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CAPITAL STRUCTURE AND PRODUCT MARKET BEHAVIOR: AN EXAMINATION OF PLANT EXIT AND INVESTMENT DECISIONS

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CAPITAL STRUCTURE AND PRODUCT MARKET BEHAVIOR: AN EXAMINATION OF PLANT EXIT AND INVESTMENT DECISIONS

Abstract

This paper examines whether capital structure decisions interact with product market characteristics to influence plant closing and investment decisions. The empirical evidence in this paper shows that a firm's capital structure, plant level efficiency, and industry capacity utilization are significant determinants of plant (dis)investment decisions. We find that the effects of high leverage on investment and plant closing are significant when the industry is highly concentrated. Following their recapitalizations, firms in industries with high concentration are more likely to close plants and less likely to invest. In addition, we find that rival firms are less likely to close plants and more likely to invest when the market share of leveraged firms is higher.

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Capital Structure and Product Market Behavior:

An Examination of Plant Exit and Investment Decisions

1. Introduction

The interaction of capital structure decisions and product market behavior has become a growing area of research in both economics and finance.[1] This paper adds to this literature by examining whether capital structure decisions interact with plant closing and investment decisions after controlling for product market characteristics. We use plant-level data from the Longitudinal Research Database at the Bureau of the Census to examine whether factors predicted to be important in the finance and industrial organization literatures affect the plant closing and investment behavior of leverage increasing firms and their rivals. In addition to capital structure, factors we examine include industry variables, such as capacity utilization, demand and demand variability, and market concentration, and firm variables, such as market share and direct measures of plant level productivity.[2]

We examine ten industries in which at least one of the top four firms recapitalizes using a large discrete change in capital structure through a leveraged buyout or recapitalization. Our results show that a firm's capital structure, plant level efficiency, and industry capacity utilization are significant determinants of a firm's plant level investment and disinvestment decisions. As might be expected, high capacity utilization is positively associated with firm investment and negatively associated with plant closings. We also find a significant negative association between total factor productivity and plant closings, providing evidence that firms closed relatively less efficient plants. Total factor productivity is also positively associated with firm investment. This provides evidence that firms increase their investment in their most productive plants. The high significance of these variables in explaining closing and investment decisions underscores the importance of controlling for productivity and capacity utilization when examining capital structure changes.

Market structure has important implications for the effect of debt. High debt by itself, when controlling for productivity and market structure, is not significantly related to closure and investment. The effect of high leverage on investment and plant closing is significant when the industry is highly concentrated. Following its recapitalization, a firm in an industry with high

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[1] Theoretical articles include Brander and Lewis (1986, 1988), Maksimovic (1988), Poitevin (1989) and Bolton and Scharfstein (1990). Empirical articles include Chevalier (1995) and Phillips (1995). Kovenock and Phillips (1995) examine how to reconcile theory and evidence.

[2] Jensen (1993) has recently drawn attention to the importance of financial factors, productivity and capacity utilization to the exit decision in his 1993 AFA presidential address.

concentration is more likely to close plants and less likely to invest. In addition, rival firms are less likely to close plants and more likely to invest when the market share of leveraged firms is higher. Our paper also attempts to control for the fact that debt choice is endogenous. We estimate a first stage regression using lagged values of firm specific and industry variables to predict whether or not a firm recapitalizes and replace the recapitalization variable with its predicted value.

These results augment previous findings for firms with high debt by Kaplan (1989), Lichtenberg and Siegel (1990), and for firms in an industry setting by Chevalier (1995) and Phillips (1995).[3] Kaplan shows that firms that undergo management leveraged buyouts experience higher operating cash flows and decrease capital expenditures relative to their competitors. Our results add to Kaplan's by linking the closure decision to both leverage and market structure. Also, while Kaplan focuses on firm-level capital expenditures, we are able to look at more detailed investment decisions and control for confounding factors such as plant-level productivity and industry capacity utilization. Lichtenberg and Siegel (1990) use Census data to examine plant-level productivity. However they do not consider capital structure interactions with product market behavior. They examine a balanced sample of manufacturing plants without considering industry structure and decisions such as exit and investment. This study adds to Lichtenberg and Siegel by examining actual closing and investment decisions controlling for productivity, industry demand and market structure.

Chevalier (1995) examines the exit decisions of firms in an intra-industry setting in the supermarket industry. This work extends Chevalier by examining 10 different manufacturing industries and by considering the influence of capacity utilization, market structure and plant-level efficiency on investment and closing decisions. In her study of the supermarket industry, Chevalier finds that unleveraged firms are more likely to open stores and less likely to exit in markets where competitors have recently experienced a leveraged buyout. Chevalier controls for demand differences in multiple markets but does not consider differential efficiency or capacity utilization as factors that influence the closure decision.[4] We construct two different measures of plant level efficiency: total factor productivity and relative plant scale. We also calculate market concentration variables and include direct measures of capacity utilization by industry.

[3] The distinction between capital structure decisions made in a single firm setting and in an industry equilibrium setting is the focus of the recent survey article by Maksimovic (1995).

[4] A recent paper by Zingales (1995) examines *firm* exit in the trucking industry after deregulation. He finds that exit is more likely by financially constrained firms in the industry. Zingales' analysis does not include industry factors such as capacity utilization, and does not distinguish between capacity that changes ownership and capacity that leaves the industry. He does not find as strong an affect of productivity on exit with trucking data.

This work augments Phillips (1995) by considering individual firm investment and plant closing decisions. Phillips examines price and quantity at the industry level subsequent to increases in leverage in 4 manufacturing industries. Finally, these results on how financing decisions interact with product market decisions add to the evidence in industrial organization which has analyzed exit decisions without considering financial structure.[5,6]

Our results shed light on the accuracy of several theoretical predictions appearing in the literature on the direct and strategic effects of capital structure changes on firm behavior. Capital structure affects a firm's behavior directly because it can influence contracting and alter the distribution of cash flows between claimants, as well as convey information about future investment. One prominent theory, most commonly associated with Jensen (1986, 1993), argues that reducing retained earnings and free cash flow by increasing debt payments forces firms to raise money from external capital markets and helps to alleviate the agency problem associated with the allocation of internal funds. According to Jensen, in the 1980s leveraged acquisitions and buyouts were instrumental in helping to eliminate excess capacity caused by demand shocks and changes in productivity. Debt facilitated disinvestment.

The strategic product market effect of leverage, or the effect of a firm's capital structure on its strategic interaction with its rivals, has recently received attention in the industrial organization literature (see Brander and Lewis (1986, 1988), Maksimovic (1988), Poitevin (1989), and Bolton and Scharfstein (1990)). While the predictions of these models vary with the particular underlying assumptions chosen, one prominent model in this genre is the limited liability model of Brander and Lewis (1986). In the most popular version of this model a firm's unilateral increase in debt would increase its own investment and reduce rival investment. Increased debt causes a firm to behave aggressively and its rivals passively.

[5] Theoretical articles which examine plant exit in industrial organization include Ghemawat and Nalebuff (1985, 1990), Reynolds (1988), and Whinston (1988). Empirical articles on exit in industrial organization include Lieberman (1990) and Hayes (1992). These articles consider the strategic role of firm size in determining exit when demand declines.

[6] Other related *non*-strategic papers include Kim and Maksimovic (1990), Schary (1991), Long and Ravenscraft (1993), and DeAngelo and DeAngelo (1991). Kim and Maksimovic (1990) consider how a firm's input use is associated with input prices, debt, and firm specific operating characteristics. Schary (1991) tests whether financial characteristics were a determinant of exit in the cotton textile industry in the 1920s and 1930s. Financial structure was not found to be important in her study. However, firms were not identified as having any sharp changes in financial structure and changes in market structure were not investigated. Long and Ravenscraft (1993) use Census data to study post-LBO changes in performance for a comprehensive sample of LBOs. DeAngelo and DeAngelo (1991) focus on real business decisions in a single industry. They examine how the domestic steel industry restructured because of excess capacity, providing evidence on how reported losses, managerial pay cuts, and layoffs were associated with future union concessions.

Our results provide support for the view that increasing the share of debt in a firm's capital structure is associated with more passive investment behavior by recapitalizing firms. This appears to provide some evidence in support of Jensen's claim that debt helps alleviate overinvestment within the firm. However, the capital structure change variables are only significant when interacted with market concentration. The importance of this interaction between concentration and increased debt points to an effect working through market structure that is absent in the Jensen analysis. One possibility is that the agency problems emphasized in the Jensen thesis are more prevalent in concentrated industries (see Leibenstein (1966)). In perfectly competitive industries product market competition should be sufficient to weed out firms with agency problems.

The significance of the concentration-debt interaction term on own investment and plant closing and the effect of high debt on rival investment and plant closing indicates the importance of strategic considerations. On the one hand, investment expansion by rivals may reduce the benefit of debt, emphasized by Jensen, in facilitating the efficient industry adjustment to new demand conditions. From a private and public policy perspective these strategic reactions need to be incorporated in any cost- benefit calculation. At the same time it is clear that several of the more prominent models addressing the strategic effects of debt are not capturing the salient features of increased leverage. In particular the predictions of the Brander and Lewis (1986) limited liability model are inconsistent with the evidence.

