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Does Firms' Financial Status Affect Plant-Level Investment and Exit Decisions?*

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Abstract: This paper investigates the influence of a firm's financial status on the within-firm allocation of funds, reflected in its plant-level investment and exit decisions. In the empirical analysis, financial status is measured by both standard measures and an indicator variable recently suggested by Kaplan and Zingales. Based on these firm-level financial variables and on plant-level investment and production data from the U.S. Census Bureau's Longitudinal Research Database (LRD), econometric models of plant operating regimes are estimated which summarize investment and exit decisions. The empirical evidence supports the view that firm-level financial status affects investment and market exit decisions observed at the plant level.

Keywords: investment; divestiture; financial constraints

JEL classification: D92; E44; G31

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1 Introduction

The effects of financial constraints on firm behavior have received much attention in recent years.[1] There are essentially three different levels of aggregation at which these effects have been investigated. At the micro (firm) level, the availability of outside finance has been identified as a major determinant of firm growth and survival. Because of financial constraints, firms may be prevented from realizing promising projects they have at hand, or even from undertaking R&D in the first place. Once a firm has started an investment project or entered a market with a new product, it may still be driven out because of a lack of funds. Both effects of incomplete capital markets are – at first sight – not desirable from a welfare view. This leads to the industry level, where both industrial and financial economists have studied the role of capital markets in industrial restructuring; these models also rely on a link between the firm's financial status and its investment policies. Welfare implications of financial constraints can be different here: Financial constraints (i. e., the fact that pressure is put on firms' management by outside suppliers of funds) can prevent overinvestment in general, and can help to reduce excess capacity in declining industries by forcing firms to exit. These effects of financial constraints involve efficiency gains and might increase aggregate welfare (although the latter issue is subject to an ongoing debate). Finally, there is a large macroeconomic literature which identifies the sensitivity of investment to the firm's financial status as a central part of the credit (or lending) channel of monetary policy transmission. These models argue that imperfections in capital markets, resulting for example in credit constraints, can lead to or exacerbate business cycle fluctuations by propagating relatively modest monetary (and in some models, also real) shocks.

While there are quite a few theoretical models of the influence of financial constraints on firm investment (with important policy implications at the firm, industry, and macro levels), empirical evidence is still mixed. There are, however, several empirical studies which confirm the sensitivity of firm investment to financial constraints. A prominent example is the paper by Fazzari *et al.* (1988); they were the first to report empirical evidence on the existence of credit rationing using firm panel data. Their empirical approach has since been refined along various dimensions. The objective of this paper is to assess whether a firm's financial status influences its investment and exit decisions at the plant level. By doing this, it addresses some objections that have been raised against earlier empirical tests of financial constraints in the tradition of Fazzari *et al.* (1988). In particular, it takes up the following issues:-

1. Using firm-level data might introduce aggregation biases into empirical models of investment decisions. The dynamics of investment spending at the plant level seem

[1] Hubbard (1998) provides a detailed review of the theoretical and empirical literature on firm investment and financial constraints.

to be much richer than firm-level data would suggest. It is therefore likely that the effects of financial constraints are most severe at the plant level and at least partially washed out when investment is aggregated to the firm level.

2. Most studies of financial constraints and investment decisions have used balanced panels of continuing firms, hence ignoring selection biases due to endogenous market exits (which might well be related to the firm's financial status). At the same time, market exits are more likely to occur at the plant level first: Before an entire firm is closed, it is likely that some of its plants are closed or sold.

3. The standard approach to identifying financially constrained firms uses indicators such as firm size or some balance-sheet variable (e. g., the dividend payout ratio or leverage) as a sample-split criterion. This approach has been challenged by Kaplan and Zingales (1997); they propose an alternative measure of a firm's financial status. In their view, its main advantages are, first, that it takes into account non-balance sheet information, and second, that it is allowed to vary over time, reflecting changes in macroeconomic conditions and/or the firms' financial policies.[2]

The empirical approach to analyzing firm behavior under financial constraints suggested in this study addresses these issues in a consistent framework, a joint model of firms' investment and market exit decisions. The sample used in this study is essentially that considered by Kaplan and Zingales (1997), which is, in turn, based on the group of firms identified as being financially constrained by Fazzari *et al.* (1988). The dataset itself consists primarily of plant-level data on output and factor inputs, including investment spending, for all plants owned by these firms during the 1972–84 period. These plant-level observations, taken from the U.S. Census Bureau's Longitudinal Research Database (LRD), are matched with data on the respective firm's financial status. Firm-level data are, first, the ordinal financial status indicator constructed by Kaplan and Zingales, and second, for comparison with standard approaches, balance-sheet variables from Compustat.

This research strategy follows Kaplan and Zingales by focusing on the effects of capital market imperfections on investment (rather than trying to identify the sources of the capital market imperfections at work). The central simplifying assumption needed to make the model operational is that the firm's financial decisions are separated from the structural model of plant-level investment and exit decisions. This approach does not amount to a full structural model of firm behavior, but it allows for a consistent treatment of investment and exit decisions at the plant level, taking firm-level financial status as given.

The remainder of this paper is structured as follows. Section 2 reviews empirical studies of firm investment under financial constraints and discusses some problems associated with

[2] Their arguments are reviewed below in Section 2.

the measurement of firms' financial status, with the endogeneity of exit decisions, and with the use of firm-level data in empirical investment models. The empirical approach taken here, matching firm and plant-level data, and the resulting dataset are described in Section 3. Estimation results for various models of plant-level operating and investment decisions are presented in Section 4. Section 5 concludes.

2 Empirical tests for financial constraints: A review

In this section, I present a selective review of the empirical literature on financial constraints and firm investment. Its main purpose is to discuss some recurrent methodological problems which I attempt to address in this study.

The early empirical literature on financially constrained firms focused on the leading special case, credit rationing (defined as a situation in which borrowers cannot borrow as much as they would like given an unconstrained optimization model with complete financial markets). It is clear that finding empirical evidence on whether credit rationing exists is difficult even in absence of any measurement problems: Only the amount of credit that is actually transacted can be observed, but – by assumption – not the amount that is demanded. A standard approach to address this problem is to estimate a reduced-form equation of firm investment which includes some variable assumed to reflect credit rationing, or more generally, financial constraints. This approach has been introduced by Fazzari *et al*. (1988). They use cash-flow as a proxy for the availability of internal funds; the hypothesis to be tested is that investment of firms that are rationed on credit markets is more sensitive to variations of internal funds than the investment of firms that are not subject to credit constraints. The investment equation basically explains investment as a function of Tobin's (marginal) q (i. e., the ratio of firm value and capital stock) which is the central determinant of firm investment in standard neoclassical models, and cash flow. The sample is split into three subsamples according to the dividend payout ratio. This allows to test whether the investment of low-payout firms is sensitive to the availability of internal funds because they are constrained on markets for outside finance. Very broadly speaking, Fazzari *et al.* find that financing constraints in capital markets affect investment.

