



## Exit from regional manufacturing markets: The role of entrant experience

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### Abstract

Producers entering a market can differ widely in their prior production experience, ranging from none to extensive experience in related geographic or product markets. In this paper, we quantify the nature of prior plant and firm experience for entrants into a market and measure its effect on the subsequent decision to exit the market. Using plant-level data for seven regional manufacturing industries in the U.S., we find that a producer's experience at the time it enters a market plays an important role in the exit decision, affecting both the overall probability of exit and the method of exit. After controlling for observable plant and market variables that affect profits, there remain systematic differences in exit patterns across three groups of plants distinguished by their prior experience: de novo entrants, experienced plants that enter by diversifying their product mix, and new plants owned by experienced firms. The results indicate that the exit decision cannot be treated as determined solely by current and future plant, firm, and market conditions, but that the plant's history also plays an important independent role in conditioning the likelihood of survival.

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## 1. Introduction

In their study of firm entry and exit patterns in U.S. manufacturing industries, [Dunne et al. \(1988\)](#) identify three distinct types or methods of firm entry into product markets and show that long-term differences in exit rates and relative firm size exist across the three categories of entrants. Their observations indicate that characteristics of a firm at the time it enters an industry are related to the ultimate success of the firm even 10 or 15 years after entry.

One explanation is that the method of entry, opening a new plant, for example, or diversifying the product mix of an existing plant, is simply a proxy for the firm's underlying productivity and profitability in the market in future periods.<sup>1</sup> In this view, variables that affect the firm's current and future profits, and not initial conditions themselves, are the determinants of firm exit. A large empirical literature demonstrates clearly that many observable characteristics of a plant or firm in year  $t$ , including size, age, productivity, capital intensity, wage rates, and diversity of product offerings, are correlated with the decision of the plant or firm to continue in operation in year  $t+1$ .<sup>2</sup> Several important theoretical models, including [Hopenhayn \(1992\)](#) and [Ericson and Pakes \(1995\)](#), are also predicated on the assumption that the determinants of firm profits follow a Markov process so that, once current characteristics are controlled for, the exit decision is not affected by the firm's past history.

An alternative explanation is that initial characteristics exert a long-term influence on the firm's exit decision, even after controlling for other determinants of current and future profits. A theoretical model that is consistent with this explanation is [Jovanovic's \(1982\)](#) model in which a firm learns about its unknown, time-invariant productivity parameter through its production experience. [Pakes and Ericson \(1998\)](#) show that an implication of this model is that a firm's size in year  $t$  will depend on the whole past history of the firm's size including its size at the time of entry. They find empirical evidence of this pattern in data on firms in the retail sector. Other empirical evidence of a role for a producer's initial size is provided by [Dunne et al. \(1989\)](#), [Audretsch \(1995\)](#), and [Mata et al. \(1995\)](#). These studies show that the initial size of a manufacturing plant is correlated with its failure probability and growth rate even after controlling for the current size and age of the plant. In his study of the early history of the U.S. auto, tire, television, and pharmaceutical industries, [Klepper \(2002\)](#) shows that the experience of a firm in related industries prior to entry is an important determinant of firm survival in these four industries. He develops a theoretical model in which initial entry conditions, specifically, prior experience and time of entry affect the subsequent survival pattern of a firm.

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<sup>1</sup> Entry method and profitability could be correlated if different entry methods were characterized by different sunk entry costs. A firm that chose a high sunk cost entry method, such as building a new plant, would require higher expected future profits in order to induce entry than a firm choosing a low entry cost method, such as altering its product line in an existing plant. [Bernard et al. \(2003\)](#) develop a theoretical model of heterogeneous firms choosing among alternate product markets that generates a positive correlation between firm productivity and the fixed costs of the products.

<sup>2</sup> This empirical literature is reviewed in [Caves \(1998\)](#).

In this paper we develop an empirical model of exit that allows both initial conditions and current firm and plant characteristics to affect the producers' decision to exit a market. To proxy differences in initial conditions we develop a set of variables that measure the degree of production experience possessed by a firm at the time it enters a product market. By focusing on a group of manufactured products that are sold in relatively small geographic markets we are able to distinguish firms that have prior experience manufacturing the product in other geographic markets from firms with no prior experience with the product. By exploiting data on the full set of products manufactured in each plant we are able, like Dunne et al. (1988), to distinguish firms that enter a product market using a plant with which they have operating experience from firms that enter with a new production facility. Thus we are able to measure both firm and plant dimensions of an entrant's prior experience.

We focus on the exit decision of a producer within a narrowly defined market. Exploiting our geographic market data, we examine the exit decision for seven different manufactured products across 181 geographic markets in the U.S. over the 1963–1997 period. This gives us a very rich set of demand and cost conditions across markets. In contrast, most previous studies of exit ignore detailed market demand and cost variables, controlling for them with industry or time dummies, and instead focus their attention on whether observable plant characteristics are correlated with the decision to close a plant.

Our first set of empirical results, based on a probit model of exit, clearly demonstrate that the prior experience of the firm and plant has an important effect on the likelihood of exit, even after controlling for current producer characteristics and market conditions. Our set of six experience variables can be simplified into three categories for which exit probabilities differ. *De novo* entrants who have no prior firm or plant experience, new plants owned by firms with some prior experience in the product or geographic market, and experienced plants that are diversifying their product mix have distinctly different exit probabilities for almost all of the industries we examine. For six of the seven industries, product-mix entrants have significantly higher exit probabilities than any other category of entrant. Experienced firms opening new plants have the lowest exit probabilities in six of the seven industries, with the difference being significant in two cases.

Plant characteristics that control for profit heterogeneity, including productivity, absolute size, relative size in the market, and degree of industry specialization, are all correlated with exit in the expected way. Firm-level characteristics, including firm size and the distance to other plants owned by the firm, are also important determinants of exit for several products. Finally, high current demand levels per producer and high rates of future demand growth both act to depress exit. One additional finding is a remarkable degree of consistency in the magnitude of the effects across products, particularly for the plant-level characteristics and market-level variables.

In a second empirical exercise, we examine how producer and market characteristics affect the method plants choose when they exit a market. In our data, two methods of exit are identified—closing the plant or diversifying out of the product market. The empirical results indicate that the type of prior experience again has a significant impact on the probability of each method of exit. The most experienced group of plants, those with both firm and plant operating history, are the most likely to exit a product market by shifting their product line but keeping the facility in operation. In addition, industry diversification

and specialization at the plant level are key determining factors in this decision. More highly diversified plants and plants with a product specialization outside of the industry under study are much more likely to exit through changes in product line. This is consistent with the argument that these plants have the most favorable set of options in other product markets. Overall, we find that, after controlling for current profit determinants, initial entry conditions play an important role in both the plant's decision to exit a product market and the choice of exit method. The exit decision is not one that can be fully captured by looking at a plant's characteristics at a point in time, but rather history matters in a significant way.

