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

Dan Kovenock
Purdue University and the Tinbergen Institute

Gordon M. Phillips
University of Maryland

We examine whether sharp debt increases through leveraged buyouts and recapitalizations interact with market structure to influence plant closing and investment decisions of recapitalizing firms and their rivals. We take into account the fact that recapitalizations and investment decisions are both endogenous and may be simultaneously influenced by the same exogenous events. Following their recapitalizations, firms in industries with high concentration are more likely to close plants and less likely to invest. 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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Corporate finance has traditionally examined the influence of capital structure on investment and exit decisions without explicitly considering the nature of competition within an industry.[1] Recently there has been a growing interest in both finance and economics on the interaction between capital structure and product market behavior.[2] This article adds to the 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.

We examine 10 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 financial recapitalization. Our results show that industry concentration, capacity utilization, and relative plant productivity are significant determinants of the recapitalizations and subsequent plant (dis)investment 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 the effects of 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 concentration is more likely to close

[1] 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.

[2] 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.

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. We find that a recapitalization, insofar as it increases the market share of high-debt firms, has a significant impact on rival firms' plant closing and investment decisions. Our results are consistent with the view that recapitalization is a strategic commitment that has an independent effect on rival firm investment.

Given that recapitalizations and investment decisions may be simultaneously influenced by contemporaneous shocks, and thus recapitalization may be endogenous, we also use predicted recapitalization as a measure of capital structure change in our regressions.[3] We estimate a first-stage regression using lagged values of plant-level productivity, industry capacity utilization, and market concentration to predict whether or not a firm recapitalizes and replace the recapitalization variable in our original regressions with its predicted value. The results with the predicted recapitalization variable are similar to those in the original regression, which shows that the debt change is indeed endogenous and is significantly associated with lagged values of productivity, industry demand, capacity utilization, and market concentration. The significance of the lagged values of capacity utilization, concentration, and demand in predicting the recapitalization shows that the capital structure change is a response to longer-run changes in industry demand and supply conditions. Single-period models and empirical analyses of changes in capital structure do not fully capture this adjustment.

These results augment previous findings for leveraged buyout firms by Kaplan (1989), Lichtenberg and Siegel (1990), and for firms in an industry setting by Chevalier (1995) and Phillips (1995).[4] Previous large sample analyses of leveraged buyouts did not examine whether recapitalization influences rival firms' decisions. 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. Lichten-

[3] Note that this approach does not solve all potential endogeneity problems. Lagged shocks to the marginal product of capital that are not captured by the exogenous variables predicting (dis)investment may influence both contemporaneous investment and closure decisions along with predicted capital structure.

[4] 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).

berg and Siegel (1990) use census data to examine plant-level productivity. They examine a balanced sample of manufacturing plants without considering industry structure and decisions such as exit and investment and the interaction of capital structure with product market behavior. This study adds to Lichtenberg and Siegel by examining exit and investment decisions controlling for productivity, industry demand, and market structure.

Chevalier (1995) examines the exit decisions of firms in an intraindustry 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.[5] 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.

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 four 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.[6,7]

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

[5] A recent article 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 effect of productivity on exit with trucking data.

[6] 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).

[7] Other related nonstrategic papers from the finance literature include Kim and Maksimovic (1990), Schary (1991), Long and Ravenscraft (1993), and DeAngelo and DeAngelo (1991).

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 negative demand shocks and changes in productivity. Debt facilitated disinvestment.

The industrial organization literature has focused on the interaction between recapitalizing firms' and rival firms' decisions. This strategic product market effect of leverage is examined in Brander and Lewis (1986, 1988), Maksimovic (1986, 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, increased debt causes a firm to behave aggressively, increasing output, and its rivals to behave passively.

We find that increasing the share of debt in a firm's capital structure is consistent with more passive investment behavior (increased probability of closure and decreased investment) by recapitalizing firms and more aggressive behavior by rival firms. 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. These strategic reactions need to be incorporated in any cost-benefit calculation for increasing debt. At the same time it is clear that most models addressing the strategic effects of debt are not capturing the salient features of increased leverage. In particular, our findings are not consistent with the prediction of more aggressive behavior of leveraged firms as in the Brander and Lewis limited liability model.[8]

This evidence does appear to provide some evidence that increased debt is associated with reduced investment. However, the capital structure change variables are only significant when interacted with market concentration. The importance of this interaction between concentration and increased debt suggests that the agency problems are more prevalent in concentrated industries, where the discipline of the market does not weed out nonoptimizing firms [see Leibenstein (1966)].

[8] Brander and Lewis explicitly consider quantity choice. We claim that the primary interest in the Brander–Lewis model derives from its investment interpretations and the resulting implications. The relationship between the Brander–Lewis quantity variable and investment is discussed in Section 2.1.

This article is organized as follows: Section 1 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 2 describes the data and the industries in this study. Section 3 presents the empirical results and discusses their implications. Section 4 concludes.

1. Models of Investment and Exit

1.1 Theoretical models

This section reviews the models that predict the important factors influencing a firm's investment decision and the decision to close down a plant. We focus on how industry factors interact with capital structure to influence firms' decisions. We classify theoretical models into three 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.

1.1.1 Capital structure and investment: 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. Given a set of investment opportunities, capital structure is chosen to align incentives to maximize firm value. Early analyses of capital structure have noted the significance of industry conditions to the amount of debt financing by firms. Myers' (1977) analysis of the affect of debt on firms in industries with growth options is relevant to our analysis in that we examine the decision to invest as well as disinvest (close). In Myers' analysis, debt decreases investment because of "debt overhang." New investment cannot be financed because of existing senior debt claims. Jensen (1986, 1993) focuses explicitly on the disinvestment decision in the face of declining demand or technological change and argues that information and contracting problems between implicit or explicit claimants to the firm can make the disinvestment decision difficult for managers. Debt and debtlike instruments reduce free cash flow that may otherwise be allocated to inefficient investments and help align managerial incentives with those of stockholders.

This disinvestment hypothesis is one of the hypotheses addressed with our evidence. Its empirical implications are that increases in debt are associated with a reduction in own investment and an increase in the incidence of own plant closings. However, this disinvestment hypothesis does not consider how rival firm behavior might be related to a firm's debt choice.

