PRODUCT LAUNCH DECISIONS BY DOMINANT AND FRINGE FIRMS

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Abstract

In this paper we analyze the product launch decisions by dominant and fringe firms. In particular, we explore three questions in the product entry process: which firms enter, when they enter, and what happens after they enter. To do this, we use a database of all product launches in the desktop laser printer industry from 1984 to 1997. We show that dominant firms are quite selective in the submarkets they pursue. In particular, they often stay out of the technologically advanced markets, and choose to enter markets well behind the technological frontier set by fringe firms. When dominant firms do enter submarkets, they are usually early entrants, launching products before many fringe firms. Additionally, we analyze what happens to markets after entry by dominant firms. Many antitrust scholars and policy-makers fear that dominant firm entry into technology markets forces out fringe competitors, leading to high market power for the dominant entrant. We find that both entry and exit rates increase after a dominant firms enters a submarket, but that there is a net increase on average in the number of competing models and substantial growth in demand. In addition, while dominant firms introduce models priced at a premium relative to the average in a product class, the average price within that class tends to decline more as a result of competition from dominant firms than from fringe firms.

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I. INTRODUCTION

The evolution of an industry is determined in part by the product launch decisions firms make. Firms must make two key decisions regarding new product launch: whether to enter a market with a new product and when to launch that product. On both of these questions, the theory and evidence are mixed on what drives these decisions. An extensive theoretical literature on the relationship between market structure and innovation contends that incumbent firms often face different incentives for innovation than do de novo entrants. Depending on the nature of the innovation (in particular, whether it is radical or incremental, or how easily imitated), incumbent firms are sometimes expected to be innovators – or early entrants into a new technical subfield or product market -- and other times to be followers. Likewise, previous empirical work on these questions has mixed findings. In some industries, incumbents are shown to be at the leading edge of innovation, at least as measured by R&D intensity and patent output (Mansfield 1964, Grabowski 1968, Scherer 1965). In others, they are shown to be second or late movers, such as in Christensen (1994), Lerner (1997) and Henderson (1989).

One source of these mixed results is that much of the empirical work on technology races or the timing of incumbent entry has not separately considered the firm's decision to enter a new submarket (or, alternatively, to participate in a technological race) from its decision when to enter. That is, the timing of market entry is usually considered without conditioning on entry. However, many firms that could

potentially enter the market, choose not to do so, so an examination of the timing of market entry must also consider the selection process of those entrants.[1]

In this paper, we consider the decision to enter and the timing of entry conditional on the decision to enter for nearby or submarket niches. We address three questions. First, which submarkets do dominant firms avoid, but fringe firms enter? Second, are dominant firms the first movers in the submarkets they choose to enter? Finally, we look at the effects of entry by a dominant firm into a submarket it has chosen to enter. Does the presence of a dominant firm reduce the rate of subsequent entry or increase the likelihood of a fringe firm's failure in a submarket? This last question relates not only to market structure, but also has important implications for the strategy of these fringe firms. Indeed, in answering this last question, we consider the full cycle of the entry process: which firms enter, when they enter, and what happens after they enter. Thus, we are able to use fine-grained measures of multi-dimensional performance to explore the consequences of entry by dominant firms on prices and market structure.

We examine these predictions in the context of the desktop laser printer industry by comparing the behavior of dominant and fringe firms for 14 years after the inception of the industry. The desktop laser printer industry is particularly appropriate for understanding these questions. First, the performance of laser printers has consistently improved over time and can be easily observed. Second, we are able to track the entry and exit of nearly every product in the industry since its inception in 1984 through 1996. Third, the competitive environment varies across the product space and over time, providing some identification power. Fourth, there are heterogeneous firms of different sizes and with varied backgrounds. Finally, and perhaps most importantly, the laser

[1] Mitchell (1989) considers such a model, which is discussed in the theory section.

printer industry shares many characteristics with other high technology industries, such as personal and mainframe computers, disk drives, fax machines, retail electronics, digital cameras, and the like. The products are differentiated; there is an innovation frontier; there is an important mass market; and product and firm turnover is prevalent. Like other industries, technical advances frequently give rise to market opportunities. These factors affect firms of all sizes, including both incumbents and entrants. Thus the insights from this study may be applicable to broad sectors of the economy.

