for price in the demand equation are the omitted input prices. In the supply relationships instruments for quantity and the quantity interaction are the demand variables and the omitted relative prices. To account for seasonality in demand, monthly dummies were included but are not reported. A time trend was also included and all price data are deflated by the wholesale price index.

[a]In the linear case the relative price is the price of aluminum cans divided by the price of polyethylene. In the loglinear case the relative price is the price of aluminum cans.

[b]The demand shock variable is the residuals from the demand equation.

[c]Debt ratio is the weighted-average debt-to-market value ratio of the public firms, weighted by sales. In the linear case, the debt ratio variable is interacted with instrumented quantity divided by the substitute price.

[d]The financial change dummy variable equals one for the months following the capital structure change.

[e]Significant at the 5% level using a two-tailed test.

[f]Significant at the 10% level using a two-tailed test.

Table 4d
Industry product market analysis: Gypsum industry

Supply relationships and the reduced-form equation test whether capital structure interacts with industry product markets. The linear (loglinear) form of the industry demand equation in the first panel is estimated with the linear (loglinear) supply relationship in the second panel using two-stage simultaneous equations. The before/after rows for the loglinear supply relationship are estimated in one equation. Before and after periods are months in the 1980's surrounding USG's announcement of a leveraged recapitalization on 5/2/88. The reduced-form of the loglinear demand and supply equations in the last panel is estimated in one step. Figures in parentheses are Newey–West heteroskedastic and autocorrelation consistent standard errors.

Demand equations – Dependent variable: Quantity

	Price	Construction	Shipments of manufactures	Relative price[a] (wood sheeting)	R^2
Linear	0.44[e]	0.75[e]	− 0.09	− 0.07	0.89
	(0.20)	(0.12)	(0.13)	(0.05)	
Loglinear	− 0.20	1.16[e]	− 0.52[e]	− 0.08	0.89
	(0.26)	(0.19)	(0.22)	(0.08)	

Supply relationships – Dependent variable: Price

	Quantity	Gas price	Electricity price	Wage	Demand shock[b]	Debt ratio[c]	Financial change dummy[d]	R^2
Linear	− 0.05	0.72	1.19[f]	0.02	− 0.06	− 0.25[e]		0.65
	(0.13)	(0.47)	(0.64)	(0.01)	(0.18)	(0.07)		
Loglinear	0.52[e]	0.30	0.45	0.49	− 0.16	− 0.08[e]		0.61
	(0.26)	(0.19)	(1.00)	(0.19)	(0.14)	(0.04)		

Loglinear

Before	1.04[e]	0.05	0.81[e]	− 0.11	0.04		− 0.12[f]	0.93
	(0.11)	(0.03)	(0.31)	(0.09)	(0.08)		(0.07)	
After	0.59[e]	− 0.16	0.07	0.67[f]	− 0.02			
	(0.12)	(0.12)	(0.16)	(0.40)	(0.06)			

Reduced form – Dependent variable: Quantity

	Construction	Shipments of manufactures	Relative price[a] (wood sheeting)	Gas price	Electricity price	Wage	Debt ratio[c]	R^2
Loglinear	0.72[e]	0.42[e]	0.07	0.12[e]	0.65[e]	1.47[e]	0.02[f]	0.94
	(0.06)	(0.19)	(0.05)	(0.04)	(0.16)	(0.28)	(0.01)	

Data are monthly indices from January 1980 to September 1990. Gypsum price and quantity data were obtained from Bureau of the Mines. All other price data were obtained from the Bureau of Labor and Statistics. Demand shift data were obtained from the Federal Reserve Board's *Industrial Production*. Instruments for price in the demand equation are the omitted input prices. In the supply relationships instruments for quantity and the quantity interaction are the demand variables and the omitted relative prices. To account for seasonality in demand, monthly dummies were included but are not reported. A time trend was also included and all price data are deflated by the wholesale price index.

[a]In the linear case the relative price is the price of wood sheeting divided by the the price of gypsum. In the loglinear case the relative price is the price of wood sheeting.