Strategic effect of capital structure. Models of strategic effects of capital structure begin with capital structure representing a credible commitment to alter plant closing or investment behavior. Given this commitment to change investment or closing decisions, rival firms may also change their closing or investment decisions. We identify and explore two different classes of models of strategic interaction. The first emphasizes the limited liability effect of debt, while the second deals with strategic investment effects of debt finance.[9]

The limited liability effect of debt financing was developed by Brander and Lewis (1986) and Maksimovic (1986). Brander and Lewis consider a two-stage game with two firms 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. Due to the limited liability enjoyed by equity, a unilateral increase in debt 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 model, this will lead to an increase in the leveraged firm's output for each level of output of the rival firm.[10] This leads to a reduction in the equilibrium output chosen by the rival. As a result of this strategic effect, each firm would like to precommit to a high debt level, leading to a prisoners' dilemma in which positive debt levels arise in equilibrium and output is greater and profits lower than in the absence of debt.

The empirical implications of the Brander–Lewis limited liability model depend on the interpretation that is given to investment. The most 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 Tirole (1988, p. 217), Shapiro (1989), Allen et al. (1994)]. Using this interpretation, quantity adjustment in the Brander–Lewis model may be equated with scale or capital adjustment, that is, investment. Hence, a firm's unilateral increase in debt would have a positive effect on its own investment and profits and a negative effect on its rival's investment and profits. These effects are also predicted when an increase in

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[9] 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 article.

[10] In the alternative case considered by Brander and Lewis, where marginal profits are lower in better states of the world, neither firm will want to have a positive level of debt.

debt is an equilibrating response to previous adjustments in leverage on the part of rivals.[11]

The "strategic investment effect" is based on the pecking-order model of finance as in Myers (1984), in which internally generated funds are less costly, or are viewed by the firm's managers as less costly, than externally generated funds. 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 model, debt causes own investment to decrease and rival investment to increase. The same result would occur with quantity setting firms, 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 costs, are present. In Kovenock and Phillips, increasing debt payments in low demand states increases the cost of investment and helps alleviate an agency induced over-production problem. The empirical predictions are higher profits for both firms, higher investment for the rival firm, and lower investment for the high-debt firm.

1.1.2 Plant-level productivity and capacity utilization. Several authors have predicted that productivity and capacity utilization are the primary exogenous factors that effect plant closing and investment. 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 on exit. 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 sunk fixed capital had higher survival probabilities when faced with the strong decline in demand during the Depression. In addition to examining capital structure, we thus examine the influence of plant-level productivity, plant size, and industry capacity utilization, on investment and exit decisions. 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.

[11] Capacity or scale adjustment is not the only interpretation that is consistent with the use of the Brander–Lewis model. Other models of investment share the same implications within the Brander and Lewis framework. For instance, reasonable specifications of standard models of cost-reducing investment [see, for instance, the case of no spillovers in d'Aspremont and Jacquemin (1988)] also have the property that increases in debt would lead to more aggressive own-firm behavior and passive rival-firm behavior.

1.1.3 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.

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. Using a simulation, they conclude that large firms may require substantial scale economies in order to reverse this finding.[12] Whinston shows that with the existence of multiplant firms no strong prediction emerges. Who exits first depends on a number of market structure factors, including the size of the firms and the number of plants per firm. In our analysis, we include both these variables as control variables.

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. We examine both investment and closing 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's analysis of the option to close a copper mine. 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. Our article does not attempt to directly estimate real option models, but rather tests whether demand and the variance of output prices in these industries influence investment and plant closing decisions.

1.2 The econometric specification

We estimate logistic and random effects probit regressions to identify factors that influence plant closings. The dependent variable equals

[12] Other models include Reynolds (1988), Ghemawat and Nalebuff (1990), and Hunsaker and Kovenock (1994). Lieberman (1990) and Hayes (1992) empirically examine plant closure in declining industries.

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 firm. As discussed in the theory section, in addition to variables capturing the capital structure changes, we include variables that capture plant-level efficiency, capacity utilization, and market structure. After estimating the probit specifications, we estimate the equations using a random effects panel probit model. This model, presented in Equation (1), allows for a random firm effect and equicorrelated errors within panel units [see Butler and Moffitt (1982) and Chamberlain (1984)]. In Equation (1) y^*_{it} is the unobserved value of closing a plant, y_{it} is the realized closure decision, X_{it} is the matrix of K independent variables which influence this decision each period, and u_i is the random firm effect:

$$\begin{aligned} &y^*_{it} = \beta' X_{it} + u_i + v_{it};\ i = 1, \ldots, N;\ t = 1, \ldots, T; \\ &y_{it} = 1 \text{ if } y^*_{it} > 0 \text{ and } 0 \text{ otherwise}; \\ &\mathrm{var}[u_i + v_{it}] = \mathrm{var}[\varepsilon_{it}] = \sigma^2_u + \sigma^2_v; \\ &\mathrm{corr}[\varepsilon_{it}, \varepsilon_{is}] = \rho = \sigma^2_u/(\sigma^2_u + \sigma^2_v). \end{aligned} \tag{1}$$

This model also allows varying observations per firm [an unbalanced panel as in Hsiao (1986)]. The random effects probit model has an advantage over the logit model in that it allows for residual serial correlation within panel units as shown above. A disadvantage of the probit model is its specific distributional assumption based on the normal distribution [see the discussion in Chamberlain (1984), pp. 1270–1282].

A recapitalization variable and interaction variables are included as independent variables in the above specification. To attempt to control for the fact that debt choice is endogenous, we estimate a two-stage regression model replacing the recapitalization variable in the second-stage regression with its predicted value. We use a first-stage regression, given in Equation (2), to predict whether or not a firm recapitalizes.

$$\begin{aligned} z^*_{it} = &\sum_{k=1}^{2} [\beta'_{1k} \text{ (Market concentration)}_{i,t-k} \\ &+ \beta'_{2k} \text{ (Capacity utilization)}_{i,t-k} \\ &+ \beta'_{3k} \text{ (Output price variance)}_{i,t-k} \\ &+ \beta'_{4k} \text{ (Change in Demand)}_{i,t-k}] \\ &+ \beta'_{5} \text{ (Plant productivity)}_{i,t-1} \\ &+ \beta'_{6} \text{ (Firm size)}_{i,t} + \varepsilon_{it}; \\ z_{it} = &\ 1 \text{ if } z^*_{it} > 0 \text{ and } 0 \text{ otherwise}; \end{aligned} \tag{2}$$

In this first-stage recapitalization logistic regression, z_{it}^* is the unobserved value of recapitalizing and z_{it} is the realized recapitalization decision. This equation is estimated using an unbalanced panel logistic regression. In this regression our independent variables capture existing industry and firm conditions, following the specification of Kovenock and Phillips (1995). We include two lags ($k = 2$) of market concentration, capacity utilization, output price variance and industry demand, and one lag of relative plant productivity, along with contemporaneous firm size. Our measure of plant productivity is described below. The rest of the variables are described in detail in the next section.