The validity of standard reduced-form models of firm investment has been questioned by many studies in recent years. An alternative to reduced-form estimation is to derive testable relationships from structural models of firm behavior. The resulting intertemporal optimality conditions (Euler equations) link marginal adjustment costs in adjacent periods and do not depend on the unobserved shadow value of capital that enters Tobin's q. Such structural models have been used to test for the effects of financial constraints as well, mostly confirming their existence; examples are papers by Whited (1992) and Bond and Meghir (1994). Leaving the econometric problems of reduced-form and structural models of firm investment aside, the central empirical issue in this literature is the identification of financially constrained firms. I take up this point next, before turning to the role of endogenous market exit decisions and aggregation biases.

2.1 Identification of financially constrained firms

A broad characterization of financially constrained firms is that their costs of external funds are higher than their costs of internal funds (i. e., cash flow). Starting with the seminal paper by Fazzari *et al.* (1988), many empirical tests of the sensitivity of investment to the availability of internal funds use sample-split approaches to identify financially constrained firms. The criterion used by Fazzari *et al.* (1988) is the firm's dividend-income ratio. The rationale is that "if the cost disadvantage of external funds is large, it should have the greatest effect on firms that retain most of their income. If the cost disadvantage is slight, then retention practices should reveal little about financing practices, q values, or investment behavior." (p. 158) Using the dividend-income ratio criterion, they divide their sample of 422 firms (those continuously contained in the Valueline database over the 1970–84 period) into three subsamples. The classification scheme is reproduced in Table 1.

`Insert Table 1 about here.`

Kaplan and Zingales (1997) criticize both the theoretical foundation of the test strategy proposed by Fazzari *et al.* (1988) and the empirical implementation of the sample-split criterion. They argue that the fundamental assumption of this literature, namely that the investment-cash flow sensitivity (tested by either reduced-form or structural methods) increases monotonically with the degree of financing constraints, is theoretically ill-posed. While it is clear that a financially constrained firm's investment should be sensitive to internal cash flow and an unconstrained firm's investment should not, it is not clear that the degree of this sensitivity should vary with the degree of financial constraints. Given that investment of the vast majority of firms analyzed by Fazzari *et al.* (1988) is sensitive to cash flow, this monotonicity assumption is crucial for standard sample-split approaches to be valid.

The central idea of Kaplan and Zingales's (1997) approach is to construct an ordinal measure for the financial status of firms that conveys more information than the sample-split approach. Their scheme "is designed to distinguish relative differences in the degree to which firms are financially constrained" (p. 173); they use a variety of sources "to derive as complete a picture as possible of the availability if internal and external funds for each firm as well as each firm's demand for funds." (p. 170) In addition to standard balance-sheet information such as leverage and cash flow, they use complementary sources of information. These are management's letters to the shareholders, the discussion of liquidity and financial status in annual reports, the 10-K reports that most publicly traded corporations in the U.S. have to file annually with the SEC, and other sources such as publicly available news pieces (taken from the Wall Street Journal Index). In the 10-K reports, for example, firms are explicitly required to discuss their liquidity, capital resources, and results of operations.

Kaplan and Zingales use this information to construct an ordinal indicator that groups each firm-year observation into one of five categories (the exact definitions are listed in Table 2). The 49 firms considered by Kaplan and Zingales are those classified as financially constrained by FHP because of their low dividend-income ratios, i. e., the 49 Class 1 firms in Table 1.

`Insert Table 2 about here.`

The most important result of this new classification scheme is that surprisingly few firms are financially constrained, both on an annual basis and over the entire sample period. Table 2 shows that less than 15 % of all firm-year observations are classified as possibly, likely, or definitely financially constrained. Based on this annual financial status indicator, Kaplan and Zingales also assign the 49 firms to three groups according to their overall financial situation over the entire 1970–84 period. Kaplan and Zingales find 19 firms to be not or likely not financially constrained over the entire sample period, while only 22 firms (less than half of the sample) have some years during which they were likely financially constrained or definitely financially constrained. The main finding reported by Kaplan and Zingales is that those firms they classify as *less* financially constrained show *higher* sensitivities of investment to cash flow. In Kaplan and Zingales's view, this result contradicts the results of existing empirical studies which argue that investment is sensitive to internal finance when a firm is financially constrained.

An interesting feature of Kaplan and Zingales's classification scheme is the fact that the financial status variable varies over time. It turns out that the financial status histories of the 49 firms in the sample are quite heterogenous. For example, even most Group 3 firms have spells during which they were *not* classified as being financially constrained or likely financially constrained. These observations highlight the fact that a time-varying measure such as the financial status indicator by Kaplan and Zingales conveys much more detailed information about firms' financial situation than standard sample-split approaches.

The financial status variable constructed by Kaplan and Zingales has been criticized for a number of reasons.[3] First of all, the classification scheme is highly judgemental, and as no specific guidelines for the classification were reported by Kaplan and Zingales, their approach is difficult to replicate for other samples of firms. Arguably, the most important question that arises is whether in the data sources used by Kaplan and Zingales, managers

[3] See the response by Fazzari *et al.* (1996). Note that this response was based on an earlier version of the paper, Kaplan and Zingales (1995). In the published version, Kaplan and Zingales (1997) address some, but not all, of the concerns brought forth by Fazzari *et al.*

report truthfully on their financial status.[4] Also, Fazzari *et al.* argue that the criterion emphasizes financial distress rather than financing constraints. A more general objection by Fazzari *et al.* is that given the problems they see with the definition of the financial status indicator, Kaplan and Zingales make unrealistically fine distinctions in the firm's availability of finance. In particular, they question whether there is enough time variation in firms' financial policies to warrant the use and interpretation of an *annual* financial status variable. Finally, Fazzari *et al.* raise some doubts about the econometric results obtained by Kaplan and Zingales using their new indicator. (However, this objection is not related to the indicator itself, but rather to econometric problems.)

Despite these objections, it seems worthwhile to further investigate the new indicator variable constructed by Kaplan and Zingales. In particular, it will be interesting to see whether variations in this variable over the sample period help to explain firms' investment decisions. Such a finding would confirm that the new variable contains useful information about firms' financial status and that financial status – as defined and measured by Kaplan and Zingales – indeed affects investment.

2.2 The role of endogenous exit decisions

When models of firm investment are estimated using panel data, the researcher usually faces some sort of panel attrition, resulting in unbalanced panels. There are several reasons for panel attrition: A firm or plant might leave a market or go bankrupt, it may be sold to a new owner, or firm representatives might just refuse to fill in questionnaires any more. Only the last event can reasonably be considered exogenous (although in some instances there might be some sort of endogeneity involved). All other forms of panel attrition must be considered endogenous (non-random) events.