This paper is organized as follows: Section 2 presents the factors, including capital structure, considered in empirical work to be potential determinants of plant investment and exit, and summarizes the theory describing their effects. Section 3 describes the data and the industries in this study. Section 4 presents the empirical results and indicates directions for future empirical work. Section 5 concludes.

2. Theoretical models of investment and exit

This section reviews the models which predict the important factors influencing a firm's investment decision and the decision to close down a plant. The focus is on both how capital structure directly affects the closure and investment decision and how other factors interact with capital structure to influence a firm's decision. We classify these theoretical models into 3 categories. First, we consider the direct and strategic effects of capital structure. Second we consider plant productivity and capacity utilization. Third, we consider models of how market structure, demand and demand changes influence investment and plant closing.

Before proceeding it should be emphasized that, in relating our evidence to theory, the choice of industries examined in this paper is based on the criterion that at least one of the four largest (by sales) firms experienced a discrete increase in debt through a leveraged buyout or public recapitalization - further emphasizing that capital structure is a choice variable by firms. Thus we do *not* select industries that are necessarily characterized by having firms in economic distress.[7] We do not select firms that have high leverage and decreased equity values because of *poor* product market performance. To attempt to control for the fact that debt choice is endogenous, we estimate a first stage regression using lagged exogenous instruments to predict whether or not a firm recapitalizes and replace the recapitalization variable with its predicted value.

The question that this approach attempts to answer is whether the cash flows are actually affected by capital structure or whether an contemporaneous shock changes investment cash flows at the same time as it makes a certain capital structure the lowest cost way to finance the investment. Our first-stage regression predicting whether or not a firm recapitalizes removes the possibility that we are capturing a contemporaneous shock that causes a firm to recapitalize. In our predicted capital structure regression we follow Kovenock and Phillips (1995) by using lagged variables that capture existing industry and firm conditions. The significance of the variables reported in Kovenock and Phillips in predicting the firm's recapitalization demonstrates that capital structure is a response to productivity and market structure conditions.

2.1. Capital structure

Direct effect of capital structure

As noted by Harris and Raviv (1991) and many other authors, capital structure can affect investment because it changes the allocation of cash flows among claimants and conveys information about investment opportunities. One prominent story illustrating a direct effect of capital structure is Jensen's (1986, 1993) argument that information and contracting problems between implicit or explicit claimants to the firm can make the disinvestment decision difficult for managers. Debt or debt-like instruments reduce free cash flow that may have been allocated to inefficient investments and helps align managerial incentives with those of stockholders. Investment and exit decisions would thus more likely reflect current demand conditions and productivity.

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[7] See Ofek (1993) and Opler and Titman (1994) for analysis that specifically examines firms that are in financial distress.

This disinvestment hypothesis is one of the hypotheses addressed with our evidence. Its empirical implications are that increases in debt would be associated with a reduction in own investment and an increase in the incidence of own plant closings. As formulated by Jensen, the theory appears to say nothing about how rival behavior might be related to a firm's debt choice.

Strategic effect of capital structure

In addition to the effect on own closing and investment decisions, capital structure may affect rivals' decisions. If capital structure changes represent credible commitments to alter plant closing or investment behavior, rival firms may also change their closing or investment 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 represent at least 25% of the market, a change in the leveraged firm's output is likely to have effects on other firms' production decisions if these models have any relevance.

We identify and explore two different classes of models of strategic interaction. The first emphasizes the limited liability effect of debt financing. In this model, highly leveraged firms have an incentive to take strategies which increase the risk of the firm given that equity is a residual claim. The second class of model emphasizes strategic investment effects of debt finance.[8]

The limited liability effect of debt financing was developed by Brander and Lewis (1986). Brander and Lewis consider a two stage game in which debt levels are chosen in the first stage to maximize firm value and output is chosen simultaneously in the second stage to maximize the return to equity. At the second stage demand is still uncertain, so output choice affects the probability of default. Due to the limited liability enjoyed by equity, a unilateral increase in debt in this model leads to an output strategy that raises returns in good states and lowers returns in bad states. Under the assumptions of the "normal" case of the Brander and Lewis model this will lead to an increase in the output chosen by the leveraged firm for each level of output of the rival firm.[9] That is, the leveraged firm's quantity best response function shifts up. Because quantity best response functions are downward sloping this leads to an equilibrium reduction of the output of the rival in the quantity setting subgame. As a result of this strategic effect, each firm would like to precommit to a high debt

[8] In Kovenock and Phillips (1995) we also examine the implications of a set of models known as strategic bankruptcy models. We do not examine the implications of these models in this paper.
[9] In the alternative case considered by Brander - Lewis, where marginal profits are lower in better states of the world, neither firm will want to have a positive level of debt.

level, leading to a prisoner's dilemma in which positive debt levels arise in equilibrium and output is greater than in the absence of debt. Profits are also lower than would exist in a world without debt financing.

The empirical implications of the Brander-Lewis limited liability model depend on the interpretation that is given to investment. A common interpretation of quantity setting models is as a reduced form for a choice of scale of capacity that determines the firms' cost functions and the conditions of price competition (see, for instance Shapiro (1989), Tirole (1988, p 217), Allen, Deneckere, Faith, and Kovenock (1994)). Using this interpretation, quantity adjustment in the Brander-Lewis model may be equated with scale or capital adjustment, i.e., investment. Hence, a firm's unilateral increase in debt would have a positive effect on its own investment and a negative effect on its rival's investment. Own profits would increase and rival profits decrease. Moreover, these effects are predicted whether the increase in debt is an equilibrating response to previous adjustments in leverage on the part of rivals, or whether it is an initial move which in turn will trigger response.

A second approach to the strategic effect of debt finance is to focus on the firm's ability to invest. We label this approach the "strategic investment effect." Underlying the strategic investment effect of debt finance is the pecking-order model of finance as in Myers (1984), in which internally generated funds are less costly to the firm than externally generated funds. As noted by Kovenock and Phillips (1995), the relevance of the strategic investment effect is based on the belief that in most tight oligopolies the question of whether investments can be internally financed or must be externally financed is much more likely to be relevant that the decision to default on debt.

There are several ways to model strategic investment effects. Generally, in this class of models debt acts as a way to strategically surrender future investment opportunities. Kovenock and Phillips (1995) detail how this effect might work in a model with profit maximizing firms that engage in price competition with goods that are imperfect substitutes. In this class of models debt causes own investment to decrease and rival investment to increase. The same result would occur with quantity setting firms (interpreting output as capacity), but own firm profit would be lower than in the absence of debt. Hence we would not expect firms to issue debt, unless other effects, such as the direct agency effects described by Jensen play a role. In Kovenock and Phillips, increasing debt payments in low demand states increases the cost of investment and helps alleviate an over-production problem. The result is higher profits for both firms, higher investment for the rival firm and lower investment for the high-debt firm.

2.2. *Plant-level productivity and capacity utilization*

Jensen (1993, p. 833) argues that "Technological and other developments that began in the mid-twentieth century have culminated in the past two decades in ... rapidly improving productivity, the creation of excess capacity and, consequently, the requirement for exit." Other authors have also examined the influence of capacity utilization and productivity. A recent study by Bresnahan and Raff (1993) shows that technological heterogeneity in the auto industry in the 1930s was important in determining survival probabilities. Those plants that adopted production line techniques and had larger fixed sunk capital had higher survival probabilities when faced with the strong decline in demand in the Depression. In addition to examining capital structure, we thus examine the influence of these primary factors, plant level productivity, plant size, and industry capacity utilization, on plant-level investment and the exit decision.

We calculate several different measures of plant-level productivity to examine whether low productivity plants were indeed more likely to be closed in these industries. We follow the procedure used by Lichtenberg and Siegel (1990) with several adjustments to construct a measure of productivity called total factor productivity, or TFP. Our calculations of TFP are described in the data appendix to this paper. TFP is also described extensively in Caves and Barton (1990). Unlike Lichtenberg and Siegel we do not require a balanced sample of either firms or plants for the examination of investment and closing decisions. Using a balanced sample, requiring that a plant is present for all survey years, potentially introduces a severe source of sample selection bias. New plants or old plants that close are thus not excluded from our sample. We calculate TFP using alternative production functions and construct two other measures of productivity - relative labor productivity and relative plant scale.

2.3. *Industry Market Structure, Demand and Demand Uncertainty*

Several studies have examined plant-level exit from a strategic management and an industrial organization perspective. Harrigan (1980, 1988) and Harrigan and Porter (1983) examine the exit decision from a strategic management perspective. They propose that conditions of competition, uncertainty, demand changes, durable and specialized assets, and managerial resistance are important factors in the exit decision. They focus on specific strategies, "Niche", "Harvest" or "Quick Divestment" that businesses can use when faced with declining demand based on their competitors' sizes, costs, and exit barriers.