We replace the debt change variable with the predicted probability of recapitalization in the second-stage regressions [Equation (1) above]. This predicted value is taken to be the measure of capital structure change in these equations. Comparing the results of the estimation using the predicted recapitalization with those using a contemporaneous capital structure change variable allows us to determine whether we are capturing a contemporaneous shock that might cause a firm to recapitalize and alter investment and plant closing decisions.

This two-stage procedure removes the influence of contemporaneous shocks that may influence both the capital structure change and the closure decision and thus impart a spurious causality to the capital structure change. This method does not solve all simultaneity problems. Lagged shocks may also influence predicted capital structure and contemporaneous investment decisions. Accordingly, we estimated other lag structures predicting capital structure change using data from two to four periods prior to the recapitalization (omitting $t - 1$ variables) and found qualitatively similar results.

Central in the above specification is a measure of plant productivity. We follow the procedure used by Caves and Barton (1990) and Lichtenberg and Siegel (1990), with several adjustments, to construct a measure of productivity called total factor productivity (TFP). Our calculations of TFP are described in the data appendix to this article. Unlike Lichtenberg and Siegel we do not require a balanced sample of either firms or plants for our analysis. Using a balanced sample, requiring that a plant is present for all years, potentially introduces a severe source of sample selection bias. New plants or old plants that close are thus not excluded from our sample.

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 given in Equation (3):

$$Q_{it} = A^* L_{1it}^{a_{1i}} L_{2it}^{a_{2i}} \ldots L_{Nit}^{a_{Ni}}; \tag{3}$$

where Q_{it} represents output of plant i, in year t, the quantity $L_{jit}^{a_{ji}}$ $(j = 1, \ldots, N)$ denotes the quantity of input j used in production for plant i, in period t, A 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).[13] 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 that we use, described in the next section, has detailed information on inputs that the firm uses to produce its output. These variables used in the calculations, both outputs and inputs, and how we account for inflation and depreciation are described in detail in the Appendix.

We also estimate limited dependent variable and Tobit censored regression 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% or more 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 that 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 used 10% as a cutoff value and found the results to be similar to those using a 5% 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.

[13] Ideally we would use the actual quantity produced. This data is, however, not available. We do control for changes in prices at the four-digit SIC code level to control for price movements of output produced. We describe the calculations and source of the data used to deflate output and some inputs in the Appendix. Actual input data in quantities is used for labor.

2. Data and Sample Selection

2.1 Plant closing and investment data

We examine exit and investment decisions using data from the Longitudinal Research Database (LRD),[14] 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, the number of employees, and investment broken down by equipment and buildings. Plant-level data 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 manufacturing. Second, coverage is at the plant level and the output is assigned by plants at the four-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 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 more than 250 employees, smaller plants are randomly selected every fifth year to complete a rotating 5-year panel.[15] 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, second, 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

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

[15] 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. The 1982 Census of Manufactures (CM) comprised 4099 plants with a total value of shipments of \$82.958 billion. 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.

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.

2.2 Industry selection

We identified 10 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: First, 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 percentage points through either a leveraged buyout or a leveraged recapitalization. Second, the industry has to produce commodity products. An industry is defined as a commodity industry if the products are easily compared across producers.[16] This criterion reduces the problems of defining the scope of the market in which the firms interact and reduces issues of product differentiation. Third, the industry has to be a manufacturing industry (SIC code between 2000 and 3999). The LRD plant-level data that we are using for this study are only available for manufacturing.

Before proceeding it should be emphasized that, in relating our evidence to theory, the choice of industries examined is based on the primary criterion that at least one of the four largest (by market share) 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 or financial distress.[17] We do not select firms that have high leverage and decreased equity values because of poor product market performance.

The industries and firms involved in recapitalizations were identified by first finding firms that were involved in leveraged buyouts,

[16] 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.

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

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 *Wall Street Journal* 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.

2.3 Empirical specification

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 rival firms (the sum of the value of shipments of all highly leveraged firms divided by the total industry value of shipments less the firm's 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. We also include a variable that interacts the own high leverage variable with the four-firm market share index.

The second class of independent variables that we examine 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.

Our third class of independent variables captures market structure, demand, and demand changes. We include variables that 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.

The market structure variables allow us to test the hypothesis that capital structure is a strategic choice variable that affects competition among firms in an industry. 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 change in demand, and the variance of the output prices. 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 four-digit SIC code. The capacity utilization number is obtained from *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.[18] 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 seven-digit SIC code product level. 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

[18] 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. See the *Annual Survey of Capacity Utilization*, Bureau of the Census, 1989.

a stationary distribution, it should provide a good proxy for output price uncertainty.

3. 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 TFP measures for closures. 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 nonrecapitalizing 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. Thus, the unconditional average TFP of plants closed by recapitalizing and nonrecapitalizing firms is not statistically different.

3.1 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 the period 1979 to 1990 and their total factor productivity are also presented for each industry.[19]

The summary statistics by industry reveal several interesting patterns. First, plant closures represent a fairly large fraction, 25.6%, of the total number of plants operating in 1979. Second, the productivity measure for all plants closed is significantly negative. These numbers are relative to the unclosed plants in the same industry and year. 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 nonrecapitalizing firms.

Table 3 estimates a logistic dependent variable regression to examine plant closing decisions. We aggregate all plant-level variables

[19] In compliance with government disclosure restrictions, we are prohibited from 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 1
Sample characteristics by recapitalization

	Sample of firms	
	Nonrecapitalizing firms	Public recapitalization and LBO firms
Number of firms at time of recapitalization[a]	827	40
Average firm size (value of shipments in $ millions)	220.68	569.77
Average industry concentration index	0.420	0.552
Standard deviation	(0.150)	(0.224)
Number of plants[a]	1482	405
Average plant age (years)[b]	9.04	13.39
Standard error of mean	(0.104)	(0.197)
Total factor productivity		
Average TFP	0.0084	−0.0125
Standard error of mean	(0.0073)	(0.0141)
Number of plant closures (1979–1990)	452	60
Total factor productivity of closures		
Average TFP	−0.2061	−0.2602
Standard error of mean	(0.0284)	(0.0655)
Number of plant openings (1979–1990)[c]	23	0

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 statistics are given for the year prior to the recapitalization for each of the recapitalizing firms. Plant-level data for the nonrecapitalizing industry firms is for the year of the first recapitalization in the same 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 four firms divided by the industry total shipments.