The resulting selection problems are clearly relevant in empirical studies of investment and financial constraints. For example, most existing studies use panels of continuing firms, excluding any exits from the analysis, although exit might well be endogenous with respect to financial status. A crude approach to deal with this issue is to ignore the selection problem when estimating the model, but to assess the direction of the resulting biases when interpreting the results. For example, Chirinko and Schaller (1995) – in a panel study of Canadian firms – note that "by eliminating firms for which data are not available for the entire sample period, we may introduce a survivor bias. Since survivors will tend to underrepresent young firms who are more likely to face information problems in capital markets, our procedure tends to be biased against finding evidence of finance constraints" (p. 529). Such an argument suggests that many studies tend to reject the null hypothesis of no financial constraints correctly *despite* the biases introduced by ignoring

[4] For a variety of reasons, Kaplan and Zingales do not consider misreporting a serious problem for their research design, see p. 182 of their paper for details.

panel exits. Still, it would be interesting to see just how important this effect is, especially when policy recommendations are derived.

Anything which goes beyond these *ad hoc* approaches requires an explicit theory of market entry and exit decisions and a structural estimation strategy (see Abowd *et al.* (1995) for a detailed discussion). When empirical work is based on an explicit theory of entry and exit, unbalanced panels (reflecting observed market entries or exits) provide the opportunity to gain a more complete understanding of firm dynamics. There are only few empirical studies that are firmly based on such models. One example of a structural model of the survival process is Olley and Pakes (1996). Based on the model of industry dynamics by Ericson and Pakes (1995), they investigate productivity and exit dynamics in the U.S. telecommunications equipment industry, using semiparametric methods to correct for attrition bias in their productivity estimates. Winter (1997) has estimated a dynamic programming model of plant-level investment and exit decisions with the same LRD-based dataset as used in this paper, finding evidence for real effects of firm-level financial status.

There is also an older (and larger) empirical literature on the determinants of firms' market exits which uses reduced-form approaches (see Siegfried and Evans (1994) for a comprehensive overview). Among others, Dunne, Roberts and Samuelson (1988, 1989) provide empirical evidence on the importance of entry and exit decisions for the analysis of firm (and industry) dynamics. Kovenock and Phillips (1997) analyze the effects of financial restructuring on firms' investment and market exit decisions using a reduced-form approach. Taken together, this literature suggests that it is important to account for endogenous exits when analyzing the effects of financial status on investment decisions.

2.3 Aggregation biases in empirical investment models

In most studies of firm behavior, aggregation biases are a problem. In standard investment theory, it is assumed that a firm chooses the level of overall investment spending (possibly subject to financial or other constraints). In reality, however, investment and exit decisions are usually made for individual projects (e. g., products, product ranges, or plants), and they are – at least partially – based on the productivity of each individual project. Hence, the desireable level of aggregation for empirical studies of investment decisions is the single investment project. However, only in rare cases are such detailed datasets available to the researcher, and if they are, the availability of variables might restrict the scope of empirical studies to very specific (though often economically very interesting) questions.

The next level of aggregation is the plant (or establishment) level. The question whether using even plant-level data introduces aggregation biases has a clear theoretical answer (yes), but it should be viewed mainly as an empirical question. In many cases, the production of a single plant will be very focused, so that plant investment decisions can still be viewed as a reasonable approximation to individual investment projects. It is an empirical question whether aggregation biases from using firm-level data are of relevance.

There is a growing literature on this issue, and the overwhelming conclusion is that the dynamics of (among others) investment, labor demand, and job creation and destruction are much richer at the plant level than at the firm level.[5] Given that the plant-level is the lowest level of aggregation at which datasets for broad samples of the manufacturing sector are available, the safest choice is to use such plant-level data whenever possible.

In this study, I want to avoid such aggregation problems by looking at plant-level decisions of firms. There are a number of data requirements for empirical studies of joint investment and exit decisions. For example, when market exit decisions are central to an empirical study, firm or plant exits from the panel must be well documented. In particular, market exit can take two distinct forms, either plant closure or plant sell-off. These should be distinguished in the data. This is the case for the Longitudinal Research Database (LRD) used in this paper, but not for many other datasets where in both cases firms would just be dropped from the panel. Unfortunately, plant-level datasets such as the LRD usually do not contain financial variables. Hence, for investigating the effect of firms' financial situation on investment, it is necessary to link plant-level and firm-level data. How this has been done in this paper is discussed in the next section.

3 A new empirical approach based on plant-level data

The central idea of the empirical approach used in this paper is to combine firm-level financial data and plant-level production and investment data to test whether the financial situation of a firm influences its investment decisions (as observed at the plant level). Using these different levels of aggregation requires an empirical model of finance and investment decisions within an existing firm.

3.1 The empirical model of firms' decisions

At the firm level, the firm chooses its financing policies, resulting in its current capital structure. Outside borrowing might by subject to credit constraints, and for some firms, raising equity might be difficult as well. Either problem would result in financial constraints at the firm level. In addition to these outside sources of finance, the firm can also use its cash flow to finance investment. This model takes the firm's financial decisions and any outside restrictions as given; hence the firm's capital structure is exogenous to the model. This is a standard approach in the theoretical and empirical literature on intertemporal investment decisions under financial constraints. While such an assumption is not entirely satisfying theoretically, it is difficult to explicitly include a firm's financing decisions under asymmetric information in a dynamic model of investment decisions (see,

[5] See Davis *et al.* (1996) for an overview of this literature and many empirical results.

e. g., Milne and Robertson (1996)). Further, the model assumes that aggregated (firm-level) cash flow is exogenous at the plant level. This assumption is clearly restrictive; its implications are discussed below. Under these assumptions, the firm's financial decisions can be treated as a black box in the empirical model, and its financial situation can be described by variables observed at the firm level. In this study, these variables are leverage (the ratio of long-term debt to total assets), cash flow, and the financial status indicator developed by Kaplan and Zingales (1997).

Given its financial status, the firm makes its operating and investment decisions, i. e., it allocates funds to the individual plants for capital investment. If the firm is not financially constrained, these decisions will be the solutions to individual intertemporal optimization problems for each plant. The capital stock installed at each plant is then a quasi-fixed factor, and output and factor input decisions are made at the plant level, given the capital stock and factor prices. This model of plant-level investment and production decisions uses only variables observed at the plant level: investment (and the resulting capital stock), variable inputs, and output. If, however, the firm is financially constrained, firm-level financial variables should be significant in the plant-level regressions, i. e., financial status affects plant-level investment after controlling for other determinants such as productivity and expected market demand. This is the central empirical idea used in this study.

