Capital Structure and Product Market Behavior: An Examination of Plant Exit and Investment Decisions

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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.

Keywords: Debt Financing, Capital Structure, Exit, Investment

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1. Introduction

Plant closings have been the focus of much public and academic attention. Researchers in the strategic management and industrial organization areas have analyzed the role of market structure, barriers to firm exit and declining demand in affecting plant closures.[1] In this paper we examine whether capital structure decisions are an important factor in understanding plant closing and the adjustment process to new demand conditions. We investigate empirically Jensen's (1993) claim that capital market pressures helped firms reduce excess capacity caused by demand shocks and changes in productivity. He argues that "in the 1980s the capital markets helped eliminate excess capacity through leveraged acquisitions and stock buybacks, hostile takeovers, leveraged buyouts, and divisional sales." (p. 832) Our focus is on the effect of increased leverage on a firm's and its competitors' exit and investment

[1] Articles in strategic management include Harrigan (1980, 1988) and Harrigan and Porter (1982). They have stressed that a commitment to a specific industry or "exit barriers" is important in understanding exit decisions. Theoretical articles which examine plant exit in industrial organization include Ghemawat and Nalebuff (1985, 1990), Reynolds (1988), and Whinston (1988). Bresnahan and Raff (1993) examine the effect of technological heterogeneity on plant exit in the automobile industry in the 1920s. Hayes (1992) considers the strategic role of size in exit decisions. Dunne, Roberts and Samuelson (1989) and Baldwin and Gorecki (1991) present plant-level exit statistics over time based on plant age in manufacturing industries. Lieberman (1990) considers exit from declining industries, while Gilbert and Lieberman (1987) examine firm-level investment.

decisions. We also examine the effect of plant level productivity and market structure or concentration in each industry.

Until recently, financial economists had not considered the explicit interaction of capital structure with real business decisions such as plant closing or investment decisions.[2] Recent articles remedying this omission have stressed firm's production functions and industry factors in explaining both investment and capital structure. Kim and Maksimovic (1990) consider how a firm's input use is associated with input prices, capacity, debt, and firm specific operating characteristics. Smith and Watts (1992) consider changes in regulation and investment opportunities. These papers have not, however, considered the effect of a firm's capital structure decision and market structure on the firm's and its rivals' exit and investment decisions. Also, no direct evidence on the effects of productivity combined with capital structure on closing decisions has been given.

Along with capital structure, we test whether industry variables such as capacity utilization, demand and demand variability, and market concentration influence the investment decision. We include firm market share variables and direct

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[2] Harris and Raviv's (1991) survey of capital structure makes this point and discusses recent theoretical work which models product market and capital structure interactions. Ravid (1988) also surveys the literature on product market interaction with capital structure.

measures of plant-level productivity to test whether debt influences the closing decision for low productivity plants. We test for strategic effects of debt finance by examining whether changes in a firm's capital structure affect rivals' closing and investment decisions.

Capital structure is predicted to be important to investment and closing decisions because it alters the distribution of cash flows among claimants and can affect contracting between claimants as well as conveying information about future investment. Reducing retained earnings and free cash flow by increasing debt payments forces firms to raise money from the external capital markets and helps to alleviate the agency problem associated with the allocation of internal funds. Strategic effects of leverage, or the effect of a firm's capital structure decision on rivals' economic decisions, have recently received attention in Brander and Lewis (1986), Maksimovic (1988), Poitevin (1989), and Bolton and Scharfstein (1990).

We examine plant closing and investment using plant-level data from the Bureau of the Census. This database includes both private and public firms with observations at the plant level for manufacturing industries. We examine whether factors predicted to be important by the financial and industrial organization literature are associated with the plant closing and investment decisions of firms that discretely increased the debt in their capital structure. 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.