Ghemawat and Nalebuff (1985, 1990), Reynolds (1988) and Whinston (1988) offer more formal models of the exit decision. Ghemawat and Nalebuff (1985) examine who exits first in a declining demand industry in which a firm's production equals its total capacity or zero. They show that smaller firms will be the last to exit when faced with declining demand. Smaller firms can remain profitable longer, covering their smaller capacity costs with smaller unit volumes. Using a simulation, they conclude that large firms may require substantial scale economies in order to reverse this finding.[10] Whinston shows that the existence of multiplant firms can reverse this prediction. With multiplant firms no strong prediction emerges. Who exits first depends on a number of market structure factors, including the size of the firms, the number of plants per firm, and the number of firms. Reynolds (1988) and Ghemawat and Nalebuff (1990) analyze the exit decision when capacity is retired incrementally. They find that when demand declines, larger firms reduce capacity over time, until they reach the size of smaller firms.

Lieberman (1990) examines the importance of plant size in declining industries to see whether smaller plants will be "shaken out" because of a lack of economies of scale or whether they can "stake out" a portion of the market by credibly threatening to outwait larger plants in a declining industry. He finds that plant size and whether the plant is part of a multiplant firm are both important in explaining plant closure. Hayes (1992) also finds that firm size is a crucial determinant of exit in retail industries; the largest firm in a market is 60% as likely to exit as the third largest firm.

The finance literature has emphasized the role of demand uncertainty in investment and exit decisions. Brennan and Schwartz (1985), McDonald and Siegel (1986), Pindyck (1988), and Dixit (1989) examine the importance of output price uncertainty and the irreversibility of investment decisions. They show that when firms are faced with stochastic output prices, initial investment decisions and plant closing decisions will be different from the decisions under perfect certainty. An increase in output price uncertainty will cause the optimal investment time and the optimal plant closing time to be at a later date. Irreversibility of investment will cause the optimal stock of capital to be lower. The intuition for these results comes directly from option theory. If investment and closing decisions are irreversible exercise decisions on perpetual options, an increase in uncertainty increases the optimal exercise date and increases the value of the option to close or invest.

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[10] Hunsaker and Kovenock (1994) show that this conclusion is sensitive to assumptions on the mode of competition, the functional form of demand, and the path of demand decline.

Brennan and Schwartz (1985) provide a general analysis of the effect of uncertainty of output prices on investment and closure decisions with an application to a copper mine. They examine the decision to open or close a mine when each decision bears a cost. They explore the effect of increasing uncertainty on both decisions. We take the view that this option to close is not costless and there is a cost of investment similar to that in Brennan and Schwartz. Pindyck (1988) also focuses on the effect of irreversibility on investment, developing predictions for the optimal stock of capital. Investment in the Pindyck model is sunk and cannot be recovered. The more volatile demand is, the greater the value of the option to invest. The prediction of the Pindyck model is that the firm's optimal capital stock decreases as uncertainty increases, holding the level of demand constant. Our paper does not attempt to estimate real option models, but rather tests whether demand and the variance of output prices in these industries influence investment and plant closing decisions.

3. Data and Sample Selection

3.1. Investment and Capital Structure Data

The first part of our study is an analysis of the plant closing decisions of both firms that increase their debt financing *and* their industry rivals. Following the examination of plant closing decisions, we examine investment decisions. We examine which firms invest, including all firms, thus not requiring a balanced sample and avoiding survivorship bias. In this study we examine three classes of variables: (1) variables capturing the capital structure changes by firms and the share of industry output that is produced by high financial leverage firms, (2) variables which capture relative plant efficiency, such as plant scale and total factor productivity, and (3) variables which capture market structure and industry demand conditions - including market share changes, 4 firm market share indexes, industry capacity utilization and change in the demand of industries using the products of these firms.

We examine exit and investment decisions using data from the Longitudinal Research Database[11] (LRD), located at the Center for Economic Studies at the Bureau of the Census. The LRD database contains detailed plant-level data on the value of shipments produced by each plant, investment broken down by equipment and buildings, and the number of employees. Plant-level data

[11] See McGuckin, Robert H. and G. Pascoe, (1988). The Longitudinal Research Database is unique in that it contains the underlying plant-level micro-data that is released in aggregate form in the Annual Survey of Manufacturers and the Census of Manufacturers. All work must be done on cite at the Census Bureau in Washington, D.C. as the individual plant data used in this study is confidential.

is aggregated to the firm level to examine investment decisions. In addition to the detailed plant-level data, there are several other advantages to this data. First, the database covers both public and private firms in the manufacturing industries. Second, coverage is at the plant level and the output is assigned by plants at the 4 digit industry SIC code. Thus, firms that produce in multiple SIC codes are not assigned to just one industry. Third, coverage at the plant level allows us to track plants even as they change owners. Fourth, the database identifies when plants are closed and not merely changing ownership.

The LRD covers approximately 50,000 manufacturing plants every year in the *Annual Survey of Manufactures (ASM)*, the database we utilize. In the ASM, plants are covered with certainty if they have greater than 250 employees, smaller plants are randomly selected every fifth year to complete a rotating 5 year panel.[12] We confine our analysis to 1979 - 1990. We use 1979 as the starting year of our analysis because it is the first year of one of the 5 year panels and, secondly, because it allows us to include several years before the first of our capital structure changes. 1990 is the last year of data available at the time the analysis was undertaken.

We also examined whether plant openings are significant relative to closures for the industries examined in this study. There were 23 explicitly identified openings in the ASM versus 512 plant closures. We also examined the full quinennial 1982 Census of Manufactures to check the relative magnitude of plant closures versus openings in the full population of plants for the United States. In the 1982 Census of Manufactures there were 28 plant openings and 132 closures for the 10 industries in this study. Of these plants, 6 of the openings and 75 of the closures were in the 1982 Annual Survey of Manufactures. Given this finding of a much smaller number of openings versus closures in the data, both in the LRD and in the 1982 Census, only closures are analyzed. We did not count as a closure or opening cases in which a firm both closed and opened a plant in the same or subsequent years.

3.2. Industry Selection

We identified ten industries for this study: broadwoven fabrics, mattresses, paper products, polyethylene, flat glass, fiberglass, gypsum, car and consumer batteries, and tractor trailers. We

[12] For the industries in this study, the 1982 Annual Survey of Manufactures comprised a total of 1879 plants, with a total value of shipments of 73.879 Billion dollars. The 1982 Census of Manufactures (CM) comprised 4099 plants with a total value of shipments of 82.958 Billion dollars. Thus, the ASM represents 89% of the total value of shipments in the CM. Both the Annual Survey and the Census cover public and private firms.

identified increases in debt that have occurred because of discrete events, including leveraged buyouts, management leveraged buyouts and public leveraged recapitalizations.

The 10 industries selected for this study satisfied the following three criteria: 1.) The industry has to have had significant financial recapitalizations either through leveraged buyouts or public leveraged recapitalizations. An industry is defined as having a firm with a major recapitalization if at least one of the top four firms (in market share) in the industry has had an increase in debt of at least 25 percent through either a leveraged buyout or a leveraged recapitalization. This criterion increases the possibility that capital structure interactions can be identified. 2.) The industry has to produce commodity products. An industry is defined as a commodity industry if the products are easily compared across producers.[13] This criterion reduces the problems of defining the scope of the market in which the firms interact and reduces issues of product differentiation. 3.) The industry has to be a manufacturing industry (SIC code between 2000-3999). The LRD plant-level data that we are using for this study are only available for manufacturing establishments.

The industries and firms involved in recapitalizations were identified by first finding firms that were involved in leveraged buyouts, management buyouts, or leveraged recapitalizations. To identify the leveraged buyout (LBO) and management buyout (MBO) firms we examined the Wall Street Journal Index and also used two lists of LBO firms used in Opler (1993) and Rodin (1992). The public recapitalizations were identified using COMPUSTAT, Securities Data Corp. (SDC), and the WSJ Index to find firms that paid out large cash dividends by increasing the debt in their capital structure. We identified 40 firms that recapitalized using LBOs and public recapitalizations in the industries examined in this study. The choice of relatively homogeneous product industries enables us to examine plant and firm level investment for specific products and match price and demand data from other sources such as the Federal Reserve Board and the Bureau of Labor Statistics.

3.3. *Methodology and Variable Selection*

We first estimate logistic regressions to identify factors that influence plant closings. The dependent variable equals one if the firm closed a plant in a given year. The independent variables capture the firm and market conditions for each of the years for the firm and the industry. The equations are estimated using 12 years of data from 1979 to 1990, allowing varying observations per

[13] This criterion was applied using the authors' judgment at the start of the analysis. No industry was dropped subsequent to the start of the study.

firm. As discussed in the theory section, in addition to variables capturing the capital structure changes, we include variables which capture plant level efficiency, capacity utilization, and market structure. We also estimate the equations using a random effects panel probit model (see Chamberlain (1984)). This model allows a firm specific random effect, as well as varying observations per firm, (for unbalanced panels see Hsiao (1986)). It has the advantage over a logit model in that the random effects probit model allows for general residual serial correlation. The disadvantage with the probit model is that there are specific distributional assumptions based on the normal distribution (see the discussion in Chamberlain (1984), pp. 1270-1282).