In general, plant-level investment and production decisions also determine plant-level cash flows which can be aggregated to firm-level cash flow. Firm-level cash flow, in turn, is a major component of the firm's financial situation, and it enters the plant-level regressions both directly and through its effect on the firm-level financial status variable. Hence, firm-level financial variables should properly be treated as endogenous in the plant-level model of investment and exit decisions. There are two major difficulties with this (and thus the current specification of the model treats firm-level financial status as exogenous at the plant level).

First, taking account of this endogeneity in the structual econometric model would require to implement some plant-level expectation mechanism for next period's firm-level financial situation, which in turn would depend on *all* plants' cash flows. Current theories of firms' internal finance (e. g., Gertner *et al.* (1994) and Stein (1997)) do not offer any clear-cut advice how this interdependence should enter an empircal model of plant-level operating and investment decisions. In any case, plant-level investment decisions could not be treated individually, and the resulting modifications would make it difficult to estimate the model. Implicitly, the model assumes that the allocation of funds is sticky across plants, i. e., if the firm moves into a financially constrained state, this restriction is transmitted uniformely to all plants. This assumption is consistent with the empirical findings of Shin and Stulz (1996).

The second problem is related to the data sources used in this study. As will become clear in the next section, data are available only for all *manufacturing* plants that belong to a given firm. It is however likely that large firms generate cash flow from non-manufacturing sources as well. The importance of these sources would be difficult to assess in practice, but it could effectively wash out an individual plant's effect on firm-level financial status. Lamont (1997), for example, presents a case study that illustrates how shocks to firm-level financial status affect investment across very different operations of a large corporation.

Both problems together imply that the exogeneity assumption for firm-level financial status is difficult to relax if investment and production data are at the plant level. However, the advantages of using plant-level data in the analysis of investment decisions seem to justify imposing such strong assumptions.

3.2 Matching firm and plant-level data

The main source of data used in this study is the Longitudinal Research Database (LRD) maintained by the Center for Economic Studies (CES) at the U.S. Bureau of the Census, Washington, D.C. All plant-level nominal investment, variable factor demand and output data as well as the information on plant operating status were obtained from the LRD. This section concentrates on the selection of firms and plants for the estimation dataset and presents some descriptive statistics. For a discussion of data sources and the construction of variables used, see the Data Appendix.

The 49 firms contained in Kaplan and Zingales's sample were matched with LRD plants using a name matching procedure. In total, data on plants owned by 40 of these 49 firms were matched with LRD plant-level data.[6] The resulting raw sample with 3989 plant-year observations was then cleaned. Table 3 contains details of the data cleaning process. First, spells with just one observation were dropped; then, the first year of each remaining spell was excluded. (This is due to the fact that the first year of each spell is used to construct state variables for the following year.) Finally, plant-year observations with zero output or input were dropped, and the sample was trimmed for outliers.[7] The resulting panel has 444 plants with 573 distinct spells and a total of 3014 plant-year observations (see Table 4). A surprisingly large fraction (almost 30%) of these plant spells ends with a plant exit (exit is defined as the plant being either closed or sold to another firm).

`Insert Table 3 about here.`

`Insert Table 4 about here.`

Table 5 reports the distribution of plant spells. Note that the observed spells are actually one year longer because the first plant-year observation in each spell is used to construct

[6] For confidentiality reasons, the names of these 40 firms cannot be disclosed; neither can a number of otherwise desireable descriptive statistics on the matched sub-sample of firms be reported.

[7] An observation was excluded if any of the following ratios was above the 99.5 percentile of the respective ratio's sample distribution: output/labor, output/materials, output/capital, capital/labor, investment/capital. Outliers in these ratios typically indicate errors in one of the variables involved.

the second year's state variables. As one can see, there is a fairly large number of plant spells which cover the whole 12-year period (1973–84), but there are also many very short spells. Many of these short spells occur in the early years of the dataset; these spells are potentially much longer, but the full plant history cannot be observed due to left-truncation. In the model used in this study, left-truncation is not a serious problem because all historic information is contained in the current period's state variables (which are actually lagged values). The only critical variable, then, is plant age, but as discussed in the Data Appendix, one can use some information on plant age from the LRD which goes back to the years before 1972 (the first year in which the other variables are observed).

`Insert Table 5 about here.`

The original Kaplan-Zingales firm-level sample contains 49 firms with 729 firm-year observations for 1970–84.[8] As the annual coverage of the LRD starts in 1972, the sample period for the plant-level data is shorter, covering 13 years instead of 15. Table 6 reports on the results of the matching process, in particular, the distribution of the financial status variable in the full sample with 49 firms and among the 40 firms for which LRD plant information was available. It is regrettable that the small sample of 49 firms was further reduced to only 40 firms, but the resulting sample still has (roughly) the same proportions of firms classified by Kaplan and Zingales as financially constrained and not constrained, respectively. Although I am unable to report further details due to disclosure restrictions, this observation suggests that the resulting sample still has enough variation in its yearly financial status indicator.

`Insert Table 6 about here.`

To analyze the plant-level operating decisions of firms, two discrete indicator variables are used. Table 7 summarizes the definitions and sample distributions of these two variables. The first variable takes four values and reflects the plant's *operating status*, i. e., whether the plant is in normal operation, idle, closed or sold in the current year. The operating status is an ordinal concept that is slightly more general than the standard binary plant exit (closure) decision, and exploits the information on operating decisions that is available in the LRD database. The second variable characterizes the *investment regime*, it takes two values. The rationale for using a discretized version of the investment variable is that investment has been shown to quite lumpy at the plant-level (e. g., Cooper *et al.* (1995)). In investment regime 0, a firm allows the capital stock at a plant to deteriorate at its rate of physical depreciation by not undertaking any replacement investment.[9] In investment regime 1, the firm decides to replace depreciated capital at least to some extend, while

[8] Six firm-year observations (for two firms that entered the panel after 1970) are missing in their data.

[9] The threshold level of 10% for classifying a plant as being in regime 0 is arbitrary, but varying this value does not change the results substantially. Kovenock and Phillips (1997) use a similar approach, with a binary investment variable that takes the value 1 if a firm increases is capital expenditure by 5 % or more in a given year.

in investemt regime 2, the firm does actually increase the plant's capital stock (i. e., net investment).

`Insert Table 7 about here.`

Table 8 reports the distribution of plant-year observations across operating status and financial status. This table contains *all* plant-year observations in the sample; one can see that there is a tendency for idle plants and exits (i. e., closures or sell-offs) to concentrate in years with a more constrained financial status. This fact is exploited in the econometric analysis presented below, where exit decisions are shown to depend, after controlling for productivity and expected demand effects, on financial status.