[b]The demand shock variable is the residuals from the demand equation.

[c]Debt ratio is the weighted-average debt-to-market value ratio of the public firms, weighted by sales. In the linear case, the debt ratio variable is interacted with instrumented quantity divided by the substitute price.

[d]The financial change dummy variable equals one for the months following the capital structure change.

[e]Significant at the 5% level using a two-tailed test.

[f]Significant at the 10% level using a two-tailed test.

5.3. Results of capital structure and product market interaction tests

The results from estimating the supply relationships in the middle panels of Tables 4a–4d show that product price is correlated with variables that indicate the industry supply relationship has changed in the high-debt environment. In all four industries, both the average industry debt ratio and the financial change dummy variable are significant, and are positively associated with product price in all but the gypsum industry. In the reduced forms of the equations, presented in the last panel of Tables 4a–4c, output is negatively associated with the average industry debt ratio. In the demand equations, product price is predicted to enter negatively under standard downward-sloping demand functions, while demand shift terms are predicted to enter positively. Parameters in the demand equations are generally of the correct sign and are significant. Quantity demanded is negatively related to price. Coefficients on variables representing general demand shifts are positive, with at least one entering significantly. The results on how price responds to input prices and demand shocks before and after the recapitalizations are less consistent. The one conclusion that can be made is that other factors besides input prices and demand shocks are important in explaining product price movements.

Table 4a presents the results of estimating the supply relationship for the fiberglass insulation industry. The results are consistent with the hypothesis that output has decreased for this industry and that increased debt is associated with higher prices. In the first specification of the supply relationship in the middle panel, the coefficient on the average debt ratio of the public firms is positive and significant. In the final supply relationship in the middle panel, where the coefficients are allowed to vary before and after the recapitalization, the dummy term representing the capital structure change is positive and significant. Finally, in the reduced-form equation, output is negatively associated with the debt ratio.

Table 4b presents the results of estimating the equations for the tractor trailer industry. Several results are consistent with the influence of debt on the supply relationship and decreased output in the industry. In the supply relationships in the second panel, the coefficient is significant and positive on both the debt ratio and the financial change dummy variable. In the reduced-form equation in the third panel, output is negatively associated with the weighted-average industry debt ratio.

Table 4c presents the results of estimating the equations for the high-density polyethylene chemical industry. Similar findings were obtained for low-density polyethylene. Several measures in the middle panel are consistent with a changed supply relationship and a decrease in output. The debt ratio is positive and significant, following the recapitalization. The reduced-form results in the third panel also show that quantity is negatively associated with the industry debt ratio. The financial change dummy, in the last supply regression, is

also positive and significant. Somewhat surprising is the size of this coefficient and the negative coefficients on the elasticities of price with respect to input prices.

The large coefficient on the financial change dummy variable may be partially caused by the aforementioned explosion of a large Phillips' Petroleum plant in 1989. The explosion of the Phillips' plant provided an opportunity for firms to expand. In response, Quantum Chemical maintained its share of capacity, Union Carbide lost almost two percentage points of the market share of capacity, while the four smaller, unleveraged firms gained three percentage points of the market share of capacity. The evidence is consistent with Quantum and Union Carbide, after their recapitalizations, responding 'less aggressively' than their rivals.

By contrast, the results presented in Table 4d for the gypsum industry are consistent with output increasing and price decreasing following the recapitalization. In the supply relationships in the middle panel, price responds more strongly to input prices after the recapitalization, while the debt ratio variables are negative and significant. The coefficients on both the debt ratio and the financial change dummy are negative and significant following the recapitalization. In addition, the coefficient on the industry debt ratio in the reduced-form equation is positive. These results are consistent with the decreased accounting performance following the recapitalization announcement documented earlier.