In this paper, we demonstrate how entry is affected by, and affects, market structure and the firm's antecedent market position. We show that dominant firms are quite selective in the submarkets they pursue. In particular, they often stay out of the technologically advanced markets, and choose to enter markets well behind the technological frontier set by fringe firms. When dominant firms do enter submarkets, they are usually early entrants, launching products before many fringe firms. Additionally, we analyze what happens to markets after entry by dominant firms. Many antitrust scholars and policy-makers fear that dominant firm entry into technology markets forces out fringe competitors, leading to high market power for the dominant entrant. We find that both entry and exit rates increase after a dominant firm enters a submarket, but that there is a net increase on average in the number of competing models and substantial growth in demand. In addition, while dominant firms introduce models priced at a premium relative to the average in a product class, the average price within that class tends to decline more as a result of competition from dominant firms than from fringe firms.

In the next section, we outline the theoretical and empirical debate that exists, and the omissions that occur. In Section III, we outline our data, method, and approach. Section IV presents our results. We conclude in Section V.

II. THEORY: TWO DEBATES AND TWO OMISSIONS

Although the literature on entry and innovation is extensive, there are two central debates in the literature: the entry decision and the timing of entry.

A. THE ENTRY DECISION

The first debate centers on the entry decision, and whether dominant or incumbent firms choose to enter new innovative markets. The theory and evidence from the economics, marketing, and innovation literature is mixed. One view of this question in the economics and innovation literature is that of Reinganum (1989), who considers a model in which a new innovation completely displaces the existing product. In this case, the incumbent has less incentive than an entrant to invest in R&D because doing so hastens the end of its existing market. Entrants are therefore likely to displace the incumbent in markets with technology races of this type. In contrast, Gilbert and Newbery (1982) treat innovations as incremental improvements to existing products. Under their assumptions, no technology race occurs at all, and the incumbent is never displaced. Empirical work finds support for both approaches, depending upon the market. For example, Lerner (1997) finds that disk drive makers, who compete in a "winner-take-all" market, behave in a way consistent with Reinganum's model. Henderson (1993) shows that incumbents successfully incorporate incremental

innovations into their products in photolithography equipment, but are overtaken by newcomers to the industry when the innovation is radical. However, others find that incumbents may be unwilling to extend their product line or brand because even incremental innovations may dilute brand equity or result in a loss of share in core markets (Randall et al 1998). Thus, even within the incremental innovation literature in economics and marketing, predictions about the dominant firm's incentive to innovate and willingness to launch new products is mixed.

Similarly, the organizations literature provides a number of theories with different implications for incumbent innovation. Several theories from this body of work suggest that costs in the form of organizational disruption or reduced value of assets differ between incumbents and entrants (among many others, Tushman and Anderson, 1986 and Hannan and Freeman, 1977). Essentially, fears of cannibalization, risk-aversion, and organizational inertia all imply that the incumbent will not enter a new submarket, even if incremental innovation is involved. However, if the incumbent perceives a threat to its core products or owns specialized assets that effectively lower its entry costs into new segments, it may be more likely to enter an emerging subfield (Brittain and Freeman, 1980). Clearly, variation in market conditions influences the outcomes, and as in the economics literature, empirical studies in organizational behavior find cases of incumbents quick to innovate as well as those that lag behind (Lambkin, 1988). Overall, the decision of dominant firms to incrementally innovative to enter new markets, no matter which literature, finds mixed, and at times conflicting, theory and evidence.