We have three principal findings. First, in industries with high concentration, highly leveraged firms are more likely to close plants and less likely to invest. High debt by itself, when controlling for productivity and market structure, is not significantly related to closure and investment decisions. Second, rival firms are less likely to close plants following the recapitalizing firm's debt increase. Third, productivity, demand, and market share variables are highly significant. The high significance of these variables in explaining closing and investment decisions underscores the importance of controlling for exogenous industry conditions and plant productivity when examining capital structure.

Industry capacity utilization is also important in explaining investment and plant closings. As might be expected, high capacity utilization is positively associated with firm investment and negatively associated with plant closing decisions. This finding provides empirical support for Jensen (1993). Jensen claims that increased debt is important in facilitating industry adjustment to new demand conditions. We also find a significant negative association between total factor productivity and plant closing decisions providing evidence that firms closed relatively less efficient plants. Total factor productivity is also positively associated with firm investment. These findings provide evidence that firms are increasing their investment in their most productive plants.

Market structure has important implications for the effect of debt. The association between high debt and plant closing decisions is positive and significant when we interact the debt variables with the 4-firm market share variable - while positive but insignificant when just considering own firm leverage. The significance of this interaction variable emphasizes the importance of market structure in explaining the effects of capital structure changes There is also a negative association between rival firms' closing decisions and increases in the share of industry output produced by highly leveraged firms. Rival firms are less likely to close down plants as the market share of highly leveraged competitors increases. They also invest more when faced with highly leveraged competitors. These results support the hypothesis that high debt firms do not behave more aggressively subsequent to recapitalizations - contrary to a theoretical prediction by Brander and Lewis (1986).

These empirical results augment previous findings in Kaplan (1989), Phillips (1991) and Chevalier (1992). 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 concentration. 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.

This work extends Chevalier (1992) 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 (1992) finds that unleveraged firms are more likely to open stores and less likely to exit in markets when faced with competitors which recently underwent a leveraged buyout. Chevalier controls for demand differences in multiple markets but does not consider differential efficiency or market structure as determinants of closures. 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. Finally, this work augments Phillips (1991) 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.

Other related papers include Schary (1991), Lichtenberg and Siegel (1990), Long and Ravenscraft (1993) and DeAngelo and DeAngelo (1991). Schary 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 for the firms in her study. However, firms were not identified as having any sharp changes in financial structure. Lichtenberg and Siegel (1990) used the Census database to study changes in total factor productivity of leverage buyouts (LBOs). Long and Ravenscraft (1993) also use Census data to study post-LBO changes in performance for a comprehensive sample of LBOs. DeAngelo and DeAngelo (1991) also focus on real business decisions. 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.

This paper is organized as follows: section 2 presents the theoretical arguments for the factors considered in the empirical work as potential determinants of plant investment and exit. It reviews the models that show how capital structure can influence these decisions. 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.

2.0 Theoretical models of exit and investment

This section reviews the models which predict what factors are important in 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.

2.1. Capital structure interaction with exit and investment

Direct effect of capital structure

As noted by Harris and Raviv's (1991) survey article and many others, capital structure can affect investment because it changes the allocation of cash flows among claimants and conveys information about investment opportunities. We choose the industries that are examined in this paper by 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 - emphasizing that capital structure is a choice variable of firms. Thus we do *not* select industries that are necessarily characterized by having firms in economic distress. We do not select firms that have high leverage and decreased equity values because of *poor* product market performance. We do include a variable that identifies the recapitalization event in regressions but only as variable that is fixed in historical time. We do not update this variable for changes in product market performance to help avoid some of the endogeneity problems that arise because it is a choice variable. We also interact this variable with the concentration level in the industry.

The question that is difficult to answer is whether the cash flows are actually affected by capital structure or whether an exogenous shock changes investment cash flows at the same time as it makes a certain capital structure the lowest cost way to finance the investment. To the extent that we appropriately control for plant productivity, demand, capacity utilization and other exogenous industry variables - we reduce the importance of the problem that capital structure change proxies for some of these other industry factors.