In the next section of this paper we develop an empirical model of plant exit and relate it to the existing theoretical models and empirical studies. Section 3 describes the data for our geographic markets and discusses the construction of the plant and firm experience variables. Section 4 provides the results from a probit model of plant exit while Section 5 reports the findings from an analysis that distinguishes two different methods of exit. The final section summarizes the results.

## 2. The decision of a plant to exit a market

We begin by specifying the current profit of a plant that produces output in a specific market. We view a market as a combination of industry and geographic area and recognize that a plant often produces and sells output in several industries. Like Dunne et al. (1988), we are interested in the decision of a producer to exit a market and this is distinct from the decision to close the plant entirely.

Let  $\pi_{igt}(z_0, x_t, m_{igt})$  be the maximum profits earned by a plant that produces output in industry  $i$  in geographic area  $g$  in year  $t$ . Plant profits are a function of a set of plant-specific characteristics at the time the plant enters the market  $z_0$ , plant characteristics that vary over time  $x_t$ , and market conditions  $m_{igt}$ . The  $z_0$  represent a set of initial conditions at the time the plant enters the market and, thus, remain fixed over time. Both  $x_t$  and  $m_{igt}$  are state variables that evolve over time, either exogenously to the plant or endogenously as a result of plant decisions. An example of a variable that evolves exogenously is population in the geographic market, a determinant of market demand. An example of a variable that could evolve endogenously is the plant's capital stock, which changes with the plant's investment decision. The plant characteristics  $z_0$  and  $x_t$  can include factors that are specific to the plant, such as the plant's productivity, or factors that arise at the firm level, such as the amount of managerial input or R&D activity of the firm, that could affect the profitability of all plants owned by the firm. That is,  $z_0$  and  $x_t$  can include firm characteristics that affect a plant's profits.

We view the plant as making a decision to continue operating in a market at the start of each year prior to observing (or choosing) the values of  $x$  and  $m$  for that year. Specifically, the plant decides to produce in year  $t+1$  by comparing the expected discounted sum of profits from operating,  $EV_{igt+1}$ , with the scrap value it earns by exiting,  $\sigma$ . Expected future profits are calculated from knowledge of the profit function  $\pi_{igt+1}$ , the observed state variables for year  $t$ ,  $(z_0, x_t, m_{igt})$ , and knowledge of the transition process for the time-varying state variables. If  $EV_{igt+1} \geq \sigma$ , the plant continues in the market and we observe the

discrete variable  $F_{igt+1}=0$ . If expected profits are less than the scrap value the plant exits the market and we observe  $F_{igt+1}=1$ . Our empirical model expresses the discrete exit variable in year  $t+1$  as a function of the initial conditions and state variables in year  $t$ :  $F_{igt+1}(z_0, x_t, m_{igt})$ .

Overall, the goal of the empirical model is to identify groups of variables—initial entry conditions, time-varying plant and firm variables, and market-level variables—that may matter to the exit decision. While the model outlined in the last paragraph is the basis for many of the empirical exit studies in the literature, our application will vary from these others in several ways. First, the primary focus in the literature has been on the set of plant characteristics in  $x_t$  that can account for differences in profitability across producers. These variables commonly include size, usually measured by employment, age, productivity, capital stock, type of technology, whether it is owned by a single or multi-plant firm, and possibly some information on the size or product market diversity of the owning firm.<sup>3</sup> A common finding is that the exit process does reflect underlying differences in productivity or efficiency. Like these other studies, we control for an important set of plant and firm-level characteristics that are correlated with differences in profits and survival, but we will also exploit some aspects of our data that let us measure differences in the experience of the plant operators at the time of entry. Specifically, we construct a set of variables that distinguish completely inexperienced producers, *de novo* entrants, from producers that had prior experience in the geographic area and/or product market.

Second, our empirical model focuses on the decision of a manufacturing plant to stop producing output for industry  $i$  in geographic market  $g$ . The main focus is *not* on the decision to close a plant. Rather, many plants produce multiple products and a plant can exit an industry without closing by altering its product mix. This is what Dunne et al. (1988) and Bernard et al. (2003) have identified in their studies. It is the exit of the plant from production in the industry that we believe is the most relevant measure of exit for industrial organization economists to understand because it directly affects the number and relative size of competitors in the market which in turn determines pricing and markup patterns.

Third, we also estimate a model that recognizes the way in which the plant exits. Our first model treats the plant as making the binary exit/continuation decision as described above. Our second model examines plants that exit and models the method of exit. Our data allow us to distinguish between two types of exit—plant shutdown or product-line exit. The latter reflects the ability of plants to remain in production but exit an individual product market by altering their product lines. We estimate a probit model that quantifies the effect of plant, firm, and market characteristics on the probability of a plant using a specific method of exit.

Fourth, we study exit in the context of a specific product market. The profits of a plant depend on the level of demand, cost conditions, and market structure in the market in which it operates and failure to control for differences in market conditions omits an important set of variables. In studies that use time-series data for a single industry which

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<sup>3</sup> A comprehensive summary of this literature is provided in Caves (1998). A recent extension, which incorporates the role of import competition in the plant shutdown decision, is Bernard and Jensen (2002).

operates in a national market, such as Olley and Pakes' (1996) study of telecommunications equipment, Deily's (1988) study of the steel industry, Das' (1992) study of cement kilns, Bresnahan and Raff's (1991) study of automobile assembly plants, Lieberman's (1990) analysis of the chemical industry or Klepper and Simon's (2000) study of the tire industry, market conditions are identical for all producers at each point in time and year dummy variables are sufficient to control for them in empirical models. Other studies of exit pool data across a large number of industries and then it does become important to control for differences in market conditions. Generally this is done by including industry and time dummy variables in the exit regression. In order to isolate the role of market-level variables in the exit process we study seven industries that operate in small geographic markets. We have multiple observations on each market over time and a 35-year time period in which there are large changes in demand and cost conditions for most markets.

### 3. Data

The data consist of observations on manufacturing plants collected in the U.S. Census of Manufactures which is taken at 5-year intervals over the period 1963–1997. There are eight annual observations over this 35-year period. We estimate separate exit models for the seven four-digit regional manufacturing industries listed in Table 1. We include three food industries (milk, baked goods, and soft drink bottling) and four industries that manufacture construction-related products (asphalt and three concrete-product industries). These industries were chosen because plants in these industries sell their output in relatively small geographic areas and this gives us a large number of markets with different demand and cost conditions to exploit in the estimation. Table 1 provides data from the 1977 Commodity Transportation Survey on shipping distances for the industries included in this study. The construction related industries (SICs 2951, 3271, 3272, 3273) appear to have the smallest local markets. Over 90% of the products shipped in these industries are shipped less than 100 miles. The food industries (SICs 2026, 2051, and 2086) have somewhat larger geographic markets. Between 61% and 83% of shipments in these industries are shipped less than 100 miles, while the vast majority of shipments in these industries are shipped less than 200 miles.