We also estimate limited dependent variable and Tobit censored regressions models to examine the factors that influence a firm's investment decisions. For the logistic regressions we code the dependent variable as one if the firm increases its capital expenditures by 5 percent in a given year. We estimate the regressions using a limited dependent variable for two reasons. First, observed investment is truncated at zero, as we do not observe disinvestment except for plant closure. Second, given that we scale the investment by net book value of the plant's assets, large investments by firms which begin the year with a small capital stock make this variable have very skewed positive values. Coding all values greater than a given cutoff as equal to one reduces the extent of this problem. We also estimated the model using 10 percent as a cutoff value and found the results to be similar to those using a 5 percent cutoff. We also estimate the investment equations using a Tobit censored regression model. The dependent variable is defined as investment in machinery and buildings divided by beginning of period book value of assets.

We include three broad classes of independent variables. First, we include variables that capture the capital structure changes. We identify the changes in financial structure and the market share of leveraged firms. The financial structure variables include the market share of highly leveraged firms, less own market share if the firm itself is highly leveraged, and a dummy variable that indicates whether the firm is highly leveraged as a result of a leveraged buyout or public recapitalization. In addition, to attempt to control for the fact that debt choice is endogenous, we estimate a first stage regression to predict whether or not a firm recapitalizes using exogenous lagged instruments and replace the debt change variable with its predicted value. Our first-stage regression predicting whether or not a firm recapitalizes removes the possibility that we are capturing a contemporaneous shock that might cause a firm to recapitalize. In our predicted capital structure regression we use variables that capture existing industry and firm conditions using the specification of Kovenock and Phillips (1995). The significance of these variables in predicting a firm's recapitalization demonstrates that capital structure is a response to productivity and market structure conditions. Lastly, a variable is included that interacts the own high leverage variable with the 4 firm market share index.

The second class of variables captures average plant level efficiency for each firm. We calculate relative plant scale for each firm and two measures of plant level productivity. A related question that this data allows us to address is whether inefficient plants close and whether the firms with relatively efficient plants increase investment in the face of changes in industry demand conditions and capital structure changes. The plant scale variable is calculated as plant capital stock divided by average industry capital stock. The two measures of plant level productivity we investigated are relative labor productivity and total factor productivity (TFP). Relative labor productivity is calculated as output per worker divided by average industry output per worker at the plant level. TFP is calculated using a regression based approach similar to Lichtenberg and Siegel (1990). The variables used in the calculations are described in the data appendix. To calculate TFP we have to make an assumption about the production function of the firm. We assume that the production function is Cobb-Douglas. The Cobb-Douglas form's advantage over merely calculating the factor share of each of the inputs is that it does not impose constant returns to scale. It is a fairly flexible form of the production function but does assume that there is constant elasticity of substitution. We also calculated TFP using a translog production function which relaxes the restriction of constant elasticity of substitution. The Cobb-Douglas form is as follows:

$$Q_{it} = A_i * L_{1it}^{a_{1i}} L_{2it}^{a_{2i}} \dots L_{Nit}^{a_{Ni}};$$

where Q_{it} represents output of plant i, in year t, the quantity $L_{jit}^{a_{ji}}$ (j=1,...,N), denotes the quantity of input j used in production for plant i, in period t. A_i represents a technology shift parameter, assumed to be constant by industry, 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.

We take the log of this production function and run a regression of log (total value of production) on log (inputs). The difference between actual shipments and predicted shipments is our measure of TFP. It is a relative measure of productivity - thus average TFP for an industry will be zero. The Census data has detailed information on inputs that the firm uses to produce its output. These inputs and how we account for inflation and depreciation are described in the appendix.

The third class of variables we include captures market structure, demand and demand changes. We include variables which measure the market structure of the industry, the size of firms and the number of plants per firm. For market structure, we include the market share of the top four producers and the firm's market share. We lag the market share variable to capture the beginning period concentration faced by a firm. Including end of period market structure would incorporate the result of closing and production decisions.

These variables allow us to test the hypothesis that capital structure is a strategic choice variable that affects competition among firms in an industry. This is an alternative but not mutually exclusive hypothesis to the capacity adjustment hypothesis advanced by Jensen (1993), which does not consider an effect on competitors. The market share variables combined with the efficiency variables allow us to examine whether plant closings result in the survival of more efficient firms and whether market shares change in the same direction as average efficiency changes in the industry.

For demand variables we include capacity utilization, the variance of the output prices, and the change in demand. This class of variables allows us to examine the conjecture advanced recently by Jensen (1993) that there has been a failure of firms to adjust to broad structural shifts in demand and technology causing excess capacity to exist in many industries. To provide some evidence on this hypothesis, we include capacity utilization at the 4-digit SIC code. The capacity utilization number is calculated based on *The Annual Survey of Capacity Utilization,* a publication of The Bureau of the Census. The capacity utilization measure we use from this survey represents output as a percentage of normal full production.[14] The external demand variables are from the Survey of Current Business and represent demand indices for *the user* of the industry's product. These demand indices vary by industry and were selected to correspond as closely as possible to a demand proxy for that industry. For example, for the gypsum industry we use the level of new residential and commercial construction, for the tractor trailer industry we use shipments of new manufactures, and for chemicals used in plastics we use auto production.

We include the variance of output prices to capture the stochastic nature of demand prices that is predicted to affect investment and plant closing by Brennan and Schwartz (1985), McDonald and Siegel (1986), Pindyck (1988), and Dixit (1989). Output price data by industry is obtained from the Bureau of Labor Statistics. We use the data at the disaggregated 7 digit SIC code product level.

[14] The procedure the Census uses to calculate capacity utilization changed in 1989. We did not attempt to adjust the pre-1989 numbers but assume that the relative differences across industries are not affected greatly.

These are available monthly over the period of time we consider. To get a measure of the product price variance we use 24 months of data, 12 months of lagged data and 12 months of leading data. It is therefore calculated using a time-series of data for each product, and thus does not represent a true cross-sectional variance. Assuming that prices are from a stationary distribution, it should provide a good proxy for output price uncertainty.

4. Results

In this section we present our results on plant closing and firm-level investment decisions of both recapitalizing firms *and* their rivals following sharp increases in debt financing. Table 1 provides statistics for the firms and plants examined in our analysis, including the number of plants and firms in the year before the recapitalizations. We also present average total factor productivity (TFP) measures for closures. TFP is a relative measure of productivity and is calculated for each industry separately at the plant level, thus the average productivity measure across an industry is zero. Our calculation of TFP using a translog production function revealed that for nearly every industry the coefficients on the additional second-order cross product terms were not significantly different from zero - thus we maintain the Cobb-Douglas specification.

Table 1 goes here.

Table 1 shows that average TFP of all the plants was not significantly different in the two samples. For each of the sets of closures, average TFP was significantly lower than the average industry plant's TFP. Average TFP for closures of the non-recapitalizing firms was -.2061 with a standard error of the mean of .0284. The average TFP for closures of the recapitalizing firms was -.260, with a standard error of the mean of .0655.

4.1. Plant Closure Decisions

Table 2 presents summary statistics by individual industries. We present both the number of firms and the number of plants they operated in 1979. The number of plant closures over 1979-1990 and their total factor productivity are also presented for each industry.[15]

Table 2 goes here.

[15] In compliance with government disclosure restrictions, we are prohibited against presenting any individual firm statistics from the LRD. This prevents us from presenting TFP statistics by industry for the plant closures of the recapitalizing firms.

The summary statistics by industry reveal several interesting results. First, plant closures represent a fairly large fraction of the total number of plants operating in 1979. Second, the productivity measure for all plants closed is significantly negative. Finally, the plants closed by high debt firms were of lower average productivity than the industry plants, and in all but two of the industries, were of lower average productivity (though not significantly so) than the plants closed by non-recapitalizing firms.

Table 3 estimates a logistic dependent variable regression to examine plant closing decisions. We aggregate all plant level variables to the firm level. For productivity, however, we use the productivity level for the firm's least productive plant the firm. Logistic limited dependent variable regressions are estimated to examine the factors which are associated with plant closing decisions for both recapitalizing and non-recapitalizing firms. The results are estimated using an unbalanced panel. This approach does not throw out firms which do not have an observation for each of the 12 years, thus avoiding a survivorship bias - especially important for the investment analysis.[16] In the plant closure analysis, the dependent variable equals one for a firm which closed at least one plant in that year. In the second logit specification we lag the TFP productivity variable, in order to control for the potential problem of low contemporaneous productivity caused by the decision not to upgrade a plant that the firm plans to close. The third logit specification in Table 3 includes the predicted capital structure change variable which is calculated using 2 lags of capacity utilization and industry price variance, one lag of productivity, firm size, industry concentration and the change in industry demand.