This paper tests the hypothesis that capital structure provides incentives and commits the firm to changes in exit and investment decisions that are fundamentally driven by investment opportunities, productivity, and demand changes. Leverage and the recapitalization reduce free cash flow that may have been allocated to inefficient investments and helps align managerial incentives with stockholders. Investment and exit decisions would thus be more likely to reflect current investment productivity and new demand conditions.

Strategic effect of capital structure

In addition to the effect on own closing and investment decisions, capital structure may have an effect on rivals' decisions. If the capital structure changes represent credible commitments to close plants or change investments, rival firms may also change their closing or investment decisions. We begin this section by reviewing several models which show how capital structure and industry product market behavior can interact. 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.

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. [3] 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 level, leading to a prisoner's dilemma in which positive debt levels arise in

[3] 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.

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 investment opportunities. 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. We distinguish two versions of the strategic investment effect. One is in the context of profit maximizing firms with no agency problems. Debt in this class of models acts as a way to strategically surrender future investment opportunities. This avoids rival preemption in investment or an aggressive product market strategy of the rival designed to force the firm to surrender future investment opportunities through the reduction of the firm's internal cash flow. The result is higher profits for both firms, higher investment for the rival firm and lower investment for the high-debt firm.

The second approach to the strategic investment effect assumes that there are agency costs between managers and shareholders. Jensen (1986,1993) argues 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 in this type of model can act to restrain investment by managers to the benefit of shareholders. Rivals noting this constraint will act more aggressively and invest and produce more. Bolton and Scharfstein (1990) show how a rival may attempt to force a highly leveraged firm out of the market. Hence, the beneficial effects of debt on agency costs are offset by negative strategic product market effects. Kovenock and Phillips (1994) attempts to formalize aspects of Jensen's model of free cash flow in a strategic industry setting that builds on the work of Fershtman and Judd (1987) - where managers compensation is partially based on the firm's market share. In Kovenock and Phillips, reducing retained earnings and free cash flow by increasing debt payments in low demand states increases the cost of investment and helps alleviate the over-production problem.

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. The calculations behind this measure are described in the data appendix to this paper. The measure of productivity is called total factor productivity, or TFP. It is also described extensively in Caves and Barton (1990). We describe our calculations in a data appendix. The largest difference in our calculations is that 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 that may be more efficient 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. Porter (1976) is one of the first studies to explicitly enumerate factors that can cause firms to hang onto loss making businesses. He calls these factors “barriers to exit”. He cites asset specificity, interpersonal costs and incentive systems that cause managers to avoid the exit decision. He examines the PIMS business unit data base to analyze the factors that keep firms from closing down businesses - finding that measures of asset specificity and durability are important in explaining the failure to exit poorly performing lines of business. 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 will require substantial scale economies in order to reverse this finding. 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 in examining whether smaller plants will be “shaken out” because of a lack of economies of scale or if they can “stake out” a portion of the market by credibly threatening to outwait larger plants in a declining industry. Lieberman finds empirical support for two of these factors. 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 plant 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.

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 problems. 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, (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[4] (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 are aggregated to the firm level to examine investment decisions. In addition to the detailed plant-level data, there are several other advantages to these 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

[4] 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.

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.[5] 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 quinquennial 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

[5] 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.

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 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.[6] 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 and Titman (1992) 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

[6] 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.

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 identify plant closings and 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 the full 12 years of data from 1979 to 1990. 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 logistic 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 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 this problem. We also estimated the model using 10 percent as a cutoff value. These results are not presented as they were 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. Variables include the market share of highly leveraged firms, less own market share if the firm itself is highly leveraged, dummy variables that indicate whether the firm is highly leveraged as a result of a leveraged buyout or public recapitalization and a dummy variable that indicates whether a rival firm is highly leveraged while the firm itself has low financial leverage. 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 these data allow 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:

$$Q_{it} = A_i * L_1^{a_{1i}} L_2^{a_{2i}} \ldots L_N^{a_{Ni}},$$

where Q_{it} represents output of plant i, in year t, the quantity $L_j^{a_{ji}}$ (j=1,...,N), denotes the quantity of input j used in production for plant i. 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 shipments) 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 have 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.