Table 1  
Number of plants, industry size, and product distance shipped

Industry (SIC)	Number of plants	Total employees (in thousands)	% Product shipped less than 100 Miles	% Product shipped less than 200 Miles
Fluid milk (2026)	1924	93.5	80.1	91.2
Bakery products (2051)	3062	178.0	61.6	82.7
Bottled and canned soft drinks (2086)	2192	114.1	83.0	94.8
Paving mixtures and blocks (2951)	1022	12.8	94.4	97.1
Concrete block and brick (3271)	1273	18.7	92.1	99.3
Concrete products, NEC (3272)	3916	61.7	94.6	99.7
Ready-mix concrete (3273)	5433	87.9	94.6	96.3

Source: 1977 Census of Manufactures and 1977 Commodity Transportation Survey.

These industries have undergone very different patterns of expansion and/or contraction over the 35-year period of our data. Both long-term shifts in demand due to population growth and the development of substitute products and long-term changes in technology have had a substantial impact on the market structure in each industry. For example, the fluid milk industry has undergone significant changes in the distribution system utilized in the industry. In 1963, there were 5713 plants while in 1997 there were only 837 plants. The shrinkage in the number of plants is due to changes in technology (improvements in refrigeration) and changes in delivery mode (supermarkets vs. home delivery). Alternatively, the number of ready-mix concrete plants has stayed relatively stable over time though firm structure has changed substantially over the period. At the beginning of our sample, single-plant producers account for 75.8% of plants, while at the end of the study they account for only 44.5%. Given the industry-specific forces affecting these markets, the exit models are estimated separately for each industry.

To identify the plants that produce in each of the seven four-digit SIC industries we use information on the entire set of products manufactured in each plant. In the data set for industry  $i$ , we include all plants that manufacture product  $i$  even if it is not the primary output of the plant. We then assign each plant to a local geographic market  $g$ . As geographic markets we use the 181 distinct regional markets identified by the Bureau of Economic Analysis (BEA) as economic areas.<sup>4</sup> Each of these geographic markets is an aggregate of a group of counties. A plant exit is defined as a plant that was producing in the geographic market-industry pair in the current census year ( $t$ ), but is not producing in the geographic market-industry pair in the next census year ( $t+5$ ). Since we recognize that plants can produce multiple products, this definition recognizes that plants can exit a market by changing the product lines they produce or by shutting down the operation completely.

As discussed in Section 2, the exit model focuses on the importance of four broad groups of variables: plant/firm experience, plant characteristics, firm characteristics, and market conditions. We discuss each group in turn and [Table A1](#) provides detailed definitions of all the variables.

### 3.1. Plant and firm experience

Our empirical specification includes information about the history of the plant in the market,  $z_0$ . An important and unique element of our data is that we observe plants at the time they first enter a market and can quantify the type of prior production experience they possess.

First, for each entrant we measure the prior production experience of that plant. In the first year we observe the plant in industry  $i$  market  $g$ , we classify the plant into one of two categories based on experience: the first category is “no experience” and contains all new plants. We refer to these as new-plant entrants. The second category contains all

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<sup>4</sup> These are defined by the BEA as “Each economic area consists of one or more economic nodes metropolitan areas or similar areas that serve as centers of economic activity and the surrounding counties are economically related to the nodes.” See [Johnson \(1995\)](#) for a detailed discussion of BEA economic areas.

Table 2  
Combinations of firm and plant experience at the time of entry

Prior firm experience	Prior plant experience	
	No (new-plant entrant)	Yes (product-mix entrant)
None	(1)	not applicable
Experience in ( <i>i</i> , <i>g</i> ) pair	(2)	(5)
Experience in industry <i>i</i>	(3)	not applicable
Experience in a different industry	(4)	(6)

previously existing plants. These plants are ones that were not producing output in industry *i* in the prior census but were producing output in some other industry. We refer to these plants as product-mix entrants. The operators of these plants have some prior experience with the plant's workforce, suppliers, transportation providers and, possibly, buyers and thus may be more knowledgeable than the operator of a new plant. It is also likely that the cost of entering industry *i* will be different for product-mix and new-plant entrants. The former do not have to incur the cost of setting up production facilities while the latter do. In Table 2, the two types of plant experience are represented by the two columns.

Second, we also classify the plant in its first year of production in industry *i* market *g* into several categories based on the prior experience of the *firm* that owns it. First, the firm may already have some experience manufacturing product *i* in market *g* with a different plant. A firm with this type of industry/geography-specific experience should have a better understanding of the technology, type of customers, and demand characteristics of the buyers of the product. To the extent that this type of expertise can be transmitted within the firm and applied to new plants in this geographic location, these firms should have better prior information than counterparts that have not operated in this industry and/or geographic market. Second, the firm may have prior experience producing in industry *i* in a different geographic market. This type of plant would benefit from the firm's experience with the technology even though it does not have any direct experience with the buyers in market *g*. Third, the firm may have no prior experience in industry *i*, but still be an ongoing entity with manufacturing experience in some other, possibly related, industry. While these firms will not have industry-specific experience with product *i*, they do have prior manufacturing experience which may give them advantages in dealing with labor markets, accounting, distribution, R&D, or product development.

Focusing on the new-plant entrants, column 1 in Table 2, the four categories of firm experience are identified. First, the firm may be new and have no prior production experience. New plants owned by these firms (de novo entrants) are denoted as type 1 in the table. Plants owned by firms with prior experience in both the industry and geographic market are denoted as type 2. Plants owned by firms with prior experience in the industry but not in the geographic market are denoted as type 3. Plants owned by firms with manufacturing experience outside of industry *i* are denoted as type 4.<sup>5</sup> For product-mix

<sup>5</sup> We do not distinguish whether this prior manufacturing experience occurs in geographic market *g* or in some other market because there were few plants in these subcategories.

entrants, column 2 in the table, only two of the categories of firm experience are possible. Since the plant already exists in the geographic market, we only need to distinguish whether the firm's prior experience is within the industry (type 5) or in some other industry (type 6).

Together these six categories distinguish the type of experience that each plant possesses when it begins production in industry  $i$  market  $g$ . In the exit model we include dummy variables to distinguish these six categories of firm/plant experience. We also test a number of models that restrict the six categories to a smaller set in which, for example, only prior plant experience matters or only prior firm experience matters. These tests help identify if a particular source of prior experience has a long-lived effect on the plant's participation decision.

Table 3 provides data on the distribution of plant experience categories in the first year the plant is observed in the market. The percentages are averaged over the six census years in which we observe entry. The most common form of entry is de novo entry (type 1). These are new firms entering with new plants. These inexperienced plants account for more than one-half of the new producers in a census year in four of the seven industries. The second most numerous group of entrants are type 6, existing plants in which the owning firm has no prior experience in industry  $i$  in the preceding census. These are producers that have entered industry  $i$  by changing the product mix of an existing plant.