B. ORDER OF ENTRY

A second debate that continues in the entry literature occurs in understanding the order of the entry—that is given a subset of firms have chosen to enter, are incumbents first-movers or followers into new market segments. The literature has characterized many factors that may influence the incentive of an incumbent firm to be an early mover, rather than to delay. Technological leadership (learning curve, patents and R&D), pre-emption of assets (preemption of input factors, preemption of geographic and product characteristics space, preemptive plant and equipment), and buyer switching costs (switching costs, buyer choice under uncertainty) are cited in different ways throughout the literature as reasons for incumbent firms to be first-movers (Lieberman and Montgomery 1988). For example, Nelson and Winter (1982) and Kamien and Schwartz (1972) argue that incumbents enter submarkets more quickly when they face potential competition. This is related to Lieberman's (1987) argument that opportunities for strategic preemption – through customer lock-in or network externalities, for example – make incumbents early movers, and that the threat of being preempted has the same effect (Wernerfelt and Karnini, 1987).

On the other hand, delay may be a dominant strategy under many conditions. The ability to "free-ride" on first-mover investments, resolution of technological and market uncertainty, and various types of "incumbent inertia" that make it difficult for the incumbent to adapt to environmental change all may lead a firm to delay entry into a new subfield (Lieberman and Montgomery 1988). For example, if a product can be easily imitated, Katz and Shapiro (1987) argue that a dominant firm is better off by being a follower into a new submarket. The delay permits the dominant firm to imitate the first mover's product and avoids having its own products imitated. In addition, incorporating

innovations can be risky for firms that have a successful formula for their existing products. Singh (1986) and March (1988) assert that in such a situation, incumbents may delay if managers are risk-averse. Note that entrants, which do not face the same organizational constraints, have no such disincentive. In fact, if firms take on more risk when facing bankruptcy or failure (Bowman, 1982), fringe firms that are "just hanging on" with a slim share are more likely to make the first high-risk move into a new market segment.

Empirical work on order of entry provides support for both sides of the argument. (see Robinson 1988, Robinson et al 1992, or Kalyanaram et al 1995 for a review of the literature) Namely, a number of studies show dominant or incumbent firms are likely to enter first (Grabowski 1968, Schmalensee 1978, Bond and Lean 1977, Moore et al 1991), while many other studies show dominant or incumbent firms are likely to hold back and be later entrants (e.g. Henderson 1989, Lerner 1997, Glazer 1985, Mansfield et al 1981). However, all of these empirical studies examine the order of entry conditional on the decision to enter, without accounting for the selection effect of that choice. Lieberman and Montgomery (1988) and Goldner and Tellis (1993), in their studies of first-mover advantages, noted that this empirical approach leads to a sample selection bias problem, because only those who enter are observed. In our paper, we estimate the order of entry decision as a two-stage process—the decision to enter and then the order of entry, to correct for this empirical problem. Only Mitchell (1989) has used this approach in estimating entry models. This paper examines incumbent behavior in the medical imaging industry over several decades and finds that conditional on their decision to enter, incumbent firms were early movers into new submarkets. However, incumbent

firms often elected to stay out of new markets, particularly if their core products were not threatened or it they lacked a competitive advantage over new firms in such a market.

C. OMISSIONS

In addition to the sample selection problem just discussed, there are a number of alternative explanations for entry behavior that have largely been omitted from empirical analysis, but which may be quite important. Potential demand is unobserved by the researcher, and firms have incomplete information. If incumbency leads to better knowledge of market conditions and identification of the best submarkets to enter, the same entry pattern would result. (Adner and Levinthal 2002). Similarly, competition may play out as a Stackelberg game in which the dominant firms move first, choosing the segment that is most profitable to them, and the fringe firms follow and play differentiated Bertrand (i.e. differentiate in product space). This would also give the same pattern. Previous papers have not considered these alternative explanations; we hope to begin to make headway in addressing these issues.