Table 3 goes here.

Results from the analysis of plant closings presented in Table 3 indicate that industry capacity utilization and plant productivity are negatively associated with plant closings. The demand growth variable shows that plants are less likely to be closed when industry growth is high. The coefficient on the 4 firm market share is negative and significant. Plants are less likely to be closed in industries with high market share by the top 4 firms. The coefficients on the variables capturing firm size and plant scale show that large plants are less likely to be closed, as the plant scale variable is negative and highly significant. The coefficient estimate on the number of plants is positive and significant, a finding which might not be surprising given the firm may have several older or more inefficient

[16] In Table 5 we present the estimation results from a random effects panel dataset model - allowing for firm specific random effects.

plants and chooses to close one given demand or efficiency considerations. This finding also supports the theoretical prediction by Ghemawat and Nalebuff (1990) that a firm with multiple plants will be more likely to close a plant down first.

The results showing the importance of capacity utilization and plant productivity provide empirical support for recent conjectures by Jensen (1993). The negative significant association between total factor productivity and plant closing decisions provides support for the claim that the relatively more inefficient plants were the ones being closed down by firms. Jensen claims that increased debt taken on by high debt firms is important in facilitating industry adjustment to new demand conditions. We find that debt is significantly related to closure decisions only in highly concentrated industries.

The variables capturing the capital structure changes show several interesting results. First, both of the dummy variables for the debt change and the predicted capital structure change are insignificant by themselves but positive and significant when interacted with the industry concentration index. These results indicate that the probability of a plant closing is higher in a concentrated industry when the firm has high financial leverage. Second, the variable capturing the effect on rival firms is significant. The total market share of highly leveraged rival firms has a negative coefficient in all regressions in Table 3. This variable excludes the firm's market share when it is also highly leveraged. This result is consistent with the conjecture that firms are less likely to close plants when large rival firms have sharply increased the debt in their capital structure

Table 4 indicates the economic significance of the logistic regression results. We compute probabilities of closing a plant holding all other variables besides TFP and debt interaction terms at their sample means. For the non-recap firms and the LBO and recapitalization firms probabilities are computed with the dummy variable equal to zero and one respectively. For the public recapitalization and LBO sample, the debt interaction term with concentration is evaluated at the mean of the concentration variable for this subsample. All other variables are evaluated at their overall sample means.

Table 4 goes here.

Table 4 shows that the probability of closure increases less than 1 percent as the productivity goes from the 90th percentile to the 10th percentile for the non-recapitalizing firms. For the recapitalizing firms the probability of closing increases from 4.48% to 6.42% as TFP decreases from the 90th to the 10th percentile. The probability of closing at the 10th percentile of TFP goes from

2.86% for the non-recapitalizing firms to 6.42% for the recapitalizing firms. Both of these results use the coefficients from the first logit regression. The second panel of Table 4 uses the coefficients from the 2nd logit regression. These probabilities incorporate both the debt variable and the debt variable interacted with concentration. These results show that the estimated models in Table 3 have a significant economic impact in addition to their statistical significance. Both productivity and concentration interacted with debt have a significant economic effect on plant closing.

Table 5 goes here.

Table 5 presents the results estimated using a random effects probit panel dataset model. This specification explicitly captures possible firm specific random components. It also allows for residual serial correlation which may be possible if firms make current decisions based on earlier period "errors". The firm size variable is excluded from these two specifications because the likelihood function did not converge with both a firm size variable and a firm random effect. The results of this model show that the signs and significance of the coefficients are very similar. The capital structure change variables remain insignificant by themselves and are only significant when interacted with the concentration index.

4.2. Firm-level Investment Decisions

This section examines the investment decisions of firms in the ten industries. Table 6 presents summary statistics for investment aggregated up to the firm-level. The table shows the average investment rates for each of the 5 TFP quintiles. Quintile 1 is thus the average investment rate for the least productive 20 percent of plants. Investment is measured as the expenditures on building and equipment divided by the average of beginning and ending plant assets. The standard error of the mean investment rate is in parentheses. Several facts stand out in this table. Without considering capital structure it is clear that total factor productivity is important in influencing firm-level investment. Investment rates are almost monotonically increasing in productivity. This finding remains when total factor productivity is lagged. Firms that are more productive invest more.

Table 6 goes here.

Table 7 presents logistic regressions and a Tobit censored regression that test whether productivity of the firm's plants and increases in debt affect the investment of the recapitalizing firms and other non-recapitalizing industry firms. As in Table 6, firms that have more productive plants invest more. The market structure variables are also highly significant. The number of the firm's plants and the firm market share are both highly significant. Firm market share has a negative coefficient indicating that larger firms are investing less (implicitly dis-investing). Productivity remains highly significant and positively related to investment throughout all specifications.

Consistent throughout, both in the logit and Tobit models, is a negative association between the firm's investment and the interaction between debt and market concentration. On the debt change variable by itself the evidence is mixed. For the first two logit specifications the coefficient on the variables identifying whether the firm recapitalized through a LBO or public recapitalization is significant and negative - indicating that high debt firms reduced their investment rate. However, in the logit specification 3, the distinction between the predicted and realized capital structure change is important. The predicted capital structure change variable is insignificantly related to investment. In the tobit specification the capital structure change variable, while negative, is insignificantly related to investment. Kaplan (1989) finds that LBO firms decrease their investment subsequent to the debt increase. Our results indicate that the negative affect upon investment is more significant in highly concentrated industries.

Also unexamined by Kaplan is whether firms that compete against LBO firms increase their investment subsequent to the increased debt of LBO firms. To investigate this issue we include a variable which measures the share of output by highly leveraged firms. We find a positive association between debt and rival firms' investment decisions. Investment is higher as the market share of the highly leveraged rival firms increases. This result is consistent and very strong across all specifications investigated. Unleveraged firms invest more when faced with a high debt rival.

Table 7 goes here.

These results are consistent with two different but not mutually exclusive theories. The results are consistent with decreased agency problems following the recapitalizations. As noted by Jensen (1986), agency costs may affect investment and the size of the firm as well as operating efficiency. Managers may have incentives to expand investment and sales beyond the optimal level. If the increase in financial leverage increases incentives for managers to maximize shareholder wealth or forces managers to pay out free cash flow to make interest payments, managers may change investment and sales. These results are also consistent with the firm committing to a less aggressive product market strategy by limiting its ability to invest in the future. A rival firm's incentive to expand will depend on the efficiency of its plants and the incentives of its managers. However, rival firms are more likely to invest when faced with high debt firms.

Table 8 presents the economic significance of the logistic regression results. We compute probabilities of investing more than the 5% cutoff, holding all other variables besides TFP and debt interaction terms at their sample means. For the non-recap firms and the LBO and recapitalization firms probabilities are computed with the dummy variable equal to zero and one respectively. For the public recapitalization and LBO sample, the debt interaction term with concentration is evaluated at the mean of the concentration variable for this subsample. All other variables are evaluated at their overall sample mean.

Table 8 goes here.

Table 8 shows that the probability of investing increases from 37.8% to 40.6% as TFP increases from the 10th to the 90th percentile. The probability of investing at the 10th percentile of TFP is 59.5% for the non-recapitalizing firms and 37.8% for the recapitalizing firms. The estimated recapitalization effect is to decrease the probability of investing by 21.7%. Both of these results use the coefficients from the first logit regression. The second panel of Table 8 uses the coefficients from the 2nd logit regression. These probabilities incorporate both the debt variable and the debt variable interacted with concentration. These results show that the factors detailed in Table 6 have a significant economic impact in addition to their statistical significance. Both productivity and concentration interacted with debt have a significant economic effect on investment.

Table 9 goes here.

Table 9 presents the results estimated using a random effects probit panel dataset model. This explicitly captures firm specific random components. Again this specification allows for residual serial correlation which may be possible if firms make decisions based on earlier period "errors". The results of this model show that the signs and significance of the coefficients are very similar to the non-random effects models. However, the capital structure change variables are insignificant for both the actual and predicted specifications. The interaction variable between capital structure and market concentration is only significant with the predicted capital structure change. Finally the variable, market share of leveraged rivals, which captures the effect on rival firms, is significant and positive.

4.3. Discussion of Results

We have identified two significant findings relating capital structure to firm plant closing and investment decisions. First, the association between recapitalization and the firm's likelihood of closing a plant is positive in highly concentrated industries. Second, there is a negative association between recapitalizations and the likelihood that a rival closes a plant. Similar results are also found when examining investment decisions. The association between high debt and investment decisions is negative when we interact the debt variables with the 4 firm market share variable. The significance of this interaction effect emphasizes the importance of considering market structure in explaining the effects of changes in capital structure.