There are some interesting similarities across industries. Both the milk (2026) and soft drink bottling (2086) industries have a very similar distribution of prior experience. De novo entry, type 1, is less important than in the other industries and product mix entry from existing plants, types 5 and 6, is more common. This represents an ability of existing producers to shift production among alternative products. For example, milk producers move in and out of other dairy product industries and soft drink bottlers move in and out of other beverages. Another interesting similarity exists between the asphalt (2951) and ready-mix concrete (3273) industries. Many of the new plants in these industries are

Table 3  
Distribution of plants by plant and firm experience categories

Industry (SIC)	(1)	(2)	(3)	(4)	(5)	(6)
Milk (2026)	49.4	8.2	7.8	2.5	12.1	19.9
Bakery products (2051)	87.8	2.7	3.0	1.0	2.1	3.7
Soft drink bottling (2086)	45.9	7.7	9.2	1.9	12.9	22.3
Asphalt paving (2951)	42.0	20.8	13.3	4.8	6.2	12.9
Concrete block (3271)	53.4	7.7	3.9	4.3	7.7	23.0
Concrete NEC (3272)	64.6	3.6	4.4	3.1	4.0	20.4
Ready-mix concrete (3273)	63.1	22.0	4.8	1.2	2.9	6.0

Experience categories:

- (1) No plant experience, no firm experience (de novo entry).
- (2) No plant experience, firm experience in industry  $i$  market  $g$ .
- (3) No plant experience, firm experience in industry  $i$ , not in market  $g$ .
- (4) No plant experience, firm experience in manufacturing but not in industry  $i$ .
- (5) Plant experience, firm experience industry  $i$ .
- (6) Plant experience, firm experience in manufacturing but not industry  $i$ .

owned by firms that already have a plant in the geographic market, type 2. This most likely reflects the fact that shipping distances are very short for these products, so that firms expand capacity by adding more plants in the geographic market, as opposed to increasing plant size.

### 3.2. Market conditions

The second broad class of profit determinants are market conditions  $m_{igr}$ . We control for differences in the profitability of different geographic markets by including a set of demand and cost shifters and a set of geographic market dummies. The demand and cost shifters account for differences in profitability over time and across markets. For the asphalt and concrete industries, we measure demand by the level of activity in construction, specifically, the level of real earnings in the construction industries.<sup>6</sup> For the food industries, we use population as the measure of demand. We express the demand variables in year  $t$  on a per-producer basis by dividing by the number of plants in the market in year  $t$ . The growth in demand is measured as the growth in the demand variable from year  $t$  to  $t+5$ , divided by the number of plants in year  $t$ . We expect that high per-producer demand and high growth both indicate higher expected profits and, thus, less exit.

To measure differences in costs across geographic markets, we construct the average wage paid and the average price of electricity for all plants operating in a geographic market as well as the changes in these variables from  $t$  to  $t+5$ . We also measure the local price of the key raw material used in each industry. In the baking industry (2051) we include the price of wheat flour, in the milk industry (2026) whole milk is the key input, in soft drink bottling (2086) it is flavoring syrups, in asphalt (2951) the key ingredient is asphalt, and in the three concrete-related industries (3271, 3272, and 3273) portland cement is the main material component.<sup>7</sup> All exit models also include time period dummies to control for aggregate shocks to the industry.

### 3.3. Plant-level characteristics

The third set of control variables are plant-level variables ( $x_{it}$ ) that act as profit determinants including measures of the plant's production efficiency. These are proxied by both the absolute size of the plant and its position relative to other producers in the same market in year  $t$ . We measure plant size using the log of total employment. We measure its relative position in the market by both its relative labor productivity and its output market share. Relative labor productivity is defined as the log of the plant's value of shipments per worker relative to the average labor productivity over all plants in the market. The market share is measured as the plant's

<sup>6</sup> The Bureau of Economic Analysis (BEA) constructs annual earnings data for each sector of the economy at the county level. We aggregate the BEA earnings data at the county level to the BEA economic area level.

<sup>7</sup> We cannot include changes in this material price variable because in 1997 the material coding changed significantly so that it was not possible to construct similar price indices for the materials variables in 1997.

share of production in the geographic market. We also include measures of the importance of diversification in a plant. A set of indicator variables is constructed to control for the number of four-digit SIC industries a plant produces in. In addition, we identify plants based on the degree of output specialization in the industry. Plants producing less than 50% of their output in the industry under study are referred to as secondary producers. Differences in specialization could produce differences in profitability if there are economies or diseconomies of scope in production. Differences in scrap values could also arise if secondary producers have better alternative uses for the plant than producers with highly specialized production, leading to higher exit rates for secondary producers. Finally, we control for plant age with a set of dummy variables distinguishing four age classes: 1–5 years, 6–10 years, 11–15 years, and more than 15 years old.<sup>8</sup>

### 3.4. Firm characteristics

A plant's profits or scrap value may also be determined by characteristics of the firm that owns it and we include a set of firm-level variables in the empirical model to account for this source of variation in plant profits. The firm variables are firm size and several measures of the geographic distribution of production by the firm. In the latter case, we want to control for the fact that multi-plant producers may face a fundamentally different exit decision than single-plant producers. For a single-plant producer, the decision to close is the decision to exit a market and perhaps close down the firm. For the multi-plant producers, it may simply represent an alternative method of capacity adjustment.<sup>9</sup> In order to control for such differences in firm structure across producers, we measure the proximity of other plants owned by the firm and information on the total number of geographic markets the firm operates in.

## 4. Empirical results—determinants of the exit decision

In this section we report coefficient estimates for probit models of plant exit. The models are estimated separately for each industry and include both fixed effects for the geographic markets and years.<sup>10</sup> Before reporting the coefficients for individual variables,

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<sup>8</sup> For the group of plants that are in operation in the first year of our data set, 1963, we cannot measure the age or entry experience variables. For these we included a separate set of year dummies that control for the age and time related patterns in their exit rates. Therefore, both the age and experience coefficients in the exit models are estimated only from information on the group of plants that enter in census years after 1967.

<sup>9</sup> Papers by Whinston (1988), Baden-Fuller (1989), and Lieberman (1990) emphasize the multi-plant shutdown decision.

<sup>10</sup> In addition to the coefficients reported in this section, we performed some sensitivity checks to the definitions of our geographic markets. In the eastern U.S., the geographic markets we use tend to be much smaller than in the western U.S. and they share many borders in common. This may allow the plants we study to more easily serve adjoining markets so that market-level demand, cost and relative size variables are less accurate for them. We have estimated the model omitting the densely populated eastern geographic areas and the results we report are robust to this change in the sample.

we examine the statistical significance of six broad groups of variables. Table 4 presents the log-likelihood ratio test statistics. The first column reports the test statistic for the hypothesis that there are no geographic market effects and, in all industries, we reject the hypothesis. Columns 2 and 3 present test statistics that the market demand and cost variables are jointly equal to zero. In six of the seven industries we reject the hypothesis that market demand variables do not matter. In four of the seven industries, we reject the null hypothesis that the market cost variables do not matter. The final two columns show that plant and firm characteristics are important in almost all industries. This is particularly the case with the nine plant variables (size, market share, productivity, plant age dummies, specialization, and multi-industry dummies). The test statistics for the plant variables (column 5) are all very large indicating that, within markets, plant heterogeneity plays a very important role in determining the plant exit patterns. Overall, we need to control for market, plant, and firm characteristics in the exit models. Next, we turn attention to the importance of the plant experience variables.