This latter point leads to a second omission in the empirical literature. After entry by dominant firms, whether early or late, what happens to an industry? The primary argument in the strategic management, innovation management, and marketing literature is that holding everything else constant, once a dominant firm enters, whether early or late, other firms are more likely to stay out of the market niche, and those already in the market niche are more likely to exit. This is because the dominant firm exerts its market power through a superior brand or lower cost, and fringe firms fail as a result (Bowman

and Gatignon 1996) even when there is easy imitation by followers ro those already in the industry (Makadok 1998).[2]

However, there is an alternative rationale that has not been explored. Entry by a dominant firm actually signals something about the market conditions that fringe firms cannot observe. For example, it might be (as above) that dominant firms have better information about market conditions, demand, and potential profitability of a market segment. Thus, dominant firm entry does not drive fringe firms out of markets, but actually attracts them into the market. Far from having a detrimental competitive effect, dominant firm entry may actually have a positive competitive effect in the market, *ceteris paribus*.

Our paper seeks to contribute to all three areas by addressing the entry decision, the timing of entry, and the effects of entry by dominant firms on competition, using data from the laser printer industry.

III. DATA AND METHOD

A. THE DESKTOP LASER PRINTER INDUSTRY

As the personal computer market expanded in 1980s, so too did the market for desktop printers. Hewlett-Packard introduced the first desktop laser printer for the retail market in 1984. By the end of 1985, 17 firms had introduced 23 models of printers. Figure 1 illustrates the number of firms and models in the industry from the beginning of

[2] Mitchell (1991) argues that one must control not only for overall order of entry effect, but the incumbent order of entry into the subfield as well. This is because there are dual clocks that determine the competitive advantage of early movers.

the industry in 1984 to 1997. At its peak in 1990, the industry had 100 firms. Since that time, the number of firms has fallen off to 87.

The information on laser printer characteristics, entry, and exit come from a variety of sources. The primary source is Dataquest's SpecCheck analysis of page printers. Dataquest follows each manufacturer's products and records a variety of product characteristics, including ship date, speed, resolution, and other features. The data were incomplete for many models, so we supplemented this data with information from trade journals, private analysts' reports, and general industry data provided to us by a private consulting firm. We believe the dataset, which covers the industry from its inception in 1984 to 1997, is the most comprehensive available. Over this 14-year period, we are able to record 2,928 printer-year observations. Though we have attempted to be as thorough as possible, there remain some printers for which we cannot identify all of the independent variables. These have been dropped from the analysis.

Three types of firms populate the industry. Ricoh, IBM, Hewlett Packard, Canon, and Xerox are examples of large, diversified firms with a strong presence. A number of medium-sized firms specialize in multiple printer technologies, such as Lexmark, Kyocera, Genicom, and Kentek. Finally, there are over 100 very small "fringe" firms, which produce few printer models, ship very few units, and tend to appear in the industry only briefly. Hewlett Packard is the dominant firm in the industry, and has maintained between 45% and 65% market share for most of the industry's history. Defining a dominant firm as one that has greater than 10% market share, we find that dominant firms account for between 51% and 83% of the total market share, but they account for only 1% and 12% of the number of products introduced.

We treat each printer with a unique model number as a distinct product whose features do not change after introduction.[3] The number of products on the market has generally been increasing over time, as seen in Figure 2, with a peak at 855 product models in 1996, while the number of firms has begun to decline. The average number of products per firm was 8.8 in 1996, up from 1.8 in 1988.[4]

B. VARIABLE DEFINITIONS

The variable definitions and descriptive statistics are found in Table 1. The average product stays on the market for four years, and costs almost $3,983. The average speed of printers is 10 PPM, and the average resolution is 450 dpi. Although printers can be characterized on a number of dimensions, the two most common measures of printer performance are speed, measured by pages per minute (PPM), and resolution, measured by dots per inch (DPI). Printers are bunched tightly in groups in the performance space. Figure 3 shows the distribution of printer models across the 20 discrete product classes (or niches) in terms of these two characteristics that we defined based on the clear groupings of printers. We provide some data on these classes in Table 1.