Third, we include variables that capture 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 intra-industry 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 affect 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.[7] 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 close 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 are obtained from the Bureau of Labor Statistics. We use the data at the disaggregated 7 digit SIC code product level. It is 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

[7] 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.

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 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.

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 by each industry.[8]

The summary statistics by industry reveal several 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.

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[8] 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.

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 variable for the least productive plant the firm owns. 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. 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.

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 plants are less likely to be closed when they are large, as the plant scale variable is negative and highly significant. The coefficient estimate on the variable controlling for 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 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 in highly concentrated industries.

The variables capturing the capital structure changes show several interesting results. First, the variable indicating the total market share of high leverage rival firms has a negative coefficient in both 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. In both regressions in table 3, the own high leverage dummy variable is 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.

Table 4 gives 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 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.

4.2. Firm-level Investment Decisions

This section examines the investment decisions of firms in the ten industries. Table 5 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 presents logistic regressions and a Tobit censored regression which 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 5, 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).

Consistent throughout, both in the logit and Tobit models, is a negative association between the firm's investment and its decision to increase sharply the debt in its capital structure. This result is shown by the negative coefficient on the variables identifying whether the firm recapitalized through a LBO or public recapitalization. These significant negative coefficients are consistent with firms decreasing their investment following the large increases in debt finance. This result confirms the earlier work on LBOs by Kaplan (1989) who found a decrease in investment by management leveraged buyouts both in unadjusted and industry adjusted levels.

However, 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 high leverage 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 very strong and consistent across all specifications investigated. The results are consistent with the unleveraged firm investing more when faced with a high debt rival.

These results are consistent with two different but not mutually exclusive theories. The results are consistent with decreased agency costs 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 7 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 7 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 goes from 59.5% for the non-recapitializing firms to 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 7 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 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.

4.3. Discussion of Results

We currently have two significant findings that relate 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. 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 industry competitors. Debt can be an important mechanism in highly concentrated industries that changes the payoffs from closure and commits firms to close plants. Own investment decreases for high leverage firms and rival investment is positively associated with the increased debt. These findings are consistent with increased debt and decreased agency costs causing firms to decrease investment, thereby increasing producer efficiency in recapitalizing industries. The results are consistent with the models in which debt commits the leveraged firms to behave less aggressively and decrease investment. Industry growth is also important in explaining investment and plant closings. As might be expected, industry capacity utilization is 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 and market structure. 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 (1991) and Chevalier (1992) 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 currently 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 also are found when examining plant investment decisions. First, recapitalization and investment are negatively associated. Second, there is a positive significant association of rival firms' investment with the recapitalization firm's debt decision. Firms are more likely to increase their investment when rival firms have high debt.

The final result we wish to emphasize is that plant level productivity and industry capacity utilization are highly significant variables in this analysis 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 industry competitors. The empirical results give 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 or the concentration of markets 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 exact role of capital structure remains a question for a full dynamic model. Left unanswered is the causality of *own firm* changes because of capital structure. We fix the capital structure variable in time and do not update its value for changes in product market performance to help avoid some of the endogeneity problems that arise because capital structure is a choice variable. 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 other industry factors. 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.

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 of 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, $*_{jt}$, 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.

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 Census Bureau, 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. Appendix 2 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 Litchenberg 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)	High debt firms: Number of plants
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, 3231)	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

Regressions test the effects of productivity and increases in debt on plant closing decisions recapitalizing firms and other non-recapitalizing industry firms. Regressions are estimated logistic limited dependent variable model. The dependent variable equals 1 if a firm has plant in that year. Both regressions contain industry fixed effects. Data are yearly from T-statistics are in parentheses.