#### 4.1. Plant and firm experience

The first set of variables we examine distinguish the six categories of prior experience. We initially test four hypotheses about whether the set of experience variables can be simplified and the  $\chi^2$  test statistics are reported in Table 5. First, we test the hypothesis that all six experience variables are jointly equal to zero. This is equivalent to specifying that there is no difference in exit probabilities between the original plants present in the 1963 cohort and the later plant entrants. The hypothesis is rejected for all seven industries. Exit probabilities are significantly different for plants that enter over the sample period.

The second hypothesis we test allows entrants to differ from the initial 1963 cohort but restricts all the firm and plant experience coefficients to be equal. This is equivalent to imposing that the type of prior experience, whether firm or plant or within the industry or not, has no effect on exit probabilities. This hypothesis is rejected in six of the seven

Table 4  
Hypothesis tests for groups of variables

Industry	Hypothesis tests				
	No geographic market effects	No market demand variables	No market cost variables	No firm variables	No plant variables
Milk (2026)	276.7*	25.6*	7.5	18.6*	1343.1*
Bakery products (2051)	206.5*	9.0	51.4*	52.6*	1011.0*
Soft drink bottling (2086)	232.3*	16.2*	17.1*	36.4*	1479.5*
Asphalt paving (2951)	282.0*	12.9*	163.8*	79.8*	465.5*
Concrete block (3271)	274.9*	27.7*	6.4	9.2	795.6*
Concrete NEC (3272)	317.4*	33.9*	5.6	80.9*	1682.2*
Ready-mix concrete (3273)	402.9*	67.9*	17.6*	124.2*	1542.5*
Critical value $\alpha=0.01$	135.8	9.2	15.1	13.3	21.7

\* Significant at the 1% level.

Table 5  
Hypothesis tests for experience coefficients

	Entrants and incumbents are the same: 1,2,3,4,5,6=0	Type of prior experience does not matter: 1,2,3,4,5,6 are equal	Firm experience does not matter: 1=2=3=4 and 5=6	Any firm experience is equivalent: 1 and 2=3=4 and 5=6
Milk (2026)	28.41*	23.53*	9.29	9.15
Bakery products (2051)	43.93*	42.84*	9.85	1.21
Soft drink bottling (2086)	33.67*	6.07	2.74	1.62
Asphalt paving (2951)	20.53*	20.35*	7.02	6.50
Concrete block (3271)	27.29*	25.19*	2.90	1.16
Concrete NEC (3272)	91.18*	37.03*	9.11	7.22
Ready-Mix concrete (3273)	73.24*	39.30*	19.45*	3.46
Critical value $\alpha=0.01$	16.82	15.09	13.28	11.35

\* Significant at the 1% level.

industries. The hypothesis is not rejected in soft drink bottling (2086). In the other six products, the source of the plant's experience at the time of entry is going to have a statistically significant effect on its exit probability.

The third hypothesis recognizes the difference in plant experience between new entrants and product-mix entrants but restricts all sources of firm experience to be unimportant. That is, it does not matter if the firm has no prior experience, experience in the industry, or experience elsewhere in manufacturing. This hypothesis is rejected in only one of the seven industries—ready-mix concrete. An alternative way of expressing this result is that, for the six industries, once we distinguish new plants (types 1, 2, 3, and 4) from old plants (types 5 and 6), there is no significant difference within each group based on the source of firm experience.

The final hypothesis we test allows three distinct categories of experience. Plants are distinguished based on whether they are new or old, and the firm is distinguished by whether it has some prior experience or not. All sources of firm experience are restricted to have an equal effect. This leaves three distinct categories—new plants owned by new firms (type 1), new plants owned by firms with some type of experience (types 2, 3, and 4), and experienced plants (types 5 and 6). This hypothesis cannot be rejected in any of the industries. This implies that, in terms of the effect on exit probabilities, it is important to distinguish whether the entering firm has prior experience, but the source of its experience, whether it is in the same industry or same geographic area, does not matter. Since we cannot reject this last hypothesis in any of the industries, we simplify our discussion of the remaining results by treating the model with three experience categories as the unrestricted model and focusing on the differences in exit among these three groups.

Table 6 presents the results of this exit model for each of the seven industries. Rather than report probit coefficients directly, we report the marginal effects: the change in the probability of exit for an infinitesimal change in the value of a continuous variable and the change in the probability of exit for a discrete change in the value of a dummy variable, evaluated at the means of all the independent variables. With the experience variables, *de novo* entrants are treated as the base group. The

Table 6  
The probability of market exit (marginal effects from probit model)

Variables	Industry						
	2026	2051	2086	2951	3271	3272	3273
<i>Entrant experience (base group is de novo entrants)</i>							
Experienced firm new plant	0.009 (0.025)	-0.071* (0.023)	-0.022 (0.020)	-0.015 (0.021)	-0.033 (0.025)	-0.024 (0.017)	-0.043* (0.010)
Experienced firm product mix	0.082* (0.023)	0.149* (0.031)	-0.037* (0.017)	0.080* (0.027)	0.082* (0.021)	0.066* (0.014)	0.054* (0.016)
<i>Demand</i>							
Initial demand	-0.128* (0.025)	-0.060* (0.028)	-0.097* (0.025)	-0.098* (0.028)	-0.113* (0.023)	-0.097* (0.018)	-0.069* (0.014)
Growth in demand	-0.112 (0.212)	-0.438* (0.212)	-0.195 (0.164)	-0.090* (0.034)	-0.129* (0.027)	-0.097* (0.020)	-0.118* (0.014)
<i>Plant characteristics</i>							
Plant size	-0.167* (0.007)	-0.182* (0.008)	-0.174* (0.007)	-0.071* (0.009)	-0.161* (0.011)	-0.165* (0.007)	-0.101* (0.005)
Market share	-0.223* (0.053)	-0.224* (0.050)	-0.081 (0.046)	-0.312* (0.072)	-0.335* (0.064)	-0.104 (0.056)	0.015 (0.079)
Productivity	-0.092* (0.008)	-0.078* (0.009)	-0.106* (0.008)	-0.101* (0.010)	-0.141* (0.013)	-0.063* (0.008)	-0.095* (0.006)
Secondary producers	0.152* (0.014)	0.206* (0.023)	0.242* (0.016)	0.164* (0.030)	0.169* (0.018)	0.213* (0.017)	0.139* (0.014)
Multiple industries 2	-0.073* (0.012)	-0.028 (0.015)	0.024 (0.014)	0.021 (0.023)	0.016 (0.017)	0.055* (0.017)	-0.063* (0.008)
Multiple industries 3+	-0.093* (0.013)	0.040 (0.027)	0.062* (0.019)	0.037 (0.032)	0.057* (0.022)	0.093* (0.021)	-0.057* (0.010)
<i>Firm characteristics</i>							
Firm size	-0.003 (0.006)	0.029* (0.007)	0.018* (0.005)	0.007 (0.004)	0.015 (0.008)	0.042* (0.005)	0.001 (0.003)
No. of geographies	0.000 (0.001)	-0.004* (0.001)	-0.004* (0.001)	0.002* (0.001)	-0.003 (0.008)	-0.009* (0.001)	0.011* (0.003)
Plant within 100 miles	0.072* (0.020)	0.045* (0.021)	0.027 (0.017)	-0.133* (0.018)	-0.043 (0.022)	-0.075* (0.015)	-0.042* (0.009)
Plant within 200 miles	0.048* (0.023)	0.022 (0.025)	0.027 (0.020)	-0.181* (0.022)	-0.095* (0.031)	-0.103* (0.018)	-0.132* (0.012)
<i>N</i>	14,165	12,437	16,030	5749	8684	17,105	25,175
Mean exit rate	0.414	0.378	0.399	0.331	0.397	0.418	0.320
Pseudo $R^2$	0.172	0.186	0.123	0.125	0.150	0.157	0.083

Standard errors of the marginal effects in parentheses.