C. METHOD

In addition to the graphical evidence and descriptive statistics used above to illustrate patterns in the industry, we employ some econometric specifications for more

[3] Unlike some product markets, firms in this industry do not change printer attributes once the product has been introduced. Rather, they introduce new products.

[4] In defining the industry, we appealed to the data and to industry experts and trade journals. These sources consistently define the desktop laser printer industry as laser printers that print 0-20 PPM, can be attached to a personal computer, and are small enough to fit on a desk. This industry definition has remained constant over the time period. Our statistical analyses are robust to small definitional changes.

refined statistics tests. Most of the methods used are standard in both the economics and the organizations literature, namely linear regressions and Poisson regressions for count variables. We also employ a bivariate probit analysis with sample selection in order to examine questions related to the joint decision to enter or not enter, and the subsequent timing of entry conditional on entering. Because this method is not common in the literature, we describe it a little more depth here. We specify the following structural model. Let the decision to enter or not enter (entry equation or selection equation) be modeled as a first stage probit of the following form:

$$I_i^* = Z_i\gamma + \varepsilon_i$$

such that
$$I_i = 1 \text{ if } I_i^* > 0$$
$$I_i = 0 \text{ otherwise}$$

and whether you choose to enter early or late (timing equation) be modeled as a second probit equation of the form:

$$Y_j^* = X_j\beta + u_j$$

such that
$$Y_j = 1 \text{ if } Y_j^* > 0$$
$$Y_j = 0 \text{ otherwise}$$
$$j \in i$$

We define, I_i^* as the latent variable that measures the perceived probability of the firm profiting from entry. Above some threshold, we observe entry, as indicated by $I_i = 1$. Otherwise we observe no entry, $I_i = 0$. Whether a firm enters or not is determined by

the explanatory variables in the matrix Z_i (discussed below). In the timing equation, Y_j^* is the relatively profitability of early entry. When profitability of early entry is sufficiently high, conditional on entry, the firm enters early. This is given by the observed $Y_j = 1$. If the firm perceives low profitability or losses to entering early, then we observe $Y_j = 0$, late entry. The probability of entering early is determined by the exogenous variables in matrix X_j (described below), where $Z_i \neq X_j$. We assume that the error terms, ε_i and u_j are jointly normally distributed with mean (vector) zero and a variance-covariance matrix of the form:

$$\Sigma = \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}$$

so that $E(\varepsilon_i, u_j) = \rho$. Thus there may be sample selection bias. The timing of entry is correlated with your decision to enter. This two equation probit model, then characterizes the structural model for the enter v. don't enter and enter early v. enter late equations.

We can estimate this model using a bivariate probit with adjustment for sample selection bias (Van de Ven 1981). Assuming that ε_i and u_j are bivariate standard normally distributed with correlation coefficient ρ, the univariate cumulative distribution function is Φ, and the bivariate cumulative normal distribution function is Φ_2, the likelihood function to be maximized is:

$$L = \prod_{I=1,Y=1} \Phi_2\left(X_j\beta, Z_i\gamma\ ;\rho\right) \bullet \prod_{I=1,Y=0} \Phi_2\left(-X_j\beta, Z_i\gamma\ ;\rho\right) \bullet \prod_{I=0} \Phi\left(, Z_i\gamma\right)$$

This accounts for the three possible outcomes. The first term encompasses observations where there has been entry and entry is early. The second term encompasses those observations where there is entry and entry is late by the firm. The final term includes those observations where there is no entry.[5] These three terms then pick up all the possible outcomes. This estimation technique allows us to jointly estimate a two equation probit model, adjusting for sample selection bias.

IV. EMPIRICAL RESULTS

Table 2 contains three panels to address the question of which submarkets dominant firms choose to compete in. The first panel shows the average of the "best" products made by several firms which achieved at least 10% market share in one year. The top of this panel presents the means of the maximum DPI and PPM of each firm's product portfolio during the years in which it was dominant, and the bottom of the panel presents the same means calculated over all years in which the firm was active. It is clear that the best product of the set of fringe firms has significantly higher DPI, but about the same speed. Figures 4 and 5 demonstrate the same point graphically: it is evident that some (though not all) fringe products are at the top of the DPI frontier, which the products of dominant firms are clustered at lower levels of resolution. However, the distribution of PPM is similar for both dominant and fringe firms.