[a]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 five-year panel of firms begins in 1984.

[b]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.

[c]There were 23 explicitly indentified 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.

to the firm level. For productivity, however, we use the productivity level for the firm's least productive plant. Logistic limited dependent variable regressions are estimated to examine the factors which are associated with plant closing decisions for both recapitalizing and nonrecapitalizing 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.[20] In the plant closure analysis, the dependent variable equals one for a firm that closed at least one plant in that year. In the second logit specification

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

Table 2
Productivity and plant closures: summary statistics

Industry	Number of firms (in 1979)	Number of plants (in 1979)	Number 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*** (0.048)	106
Mattresses (2515)	92	110	42	−0.234*** (0.081)	24
Paper mills (2611, 2621, 2631)	157	417	47	−0.256*** (0.065)	59
Oil-based chemicals (2821)	117	209	61	−0.027 (0.090)	35
Glass products (3211, 3221, 3231)	163	316	104	−0.248*** (0.063)	31
Gypsum (3275)	16	74	9	−0.273 (0.270)	61
Roofing and insulation (3296)	23	53	14	−0.147 (0.103)	36
Batteries: car (3691)	67	145	39	−0.181* (0.105)	23
Batteries: consumer (3692)	13	28	5	−0.071 (0.188)	13
Tractor trailers (3715)	117	139	53	−0.149* (0.082)	17
All industries	1000	1996	512	−0.212*** (0.026)	405[a]

Total factor productivity is a relative measure of productivity calculated using a Cobb–Douglas production function at the four-digit SIC code level. Given that TFP is the residual of this production function, the average TFP in an industry 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. *, **, *** average significantly different from zero at the 10%, 5%, and 1% level of significance, respectively, using a two-tailed *t*-test.

[a]There were 60 plant closures by high-debt firms across the 10 industries. Average TFP for these closures was −0.260 with a standard error of 0.066. Average TFP for the 452 plants closed by nonrecapitalizing firms was −0.206 with a standard error of the mean of 0.028. Individual industry data on closures for these high-debt firms cannot be disclosed because of government restrictions regarding the disclosure of confidential data.

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 two lags of capacity utilization, industry price variance, industry concentration, and the change in industry demand, one lag of productivity, and firm size.

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 four-firm market share is negative and significant. Plants are less likely to be closed in industries with high market share by the top four firms. The coefficients on the variables capturing firm size and plant scale show that large plants are less likely to be closed, because the plant scale variable is negative and highly significant. The coefficient estimate on the number of plants is positive and significant, a finding that 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 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. 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.

In logit specification C we replaced the recapitalization variable with the predicted recapitalization variable from our first-stage regression. We do not report the results from the first-stage regression in this article, but discuss the results of that estimation here.[21] We found that our explanatory variables are significant in predicting firm recapital-

[21] Specific results from this regression run in cross section at the time of recapitalization are reported in Kovenock and Phillips (1995).

Table 3
Plant closing decisions, productivity, and capital structure

Variable	Dependent variable: plant closing		
	Logit A	Logit B	Logit C
Industry demand and price variables			
Capacity utilization	−0.023	−0.014	−0.033
	(−3.589)***	(−2.793)***	(−2.70)***
Output price variance	−0.002	−0.004	−0.002
	(−1.092)	(−1.805)*	(−0.899)
Change in output demand	−1.517	−1.233	−0.719
	(−1.659)*	(−1.544)	(−.889)
Market-structure variables			
Lagged industry concentration	−3.405	−3.469	−1.193
	(−5.262)***	(−5.52)***	(−2.794)***
Number of plants owned by firm	0.254	0.261	0.241
	(12.007)***	(14.055)***	(12.757)***
Value of firm shipments	−0.001	−0.001	−0.001
	(−3.857)***	(−3.991)***	(−3.420)***
Productivity variables			
Total factor productivity			
Firm's lowest productivity plant	−0.575		
	(−3.906)***		
Lagged TFP		−0.932	−0.299
		(−5.270)***	(−1.802)*
Relative plant scale	−3.671	−3.141	−3.082
	(−5.008)***	(−5.134)***	(−5.209)***
Maximum plant age	0.058	0.026	0.005
	(4.015)***	(2.061)**	(0.404)
Capital-structure variables			
High-debt dummy variable	0.741	0.412	
	(1.136)	(0.641)	
Predicted capital–structure change			1.497
			(.851)
Capital-structure variable * concentration	0.668	0.319	1.338
	(1.827)*	(1.806)*	(1.910)*
Rival high-debt market share	−0.502	−0.571	−0.556
	(−1.716)*	(−2.057)**	(−1.783)*
Total firm years	10395	8214	8214
Plant closings	476	424	424
Chi-square statistic	557.83	550.34	288.94
Significance level (p-value)	< 1%	< 1%	< 1%

Regressions test the effects productivity and increases in debt on plant closing decisions of recapitalizing firms and other nonrecapitalizing industry firms. Regressions are estimated using a logistic limited dependent variable model. The dependent variable equals one if a firm has closed a plant in that year. Lagged industry concentration is the proportion of industry sales by the top four firms. Total factor productivity 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 two lags of capacity utilization, output price variance, plant productivity, and firm size. Data are yearly from 1979 to 1990. t-statistics are in parentheses. $*$, $**$, $***$ significantly different from zero at the 10%, 5%, and 1% level of significance, respectively, using a two-tailed t-test.

ization, demonstrating that capital structure changes are a response to productivity and market conditions. We found that firms are more likely to recapitalize when they have individual plants of low productivity, when they operate in an industry that is highly concentrated, or when industry capacity utilization is low. The lagged values of productivity, market concentration, capacity utilization, and demand that are included in this regression are highly significant. The significance of the multiple lagged values, up to three years prior to the recapitalization, that are not included in the main regression show that capital structure changes are a result of an adjustment to longer-run changes to supply and demand conditions.

The results of logit specification C with the predicted recapitalization variable are similar to those in the original regression. These results show that the debt change is indeed endogenous and is significantly associated with lagged values of productivity, industry demand, and market structure. Since the results of the estimation using the predicted recapitalization are similar to those using the capital structure variables, we conclude that we not capturing a contemporaneous shock.