`Insert Table 8 about here.`

Finally, Table 9 contains correlation coefficients of the financial status indicator constructed by Kaplan and Zingales and other variables typically considered in theoretical and empirical studies on the effects of firms' financial situation on its investment decisions (computed for the 40 firm sample over the entire 1972–84 period). As can be seen from the table, the correlations are far from perfect, which suggests that the Kaplan and Zingales variable indeed contains information other than that used in standard models. The correlations, however, have the expected sign: High-leverage firms tend to be classified as being financially constrained and firms with large cash flows tend to be classified as not being constrained acccording to Kaplan and Zingales.

`Insert Table 9 about here.`

4 Econometric analysis of plant-level investment and exit decisions

The empirical models of plant growth presented in this section are simple econometric devices that allow to analyze the implications of standard intertemporal optimization models of plant dynamics.[10] At the same time, they can be used to test whether firm-level financial variables affect these real decisions. The analysis starts with the estimation of a plant-level production function which is used to construct measures of (relative) productivity. The first group of substantive results are probit and ordered probit regressions that analyze the determinants of a plant's operating decision (i. e., whether a plant is in normal operation, idle, sold or closed). If the plant is either sold or closed, the firm has made an exit decision for that plant. The second group of results are for a model that explains investment decisions (in levels) and at the same time corrects for selection bias

[10] A more detailed analysis of plant-level investment and market exit decisions can be found in Winter (1997).

that arises because exit decisions are endogenous, using the standard sample selection framework introduced by Heckman (1979).

4.1 Plant-level production functions and productivity indexes

The empirical analysis builds on a production function regression with capital, labor, and materials as inputs, and with a time index to capture technical progress. The residuals from these regressions are used as measures of productivity in subsequent regressions. Note that this productivity index measures *relative* productivity (relative to the industry mean). This concept has been used widely in the plant-level productivity research (see, e. g., Doms *et al.* (1995)). The regression equation is given by:

$$y_{it} = \beta_0^c + \beta_0^t t + \beta_0^k k_{it} + \beta_0^l l_{it} + \beta_0^m m_{it} + \sum_{j,k} \beta_0^{jk} \text{cross products } (j,k) + \epsilon_{it}\,, \tag{1}$$

where y is output, k is capital, l is labor, m is materials, and ϵ is the error term. The results of alternative production function specifications are contained in Table 10. Generally, signs and magnitudes of the coefficients of the production functions are as expected (according to standard applied production analysis). The specification used to construct the productivity index from estimated residuals is reported the last column (Translog II).

`Insert Table 10 about here.`

4.2 Determinants of plants-level operating and investment regimes

This section contains regression results for discrete variables that characterize a firm's plant-level operating decisions (for the definition of these variables, see Table 7). Explanatory variables contained in all regressions include capital stock (as a measure of plant size), plant age, the (relative) productivity index described above, and the capital/labor ratio as a measure of technology. These variables are standarad in productivity analysis and capture the influence of "real" factors that determine a plant's operating status (e. g., Doms *et al.* (1995)). Experiments with other sets of variables did not deliver results that were substantially different from those reported here.

The most important decision that is available to the firm is the operating regime. Tables 11 and 12 contain ordered probit regressions of plants' operating status. Table 11 contains results for all 3014 plant-year observations, while the regressions in Table 12 are for the last observed year of each plant spell only, to highlight the exit effects (here, the total number of observations is 573). The interesting finding here is that including firm-level financial variables generally increases the model's ability to explain plant-level operating decisions. The financial status indicator proposed by Kaplan and Zingales, however, is insignificant in all equations, while the cash-flow variable is significant – even though we include the Kaplan-Zingales variable to control for firm-level financial status.

`Insert Table 11 about here.`

`Insert Table 12 about here.`

The second decision a firm has for its plants is the investment regime. Table 13 contains the results of ordered probit regressions of the plant-level investment regime. In the investment regressions, however, firm-level financial variables play a much stronger role. The cash-flow/assets ratio has a strong positive effect on plant-level investment. The debt/assets ratio has an insignificant negative effect as in the operating status equation, but it is somewhat stronger, and negative, as expected. The Kaplan-Zingales indicator has a significant effect if no other firm-level financial variables are included, and in this case, it has a negative sign, as would be expected. I will return to the interpretation of the results for the Kaplan-Zingales indicator variable in the concluding section.

`Insert Table 13 about here.`

4.3 An empirical model of joint investment and exit decisions

The model used here to analyze firms' joint investment and exit decisions at the plant level is one of the earliest attempts to address the selection problem in applied econometric work. There are now many more sophisticated models available, and Heckman's (1979) model was chosen mainly for its simplicity and its intuitive appeal. It has also been used in other studies of firm growth and survival (such as Doms *et al.* (1995)). The model consists of two equations, a plant exit equation and a plant growth equation:

$$I(\text{exit}_{it}) = P(x'_{it}\beta_1) + \mu_{1it}\,, \tag{2}$$

$$\text{investment}_{it} = x'_{it}\beta_2 + \sigma_{12}\frac{\phi(x'_{it}\hat{\beta}_1)}{1-\Phi(x'_{it}\hat{\beta}_1)} + \mu_{2it}\,. \tag{3}$$

The explanatory variables are collected, together with a constant, in the vector x; they are the same as in the operating status regressions reported previously. The investment equation also has the inverse Mill's ratio as a right-hand side variable, which allows to control for the probability of exit in a given plant year; $\phi(\cdot)$ and $\Phi(\cdot)$ are the p.d.f. and c.d.f. of the Normal distribution, respectively. The plant exit equation is formulated as a binary Probit model, while the investment equation is estimated using OLS. It should be noted that identification of the parameters in the two-equation system given by (2) and (3) relies on the non-linearity (in x) of the Mill's ratio that enters (3) as an additional regressor (and on the assumption that the errors μ_{1i} and μ_{2i} are jointly normally distributed, which is essentially untestable). In general, identification could also be achieved by imposing some exclusion restriction on either equation. In the application considered here, however, the underlying model of firm investment and exit implies that the driving forces of investment and exit are the same.

Table 14 contains the estimates of the plant exit equations, while Table 15 contains the results for the plant investment equations. Generally, the estimation of the parameters in both equations turned out to be relatively precise, but the productivity variable did not have any significant effect on exit and investment decisions. The results for the Kaplan-Zingales indicator are interesting: If no other financial variables are included, it is insignificant. If other financial variables are included, it is significant, but does not have the expected sign: Firms that are classified as being constrained in a given year are less likely to exit and invest more, according to these results. Again, I return to the discussion of how these results should be interpreted in the conclusions.

`Insert Table 14 about here.`

`Insert Table 15 about here.`

5 Conclusions

On balance, the empirical results reported in this paper confirm the finding in much of the existing literature on the effects of financial status on ivestment: They exist. Here, this result was obtained using a new measure of the firm's financial status which reflects more information than simple sample-split approaches. This result was obtained from a reduced-form model of firm decisions that was designed to account for endogenous exit decisions, a problem usually ignored in similar studies. In the sample used here, exits are important: Almost 30% of plant spells end with an exit (i. e., either plant closure or sell-off).