The middle panel of Table 2 shows results from a regression of a firm's best DPI or PPM in each year on a few firm and market characteristics and year fixed effects. With such a small sample size, the results should be interpreted with some caution;

[5] We can say that: Prob (Y = 1/ I = 1) + Prob (Y = 0/ I = 1) + Prob (I = 0) = 1

however, it appears that dominant firms are significantly behind the best fringe firms on both product characteristics.

Finally, the bottom panel of Table 2 shows the number of years firms were able to stay at the frontier, or lead the industry in terms of technology. There appears to be quite a bit of turnover at the top for resolution, a pattern similar to that in disk drives established by Lerner. However, the top players in speed are much more stable. We can only speculate at this point why we see this divergence. Perhaps firms did not engage in racing behavior on the speed dimension because during this period, laser printing technology was significantly slower than dot-matrix technology. Consumers who valued speed would likely not be in the laser printer market at all.

Table 3 presents results from the bivariate probit model with sample selection. These specifications address our second question of whether dominant firms are first-movers. The first stage estimates the probability of entry into a new submarket, and the second stage estimates the probability that a firm is the first mover into that submarket, conditional on entry. Results from the first stage indicate that, consistent with Mitchell's findings, a firm that has a specialized asset that provides a competitive advantage in other market segments (i.e., has received an editorial award for one of its products) is more likely to launch a product in a new niche. Dominant firms are less likely to introduce a product in a new submarket, all else equal. Conditional on entry, however, they tend to be the first movers in the class.

Interestingly, Hewlett-Packard (HP), which has by far the largest market share in this industry, does not appear to follow the same entry patterns as other dominant firms. The second column of Table 3 has results from a specification that includes a dummy

variable for HP. The probability that HP introduces a product in a new submarket is statistically indistinguishable from zero, and when it does enter, it has a much higher probability of being an early mover.

It is also important to note that accounting for the selection effect of the entry decision is quite important in understanding the patterns of dominant firm innovation in this industry. To illustrate this concern which has been elucidated, but rarely addressed, in the empirical literature, we present Models 3 and 4, which replicate the second stage regressions from Models 1 and 2, but do not include the selection effects. Although the coefficients on DOMINANT FIRM and HP are positive and statistically significant as before, they are nearly twice the magnitude that they are in Models 1 and 2. To interpret such a result as indicating that dominant firms are first movers into innovative segments would be erroneous on two counts. First, as pointed out in Models 1 and 2, the dominant firms are less likely to enter any given class of printers, thus the "first mover effect" is true only for select classes of printers that dominant firms choose to enter. In general, dominant firms are slower to enter innovative classes. Second, when they do enter, unless one controls for the selection effect, the dominant firm first mover effect will be substantially overstated.

Tables 4 and 5 present specifications to address our final question: how does entry by a dominant firm affect competitors? We examine three effects: price, entry, and exit. In the first column of Table 4, we regress the average wholesale price within a product submarket one year after entry by a dominant firm, controlling for other market conditions. Price falls substantially with competition from one or two dominant firms, by far more than entry by a fringe firm. The coefficients on the dummy variables for the

number of dominant firms competing in the class are statistically significant at the 10% level despite the small number of observations. In contrast, fringe firms would have to introduce 30 competing products in the same niche to have the same effect on the average price as the presence of one dominant firm. The second column of Table 4 regresses the relative price of a new printer model to the average within a product class. Dominant firms appear to price their products at approximately 14% over the average, and this coefficient is significant at the 10% level. One interpretation of these results is that while dominant firms can enjoy a price premium, their presence in a class heightens competition among the fringe firms, which cut their prices in response to dominant firm entry.