\* Significant at 5% level for a two-tailed test on the estimated parameter in the probit equation.

negative coefficients for experienced firms entering with new plants imply they have lower exit probabilities than de novo entrants and the difference is statistically significant in baked goods (2051) and ready-mix concrete (3273). In contrast, the experienced product-mix entrants have a significantly greater probability of exit than de novo entrants in six of the seven industries. The probability of exit for product-mix

entrants is 0.054 to 0.149 greater than de novo entrants across these industries. We reject the hypothesis that exit of a plant at time  $t$  is only determined by characteristics of the plant at time  $t$ , in favor of an alternative explanation that also relies on a role for initial entry conditions.<sup>11</sup>

#### 4.2. Market characteristics

The second set of variables in Table 6 represent controls for demand conditions. Across all industries increases in demand lower the probability of exit from the industry. The general pattern is that, for the food industries, a higher initial level of demand, as measured by the log of population per producer, leads to lower subsequent exit. For the construction industries, both the initial demand and the growth in demand are negatively correlated with the probability of producer exit. The five parameters associated with the market-level cost variables are not reported since there are no strong patterns in the cost parameters across industries, and in most cases, the individual cost variables are not statistically significant at the 5% level.

#### 4.3. Plant characteristics

The third set of variables in Table 6 reports results for six plant characteristics. As expected, an increase in plant size (log of total plant employment) has a negative and statistically significant impact on the probability of exit in all industries. For example, in the three food industries, an increase in the plant size by 10 employees, which represents a 23–33% increase in average plant size, decreases the probability of exit by 0.037 to 0.046 across the food industries. This is a substantial effect as the average probability of exit varies between 0.38 and 0.41 across these industries. The negative relationship between size and the probability of exit agrees with most other studies of exit (for example, Evans (1987), Dunne et al. (1989), Levinsohn and Petropoulos (2000), and Bernard and Jensen (2002)). The next two rows report the results for variables that measure the relative performance of a producer in the geographic market—market share and relative labor productivity. In almost all industries, greater market share and higher relative productivity lead to lower exit probabilities. The only exception is SIC 3273 where the market share effect is positive although not statistically significant. The effect of an increase in the market share by 10 percentage points would be to lower the probability of exit by 0.022 to 0.034 across the four industries where the market share is negative and statistically significant. In the case of the relative labor productivity, a producer that is twice as

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<sup>11</sup> The results for the experience coefficients in Table 6 indicate a significant role for initial plant conditions in the subsequent exit patterns, but they do not allow the experience effects to diminish as the plant ages. We check if the role of entry experience diminishes as the plant ages in the market by including a set of interaction terms between plant age and the prior production experience variables. The plant age–firm experience interactions are generally not significant and we do not observe a different aging pattern in the probabilities of exit for firms that entered with different types of prior experience. In six of the seven industries we could not reject the hypothesis that the effect of experience was constant as the plant aged. This lends further support to the argument that prior experience has a long-lived effect on plant participation.

productive as the average producer in the geographic market has a 0.063 to 0.141 lower probability of exit than the average producer.<sup>12</sup>

The last group of plant characteristics reported in [Table 6](#) measures the industry diversification of a plant. The first variable identifies whether the plant has only a secondary specialization in the industry. Across all industries, secondary producers have a much higher probability of exit from the industry. The difference in the probability of exit of a secondary producer compared to a primary producer ranges from a low of 0.139 in ready-mix concrete (3273) to a high of 0.242 in bottled and canned soft drinks (2086). The next two variables identify whether the firm produces in multiple four-digit SIC industries. The dummy variables distinguish between plants producing in one industry (the omitted group), plants producing in two industries and plants producing in three or more separate industries. The results, while often statistically significant, are mixed in terms of the direction of the effect. For plants in the soft drink (2086), concrete block (3271), or miscellaneous concrete product (3272) industries, presence in a larger number of products is positively correlated with the probability of exit. This finding is sensitive to the industry, with plants in milk (2026) and ready-mix concrete (3273) having a lower probability of exit if they produce multiple products. The role of multi-industry production in the exit process will be clearer when we examine the determinants of the mode of exit in the next section.

#### 4.4. Firm characteristics

The last set of variables we examine are the firm characteristics, including variables that measure the proximity of other facilities owned by the firm, firm size, and the number of geographic markets each firm operates in. The first finding is that plants owned by large firms generally have a higher probability of exiting a market than plants owned by smaller firms. The marginal change in probability is positive in six of seven industries and statistically significant in three of the seven industries.<sup>13</sup> The second variable controls for the number of geographic markets that a firm operates and it has little systematic effect on the probability of exit across industries.

The last two firm characteristics measure the proximity of nearby facilities. The first variable is a dummy indicating whether a firm has another facility producing in the same industry within 100 miles of the plant. The second variable is a dummy variable that indicates that while a firm does not have a plant within 100 miles it has a plant producing in the industry between 100 and 250 miles away from the plant. These variables control for the fact that multi-plant producers face a different exit problem than

<sup>12</sup> While not reported, we also include controls for plant age in the probit model. The pattern is quite consistent across industries. In all industries for all years the coefficients are negative indicating that older plants exit less frequently than new plants (the omitted group). For all but two industries (2951 and 3273), the probability of exit declines monotonically through the first two age groups (6–10 years old and 11–15 years old). For the oldest plants (greater than 16 years of age), the pattern is mixed. In general these aging patterns agree with the prior studies that have found that the probability of exit generally declines with age (see the papers reviewed in [Caves \(1998\)](#)).

<sup>13</sup> This is similar to the findings of [Lieberman \(1990\)](#) for the chemical products industry. Controlling for plant size he finds that large firms had a higher probability of closing a plant.

single-plant producers. Presumably, a nearby plant could service the customers in a geographic market in the face of the exit of an individual facility. The results differ across the two industry groups. In the food industries, nearby plants raise the probability of exit although the effect is often not statistically significant. This is consistent with the firm consolidating nearby plants. In contrast, the most robust pattern is that for the construction industries: a nearby facility is correlated with a lower probability of exit for a plant. Overall, while firm characteristics are often statistically significant in the exit regressions, the effects are less robust than the plant characteristics, market demand, and experience variables.