Overall, the tests show that capital structure interacts with industry quantity for the industries in this study. Coefficients on variables that indicate an effect of capital structure change on industry supply relationships following the recapitalizations are positive for the tractor trailer, insulation, and polyethylene industries, and negative for the gypsum industry. The positive coefficients indicate that price increases as output decreases in the high-debt environment, while the negative coefficient for the gypsum industry indicates that price decreases as output increases. In the reduced-form equations, output is negatively associated with the debt ratios for the first three industries. These results indicate a decrease in output, controlling for changes in demand and marginal cost. In the reduced-form equation for the gypsum industry, output is positively associated with the industry debt ratio. These results are similar using a simple financial change dummy variable.

6. Firm stock performance and executive compensation

The previous section provides evidence that industry product markets, and specifically industry output, are affected by capital structure. However, it remains to be examined whether managers were inefficiently expanding the size of the firm prior to the recapitalizations, or whether increased debt reduces

internal funds to a level such that positive net present value investments are not undertaken. Two types of evidence are examined. First, stock market returns at the time of the announcement using a standard event study are examined. Second, I examine whether the relationship between compensation and a firm's sales and stock performance changes after the firms' leveraged recapitalizations. This second test is more powerful because I examine the relationship between shareholder wealth and executive compensation relationship over a 15-year period.

The evidence provided by examining excess returns is somewhat hard to interpret as it suffers from the criticism that the response was because of the announcement of the large special dividend paid out at the time of the recapitalization. Examining competitors' returns also does not separate out the market's priors as the expectation may be for similar large dividends to be paid out by these firms. With these limitations in mind, the evidence is at least consistent with the view that the stock market viewed the recapitalizations as increasing the wealth of stockholders. I calculated two-day announcement excess returns for the recapitalizing firms. The two-day excess returns were 12.73% for Owens–Corning Fiberglas, 17.97% for USG, 19.18% for Fruehauf, and 20.61% for Quantum Chemical. I used a market model and 120 days of stock return data prior to the announcement date. The announcement date used was the earlier date of either the announcement of the leveraged recapitalization or the first date of any takeover interest in the company.

The evidence provided by examining the association between management compensation and shareholder wealth is stronger as it provides a time series of 15 years to examine for the executives in each firm. Table 5 shows that for Owens–Corning Fiberglas, Fruehauf, Quantum Chemical, and USG, managers own a higher percentage of the company subsequent to the recapitalization. Combined with higher interest costs which reduce discretionary cash flow, increased options and shares may provide increased incentives for managers to maximize shareholder wealth. In the following tests, the influence of debt versus compensation changes is not separated. I test whether the coefficients in regressions of executive compensation on sales and shareholder wealth are significantly different following the leveraged recapitalizations. While not direct evidence, an increase in the coefficient on shareholder wealth is consistent with managers having greater incentives to undertake investments which increase shareholder wealth.

As in Murphy (1985) and Jensen and Murphy (1990), this section examines the pay–performance relationship. The tests here, however, examine whether the pay–performance relationship changes following recapitalizations. Murphy shows that sales growth and stock market returns are positively related to compensation in 72 corporations. Jensen and Murphy show that changes in executive compensation are positively related to changes in shareholder wealth for 1,049 corporations. They point out, however, that the economic significance

Table 5

Management compensation surrounding recapitalizations

Management compensation data are summary statistics for 27 executives that served a minimum of five consecutive years during 1977–1992. All monetary data are in CPI-deflated 1983 dollars. Compensation data are from yearly proxy statements. Share ownership data are from the recapitalization prospectuses and represent fully-diluted ownership positions.

	Before/After recapitalization	Number of executives[a]	Mean salary and bonus	Mean contingent compensation[c]	Mean value stock options[d]	Officers' and directors' share ownership
Owens–Corning Fiberglas	Before	6	288,053	21,712	39,846	1.1%
	After	5	615,710	109,416	173,650	6.1%
Fruehauf[b]	Before	5	327,635	0	37,697	0.7%
	After	2	267,829	0	36,071	28.7%
Quantum Chemical	Before	6	307,050	55,673	81,785	3.3%
	After	3	401,655	188,520	359,730	4.7%
USG	Before	7	382,294	55,507	106,515	1.1%
	After	5	403,451	165,243	210,146	3.6%

Data are for 15 years surrounding the recapitalizations excluding the year of the recapitalization announcement. Data for Owens–Corning Fiberglas' pre-recapitalization period are for the years 1977–1985. Data for the post-recapitalization period are for the years 1987–1992. Similarly for Fruehauf, the pre-recapitalization years are 1977–1985 and the post-recapitalization years are 1987–1989. For Quantum Chemical, the pre-recapitalization years are 1977–1987 and the post-recapitalization years are 1989–1992. For USG, the pre-recapitalization years are 1977–1987 and the post-recapitalization years are 1989–1992.