We also find that the market share of recapitalizing firms has a significant impact on rival firms' plant closing decisions. 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. Furthermore, the effect of recapitalizations on rival firms' decisions remains significant when including the predicted recapitalization variable as an independent regressor in place of the actual recapitalization in the two-stage procedure described in the methodology section. While we do not control for all possible endogeneity problems, the fact that the market share of highly leveraged rival firms remains significant is consistent with the view that recapitalization is a strategic commitment that has an independent effect on rival firm behavior.

Table 4 indicates the economic significance of the logistic regression results.[22] We compute probabilities of closing a plant holding all other variables besides TFP and debt interaction terms at their sample means. For the nonrecapitalizing firms and the LBO and recapitalizting 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 by 1% for logit specification A and approximately 2% for specification B, as productivity goes from the 90th percentile to the 10th percentile for the

[22] We do not present the economic significance of the regressions with the predicted recapitalization variable because we wanted to focus on actual realizations in this table.

Table 4
Plant closure and productivity: estimated closure probabilities

Total factor productivity	All firms	Nonrecapitalizing firms	LBO and recapitalizing firms[a]
	Sample of firms		
Probabilities estimated 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 estimated 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%

Estimated probabilities of plant closure for firms at the 10th, 25th, 50th, and 90th percentiles of TFP for the full sample of firms 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.

[a]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.

nonrecapitalizing 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 nonrecapitalizing 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 second logit regression. These probabilities incorporate both the debt variable and the debt variable interacted with concentration. These results show that the estimated effects 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.

We reestimate the regressions in Table 3 to control for unbalanced panels and correlation within years for a given firm. Table 5 presents the results estimated using a random effects probit panel dataset model. This specification explicitly captures possible firm-specific random effects. 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. Probit specification A includes the actual recapitalization indicator variable, while specification B replaces the realized recapitalization variable with its predicted value.

Table 5
Plant closing decisions: panel probit estimation

Variable	Dependent variable: plant closing	
	Random effects panel probit model	
	Panel Probit: A	Panel Probit: B
Industry demand and price variables		
Capacity utilization	−0.019	−0.019
	(−13.049)***	(−13.139)***
Output price variance	−0.002	−0.001
	(−1.310)	(−1.302)
Change in output demand	−0.286	−0.276
	(−.719)	(−.687)
Market-structure variables		
Lagged industry concentration	−0.699	−0.730
	(−3.043)***	(−3.296)***
Number of plants owned by firm	0.111	0.110
	(14.061)***	(14.122)***
Productivity variables		
Total factor productivity	−0.137	−0.139
Lowest productive plant: lagged TFP	(−1.936)*	(−1.944)*
Relative plant scale	−1.924	−1.927
	(−8.344)***	(−8.418)***
Maximum plant age	0.029	0.027
	(.445)	(.414)
Capital-structure variables		
High-debt dummy variable	0.192	
	(.509)	
Predicted capital-structure change		0.566
		(.530)
Capital-structure variable * concentration	0.766	0.781
	(1.987)**	(2.028)**
Rival high-debt market share	−0.302	−0.317
	(−1.766)*	(−1.888)**
Joint significance test of capical structure variables (chi-square statistic)	9.662**	14.0***
Total firm years	8214	8214
Plant closings	424	424
Chi-square statistic (full model)	271.34***	272.98***
Chi-square random effects vs. full	12.9***	12.49***

Regressions test the effects of productivity and increases in debt on plant closing decisions of recapitalizing firms and other nonrecapitalizing firms. Regressions are estimated using random effects probit panel data model. This model allows for a random firm effect and different number of observations per firm (an unbalanced panel). The dependent variable equals one if a firm has closed a plant in that year. Lagged industry concentration is the proportion of industry sales by the top four firms. Total factor productivity 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 lagged independent variables. Data are yearly from 1979 to 1990. *t*-statistics are in parentheses. $*$, $**$, $***$ significantly different from zero at the 10%, 5%, and 1% level of significance, respectively, using a two-tailed *t*-test.

The results of this model show that the signs and significance of the coefficients are very similar to those presented in Table 3. The capital structure change variables remain insignificant by themselves and are only significant when interacted with the concentration index, again indicating the importance of market structure.

3.2 Firm-level investment decisions

This section examines the investment decisions of firms in the 10 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 five TFP quintiles. Quintile 1 is thus the average investment rate for the least productive 20% 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 investment. Investment rates are almost monotonically increasing in productivity. The last column shows that investment by firms in the highest productivity quintile is significantly higher than investment by firms in the lowest productivity quintile. These findings remain when total factor productivity is lagged. Firms that are more productive invest more.

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 nonrecapitalizing 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 disinvesting). 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 an LBO or public recapitalization is significant and negative, indicating that high debt firms reduced their investment rate. However, in the third logit specification, predicted capital structure is insignificantly related to investment. Also, in the Tobit specification the capital structure change variable is insignificantly related to investment. These results indicate that the distinction between predicted and realized recapitalization is important. The actual recapitalization variable may capture a contemporaneous shock. The significance of the capital structure variable interacted with market concentration and the significance of the market share of rival leveraged firms, even when including the predicted capital structure, is consistent with the recapitalization having an effect on behavior in concentrated industries.

Table 6
Investment across productivity quintiles

Industry	TFP Quintile 1	TFP Quintile 2	TFP Quintile 3	TFP Quintile 4	TFP Quintile 5	Quintile 5-Quintile 1 Difference
Fabric mills (2211, 2221, 2231)	−0.055	0.041	0.061	0.072	0.040	0.094**
	(0.018)	(0.11)	(0.009)	(0.010)	(0.013)	(0.022)
Mattresses (2515)	0.019	0.062	0.111	0.100	0.139	0.120*
	(0.035)	(0.036)	(0.029)	(0.032)	(0.047)	(0.058)
Paper mills (2611, 2621, 2631)	0.062	0.074	0.083	0.075	0.103	0.041*
	(0.017)	(0.009)	(0.007)	(0.007)	(0.008)	(0.019)
Oil-based chemicals (2821)	0.023	0.041	0.072	0.120	0.148	0.125**
	(0.021)	(0.015)	(0.013)	(0.018)	(0.024)	(0.032)
Glass products (3211, 3221, 3231)	0.026	0.101	0.099	0.127	0.125	0.099**
	(0.022)	(0.017)	(0.018)	(0.016)	(0.021)	(0.031)
Gypsum (3275)	0.088	0.117	0.079	0.067	0.064	−0.024
	(0.044)	(0.021)	(0.023)	(0.025)	(0.020)	(0.049)
Roofing and insulation (3296)	−0.026	0.056	0.076	0.089	0.041	0.067
	(0.045)	(0.028)	(0.012)	(0.029)	(0.033)	(0.056)
Batteries: car (3691)	−0.025	0.061	0.094	0.093	0.083	0.108*
	(0.036)	(0.023)	(0.022)	(0.021)	(0.030)	(0.046)
Batteries: consumer (3692)	0.009	.084	.092	.090	.146	.136
	(0.069)	(0.040)	(0.018)	(0.054)	(0.056)	(0.088)
Tractor trailers (3715)	−0.105	−0.004	0.091	0.170	0.166	0.271**
	(0.034)	(0.036)	(0.033)	(0.037)	(0.036)	(0.050)
All industries	0.005	0.062	0.082	0.096	0.100	0.094**
	(0.008)	(0.006)	(0.005)	(0.006)	(0.007)	(0.011)