One of the main goals of this paper was to assess the empirical performance of the financial status indicator variable proposed by Kaplan and Zingales (1997). The variable turned out to be insignificant in all plant-level operating and investment equations that were estimated. However, if other financial variables were included, they were in most cases significant and of the expected sign: low firm-level debt-to-asset ratios and high firm-level cash flows increase plant-level investment and decrease the likelihood of exits (plant closures or sell-offs). These effects were uniformly stronger for cash flow. This result confirms many earlier studies of investment: Cash flow is a strong predictor of investment activities. Moreover, this result was obtained even after controlling for firm-level financial status as measured by Kaplan and Zingales. Taken together, these results add more empirical evidence to the hypothesis that financial status affect investment, or as this study has shown, that firm-level financial status affects plant-level investment and exit decisions.

A major concern with the empirical implementation here is sample size. While the size of the sample is fairly large in terms of individual plants covered, the number of firms is small. This is mainly due the fact that the financial status indicator had been constructed for a very small sample in the first place. To construct measures of firms' financial status for larger panels of firms must be left to future research. One recent alternative to using indirect measures of firms' financial status is to construct a direct measure, using data on the actual underwriting cost of issuing new equity (see Calomiris and Himmelberg (1998)). It would be interesting to see how such alternative measures of financial status work in these models.

Given the results of this study, I would argue that the central problem of empirical tests of financial constraints is not so much the proper measurement of firms' financial status, rather it is the formulation of the theoretical and empirical model of firm investment. While this study has attempted to address aggregation issues and endogenous exit decisions, it has used very strong assumptions about the intra-firm allocation of funds. This is clearly an issue that needs to addressed in future work on the interaction of outside and inside finance at the firm level, and investment and exit decisions at the plant level. Finally, an alternative, and theoretically preferrable, econometric approach to the reduced-form models used here would be to use a structural model of firm's joint investment and exit decisions (see Winter (1997) for an attempt in that direction). In such a model, one could make firm-level financial variables endogenous, say, by including financial assets as a state variable in the optimization model, as suggested by Pakes (1994). This task is, however, beyond the scope of this paper. Also, neither would such a model be amenable to structural estimation given current techniques, nor do databases exist with sufficient information *both* on production and investment decisions and on financial variables.

Data Appendix

This appendix contains details on the sources of data and on the construction of variables used in this paper.

A.1 Sources of plant, firm, and industry-level data

The main source of data is the Longitudinal Research Database (LRD) maintained by the Center for Economic Studies (CES) at the U.S. Bureau of the Census, Washington, D.C. The information on individual establishments contained in the LRD is confidential and protected by Title 13, U.S. Code, which specifies that the Census Bureau may not publish or release any data provided by individual respondents to censuses and other Census Bureau surveys. Hence, all work using LRD plant-level data has to be conducted on site at the CES, and all research output is reviewed by CES staff for violation of disclosure rules. In particular, these procedures are designed to ensure that no information on any individual plant or firm can be reconstructed from released research output. For a detailed description of the LRD, see McGuckin and Pascoe (1988) and the technical appendix in Davis *et al.* (1996).

The LRD contains annual cost and output data on manufacturing establishments (plants) based on the quinquennial Census of Manufactures (CM) conducted in the years 1963, 1967, 1972, 1977, 1982, 1987, and 1992. For the remaining (henceforth, non-census) years since 1972, the LRD contains information obtained through the Annual Survey of Manufactures (ASM). The datafiles for the individual years can be linked to form an unbalanced longitudinal panel, with annual observations ranging from 1972 through, currently, 1993. The number of plants in the CM is about 300,000–400,000, covering all but the smallest manufacturing establishments in the U.S. In non-census years, data are available only for a probability sample of about 50,000–70,000 plants taken from the CM. While all large establishments (over 250 employees) are included in the ASM, smaller plants are included in the ASM panel with probability increasing with plant size. These establishments, in turn, are included only for five years; then, a new sample of ASM establishments is drawn for the next five years (resulting in a rotating five year panel). Hence, there are only few small establishments in consecutive AMS years. In general, this will lead to some selection biases for small establishments.

After the plant-level variables were retrieved from the LRD for the firms considered in this study, they were augmented with financial variables recorded at the firm level and with price indexes and depreciation rates recorded at the industry level. For the set of firms identified as being financially constrained by Fazzari *et al.* (1988) and further investigated by Kaplan and Zingales (1997), the values of the annual financial status variable were taken *verbatim* from the appendix in Kaplan and Zingales (1997). Further details on the financial status variable can be found in Section 2. Other firm-level financial variables used in this study are based on publicly available balance-sheet information. They were extracted from the NBER Manufacturing Masterfile (see Hall (1990)) which in turn is based on firms' balance-sheet data contained in the Compustat database. All firm-level financial variables were matched with LRD plant-level variables using a name matching procedure.

Deflators for the various output and input measures used in this study are taken, at the 4-digit industry level, from the NBER Manufacturing Productivity Database (see Bartelsman and Gray (1994) for details). These annual deflators have 1987 as their base year, hence all real variables used in this study are expressed in terms of 1987 dollars. The annual capital depreciation rates used for constructing capital stocks are based on the 2-digit industry level. They were obtained from the Bureau of Economic Analysis (BEA). The method used by BEA for constructing the underlying industry-specific capital input measures is, in turn, the same as that used by the Bureau of Labor Statistics in their productivity studies; see Hulten and Wykoff (1981), U.S. Bureau of Labor Statistics (1983) and U.S. Bureau of Economic Analysis (1984) for detailed discussions.

A.2 Construction of variables

Discrete operating decision The LRD contains detailed information on the operating status of a given plant in each year. In particular, this "coverage code" allows to identify plants that were closed permanently or experienced ownership changes. The definition of the operating status variable is discussed in Section 3 in detail; see also Table 7.

Real investment The investment variable is constructed by adding the LRD variables for equipment and structures investment. For the definition of the discrete investment regime variable, see Section 3 and Table 7. Conversion to 1987 Dollars uses the deflators discussed above.

Real capital stock The capital stock measures are constructed for equipment capital and building structures separately; only after all the following adjustments have been made are these two components added to yield a single real capital stock variable. Initial capital stocks (used in the first year a plant is observed in the sample) are constructed from the book values reported in the LRD. For the remaining years, a perpetual inventory method with time-varying annual depreciation factors is used. This method is considered to be more reliable than the standard approach which amounts to picking a more or less arbitrary depreciaction rate (such as, say, 10 %) and leaving it constant over time and across industries. Conversion to 1987 Dollars uses the deflators discussed above.