Our results suggest that industry structure and capital structure are important in explaining post-recapitalization plant closing and investment decisions for both recapitalizing firms and their competitors. In highly concentrated industries, debt can be an important mechanism that changes the payoffs to plant closure and investment. Our results are consistent with models in which debt commits leveraged firms to behave less aggressively in product markets. Own investment decreases for highly leveraged firms and rival investment is positively associated with the increased debt. One potential justification is that debt acts to decrease agency costs in the form of inefficient overinvestment. Rival firms' closing and investment decisions are influenced as debt commits leveraged firms to decreased investment. As might be expected, plant level productivity and industry capacity utilization are positively associated with firm investment and negatively associated with plant closing decisions.

5. Conclusions

This paper provides an analysis of how capital structure choices and product market characteristics interact with investment and plant closing decisions. Explicit account is taken of changes in industry demand, plant level efficiency, market structure, and both actual and predicted capital structure changes. We empirically investigate product market behavior following major financial recapitalizations by firms that have had substantial discrete increases in debt. Data on financial structure, product market characteristics, and plant level efficiency are used to capture the effects of changes in leverage on investment and plant closing decisions. The measured effects are used to assess the predictions of the theoretical models appearing to date and to help construct new theoretical models that capture the more salient empirical results. The empirical evidence thus adds to the evidence presented by Kaplan (1989), Phillips (1995) and Chevalier (1995) on product market interactions with capital structure. It extends previous work by including both market structure and plant level efficiency as determinants of investment and plant closing decisions.

We have several significant empirical findings that relate capital structure to plant closure and investment decisions. The association between high debt and plant closing decisions is significant when we interact the debt variables with the 4 firm market share variable. The significance of this interaction effect emphasizes the importance of considering market structure in explaining the effects of changes in capital structure. We also find that competitors are less likely to close down plants when leveraged firms have high market share. Two similar results are found when examining plant investment decisions. First, recapitalization and investment are negatively associated. Second, there is a significant positive association between rival firms' investment and a recapitalizing firm's debt decision. Firms are more likely to increase their investment when rival firms have high debt. This strategic effect of debt financing emphasizes the point that firms do not operate in isolation. Their decisions, both real and financial, are taken into consideration by competing firms.

The final result we wish to emphasize is that plant level productivity and industry capacity utilization are highly significant variables in explaining investment and plant closings. These variables seem to be more important for closing and investment decisions than capital structure, by itself, as it is measured. This paper shows the importance of taking into account underlying exogenous industry conditions. The negative significant association between total factor productivity and plant closing provides support for the claim that the relatively more inefficient plants were the ones being closed down by firms. In addition, high capacity utilization is positively associated with firm investment and negatively associated with plant closing.

Overall, our results suggest that industry structure and plant level productivity combined with capital structure are important in explaining investment and plant closing decisions for both recapitalizing firms and their competitors. The empirical results give qualified support for Jensen's (1993) predictions about the importance of technological productivity, capacity utilization and of capital structure for industry adjustments to new demand conditions. Jensen claims that increased debt taken on by firms is important in facilitating industry adjustment to new demand conditions. This paper provides evidence that market structure is important in determining the significance of capital structure.

The results in this paper are consistent with the capital structure changes being the least costly way of undertaking the adjustments to underlying exogenous industry conditions. The effect on rival firms' investment and closing decisions is supportive of the conclusion that capital structure signals new behavior to the firms' rivals. The results are consistent with the models in which debt commits the leveraged firms to behave *less* aggressively and decrease investment. The exact role of capital structure remains a question for a dynamic model. We explicitly recognize that capital structure is chosen in response to industry and firm characteristics and estimate our regressions with a predicted capital structure change variable to help control for some of the endogeneity problems that arise because capital structure is a choice variable. We include lags of both industry and firm specific variables to obtain a predicted capital structure change variable. In addition, to the extent that we appropriately control for plant productivity, demand, capacity utilization and other exogenous industry variables - we reduce the problem that capital structure change proxies for some of these factors.

We wish to emphasize that the effects and results in this paper are sensitive to industry specific market structures, cost and size asymmetries, as well as the dynamics of costly industry adjustment. By directing attention to plant-level and industry-specific factors we hope to provide a clearer picture of the incidence of the various hypothesized effects of leverage and a better gauge of their importance.

Appendix

Total Factor Productivity calculations:

We calculate total factor productivity (TFP) using a regression based approach assuming a Cobb-Douglas production function. This approach compares the amount of output produced for a given amount of inputs with coefficients derived given the regression based approach. In other words, the TFP measure is the estimated residual from the regression model. We calculate TFP for each industry and also include year dummy variables. Average TFP is thus zero for each industry. Given the data available, we include three different types of inputs: capital, labor, and materials. All of these data exist at the plant level. Adjustments for price level changes and depreciation are made using industry level data. Price deflators at the four digit industry level were obtained from the Bartelsman and Gray (1994) database at the National Bureau cf Economic Analysis.

Some adjustments to each of the inputs had to be made in order to run the regressions. The LRD does not contain the actual amount of output produced but rather contains plant level value of output, which is equal to price times quantity. For labor, we also make an adjustment. Data on total number of employees, the number of production workers and hours worked by production workers exist at the plant level. Given that non-production worker hours are not reported in the LRD, we make the following adjustment to production worker hours. Labor input is defined as production worker hours times the ratio of total wages to production wages. This adjustment assumes that relative production and salary wages are equal to the ratio of their marginal products. Material input used is the value of materials used in producing the product. We included energy used in the production process in the materials numbers. Ideally we would want an estimate of the quantity of each input used in producing the product. However, we just have the reported total value of materials consumed. As noted by Lichtenberg and Siegel (1990), using the available data on the value of materials will not cause any distortions as long as the markets for materials are perfectly competitive. There is some reported evidence (Baker and Wruck, (1989)) that high debt firms were able to negotiate better terms from their suppliers. Thus we might expect TFP to increase for the highly leveraged firms. This would bias our results against finding an influence of debt on closing decisions as high-debt firms would be less likely to close plants for a fixed TFP cutoff.

To construct measures of real capital stock, we followed a procedure similar to Lichtenberg and Siegel (1990). In the initial year of the time series for any plant we deflated the gross book value (GBV) of equipment and structures separately using 2 digit deflators for each type of capital from the Bureau of Economic Analysis. Deflators were given by the ratio of industry net capital stock in constant dollars divided by the industry gross capital stock in historical dollars. The initial year for capital stock is thus:

$$K_{ijt} = GBV_{ijt} * \frac{NSTK_{jt}}{GSK_{jt}}$$

This measure allows a constant amount of depreciation depending on the amount of capital and differences in the price level for plants that begin in different years that have already depreciated over time. We use this procedure for plants that appear in the database the first time but are not new plants. Plants will appear for the first time in the database, in cases other than newly opened plants, at either the beginning of the database, 1972, or for smaller plants when they become part of the annual survey. For new plants we just adjust for differences in the price level and make no adjustment for depreciation.

To come up with a value of capital stock for subsequent years we use the following recursive formula,

$$K_{ijt} = K_{ijt-1} * (1 - \delta_{jt}) + CAPEXP_{ijt} / IDEF_{jt}$$

For subsequent years we use a recursive formula to come up with the net values of capital stock adjusting for depreciation at the industry level. We used depreciation rates, δ_{jt}, from the BEA at the 2 digit industry for each form of capital. $IDEF_{jt}$ is the price deflator for industry j for period t. Since separate data exist for both plant and equipment, we calculate the capital stock for each and add them together to get our final measure of capital stock.

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Table 1
Sample Characteristics by Recapitalization

Sample characteristics of plants of firms for the ten industries examined in this study. Plant-level data is obtained from the Annual Survey of Manufactures (ASM) from the Bureau of the Census, U.S. Department of Commerce. Total factor productivity (TFP) statistics are given for the year prior to the recapitalization for each of the recapitalizing firms. Plant-level data for the non-recapitalizing industry firms is for the year of the first recapitalization in the four digit SIC code. The data appendix contains the procedure used to calculate TFP. It is a relative measure of productivity calculated such that the average industry TFP equals zero. The industry concentration index is the total value of shipments of the largest 4 firms divided by the industry total shipments.

	Sample of Firms	
	Non-Recapitalizing Firms	Public Recapitalization and LBO firms
Number of Firms - At Time of Recap*	827	40
Average Firm Size (Value of Shipments - $ Millions)	220.68	569.77
Average Industry Concentration Index	.420	.552
Standard Deviation	(.150)	(.224)
Number of Plants*	1482	405
Average Plant Age (Years)**	9.04	13.39
Standard Error of Mean	(.104)	(.197)
Total Factor Productivity (TFP)		
Average TFP	.0084	-.0125
Standard Error of Mean	(.0073)	(.0141)
Number of Plant Closures (1979-1990)	452	60
Total Factor Productivity (TFP) of Closures		
Average TFP	-.2061	-.2602
Standard Error of Mean	(.0284)	(.0655)
Number of Plant Openings (1979-1990)***	23	0

* Mergers and plant closures between 1979 and the recapitalizations prevent these numbers from adding up to the totals for 1979 reported in Table 2. In addition, a new 5 year panel of firms begins in 1984.