In Table 5, we present estimates from Poisson models of the count of new products in a class, as well as the count of exiting products from a class, and include dummy variables for whether one or two dominant firms were competing in the class one year earlier. This allows us to examine the effect of dominant firm entry on market structure and fringe firm behavior. Models 1a and 1b do not include demand growth in the class as a control variable, while Models 2a and 2b do. The results indicate that the presence of a dominant firm both increases entry and induces exit. It may be that competitors are revamping their product lines in response to dominant entry, which would cause them to withdraw current products and introduce new ones. It may also be that entry by a dominant firm signals that the class is profitable, but fringe firms do not account for entry by other fringe firms when making their own entry decision (or systematically underestimate it). This would lead to "excess" entry, and thus also high failure rates.

V. CONCLUSION

In the process of creative destruction, firms choose which markets to enter, and when to enter those markets. These strategic choices are determined by what type of innovation is being pursued (radical versus incremental); moreover, these strategic choices can also have a substantial impact on the market structure in industries. In this paper, we examine the desktop laser printer industry to determine how dominant firm and fringe firm product launch strategies differ.

We show that dominant firms are quite selective in the submarkets they pursue. In particular, they often stay out of the most innovative markets, and choose to enter markets well behind the innovative frontier set by fringe firms. In our study, this is especially true in the DPI dimension of printers. When dominant firms do enter markets, they are usually early entrants, launching products before many fringe firms.

What is more interesting, though, is to what happens to markets after dominant firm entry. Many antitrust scholars and policymakers are wary of dominant firm entry into technology markets, fearing that such dominant entrants will wipe out fringe competitors, leading to high market power for the entrant. However, the entry of the dominant firm is followed by a wave of entry by other fringe firms. Thus, although exit rates increase, this increase in exit is offset by an infusion of entrants that come in after the dominant firm. The average price within a submarket declines more after entry by a dominant firm than after entry by fringe firms. In addition, after entry by the dominant

firm, the demand in the submarket increases substantially.[7] Nevertheless, the increase in net entry and lower average prices suggest that entry by dominant firms does not harm competition in this industry, at least in the short run. Consumers potentially benefit from the presence of both fringe firms, which introduce more technologically advanced products, as well as dominant firms, whose competitive effect appears to lower prices. Consumers potentially benefit from the presence of both fringe firms, which introduce more technologically advanced products, as well as dominant firms, whose competitive effect appears to lower prices.

This paper contributes to our understanding of the behavior of dominant and fringe firms in technologically advancing markets. In particular, we demonstrate that dominant and fringe firms focus on different product segments and have different effects on competition. The differences in the launch strategies of these types of firms have important implications for the evolution of technology and market structure within an industry.

[7] Whether this is because dominant firms can better predict submarket growth, or because dominant firms cause submarket growth, is still an open question.

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Table 1: Variable definitions and summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Dummy variable for editorial award	3214	0.2526	0.4346	0	1
Units shipped	1641	12244.2300	48566.6700	0	650000
PPM (pages per minute)	3214	10.1696	4.2623	2	18
DPI (dots per inch)	3214	449.9517	260.8171	240	1800
PPM class	3214	3.8370	1.7159	1	6
DPI class	3214	1.5087	0.8292	1	4
Total # products in same DPI class	3214	193.5411	101.1172	1	320
Total # products in same PPM class	3214	107.9319	66.9080	1	255
Total # products in same DPI and PPM class	3214	43.3983	35.4591	1	127
Demand growth in class	3010	14.9657	167.4814	-1	2174.721
# firm's own products in same PPM class	3214	5.0669	4.3579	1	24
# firm's own products in same DPI class	3214	6.4406	5.4498	1	30
# firm's own products in same PPM-DPI class	3214	2.9502	2.1382	1	13
Total # models on market	3214	588.4661	185.6672	1	855
# new products in year	3214	168.4309	94.3193	1	416
List price of printer	2875	4018.0430	2921.1790	219	24950
Average list price within PPM-DPI class	2848	3983.1870	2107.0310	329	19950
Relative list price of printer to average in PPM-DPI class	2848	1.0216	0.6419	0.0931	13.5007
Market share	2910	0.0405	0.1111	0	0.6351
Dominant firm dummy (at least 10% share)	3379	0.0769	0.2665	0	1
Number of dominant firms in PPM-DPI class	3192	0.6764	0.6733	0	2
# new products in PPM-DPI class	3571	6.3957	6.6100	0	26
# exiting products from PPM-DPI class	3571	9.4060	11.9100	0	46