Plant age For plants that were established after 1972, age (in years) is straightforward to construct. For older plants (i. e., plants observed in the LRD in 1972 and not reported to be newly established in that year), the LRD records for the years 1963 and 1967 were checked. If a plant was already in operation in these years, it is classified as being 10 or 5 years old, respectively, in 1972. This method reduces the bias introduced by left-truncation of plant histories, but of course cannot remove it entirely.

Financial status variables These firm-level variables are taken *verbatim* from Kaplan and Zingales (1997, Appendix), and from the NBER Manufacturing Masterfile.

Real output and real variable factor inputs These variables are constructed from the respective nominal LRD variables, applying the standard variable definitions used by LRD researchers. They are then converted to 1987 Dollars using the deflators discussed above. Plant-level output is defined as the total value of shipments, adjusted for inventory changes.

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Table 1: The sample-split criterion used by Fazzari *et al.* (1988)

Category	Dividend-income ratio	Firms	
1	Less than 10 %[a]	49	11.6 %
2	Between 10 % and 20 %[a]	39	9.2 %
3	20 % and above	334	79.1 %
Total		422	

Source: Fazzari *et al.* (1988), Table 2.

[a] For at least 10 years.

Table 2: The financial status indicator by Kaplan and Zingales (1997)

Category	Financial status (annual)	Firm years[a]	
0	Not financially constrained	389	53.4 %
1	Likely not financially constrained	233	32.0 %
2	Possibly financially constrained	53	7.3 %
3	Likely financially constrained	34	4.7 %
4	Financially constrained	20	2.7 %
Total		729	

Source: Kaplan and Zingales (1997), Appendix.

[a] Six firm years (1970–73 for Commodore Intl. Ltd. and 1970–71 for James River Corp.) are missing in the Kaplan-Zingales sample, so the total number of firm-year observations is $49 \times 15 - 6 = 729$.

Table 3: Details of the data cleaning process

	Observations
Raw sample	3989
Single observation spells	169
First observation of each remaining spell	573
Plant-years with zero output or input	160
Plant-years lost due to outlier trimming	73
Cleaned sample (final panel)	3014

Source: Longitudinal Research Database (LRD), U.S. Bureau of the Census; and own calculations.

Table 4: Sample characteristics

	Raw sample		Cleaned sample[a]	
Firms	40		40	
Plants	514		444	
Operating status: sold	176	34.2%	100	22.5%
Operating status: closed	86	16.7%	30	6.8%
Total exits	262	59.0%	130	29.3%
Plant spells	742		573	
Plant-year observations	3989		3014	

Source: Longitudinal Research Database (LRD), U.S. Bureau of the Census; and own calculations.

[a] The cleaned sample is the sample used for estimation.

Table 5: Distribution of plant spell lengths

Years	Plants	
1	92	16.1 %
2	83	14.5 %
3	61	10.7 %
4	56	9.8 %
5	35	6.1 %
6	68	11.9 %
7	27	4.7 %
8	25	4.4 %
9	19	3.3 %
10	30	5.2 %
11	18	3.1 %
12	59	10.3 %
Total	573	

Source: Longitudinal Research Database (LRD), U.S. Bureau of the Census; and own calculations.

Table 6: Distribution of firm-level financial status[a]

Financial status	Kaplan-Zingales sample		Sample matched with LRD data[b]	
Not or likely not constrained	19	38.8 %	16	40.0 %
Possibly constrained	8	16.3 %	24	60.0 %
Likely or definitely constrained	22	44.9 %		
Total	49		40	

Source: Kaplan and Zingales (1997), Appendix; Longitudinal Research Database (LRD), U.S. Bureau of the Census; and own calculations.

[a] The financial constraints status reported in this table is Kaplan and Zingales's classification of firms for the entire sample period, not the annual indicator variable used elsewhere in this study.

[b] Due to disclosure restrictions, values for some individual cells based on LRD plant-level data cannot be reported; these cells have been collapsed pairwise in this table.

Table 7: Discrete operating status and investment variables

Category	Operating status (last observed year of each plant spell)	Plants	
0	Plant in normal operation (positive output)	395	68.9 %
1	Plant idle (zero output)	48	8.4 %
2	Plant sold	100	17.5 %
3	Plant permanently closed	30	5.2 %
Total		573	
Category	**Investment regime (all plant years)**	**Plant years**	
0	Investment less than 10% of physical depreciation	281	9.3 %
1	Investment between 10% and 100% of physical depreciation	1086	36.0 %
2	Investment above 100% of physical depreciation	1647	54.6 %
Total		3014	

Source: Longitudinal Research Database (LRD), U.S. Bureau of the Census; and own calculations.

Table 8: Plant operating status and firm-level financial status

	Total		Operating		Not operating[a]				
KZI					Total		Idle	Sold	Closed
0	1976	65.6 %	1854	65.4 %	122	68.5 %	30	74	18
1	651	21.6 %	622	21.9 %	29	16.3 %	7	17	5
2	196	6.5 %	182	6.4 %	14	7.9 %			
3	102	3.4 %	94	3.3 %	8	4.5 %			
4	89	3.0 %	84	3.0 %	5	2.8 %			
Total	3014	100.0 %	2836	100.0 %	178	100.0 %			

Source: Kaplan and Zingales (1997), Appendix; Longitudinal Research Database (LRD), U.S. Bureau of the Census; and own calculations.

[a] Due to disclosure restrictions, values for some individual cells based on LRD plant-level data cannot be reported.

Table 9: Correlations among alternative measures of firms' financial status

		correlation	P-value
Kaplan-Zingales indicator	vs. Debt-assets ratio	0.1678	0.0010
Kaplan-Zingales indicator	vs. Cash flow-assets ratio	-0.1782	0.0005
Cash flow-assets ratio	vs. Debt-assets ratio	-0.2316	0.0000

Source: Kaplan and Zingales (1997), Appendix; NBER Manufacturing Masterfile; and own calculations.

Notes: Correlations are based on all firm years in the estimation sample; if the (ordinal) Kaplan-Zingales financial constraints indicator variable is included, Spearman's rank correlation coefficient is reported.

Table 10: Plant-level production function equations (OLS estimates)

Specification	Cobb-Douglas		Translog I		Translog II	
Constant	0.157	(0.55)	0.213	(0.76)	-0.131	(-0.68)
Time	0.018	(4.89)	0.017	(4.60)	0.015	(6.22)
Capital, K	0.170	(13.93)	0.253	(15.58)	-0.068	(-4.68)
Labor, L	0.689	(44.84)	0.711	(38.15)	0.496	(25.28)
Materials, M					0.520	(29.48)
$K \times K$			0.035	(4.45)	-0.012	(-2.05)
$L \times L$			0.048	(4.32)	0.090	(8.91)
$M \times M$					0.045	(5.84)
$K \times L$					-0.024	(-1.79)
$K \times M$					0.057	(5.09)
$L \times M$					-0.156	(-11.86)
Observations	3014		3014		3014	
Total SS	5451.3		5451.3		5451.3	
Residual SS	1297.9		1256.8		578.6	
R^2	0.762		0.769		0.894	
Probability of F-Test	0.000		0.000		0.000	

Source: Longitudinal Research Database (LRD), U.S. Bureau of the Census; and own calculations.
Note: t-values in parentheses. The regressions also contain industry dummies; parameter estimates for these are not reported here.