Variable	Dependent Variable: Plant Closing	
	LOGIT: A	LOGIT: B
Industry Demand and Price		
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)
High debt dummy * 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	8316
Plant Closings	476	476
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, using a two-tailed t-test.

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

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	.041	.061	.072	.040
	(.018)	(.011)	(.009)	(.010)	(.013)
Mattresses (2515)	.019	.062	.111	.100	.139
	(.035)	(.036)	(.029)	(.032)	(.047)
Paper Mills (2611, 2621, 2631)	.062	.074	.083	.075	.103
	(.017)	(.009)	(.007)	(.007)	(.008)
Oil Based Chemicals (2821)	.023	.041	.072	.120	.148
	(.021)	(.015)	(.013)	(.018)	(.024)
Glass Products (3211, 3221, 3231)	.026	.101	.099	.127	.125
	(.022)	(.017)	(.018)	(.016)	(.021)
Gypsum (3275)	.088	.117	.079	.067	.064
	(.044)	(.021)	(.023)	(.025)	(.020)
Roofing and Insulation (3296)	-.026	.056	.076	.089	.041
	(.045)	(.028)	(.012)	(.029)	(.033)
Batteries: Car (3691)	-.025	.061	.094	.093	.083
	(.036)	(.023)	(.022)	(.021)	(.030)
Batteries: Consumer (3692)	.009	.084	.092	.090	.146
	(.069)	(.040)	(.018)	(.054)	(.056)
Tractor Trailers (3715)	-.105	-.004	.091	.170	.166
	(.034)	(.036)	(.033)	(.037)	(.036)
All Industries	.005	.062	.082	.096	.100
	(.008)	(.006)	(.005)	(.006)	(.007)

Table 6
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 variable and censored regression (TOBIT) models. For the LOGIT models the dependent variable one if the firm invested 5% of ending period assets in that year. For the TOBIT model the dependent equals capital expenditures divided by beginning period assets. All regressions contain industry fixed Data are yearly from 1979-1990. T-statistics are in parentheses.

Variable	Dependent Variable: Investment		
	LOGIT: A	LOGIT: B	TOBIT
Industry Demand and Price Variables			
Capacity utilization	0.003	0.004	0.007
	(1.316)	(1.845)*	(2.104)*
Output price Variance	-0.002	-0.002	-0.002
	(-1.902)*	(-2.361)**	(-1.997)**
Change in output demand	-0.093	-0.197	-0.034
	(-.259)	(-.513)	(-.675)
Market - Structure Variables			
Lagged industry concentration	0.381	0.226	0.163
	(1.503)	0.808	(4.279)***
Number of plants owned by firm	0.099	0.092	0.059
	(7.292)***	(6.568)***	(3.931)***
Firm market share	-1.829	-1.775	-0.253
	(-2.473)**	(-2.273)**	(-2.688)***
Total Firm Shipments	.0001	.0001	-.00005
	(.847)	(.698)	(-2.799)***
Productivity Variables			
Total factor productivity (TFP)	0.211		
	(3.049)***		
Lagged TFP		0.269	0.024
		(3.168)***	(2.105)**
Relative Plant Scale	1.599	1.719	0.129
	(8.529)***	(8.294)***	(5.251)***
Maximum Plant Age	-0.014	-0.003	-0.080
	(-3.032)***	(-.645)	(-10.451)***
Capital Structure Variables			
High debt dummy variable	-0.641	-0.596	0.003
	(-1.863)*	(-1.709)*	(-.071)
High debt dummy * concentration index	-0.492	-0.309	-0.103
	(-3.932)***	(2.182)**	(4.708)***
Rival high debt market share	0.650	0.464	0.081
	(2.496)**	(1.654)*	(2.118)**
Total Firm Years	10395	8220	8220
Years Investment > 5% Assets	5961	4653	
Chi - Squared Statistic	432.85	368.08	n.a.
Significance Level (p-value)	<1%	<1%	

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

Table 7
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.

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