This table shows the average investment rates for each five TFP quintiles. Quintile 1 thus represents the average investment rate for the 20% 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.
*, **, difference between Quintiles 5 and 1 are significantly different from zero at the 5% and 1% level of significance, respectively, using a two-tailed t-test.

Table 7
Investment decisions, productivity, and capital structure

Variable	Dependent variable: investment > 5% beginning assets			
	Logit A	Logit B	Logit C	Tobit
Industry demand and price variables				
Capacity utilization	0.003	0.004	0.002	0.007
	(1.316)	(1.845)*	(0.474)	(2.104)*
Output price variance	−0.002	−0.002	−0.007	−0.002
	(−1.902)*	(−2.361)**	(−3.639)**	(−1.997)**
Change in output demand	−0.093	−0.197	−0.083	−0.034
	(−0.259)	(−0.513)	(−0.977)	(−0.675)
Market-structure variables				
Lagged industry concentration	0.381	0.226	0.050	0.163
	(1.503)	(0.808)	(1.062)	(4.279)***
Number of plants owned by firm	0.099	0.092	0.024	0.059
	(7.292)***	(6.568)***	(6.744)***	(3.931)***
Firm market share	−1.829	−1.775	−0.544	−0.253
	(−2.473)**	(−2.273)**	(−2.950)***	(−2.688)***
Total firm shipments	0.0001	0.0001	0.0001	−0.00005
	(0.847)	(0.698)	(1.406)	(−2.799)***
Productivity variables				
Total factor productivity	0.211			
Firm's lowest productivity plant	(3.049)***			
Lagged TFP		0.269	0.050	0.024
		(3.168)***	(2.750)***	(2.105)**
Relative plant scale	1.599	1.719	0.371	0.129
	(8.529)***	(8.294)***	(7.998)***	(5.251)***
Maximum plant age	−0.014	−0.003	0.001	−0.080
	(−3.032)***	(−0.645)	(1.077)	(−10.451)***
Capital-structure variables				
High-debt dummy variable	−0.641	−0.596		0.003
	(−1.863)*	(−1.709)*		(−0.071)
Predicted capital-structure change			−0.120	
			(−0.427)	
Capital-structure variable * concentration	−0.492	−0.309	−0.231	−0.103
	(−3.932)***	(−2.182)**	(−3.049)***	(−4.708)***
Rival high-debt market share	0.650	0.464	0.062	0.081
	(2.496)**	(1.654)*	(1.677)*	(2.118)**
Total firm years	10395	8220	8220	8220
Years investment > 5% assets	5961	4604	4604	
Chi-square statistic	432.85	368.08	278.60	na
Significance level (p-value)	< 1%	< 1%	< 1%	

Regressions test the effects of productivity and increases in debt on investment decisions of recapitalizing firms and other nonrecapitalizing 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 four firms. Total factor productivity 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 two lags of capacity utilization, output price variance, plant productivity, and firm size. Data are yearly from 1979–1990. t-statistics are in parentheses. $*$, $**$, $***$ 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.

Kaplan (1989) finds that LBO firms decrease their investment subsequent to the debt increase. Our results add evidence on where this decreased investment is present. We find that the negative association between investment and the recapitalization is significant in highly concentrated industries. We also examine 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 that measures the share of output of highly leveraged firms. We find a positive association between debt and rival firms' investment. Investment is higher as the market share of 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.

These results are consistent with several different but not mutually exclusive theories. The results are consistent with decreased investment following the recapitalizations. In Myers (1977), debt has a negative effect on investment in industries with growth options. In industries where these growth options have decreased, increased debt may be associated with decreased investment. 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.

However, we do not find unqualified support for a decreased investment and high debt association independent of market structure. We find that the negative association between investment and the recapitalization is present in concentrated industries. The importance of this interaction between concentration and increased debt points to an effect working through market structure. The evidence in this article suggests that the agency problems are more prevalent in concentrated industries, where the discipline of the market does not weed out nonoptimizing firms. A firm recapitalizing in a concentrated industry exhibits more passive investment behavior. 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 nonrecapitalizing firms and the LBO and recapitalizing 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 shows that the probability of investing for the recapitalizing firms increases from 37.8% to 40.6% as TFP increases from the

Table 8
Investment and productivity: estimated probabilities

	Sample of Firms		
Total factor productivity	All firms	Nonrecapitalizing firms	LBO and Recapitalizing firms[a]
Probabilities estimated from Table 6, logit regression A, with lowest productivity plant			
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 estimated 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%

Estimated probabilities of investing a minimum of 5% of assets for firms at the 10th, 25th, 50th, and 90th percentiles of TFP for the full sample of firms and by whether the firm recapitalized, increasing its debt. The time period covered is 1979 to 1990. Probabilities are computed holding all other variables besides TFP and debt interaction terms at their sample means. For the nonrecapitalizing firms and the LBO and recapitalizing 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.
[a]For the recapitalizing 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.

10th to the 90th percentile. The probability of investing at the 10th percentile of TFP is 59.5% for the nonrecapitalizing 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 second 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 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." Probit specification A includes the actual recapitalization indicator variable, while specification B replaces the realized recapitalization variable with its predicted value. The results of this model show that the signs and significance of the coefficients are very similar to the nonrandom effects models. However, the capital structure change variables are insignificant for both the actual and predicted specifications. The variable capturing the interaction between capital structure and market concentration is significant and negative, signifying decreased investment by recapitalizing firms in highly concentrated industries. Finally the variable "market share of leveraged rivals," which captures the effect on rival firms, is significant and positive, again emphasizing a strategic effect on rival firms. Rival firms expand investment when faced with highly leveraged firms.