**Average plant age is calculated as the recapitalizing year less the first time the plant appeared in the database. We checked back as far as the 1972 Census of Manufactures for plant births.

***There were 23 explicitly identified openings in the Annual Survey of Manufactures (ASM). However, the ASM does not cover with certainty plants of less than 250 employees. Given the much smaller number of openings versus closures in the data, only closures are analyzed. In the full quintennial Census of Manufactures for 1982 there were 28 plant openings and 132 closures for the 10 industries in this study. Of these plants, 6 of the openings and 75 of the closures were in the ASM.

Table 2
Productivity and Plant Closures

The table presents summary statistics for each industry, including the number of plant closures and the average total factor productivity of these plants. Total factor productivity (TFP) is a relative measure of productivity calculated in a procedure similar to Lichtenberg and Siegal (1990). TFP is a relative measure of productivity calculated such that the average TFP in an industry is equals 0. Thus the TFP numbers for the closed plants show the relative productivity versus all plants in the industry. Standard errors of the mean are in parentheses.

Industry	Number of Firms (in 1979)	# of Plants (in 1979)	# of Plant Closures (1979-1990)	Average Productivity (TFP) of closed plants	High debt firms: Number of plants (a)
Fabric Mills (2211, 2221, 2231	235	505	138	-0.288 (.048)	106
Mattresses (2515)	92	110	42	-0.234 (.081)	24
Paper Mills (2611, 2621, 2631)	157	417	47	-0.256 (.065)	59
Oil Based Chemicals (2821)	117	209	61	-0.027 (.090)	35
Glass Products (3211, 3221, 32	163	316	104	-0.248 (.063)	31
Gypsum (3275)	16	74	9	-0.273 (.270)	61
Roofing and Insulation (3296)	23	53	14	-0.147 (.103)	36
Batteries: Car (3691)	67	145	39	-0.181 (.105)	23
Batteries: Consumer (3692)	13	28	5	-0.071 (.188)	13
Tractor Trailers (3715)	117	139	53	-0.149 (.082)	17
All Industries	1000	1996	512	-0.212 (.026)	405 (a)

a - There were 60 plant closures by high debt firms across the 10 industries. Average TFP for these closures was -.260 with a standard error of .066. Average TFP for the 452 plants closed by non-recapitalizing firms was -.206 with a standard error of the mean of .028. Individual industry data on closures cannot be disclosed because of government restrictions regarding the disclosure of confidential data.

Table 3
Plant Closing Decisions

Regressions test the effects of productivity and increases in debt on plant closing decisions of recapitali:
other non-recapitalizing industry firms. Regressions are estimated using a logistic limited dependent va
The dependent variable equals 1 if a firm has closed a plant in that year. Lagged industry concentration
of industry sales by the top 4 firms. Total Factor Productivity (TFP) is calculated assuming a Cobb-Dou
function. Plant scale is the average for the firm of its plants asset size divided by the average assets for
industry. Predicted capital structure change is calculated using a first stage regression with 2 lags of cap
output price variance, plant productivity and firm size. Data are yearly from 1979-1990. T-statistics are

Variable	Dependent Variable: Pla	
	LOGIT: A	LOGIT: B
Industry Demand and Price Variables		
Capacity Utilization	-0.023 (-3.589)***	-0.014 (-2.793)***
Output Price Variance	-0.002 (-1.092)	-0.004 (-1.805)*
Change in Output Demand	-1.517 (-1.659)*	-1.233 (-1.544)
Market - Structure Variables		
Lagged Industry Concentration	-3.405 (-5.262)***	-3.469 (-5.52)***
Number of Plants Owned by Firm	0.254 (12.007)***	0.261 (14.055)***
Value of Firm Shipments	-0.001 (-3.857)***	-0.001 (-3.991)***
Productivity Variables		
Total Factor Productivity (TFP)		
Firm's lowest productivity plant	-0.575 (-3.906)***	
Lagged TFP		-0.932, (-5.270)***
Relative Plant Scale	-3.671 (-5.008)***	-3.141 (-5.134)***
Maximum Plant Age	0.058 (4.015)***	0.026 (2.061)**
Capital Structure Variables		
High debt dummy variable	0.741 (1.136)	0.412 (.641)
Predicted Capital Structure Change		
Capital Structure Variable * Concentration	0.668 (1.827)*	0.319 (1.806)*
Rival high debt market share	-0.502 (-1.716)*	-0.571 (-2.057)**
Total Firm Years	10395	8214
Plant Closings	476	424
Chi - Squared Statistic	557.83	550.34
Significance Level (p-value)	<1%	<1%

*, **, *** - significantly different from zero at the 10%, 5%, and 1% level of significance, respectively.

Table 4
Plant Closing and Productivity: Estimated Closure Probabilities

Estimated probabilities of plant closing for firms at the 10th, 25th, 50th and 90th percentiles of total factor productivity (TFP) for the full sample of firm and by whether firm recapitalized increasing its debt. The time period covered is 1979-1990. Probabilities are computed holding all other variables besides TFP and debt interaction terms at their sample means. For the non-recap firms and the LBO and recapitalization firms probabilities are computed with the dummy variable equal to zero and one respectively. Estimated probabilities are from logit regressions predicting plant closure, controlling for market structure and industry demand.

	Sample of Firms		
Total Factor Productivity	All Firms	Non-Recap Firms	LBO & Recap Firms*
Probabilities from Table 3, logit regression A, with lowest productivity plant			
Probability at TFP 10th percentile	3.77%	2.86%	6.42%
at TFP 25th percentile	3.45%	2.61%	5.88%
at TFP 50th percentile	3.15%	2.38%	5.39%
at TFP 90th percentile	2.61%	1.97%	4.48%
Probabilities from Table 3, logit regression B, with lagged TFP			
Probability at TFP 10th percentile	5.00%	4.59%	7.52%
at TFP 25th percentile	4.38%	4.02%	6.61%
at TFP 50th percentile	3.82%	3.50%	5.76%
at TFP 90th percentile	2.90%	2.66%	4.42%

* For the recap and LBO sample, the debt interaction term with concentration is evaluated at the mean of the concentration variable for this subsample. All other variables are evaluated at their overall sample mean.

Table 5

Plant Closing Decisions: Panel Dataset Estimation

Regressions test the effects of productivity and increases in debt on plant closing decisions of recapitalizing firms and other non-recapitalizing industry firms. Regressions are estimated using random effects probit panel data model (see: Chamberlain (1984)). This model allows for a random firm effect and different number of observations per firm (unbalanced panel). The dependent variable equals 1 if a firm has closed a plant in that year. Lagged industry concentration is the proportion of industry sales by the top 4 firms. Total Factor Productivity (TFP) is calculated assuming a Cobb-Douglas production function. Plant scale is the average for the firm of its plants asset size divided by the average assets for plants in each industry. Predicted capital structure change is calculated using a first stage regression with 2 lags of capacity utilization, output price variance, plant productivity and firm size. Data are yearly from 1979-1990. T-statistics are in parentheses.

Variable	Dependent Variable: Plant Closing	
	Random Effects Panel Probit Model	
Industry Demand and Price Variables		
Capacity Utilization	-0.019 (-13.049)***	-0.019 (-13.139)***
Output Price Variance	-0.002 (-1.310)	-0.001 (-1.302)*
Change in Output Demand	-0.286 (-.719)	-0.276 (-.687)
Market - Structure Variables		
Lagged Industry Concentration	-0.699 (-3.043)***	-0.730 (-3.296)***
Number of Plants Owned by Firm	0.111 (14.061)***	0.110 (14.122)***
Productivity Variables		
Total Factor Productivity (TFP) Lowest productive plant: lagged TFP	-0.137 (-1.936)*	-0.139 (-1.944)*
Relative Plant Scale	-1.924 (-8.344)***	-1.927 (-8.418)***
Maximum Plant Age	0.029 (.445)	0.027 (.414)
Capital Structure Variables		
High debt dummy variable	0.192 (.509)	
Predicted Capital Structure Change		0.566 (.530)
Capital Structure Variable * Concentration	0.766 (1.987)**	0.781 (2.028)**
Rival high debt market share	-0.302 (-1.766)*	-0.317 (-1.888)**
Total Firm Years	8214	8214
Plant Closings	424	424
Chi - Squared Statistic	12.90	12.49
Significance Level (p-value)	<1%	<1%

*, **, *** - significantly different from zero at the 10%, 5%, and 1% level of significance, respectively, using a two-tailed t-test.

Table 6

Productivity and Investment

The table shows the average investment rates for each of 5 TFP quintiles. Quintile 1 thus represents the average investment rate for the 20 percent least productive plants. Investment is measured as the expenditures on building and equipment divided by the average of beginning and ending plant assets. The standard error of the mean investment rate is in parentheses.