## 5. Empirical results—plant shutdown versus product-line exit

In addition to measuring market exit, our data allow us to examine the determinants of the mode of exit. A plant can exit the market by completely shutting down its operation, or alternatively, the plant can remain open but shift its production toward other products. We will refer to the first method of exit as plant shutdown and the second method as product-line exit. While both of these cases result in the plant exiting the industry in market  $g$ , they are likely to reflect different opportunity costs for the plant. In the case where the plant shuts down entirely, the decision is likely to be affected by the characteristics and quality of the plant's capital stock or workforce. Plants that have limited options in other industries, because, for example, they have low overall productivity or have physical assets that are highly specialized in the production of one product, will be more likely to exit through plant closure. In contrast, a plant that is relatively efficient in production may exit an industry because the inputs can be more profitably allocated to other types of output. The product-line exit alternative is likely to be more attractive for a multi-product plant that is already selling some of its output in a different product market, since they are likely to have already established distribution or sales networks or contacts. Similarly, on the supply side, plants that have more flexible technologies may find it less costly to shift production lines toward alternative products and thus be more likely to remain in operation, even if we observe them exiting a specific industry. Thus, the variables that capture the plant's ability to diversify may be particularly important in determining the mode of exit. We model the plant's choice of exit method using a probit model where the decision to close a plant is categorized as a zero and the decision to shift product lines as a one. We estimate this model using data only for producers that exited a market and the same set of independent variables as the probit model in Section 4.<sup>14</sup>

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<sup>14</sup> We have also specified multinomial models that include “do not exit” as an additional option for each plant and estimated them with all the plant–market observations used in Table 6. The conclusions regarding the determinants of the two exit methods are identical to those reported in Table 7 below, but we have chosen to report the probit estimates for the method of entry because they are simpler to interpret and the effect of different experience categories is more transparent. The observations on exiting plants used in Table 7 differs slightly from the set of exiting plants underlying Table 6 because, in some geographic markets, there is no variation in the type of exit. Plants in these areas are excluded from the estimation because we also include dummy variables for each geographic area.

Before estimating the model we examine the incidence of each choice. The amount of exit resulting from product-line shifts in ongoing plants averages 22% of all exit across our seven industries, while plant closure accounts for the remaining 78% of exit. The relative importance of product-line exit, however, varies significantly across industries. The frequency is relatively low in bakery products (2051) and ready-mix concrete (3273), where product-line exit accounts for about 10% of all exit, but is much higher in concrete block and brick (3271) and concrete products NEC (3272) where it accounts for a third of exit.

The estimated marginal effects from the probit model of product-line exit are presented in [Table 7](#). Focusing on the entrant experience variables, we find that, in all industries, product-mix entrants are more likely to utilize product-line exit than de novo entrants or experienced entrants. The magnitude of the effect is particularly large for the construction industries where product-mix entrants have, on average, a 0.16 greater probability of exiting by product line than de novo entrants.

The market demand variables indicate almost no effect on the mode of exit. Thus, while the demand variables do affect the overall probability of exit they do not affect the mode of exit. In results not reported here, we explored the possibility of including additional market controls to measure demand changes in industries in which plants were most likely to switch into. Similar to the demand variables reported in [Table 7](#), these other demand controls were not statistically significant.<sup>15</sup>

Examining the plant characteristics, larger and more productive plants generally are more likely to exit by changing their product line. However, the magnitude of the effects is much smaller in comparison to the effects of plant size and productivity on the decision to exit the market reported in [Table 6](#). The results for market share are mixed. The key plant characteristics in determining the mode of exit are clearly the variables that measure industry specialization and industry diversification. If a plant is a secondary producer of the good, the probability of using product-line exit averages 0.26 higher than plants that are primary producers in the industry, across the seven industries. Similarly, if a plant produces in multiple industries, it is more likely to use product-line exit, and the magnitude of the effect increases with the number of outside industries for five of the seven products. Finally, the firm variables are rarely statistically significant and play little role in determining the mode of exit.

Using the results of this section, we can broadly characterize the type of plant that chooses each exit method. Initial conditions, in this case experience at the time of entry, are an important differentiating factor. Plants that had prior experience operating in other product markets at the time of entry are much more likely to exit by shifting product lines. This is consistent with the view that these plants have the best set of profit opportunities in other product markets, as evidenced by their history of operating in

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<sup>15</sup> The variables we constructed measured changes in shipments, employment and number of producers in the industries which were the most likely target industries for each of the plants. These target industries were identified by examining the overall pattern of industry participation and industry switching for plants producing each of our seven products. Typically, there were approximately three four-digit industries that were commonly targeted by plants that switched among industries.

Table 7  
The probability of product-line exit (marginal effects from probit model)

Variables	Industry						
	2026	2051	2086	2951	3271	3272	3273
<i>Entrant experience (base group is de novo entrants)</i>							
Experienced firm new plant	-0.012 (0.026)	-0.024* (0.061)	-0.018 (0.022)	0.049 (0.040)	0.017 (0.044)	-0.010 (0.028)	-0.021 (0.010)
Experienced firm product mix	0.048* (0.024)	0.061* (0.024)	0.049* (0.019)	0.265* (0.049)	0.183* (0.033)	0.086* (0.020)	0.112* (0.021)
<i>Demand</i>							
Initial demand	-0.000 (0.030)	-0.020 (0.019)	-0.021 (0.027)	0.027 (0.047)	0.032 (0.038)	-0.021 (0.027)	0.031* (0.014)
Growth in demand	0.003 (0.250)	0.080 (0.148)	-0.097 (0.184)	-0.024 (0.055)	-0.008 (0.045)	-0.004 (0.029)	0.029 (0.015)
<i>Plant characteristics</i>							
Plant size	0.043* (0.007)	0.021* (0.005)	0.048* (0.007)	0.060* (0.014)	0.033* (0.016)	0.050* (0.009)	0.021* (0.005)
Market share	-0.101 (0.075)	0.056 (0.045)	-0.026 (0.063)	-0.434* (0.143)	-0.050 (0.105)	-0.353* (0.107)	0.009 (0.080)
Productivity	0.037* (0.008)	0.024* (0.006)	0.036* (0.008)	0.047* (0.017)	0.011 (0.018)	0.084* (0.012)	0.001 (0.006)
Secondary producers	0.373* (0.021)	0.239* (0.038)	0.169* (0.020)	0.243* (0.050)	0.379* (0.029)	0.218* (0.027)	0.176* (0.021)
Multiple industries 2	0.057* (0.018)	0.045* (0.015)	0.200* (0.025)	0.082* (0.041)	0.167* (0.033)	0.310* (0.029)	0.076* (0.013)
Multiple industries 3+	0.011 (0.018)	0.020 (0.019)	0.214* (0.027)	0.139* (0.055)	0.185* (0.044)	0.318* (0.034)	0.083* (0.017)
<i>Firm characteristics</i>							
Firm size	-0.007 (0.006)	-0.004 (0.004)	0.006 (0.006)	0.008 (0.007)	-0.006 (0.012)	-0.007 (0.007)	0.003 (0.004)
No. of geographies	0.0014* (0.0006)	-0.000 (0.001)	-0.003* (0.001)	-0.001 (0.002)	0.034* (0.013)	-0.003 (0.003)	0.005 (0.003)
Plant within 100 miles	-0.033 (0.020)	0.003 (0.013)	-0.022 (0.017)	-0.008 (0.032)	-0.017 (0.037)	0.027 (0.025)	-0.039* (0.009)
Plant within 200 miles	-0.039 (0.023)	-0.016 (0.013)	-0.068* (0.016)	-0.031 (0.039)	0.092 (0.062)	-0.008 (0.034)	-0.027 (0.012)
<i>N</i>	5596	4012	6209	1711	3411	7152	7712
Mean product-line exit rate	0.211	0.093	0.223	0.237	0.346	0.332	0.118
Pseudo $R^2$	0.313	0.350	0.378	0.348	0.334	0.356	0.222

Standard errors of the marginal effects in parentheses.