[a]An executive can be in both the before and after periods.

[b]Fruehauf compensation data ends in 1989 when it was acquired by another firm.

[c]Any stock grants are included in contingent compensation and are valued at the time of the grant. Changes in the value of stockholdings are not included in the compensation variables.

[d]Stock options are valued using the Black–Scholes formula. The last 60 months of stock return data are used to compute the estimated standard deviation of stock returns.

of the sensitivity of changes in compensation to changes in shareholder performance is low. Jensen and Murphy (Table 1, column 3) report that CEO total current compensation changes by only 2.35 cents for every $1,000 change in current shareholder wealth. They also report that the present value of CEO cash compensation changes by $0.30, and total CEO wealth, including stockholdings in their company, changes by $3.25 for every $1,000 change in shareholder wealth.

The pay–performance relation in this paper is investigated over a 15-year period split into periods before and after the firms' recapitalizations. There are several ways in which the relationship can be affected by recapitalization. At the time of the recapitalizations, the four firms considered in this section simultaneously revised their incentive compensation plans. Subsequently, contingent compensation, share grants, and option grants to executives may change. Bonuses may also be more closely tied to firm performance. Finally, the recapitalization forces managers to pay out more cash flow as interest payments, potentially decreasing investment and future sales.

Data on executive compensation are collected from the annual corporate proxy statements for the top recapitalizing firms in each industry: Owens–Corning Fiberglas, Fruehauf, Quantum Chemical, and USG. Only the leading firms are examined, as annual compensation data is unavailable after capital structure changes for the secondary firms which recapitalized using LBOs. The annual salary and bonus, contingent compensation, share grants and option grants are collected for the top executives which are reported in the proxy statement. The procedure used for data selection and option valuation follows Murphy (1985). Share grants are valued at the date of grant at the market price per share. Options are valued using the Black–Scholes model, using a 10-year horizon and the 10-year yield for outstanding U.S. Government securities from the *Federal Reserve Bulletin* as the risk-free rate. The last 60 months of stock return data are used to compute the estimated standard deviation of stock returns. A continuous dividend yield was assumed using the prior year dividend payments. Executives are included in the final sample if they served for five continuous years during 1977–1992. The final sample contains 27 executives from the top firms in each of the four industries for a total of 228 compensation-year observations. Share ownership data for the officers and directors are obtained from the recapitalization prospectuses and represent fully-diluted ownership positions, including all granted options and shares owned in company retirement plans. Table 5 presents summary statistics for the compensation and share ownership data for Owens–Corning Fiberglas, Fruehauf, Quantum Chemical, and USG.

The summary statistics indicate that contingent compensation, composed of share grants and other conditional awards and stock option grants, increased relative to the years before the recapitalization. Increases in share ownership also occurred, as the recapitalizations included simultaneous share grants to

executives. At the time of the recapitalization, public shareholders received a one-time large cash dividend. Instead of receiving this dividend in cash, executives received the cash equivalent of the dividend in shares.

Using these data, the relationship between compensation, firm performance, and sales is investigated by regressing changes in executive compensation on changes in shareholder wealth, stock returns, returns on assets, and changes in sales for these four firms. The regressions are estimated using the annual change in each variable and separate intercept terms, or fixed effects, for each executive. To help control for correlation in salary raises each year by each firm, firm-year fixed effects are also included. These variables equal one for the executives of a given firm in a given year and zero otherwise. The effect of including the firm-year fixed effects was mainly an increase in the correlation coefficient for the regression. As the regressions are estimated in changes, 201 observations remain for the regressions over the 15-year period from 1977 to 1992.