Industry	TFP Quintile 1	TFP Quintile 2	TFP Quintile 3	TFP Quintile 4	TFP Quintile 5
Fabric Mills (2211, 2221, 2231	-.055 (.018)	.041 (.011)	.061 (.009)	.072 (.010)	.040 (.013)
Mattresses (2515)	.019 (.035)	.062 (.036)	.111 (.029)	.100 (.032)	.139 (.047)
Paper Mills (2611, 2621, 2631)	.062 (.017)	.074 (.009)	.083 (.007)	.075 (.007)	.103 (.008)
Oil Based Chemicals (2821)	.023 (.021)	.041 (.015)	.072 (.013)	.120 (.018)	.148 (.024)
Glass Products (3211, 3221, 32	.026 (.022)	.101 (.017)	.099 (.018)	.127 (.016)	.125 (.021)
Gypsum (3275)	.088 (.044)	.117 (.021)	.079 (.023)	.067 (.025)	.064 (.020)
Roofing and Insulation (3296)	-.026 (.045)	.056 (.028)	.076 (.012)	.089 (.029)	.041 (.033)
Batteries: Car (3691)	-.025 (.036)	.061 (.023)	.094 (.022)	.093 (.021)	.083 (.030)
Batteries: Consumer (3692)	.009 (.069)	.084 (.040)	.092 (.018)	.090 (.054)	.146 (.056)
Tractor Trailers (3715)	-.105 (.034)	-.004 (.036)	.091 (.033)	.170 (.037)	.166 (.036)
All Industries	.005 (.008)	.062 (.006)	.082 (.005)	.096 (.006)	.100 (.007)

Table 7
Investment Decisions

Regressions test the effects of productivity and increases in debt on investment decisions of recapitalizing firms and other non-recapitalizing industry firms. Regressions are estimated using logistic limited dependent variable and censored regression (TOBIT) models. For the LOGIT models the dependent variable equals one if the firm invested 5% of ending period assets in that year. For the TOBIT model the dependent variable equals capital expenditures divided by beginning period assets. Industry concentration is the proportion of industry sales by the top 4 firms. Total Factor Productivity (TFP) is calculated assuming a Cobb-Douglas production function. Plant scale is the average for the firm of its plants asset size divided by the average assets for plants in each industry. Predicted capital structure change is calculated using a first stage regression with 2 lags of capacity utilization, output price variance, plant productivity and firm size. Data are yearly from 1979-1990. T-statistics are in parentheses.

Variable	Dependent Variable: Investment			
	LOGIT: A	LOGIT: B	LOGIT: C	TOBIT
Industry Demand and Price Variables				
Capacity utilization	0.003 (1.316)	0.004 (1.845)*	0.002 (.474)	0.007 (2.104)*
Output price Variance	-0.002 (-1.902)*	-0.002 (-2.361)**	-0.007 (-3.639)***	-0.002 (-1.997)**
Change in output demand	-0.093 (-.259)	-0.197 (-.513)	-0.083 (-.977)	-0.034 (-.675)
Market - Structure Variables				
Lagged industry concentration	0.381 (1.503)	0.226 (.808)	0.050 (1.062)	0.163 (4.279)***
Number of plants owned by firm	0.099 (7.292)***	0.092 (6.568)***	0.024 (6.744)***	0.059 (3.931)***
Firm market share	-1.829 (-2.473)**	-1.775 (-2.273)**	-0.544 (-2.950)***	-0.253 (-2.688)***
Total Firm Shipments	.0001 (.847)	.0001 (.698)	.0001 (1.406)	-.00005 (-2.799)***
Productivity Variables				
Total Factor Productivity (TFP)	0.211 (3.049)***			
Firm's lowest productivity plant				
Lagged TFP		0.269 (3.168)***	0.050 (2.750)***	0.024 (2.105)**
Relative Plant Scale	1.599 (8.529)***	1.719 (8.294)***	0.371 (7.998)***	0.129 (5.251)***
Maximum Plant Age	-0.014 (-3.032)***	-0.003 (-.645)	0.001 (1.077)	-0.080 (-10.451)***
Capital Structure Variables				
High debt dummy variable	-0.641 (-1.863)*	-0.596 (-1.709)*		0.003 (-.071)
Predicted Capital Structure Change			-0.120 (-.427)	
Capital Structure Variable*Concentration	-0.492 (-3.932)***	-0.309 (-2.182)**	-0.231 (-3.049)***	-0.103 (-4.708)***
Rival high debt market share	0.650 (2.496)**	0.464 (1.654)*	0.062 (1.677)*	0.081 (2.118)**
Total Firm Years	10395	8220	8220	8220
Years Investment > 5% Assets	5961	4604	4604	
Chi - Squared Statistic	432.85	368.08	278.60	n.a.
Significance Level (p-value)	<1%	<1%	<1%	

*, **, *** - significantly different from zero at the 10%, 5%, and 1% level of significance, respectively, using a two-tailed t-test. Note that a joint significance test for the coefficients in the TOBIT model is not possible.

Table 8
Investment and Productivity: Estimated Probabilities

Estimated probabilities of investing a minimum of 5 percent of assets for firms at the 10th, 25th, 50th and 90th percentiles of total factor productivity (TFP) for the full sample of firm and by whether the firm recapitalized - increasing its debt. The time period covered is 1979-1990. Probabilities are computed holding all other variables besides TFP and debt interaction terms at their sample means. For the non-recap firms and the LBO and recapitalization firms probabilities are computed with the dummy variable equal to zero and one respectively. Estimated probabilities are from logit regressions predicting investment, controlling for industry demand and market structure.

	Sample of Firms		
Total Factor Productivity	All Firms	Non-Recap Firms	LBO & Recap Firms*
Probabilities from Table 6: logit regression A, with average TFP			
Probability at TFP 10th percentile	56.48%	59.47%	37.79%
at TFP 25th percentile	57.20%	60.17%	38.48%
at TFP 50th percentile	57.45%	60.86%	39.16%
at TFP 90th percentile	59.23%	62.29%	40.62%
Probabilities from Table 6: logit regression B, with lagged TFP			
Probability at TFP 10th percentile	55.15%	57.41%	38.96%
at TFP 25th percentile	56.14%	58.39%	39.91%
at TFP 50th percentile	57.16%	59.39%	40.91%
at TFP 90th percentile	59.15%	61.35%	42.90%

* For the recap and LBO sample the debt interaction term with concentration is evaluated at the mean of the concentration variable for this subsample. All other variables are evaluated at their overall sample mean.

Table 9

Investment Decisions: Panel Dataset Estimation

Regressions test the effects of productivity and increases in debt on plant closing decisions of recapitalizing firms and other non-recapitalizing industry firms. Regressions are estimated using random effects probit panel data model (Chamberlain (1984)). This model allows for a random firm effect and different number of observations per firm (unbalanced panel). The dependent variable equals 1 if a firm has invested 5% of beginning period assets in that year. Lagged industry concentration is the proportion of industry sales by the top 4 firms. Total Factor Productivity (TFP) is calculated assuming a Cobb-Douglas production function. Plant scale is the average for the firm of its plants asset size divided by the average assets for plants in each industry. Predicted capital structure change is calculated using a first stage regression with 2 lags of capacity utilization, output price variance, plant productivity and firm size. Data are yearly from 1979-1990. T-statistics are in parentheses.

Variable	Dependent Variable: Investment > 5% Beginning Assets	
	Random Effects Panel Probit Model	
Industry Demand and Price Variables		
Capacity Utilization	0.010 (.906)	0.001 (.899)
Output Price Variance	-0.002 (-2.818)***	-0.002 (-2.846)***
Change in Output Demand	-0.292 (-1.162)	-0.300 (-1.191)
Market - Structure Variables		
Lagged Industry Concentration	-0.111 (-.643)	-0.104 (-.610)
Number of Plants Owned by Firm	0.084 (8.331)***	0.084 (8.276)***
Firm Market Share	-1.848 (-2.738)***	-1.772 (-2.613)***
Productivity Variables		
Total Factor Productivity (TFP) Lowest productive plant: lagged TFP	0.138 (2.398)**	'0.138 (2.399)*
Relative Plant Scale	1.469 (9.119)***	1.464 (9.085)***
Maximum Plant Age	-0.006 (-1.236)	-0.006 (-1.256)
Capital Structure Variables		
High debt dummy variable	-0.059 (-.212)	
Predicted Capital Structure Change		-0.654 (-.504)
Capital Structure Variable * Concentration	-0.373 (-.647)	-0.466 (-1.890)*
Rival high debt market share	0.390 (1.892)*	0.381 (1.855)**
Total Firm Years	8220	8220
Years Investment > 5% Assets	4604	4604
Chi - Squared Statistic	686.14	687.68
Significance Level (p-value)	<1%	<1%

*, **, ***-significantly different from zero at the 10%, 5%, and 1% level of significance, respectively, using a two-tailed t-test.

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