\* Significant at 5% level for a two-tailed test on the estimated parameter in the probit equation.

other product markets. These initial conditions matter even after controlling for a rich set of current plant and firm characteristics including detailed controls for current industry diversification and plant specialization in the industry. We also find that plants that are larger and have higher productivity are more likely to use the product-line exit option

and these are the plants that we would expect to have the best opportunities in other product markets.

## 6. Conclusions

This paper examines the role of entry experience and plant, firm, and market characteristics as determinants of the plant's decision to exit a market. The paper finds that the producer's experience at the time it enters the market plays an important role in the subsequent exit decision, affecting both the overall probability of exit and the mode of exit, specifically plant closure versus a shift in product line. In the seven manufacturing industries we study, many new suppliers in a market begin with significant prior operating experience, but the nature of that experience, whether it is in the same industry or geographic area or with the same plant, can differ. We find that three combinations of plant and firm experience lead to distinct exit patterns. After controlling for observable profit determinants of the plant, experienced plants that enter by diversifying their product mix have the highest exit rates, followed by *de novo* entrants, and then new plants owned by experienced firms though the difference between last two entrant groups is often not statistically significant. The plants that entered through changes in product mix are also more likely to use shifts in product lines to exit an industry than are the other types of entrants. Overall, we find that the characteristics of the plant at time  $t$  are not sufficient to explain the decision to exit a market, but that initial conditions of the plant, in this case the type of experience it possessed at entry, also lead to long-term differences in the probability of exit.

In addition to the measures of prior experience, we find that current and future market demand levels are also important. An increase in current demand per producer and an increase in the growth rate of future demand generally lowers exit rates across our regional manufacturing industries. In contrast, differences in market level cost conditions across locations do not play an important role in the exit process, probably because many of the important cost differences exist at the plant, not market, level. We also control for a large set of plant and firm-level characteristics that can account for profit differences across plants. We generally confirm the findings of other empirical studies that stress the important role of producer heterogeneity in the exit process. We find that plants that are larger, both in absolute size and market share, are older, have higher labor productivity, and are more specialized are less likely to exit the market. Our controls for firm characteristics, the number of other plants owned by the firm, whether or not they are geographically close, and firm size, have a much weaker and less systematic effect on exit than the plant characteristics. Finally, we estimate our exit models separately for seven regional manufacturing industries. The patterns of coefficients and corresponding significance level are quite consistent across these industries, indicating that the process that drives exit has similar components across industries.

Our empirical findings on the important role of entry characteristics in the exit decision reinforce the findings of Dunne et al. (1989), Audretsch (1995), Mata et al.

(1995), Pakes and Ericson (1998) for the retail sector, and Klepper (2002). They suggest that the exit decision cannot be treated as determined solely by current and future plant and market conditions, but that the plant's history plays an important, independent role in conditioning the likelihood of survival.

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## Appendix A

Table A1  
Variable definitions

Variable name	Definition
Exit	An indicator variable that takes the value 1 if the plant exits the industry/geographic market between census year $t$ and census year $t+5$ .
Plant size	Log of total plant employment in census year $t$ .
Market share in the geographic market	Ratio of a plant's value of production in a four-digit industry in a geographic market to the total production in the four-digit industry in the geographic market.
Relative productivity	Ratio of a plant's labor productivity, measured as value of shipments per employee, to the average plant-level productivity in the industry–geographic market.
Multiple industry 2	Indicator variable that takes value of 1 if the plant produces in two four-digit SIC industries.
Multiple industry 3+	Indicator variable that takes value of 1 if the plant produces in three or more four-digit SIC industries.
Secondary producer	Indicator variable that takes the value of 1 if less than 50% of the total value of shipments of the plant is in the industry.
Plant age	For plants that enter after 1963, they are grouped into four age categories: 0–5 years old, 6–10 years old, 11–15 years old, and 16 or more years old. We include dummy variables for the latter three categories. For plants in existence in 1963, we cannot measure their age and instead include a separate set of year dummy variables for plants in this cohort. The omitted time dummy for the 1963 cohort is 1967.
Firm size	Log of a firm's total employment in the manufacturing sector in census year $t$ .
Number of geographies	A count of the number of different geographic markets in which the firm has a plant producing the product in.
Nearby plant-1	An indicator variable that is set to 1 if a firm has another plant in the industry within 100 miles of the plant.
Nearby plant-2	An indicator variable that is set to 1 if a firm does not have another plant in the industry within 100 miles of the plant but does have another plant in the industry between 100 miles and 250 miles of the plant.
Plant and firm experience variables	A set of six dummy variables measuring the combination of plant/firm experience at the time of plant entry. See Table 2 for details on the classification scheme.

(continued on next page)

Table A1 (continued)

Variable name	Definition
Initial market demand per plant	We utilize two different measures of market demand depending upon the industry. For the manufacturing industries that service the construction sector (SIC 2951, 3271, 3272, and 3273), construction earnings in the geographic area are used. The source of this data is the Bureau of Economic Analysis. For the food industries (SIC 2026, 2051 and 2086), population in the geographic market is used. For initial demand, we use the log of demand (construction earnings or population) per plant in period $t$ .
Growth in demand	Change in the log of per plant demand from period $t$ to $t+5$ . The number of plants is measured in period $t$ .
Initial wage and change in wages	This measures the average hourly wage paid over all plants operating in the two-digit sector and geographic market measured in logs. We include both the initial level and changes.
Electricity price and change in electricity price	The average price per kilowatt-hour of electricity purchased by plants operating in the two-digit sector and geographic market measured in logs. We include both the initial level and changes.
Materials price	The average price per given unit of raw material purchased by plants operating in the industry and geographic market. The raw material differs for each of the industries we study and is the most important raw material in terms of total expenditure by plants in the industry. We include only the levels because we are unable to construct the prices in 1997 because of changes in the material definitions collected by the census. Without the 1997 prices we cannot construct input price growth rates from 1992 to 1997.
Geographic market effects	181 dummy variables for the BEA economic areas. Each area is a combination of U.S. counties.
Time effects	A time dummy for each census year is included in all estimating equations. The omitted time period is 1967.

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