In the first panel of regressions in Table 6, the change in total compensation, composed of salary, bonus, contingent compensation, and option compensation, is regressed on current and lagged shareholder wealth as well as the change in sales. (Results without considering the option based part of compensation are also available from the author.) As in Jensen and Murphy (1990), the regressions in the first panel are estimated as changes in levels. Dummy variables for chairman and president are also included. The regressions are estimated first over the entire 15 years from 1977 to 1992, and then split into before- and after-recapitalization subsets. As in Murphy (1985), the equations in the second panel are estimated using a loglinear specification. The change in log compensation is regressed on the firm's current stock return, the change in the log of its sales, and its operating return on assets. The operating return on assets is calculated as operating income before depreciation and interest, divided by the book value of assets.

Results presented in Table 6 indicate that changes in compensation are positively related to changes in shareholder wealth for the full period and the period following the recapitalization but not for the period before the recapitalization. The change in sales is positively and significantly associated with executive compensation before the recapitalization in the loglinear specification. This result is consistent with the hypothesis that managers had incentives to increase sales before the recapitalizations. A Chow structural change test that the coefficients on shareholder wealth and change in sales are the same for the before and after periods was rejected at the 1% level for both the linear and loglinear specifications. The F-statistic for this test was 6.12 for the linear specification and 6.45 for the loglinear specification (the second panel).

The economic magnitude of the results also changes following the recapitalizations. Looking at the linear specification in the first panel, we can interpret these coefficients in terms of dollar values. The coefficient on the change in shareholder wealth prior to the recapitalization is 0.0000643, which implies that

Table 6

Management compensation and shareholder wealth

Regressions test whether changes in management compensation are related to changes in shareholder wealth and sales. The first panel contains the linear estimation. In the loglinear relationship in the second panel, coefficients represent elasticities of management compensation with respect to the independent variables. Coefficients are estimated with a separate intercept (fixed effect) for each executive and for each firm-year. Executives have served a minimum of five years over 1977–1992. The chairman of the board was also the CEO for all four companies. Standard errors are in parentheses.

Linear specification (Jensen–Murphy, 1990) – Dependent variable: Change in total compensation[a] (in 1983 $000)

	Change in shareholder wealth[b]			Position dummies		
	Current year	Lagged year	Change in sales	Chair./CEO	President	$\bar{R}^2$
Full period: 1977–1992						
Execs = 29	0.000429[c]	− 0.000115	0.0000402[c]	335.21	73.767	0.635
Exec. years = 201	(0.0000547)	(0.000063)	(0.0000104)	(211.42)	(171.57)	
Before recapitalization						
Execs = 24	0.0000643	− 0.000067	0.000134[c]	133.95	− 175.95[c]	0.214
Exec. years = 152	(0.0000549)	(0.000057)	(0.0000326)	(105.23)	(87.80)	
After recapitalization						
Execs = 15	0.000571[c]	− 0.000232	0.000195	542.621	− 45.943	0.545
Exec. years = 49	(0.000167)	(0.000185)	(0.000423)	(193.04)	(855.45)	

Loglinear specification (Murphy, 1985) – Dependent variable: Change in log total compensation[a] (in 1983 $000)

	Stock return[c]	Change in ln(Sales)	Return on assets[d]	Position dummies		R^2
				Chair./CEO	President	
Full period: 1977–1992						
Execs = 29	0.252[e]	0.182	− 0.069	0.191	− 0.041	0.453
Exec. years = 201	(0.104)	(0.214)	(0.285)	(0.132)	(0.073)	
Before recapitalization						
Execs = 24	0.058	0.544[f]	0.098	0.402[f]	− 0.017	0.590
Exec. years = 152	(0.128)	(0.310)	(0.822)	(0.217)	(0.174)	
After recapitalization						
Execs = 15	0.493[e]	− 0.740	0.508	0.129	− 0.321	0.544
Exec. years = 49	(0.212)	(1.13)	(1.35)	(0.392)	(0.417)	

Chow structural change tests reject at the 1% level the hypothesis that the coefficients on shareholder wealth, stock return, and change in sales are the same for the before and after periods. F-statistics for the Chow tests were 6.12 for the linear and 6.45 for the loglinear regressions.