Table 11: Operating status equations (ordered probit estimates)

Specification	I		II		III	
Capital	-0.008	(-5.21)	-0.008	(-5.26)	-0.007	(-4.56)
Plant age	0.013	(1.96)	0.012	(1.90)	0.009	(1.32)
Productivity	-0.100	(-1.15)	-0.100	(-1.17)	-0.011	(-1.32)
Capital-labor ratio	0.098	(5.24)	0.098	(5.24)	0.091	(4.87)
Kaplan-Zingales indicator			-0.016	(-0.40)	-0.042	(-0.97)
Debt-assets ratio					-0.091	(-0.45)
Cash flow-assets ratio					-0.679	(-2.56)
Cut 1	1.770	(21.12)	1.757	(19.55)	1.521	(10.97)
Cut 2	1.936	(21.38)	1.913	(20.15)	1.678	(11.85)
Cut 3	2.563	(24.10)	2.550	(22.62)	2.319	(15.47)
Observations	3014		3014		3014	
Log likelihood	-831.7		-831.6		-828.8	
Likelihood ratio χ^2	37.1		37.3		42.9	
Probability of LR-Test	0.000		0.000		0.000	

Source: Longitudinal Research Database (LRD), U.S. Bureau of the Census; and own calculations.
Note: All plant-year observations. t-values in parentheses.

Table 12: Operating status equations (ordered probit estimates)

Specification	I		II		III	
Capital	-0.008	(-3.78)	-0.007	(-3.61)	-0.006	(-2.55)
Plant age	-0.004	(-0.49)	-0.004	(-0.41)	-0.012	(-1.23)
Productivity	-0.010	(-0.08)	-0.006	(-0.05)	-0.018	(-0.14)
Capital-labor ratio	0.086	(3.99)	0.085	(3.96)	0.072	(3.38)
Kaplan-Zingales indicator			0.041	(0.68)	-0.010	(-0.15)
Debt-assets ratio					0.168	(0.56)
Cash flow-assets ratio					-1.127	(-2.80)
Cut 1	0.499	(4.05)	0.530	(4.02)	0.211	(1.00)
Cut 2	0.759	(5.89)	0.789	(5.79)	0.475	(2.23)
Cut 3	1.663	(11.56)	1.693	(10.94)	1.394	(6.32)
Observations	573		573		573	
Log likelihood	-519.5		-519.2		-514.3	
Likelihood ratio χ^2	19.1		19.7		29.5	
Probability of LR-Test	0.007		0.001		0.001	

Source: Longitudinal Research Database (LRD), U.S. Bureau of the Census; and own calculations.
Notes: Last observed year of each plant spell only. t-values in parentheses.

Table 13: Investment regime equations (ordered probit estimates)

Specification	I		II		III	
Capital	0.005	(5.17)	0.005	(4.75)	0.003	(3.15)
Plant age	-0.014	(-3.57)	-0.015	(-3.83)	-0.008	(-1.84)
Productivity	0.121	(2.17)	0.115	(2.04)	0.125	(2.20)
Capital-labor ratio	-0.180	(-16.11)	-0.180	(-16.03)	-0.160	(-13.87)
Kaplan-Zingales indicator			-0.069	(-3.19)	-0.026	(-1.16)
Debt-assets ratio					-0.171	(-1.38)
Cash flow-assets ratio					1.094	(6.51)
Cut 1	-1.728	(-33.35)	-1.787	(-32.41)	-1.490	(-16.85)
Cut 2	-0.465	(-9.41)	-0.521	(-9.87)	-0.213	(-2.42)
Observations	3014		3014		3014	
Log likelihood	-2668.3		-2663.6		-2636.7	
Likelihood ratio χ^2	204.5		214.0		267.7	
Probability of LR-Test	0.000		0.000		0.000	

Source: Longitudinal Research Database (LRD), U.S. Bureau of the Census; and own calculations.
Note: t-values in parentheses.

Table 14: Plant exit equations (Probit estimates)

Specification	I		II		III	
Constant	-2.070	(-20.92)	-2.020	(-19.30)	-1.812	(-10.58)
Capital	-0.008	(-3.49)	-0.008	(-3.61)	-0.007	(-3.12)
Plant age	0.026	(3.51)	0.025	(3.35)	0.018	(2.39)
Productivity	-0.017	(-0.16)	-0.019	(-0.18)	-0.027	(-0.24)
Capital-labor ratio	0.094	(4.72)	0.095	(4.75)	0.083	(4.08)
Kaplan-Zingales indicator			-0.064	(-1.34)	-0.110	(-2.16)
Debt-assets ratio					0.284	(1.16)
Cash flow-assets ratio					-0.978	(-2.82)
Observations	3014		3014		3014	
Log likelihood	-517.7		-516.9		-510.6	
Likelihood ratio χ^2	35.93		37.80		50.48	
Probability of LR test	0.000		0.000		0.000	

Source: Longitudinal Research Database (LRD), U.S. Bureau of the Census; and own calculations.
Note: t-values in parentheses.

Table 15: Investment equations (OLS estimates)

Specification	I		II		III	
Constant	1.039	(3.55)	1.288	(3.89)	-1.387	(-2.58)
Capital	0.119	(13.41)	0.113	(12.73)	0.121	(17.01)
Plant age	-0.083	(-2.59)	-0.065	(-2.15)	-0.070	(-3.09)
Productivity	-0.242	(-1.17)	-0.262	(-1.26)	-0.155	(-0.76)
Capital-labor ratio	-0.560	(-3.63)	-0.459	(-3.08)	-0.640	(-5.32)
Kaplan-Zingales indicator			-0.120	(-1.12)	0.384	(3.01)
Debt-assets ratio					-1.906	(-3.59)
Cash flow-assets ratio					7.640	(7.76)
Mills ratio	11.120	(1.65)	6.482	(1.00)	21.993	(3.91)
Observations	3014		3014		3014	
Total SS	80318.3		80318.3		80318.3	
Residual SS	60912.3		60855.8		58990.2	
R^2	0.242		0.242		0.266	
Probability of F-Test	0.000		0.000		0.000	

Source: Longitudinal Research Database (LRD), U.S. Bureau of the Census; and own calculations.
Note: t-values in parentheses.

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