4. Conclusions

This article provides an analysis of how capital structure choices and product market characteristics relate to investment and plant closing decisions. Our analysis takes explicit account of changes in industry demand, plant-level efficiency, market structure, and actual and predicted capital structure changes. We investigate product market behavior following financial recapitalizations by firms that have had substantial increases in debt through leveraged buyouts and leveraged recapitalizations. The results show that single-period models and empirical analyses of changes in capital structure do not capture the adjustment process to new demand and supply conditions without controlling for market structure. The empirical evidence adds to the evidence presented by Kaplan (1989) on capital structure changes and to the evidence from Chevalier (1995) and Phillips (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 is positive and significant when we interact the debt variables with market concentration variables. 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 in highly concentrated industries. Second, there is a significant positive association between rival firms' investment and a recapitalizing firm's increase in leverage. Firms are more likely to increase their investment when rival firms have high debt. Our results are consistent with strategic models of capital structure in which debt commits leveraged firms to behave less aggressively in product markets. These strategic effects of debt financing emphasize the point that firms do not operate in isolation. Firms' decisions, both real and financial, are taken into consideration by competing firms.

Table 9
Investment decisions: panel probit estimation

Variable	Dependent Variable: Investment > 5% Beginning Assets	
	Random effects panel probit model	
	Panel probit A	Panel probit B
Industry demand and price variables		
Capacity utilization	0.010	0.001
	(0.906)	(0.899)
Output price variance	−0.002	−0.002
	(−2.818)***	(−2.846)***
Change in output demand	−0.292	−0.300
	(−1.162)	(−1.191)
Market-structure variables		
Lagged industry concentration	−0.111	−0.104
	(−0.643)	(−0.610)
Number of plants owned by firm	0.084	0.084
	(8.331)***	(8.276)***
Firm market share	−1.848	−1.772
	(−2.738)***	(−2.613)***
Productivity variables		
Total factor productivity	0.138	0.138
Lowest productive plant: lagged TFP	(2.398)**	(−2.399)**
Relative plant scale	1.469	1.464
	(9.119)***	(9.085)***
Maximum plant age	−0.006	−0.006
	(−1.236)	(−1.256)
Capital-structure variables		
High-debt dummy variable	−0.059	
	(−0.212)	
Predicted capital-structure change		−0.654
		(−0.504)
Capital-structure variable * concentration	−0.373	−0.466
	(−0.647)	(−1.890)*
Rival high-debt market share	0.390	0.381
	(1.892)*	(1.855)**
Joint significance test of capital-structure variables (chi-square statistic)	9.6**	14.0***
Total firm years	8220	8220
Years investment > 5% assets	4604	4604
Chi-square statistic (full model)	277.18***	275.95***
Chi-square random effects vs. full	686.14***	687.68***

Regressions test the effects of productivity and increases in debt on investment decisions of recapitalizing firms and other nonrecapitalizing 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 one 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 four firms. Total factor productivity is calculated assuming a Cobb–Douglas production function. Plant scale is the average for the firms 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 lagged independent variables. Data are yearly from 1979 to 1990. t-statistics are in parentheses. $*$, $**$, $***$ significantly different from zero at the 10%, 5%, and 1% level of significance, respectively, using a two-tailed t-test.

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 article 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.

Our results give qualified support to the predictions of Myers (1977) about the effect of debt on investment varying with industry characteristics. We also find qualified support for Jensen's (1993) predictions about the importance of technological productivity, capacity utilization, and capital structure in explaining industry adjustment to new demand conditions. The evidence in this article suggests that capital structure may have more of a role in influencing investment and closure in concentrated industries, where the discipline of the market may not weed out nonoptimizing firms. 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 models in which debt commits the leveraged firms to behave less aggressively and decrease investment.

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. We find that these lagged values are significantly associated with the recapitalization decision, showing that capital structure and investment decisions are the result of an adjustment to long-run supply and demand conditions. 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 captures contemporaneous shocks to industry demand and supply conditions. Our main conclusions, the negative association between recapitalization and own-firm investment in concentrated industries, and the positive association between recapitalization and rival firms' investment, remain significant. Rival firms invest more and are less likely to close plants subsequent to recapitalizations in highly concentrated industries.

We wish to emphasize that the effects and results in this article are sensitive to industry-specific market structures, cost and size asymmetries, as well as the dynamics of costly industry adjustment. An estimation of a dynamic model that explicitly takes into account the adjustment to industry demand and supply shocks is the next step in understanding the role of capital structure. By directing attention to plant-level and industry-specific factors we hope to provide a clearer picture of how industry structure and industry supply and demand conditions influence the extent and nature of the role that capital structure plays in investment and product market decisions.

Appendix: Total Factor Productivity Calculations

We calculate 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 only 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 because 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 two-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 for 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 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 two-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.

References

Allen, B., R. Deneckere, T. Faith, and D. Kovenock, 1994, "Capacity Precommitment as a Barrier to Entry: A Bertrand-Edgeworth Approach," Tinbergen Institute Discussion Paper no. 94-125.

Baker, G. P., and K. H. Wruck, 1989, "Organizational Changes and Value Creation in Leveraged Buyouts: The Case of the O. M. Scott & Sons Company," *Journal of Financial Economics*, 25, 163–190.

Bartelsman, E. J., and W. Gray, 1994, "NBER Manufacturing Productivity Database," mimeo.

Bolton, P., and D. Scharfstein, 1990, "A Theory of Predation Based on Agency Problems in Financial Contracting," *American Economic Review*, 80, 93–106.

Brander, J., and T. Lewis, 1986, "Oligopoly and Financial Structure," *American Economic Review*, 76, 956–970.

Brander, J., and T. Lewis, 1988, "Bankruptcy Costs and the Theory of Oligopoly," *Canadian Journal of Economics*, 21, 221–243.

Brennan, M. J., and E. S. Schwartz, 1985, "Evaluating Natural Resource Investments," *Journal of Business*, 58, 135–157.

Bresnahan, T. F., and D. M. G. Raff, 1993, "Technological Heterogeneity, Adjustment Costs, and the Dynamics of Plant Shutdown Behavior: The American Motor Vehicle Industry in the Time of the Great Depression," working paper, Stanford University.

Butler, J. S., and R. Moffitt, 1982, "A Computationally Efficient Quadrature Procedure for the One-Factor Multinomial Probit Model," *Econometrica*, 50, 761–764.

Caves, R. E., and D. R. Barton, 1990, *Efficiency in U.S. Manufacturing*. MIT Press, Cambridge, Mass.