[a]Total compensation is defined as the sum of salary, bonus, contingent, and option compensation. Similar results are obtained, available from the author, without including the value of option grants. Any stock grants are included in contingent compensation and are valued at the time of the grant. The relationship is also estimated including changes in the value of existing stockholdings. Results discussed in the text, also available from the author, show that the sensitivity of pay to performance increases following the recapitalization. All compensation data are deflated by the consumer price index.

[b]Change in shareholder wealth is the change in the aggregate value, deflated by the consumer price index, of common stock including dividends for the current year and the prior year ending in December.

[c]Stock return is the return including any dividends for the year ending in December.

[d]Return on assets is the operating cash flow, before any interest payments, divided by the year-end book value of the firm's assets.

[e]Significant at the 5% level using a two-tailed t test.

[f]Significant at the 10% level using a two-tailed t test.

average executive compensation increased 6.4 cents for each $1,000 increase in shareholder wealth. The 6.4 cents is comparable to the 17.6 cents found by Jensen and Murphy (1990, Table 2, column 2). Following the recapitalization, the coefficient increases to 0.000571, implying that on average executive compensation increased 57.1 cents for each $1,000 increase in shareholder wealth. These numbers assume that the increase in executive compensation is temporary, not taking into account the present value of permanent increases in compensation. The results do take into account new stock holdings and stock options at the time of the grant. Excluding stock options, the coefficients were 0.0000518 before and 0.000393 after the recapitalizations, implying that on average executive compensation increased 5.2 cents before, comparable to the 2.35 cents from Jensen and Murphy (Table 1, column 3), and 39.3 cents after the recapitalization for each $1,000 increase in shareholder wealth.

Lewellen (1971) is the first to document that changes in the value of executive shareholdings are frequently larger in absolute value than the amount of direct compensation that an executive receives. Thus, I also examine the changes in the value of executive stockholdings. Including prior stockholdings as part of compensation has a large impact on the coefficients. Results (available from the author) show that the coefficient on changes in shareholder wealth is 0.00250 before and 0.00445 after the recapitalizations, implying that average executive compensation increased $2.50 before and $4.45 after the recapitalizations for each $1,000 increase in shareholder wealth. However, the number of executives with share holding data decreases to 21. The prior number of shares owned by executives who are not on the board of directors is not available as the proxy statements only give the stock of shares owned for board members.

The results for the loglinear specification are similar to the linear results. The coefficients represent elasticities, as the variables are in logs. Changes in compensation are significantly associated with the current stock return for the full period, but when the observations are split into before- and after-recapitalization subsets, the current stock return is only significant for the period following the recapitalizations. The change in sales is the only continuous variable in the regressions that is significantly associated with changes in compensation before the recapitalization. The return on assets was not significantly associated with changes in compensation. Similar results were obtained using other measures of accounting returns, such as earnings before taxes divided by assets.

These results indicate that the relationship between executive compensation and shareholder wealth changes sharply following the recapitalizations. Subsequent to the recapitalization, executive compensation is significantly related to shareholder wealth. The increased responsiveness of executive compensation to shareholder wealth is perhaps not surprising, given the increases in contingent compensation for three of the four firms. In the period before the recapitalization, the change in sales and not shareholder wealth is significantly associated with changes in executive compensation. Again, this result is consistent with the

hypothesis that executives had incentives to inefficiently expand the size of the firm prior to the recapitalization. The result that compensation is associated with changes in shareholder wealth following the recapitalization, and the positive stock market response at the time of the recapitalization announcement are consistent with executives having stronger incentives to accept positive net present value investments subsequent to the recapitalization. The results suggest that the pay–performance relationship changes and that executives have stronger incentives to maximize shareholder wealth following the recapitalizations. These results, combined with the product market results which show that industry output is affected by capital structure, lend support to the hypothesis that managers have incentives to make changes in output following the recapitalizations.