Chamberlain, G., 1984, "Panel Data," in Z. Griliches and M. D. Intriligator (eds.), *Handbook of Econometrics* (vol. 2), Elsevier Science, New York, 1247–1318.

Chevalier, J., 1995, "Debt and Product Market Competition: Local Market Entry, Exit, and Expansion Decisions of Supermarket Chains," *American Economic Review*, 85, 415–435.

d'Aspremont, C., and A. Jacquemin, 1988, "Cooperative and Noncooperative R&D in Duopoly with Spillovers," *American Economic Review*, 78, 1133–1137.

DeAngelo, H., and L. DeAngelo, 1991, "Union Negotiations and Corporate Policy: A Study of Labor Concessions in the Domestic Steel Industry During the 1980s," *Journal of Financial Economics*, 26, 3–43.

Dixit, A., 1989, "Entry and Exit Decisions under Uncertainty," *Journal of Political Economy*, 97, 620–638.

Ghemawat, P., and B. Nalebuff, 1985, "Exit," *Rand Journal of Economics*, 16, 184–194.

Ghemawat, P., and B. Nalebuff, 1990, "The Devolution of Declining Industries," *Quarterly Journal of Economics*, 105, 184–186.

Harrigan, K. R., 1980, "The Effect of Exit Barriers upon Strategic Flexibility," *Strategic Management Journal*, 1, 165–176.

Harrigan, K. R., 1988, *Strategies for Declining Businesses*, Lexington Books, Lexington, Mass.

Harrigan, K. R., and M. E. Porter, 1983, "End-Game Strategies for Declining Industries," *Harvard Business Review*, 61, 112–120.

Harris, M., and A. Raviv, 1991, "The Theory of Capital Structure," *Journal of Finance*, 46, 297–355.

Hayes, J., 1992, "Do Firms Play Exit Games? Some Evidence on Exit Games and the Strategic Role of Size," working paper, University of Wisconsin.

Hsiao, C., 1986, *Analysis of Panel Data*. Cambridge University Press, Cambridge.

Hunsaker, J., and D. Kovenock, 1994, "The Pattern of Exit from Declining Industries," mimeo, Purdue University.

Jensen, M. C., 1986, "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers," *American Economic Review*, 76, 323–329.

Jensen, M. C., 1993, "The Modern Industrial Revolution and the Challenge to Internal Control Systems," *Journal of Finance*, 48, 831–880.

Kaplan, S. N., 1989, "The Effects of Management Buyouts on Operating Performance and Value," *Journal of Financial Economics*, 24, 217–254.

Kim, M., and V. Maksimovic, 1990, "Debt and Input Misallocation," *Journal of Finance*, 45, 795–816.

Kovenock, D., and G. Phillips, 1995, "Increased Debt and Product-Market Rivalry: How Do We Reconcile Theory and Evidence," *American Economic Review*, 85, 403–408.

Leibenstein, H., 1966, "Allocative Efficiency vs. 'X-Efficiency'," *American Economic Review*, 56, 392–415.

Lichtenberg, F. R., and D. Siegel, 1990, "The Effects of Leveraged Buyouts on Productivity and Related Aspects of Firm Behavior," *Journal of Financial Economics*, 27, 165–194.

Lieberman, M., 1990, "Exit from Declining Industries: "Shakeout" or "Stakeout"?," *Rand Journal of Economics*, 21, 538–554.

Long, W. F., and D. J. Ravenscraft, 1993, "Decade of Debt: Lessons from LBOs in the 1980s," in M. Blair (ed.), *The Deal Decade: What Takeovers and Leveraged Buyouts Mean for Corporate Governance*, Brookings Press, Washington, D.C., pp. 205–238.

McDonald, R., and D. Siegel, 1986, "The Value of Waiting to Invest," *Quarterly Journal of Economics*, November, 707–727.

Maksimovic, V., 1986, "Capital Structure in a Stochastic Oligopoly," Ph.D. dissertation, Harvard University.

Maksimovic, V., 1988, "Capital Structure in Repeated Oligopolies," *Rand Journal of Economics*, 19, 389–407.

Maksimovic, V., 1995, "Financial Structure and Product Market Competition," in R. Jarrow, V. Maksimovic, and W. Ziemba (eds.), *Handbook of Finance*, North-Holland, Amsterdam.

McGuckin, R. H, and G. Pascoe, 1988, "The Longitudinal Research Database: Status and Research Possibilities," *Survey of Current Business.*

Myers, S., 1977, "Determinants of Corporate Borrowing," *Journal of Financial Economics*, 5, 147–175.

Myers, S., 1984, "The Capital Structure Puzzle," *Journal of Finance*, 39, 575–592.

Ofek, E., 1993, "Capital Structure and Firm Response to Poor Performance: An Empirical Analysis," *Journal of Financial Economics*, 34, 3–30.

Opler, T., 1993, "Controlling Financial Distress Costs in Leveraged Buyouts with Financial Innovation," *Financial Management*, 22, 79–90.

Opler, T., and S. Titman, 1994, "Financial Distress and Corporate Performance," *Journal of Finance*, 49, 1015–1040.

Phillips, G. M., 1995, "Increased Debt and Industry Product Markets: An Empirical Analysis," *Journal of Financial Economics*, 37, 189–238

Pindyck, R. S., 1988, "Irreversible Investment, Capacity Choice, and the Value of the Firm," *American Economic Review*, 78, 969–985.

Poitevin, M., 1989, "Financial Signaling and the "Deep-Pocket" Argument," *Rand Journal of Economics*, 20, 26–40.

Reynolds, S., 1988, "Plant Closings and Exit Behavior in Declining Industries," *Economica*, 55, 493–503.

Rodin, D., 1992, "The Effects of Leveraged Buyouts on Firm Investment," Ph.D. dissertation, Purdue University.

Schary, M. A., 1991, "The Probability of Exit," *Rand Journal of Economics*, 22, 339–353.

Shapiro, C., 1989, "Theories of Oligopoly Behavior," in R. Schmalensee and R. D. Willig (eds.), *Handbook of Industrial Organization*, North-Holland, Amsterdam, pp. 329–410.

Tirole, J., 1988, *The Theory of Industrial Organization*, MIT Press, Cambridge, Mass.

Whinston, M. D., 1988, "Exit with Multiplant Firms," *Rand Journal of Economics*, 19, 568–588.

Zingales, L., 1995, "Survival of the Fittest or the Fattest? Exit and Financing in the Trucking Industry," mimeo, University of Chicago.