7. Conclusions

This paper presents evidence that industry product markets, and specifically industry output, are influenced by capital structure. Four industries are investigated in which the leading firms increased their financial leverage by more than 25% using leveraged recapitalizations and in which the top four firm have a combined market share close to or exceeding 50%. Summary statistics show sharp changes in market share and plant closings following the leveraged recapitalizations. Tests which use detailed product price and quantity data indicate changes in product market behavior subsequent to major increases in financial leverage by the largest firms. In these industries, the sales-weighted industry debt ratio and simple variables capturing the increase in debt are significantly associated with industry price in supply equations and with industry output in reduced-form equations.

The industry-level results show that in the fiberglass insulation, tractor trailer and polyethylene industry, output is negatively associated with the average industry debt ratio in reduced-form equations. In the supply relationships, product price is positively associated with the average debt ratio, controlling for input prices and the scale of production. In these industries, rival firms also have high financial leverage and entry is relatively difficult. These results are consistent with the hypothesis that firms which increase their financial leverage commit to decreases in output and discretionary expenditures. As firms restrict free cash flow, fewer funds are available to spend on capacity expansion, advertising, and other investments. Capital structure affects product markets and particularly output decisions of firms and their rivals because it can act as a credible commitment not to exercise investment opportunities and to behave 'less aggressively'.

These findings suggest that increased debt and decreased agency costs cause firms to decrease output, thereby increasing producer efficiency in the fiberglass,

tractor trailer, and polyethylene industries. Along with the increases in operating performance, leveraged firms lose market share or fail to gain share when small rivals exit the industry. This loss of market share is additional evidence that the increased debt commits the firm to compete less aggressively. The results are consistent with the models by Glazer (1989) and Phillips (1992) in which debt commits the leveraged firms to behave less aggressively and decrease output and with models that predict decreased output because of decreased agency costs.

In the gypsum industry, however, price decreases as output increases. Product price is negatively associated with the average industry debt ratio in supply relationships for the gypsum industry. Output is positively associated with the debt ratio in the reduced-form equation. USG, the market leader, gained market share, but accounting margins decreased for USG and other firms in the industry. The gypsum industry is different in several ways from the other industries analyzed in this study. Barriers to entry are low because the production technology is simple with small plant sizes relative to the size of the market. In addition, the third and fourth largest firms in the industry had low financial leverage and both gained market share. The increases in output documented in the gypsum industry are consistent with firms adopting riskier production strategies and expanding output, as models by Brander and Lewis (1986) and Maksimovic (1988) predict. These changes are not consistent with increased predatory behavior of rival firms that the deep purse models predict, as the recapitalizing firms also increase their output.

Results from the examination of the relationship between executive compensation and firm performance show that changes in executive compensation are significantly related to changes in shareholder wealth after, but not before, the recapitalizations. Prior to the recapitalization average executive compensation increases 6.4 cents for each $1,000 increase in shareholder wealth. Following the recapitalization average executive compensation increases 57.1 cents for each $1,000 increase in shareholder wealth. Results including share ownership also show a similar significant increase in the association between compensation and shareholder wealth following the recapitalization. Sales growth is significantly associated with changes in executive compensation before, but not after, the recapitalizations. Combined with the product market results which show that industry output is affected by capital structure, these results lend support to the hypothesis that managers had incentives to increase sales prior to the recapitalization and that managers' incentives to maximize shareholder returns have increase following the recapitalizations. Overall, the product market tests combined with simple market share statistics and compensation tests serve to illustrate the industry adjustments and the interaction with capital structure that are occurring in these industries.

The results are consistent with firms' output behavior and margins varying with the increased debt ratios. Results suggest that industry structure, which

includes rival firms' financial leverage and the ease of expansion and entry into the industry, as well as input use and total factor productivity discussed in previous studies of leveraged buyouts, is important for understanding the sources of observed *ex post* changes in firms' cash flows following recapitalizations. Future questions to be addressed include an investigation of entry, expansion, and exit decisions in industries with firms with high financial leverage.

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