Table 2: Technological position

Panel 1

	DPI		PPM	
Best products while dominant	Mean	Std. Dev.	Mean	Std. Dev.
APPLE_COMPUTER_CO	300	0	8	0
FRINGE FIRMS	1370.88	355.15	17.94	0.66
FUJITSU_AMERICA_INC	600	0	18	0
HEWLETT-PACKARD_COMPANY	547.83	114.97	16.02	2.83
IBM/LEXMARK	1200	0	16	0
Best products over all years for firms dominant in any year				
APPLE_COMPUTER_CO	533.33	126.49	14.22	4.02
FRINGE FIRMS	1368.06	354.87	17.94	0.63
FUJITSU_AMERICA_INC	648.39	233.63	18.00	0.00
HEWLETT-PACKARD_COMPANY	542.55	119.32	15.85	3.04
IBM/LEXMARK	924.59	356.21	14.82	1.84
NEC_TECHNOLOGIES_INC	528.00	130.77	9.28	0.98

Panel 2

Regression of Y = Best DPI/PPM of firm's portfolio

	DPI	**PPM**
	Coef. (Std. Err.)	Coef. (Std. Err.)
Dominant firm	-827.119**	-4.983**
	(88.715)	(1.657)
Total # models in mkt	1.374**	0.005
	(0.353)	(0.007)
Total # new models on mkt	-0.242	-0.012
	(0.697)	(0.013)
Constant	500.329*	18.370**
	(234.968)	(4.388)
N	25	25
Adj Rsq	0.845	0.2981
FE	Year	Year

Panel 3

	Years at DPI frontier		Years at PPM frontier
LASERMASTER	7	KYOCERA_UNISON	11
PRINTWARE	7	FUJITSU	10
XANTE	5	LEXI_CORP	9
DEC	3	JRL_SYSTEMS	6
GCC_TECHNOLOGIES	3	OLYMPUS	5
HEWLETT-PACKARD	3	PRINTER_SYSTEMS	5
NEWGEN_SYSTEMS	3	HEWLETT-PACKARD	3
QMS_INC	3		
SAMSUNG	3		

Table 3: Order of entry

	Model 1	**Model 2**	**Model 3**	**Model 4**
Second Stage: Y = 1 if firm is the first mover in class	Coef. (Std. Err.)	Coef. (Std. Err.)	Coef. (Std. Err.)	Coef. (Std. Err.)
Dominant firm	0.480*		0.821**	
	(0.217)		(0.110)	
HP		0.715*		1.157**
		(0.282)		(0.132)
Engine manufacturer dummy	-0.187	-0.166	-0.238**	-0.172*
	(0.121)	(0.127)	(0.075)	(0.076)
# firm's models in same ppm class	0.073**	0.077**	0.068**	0.074**
	(0.020)	(0.021)	(0.009)	(0.009)
# firm's models in same dpi class	-0.028	-0.031	-0.035**	-0.037**
	(0.015)	(0.016)	(0.008)	(0.008)
Constant	0.847**	0.765*	-0.572**	-0.630**
	(0.267)	(0.305)	(0.092)	(0.094)
FE	Class	Class	Class	Class
First Stage: Y = 1 if firm enters class				
Dominant firm	-0.278*			
	(0.120)			
HP		-0.199		
		(0.148)		
Editorial award for one of firm's products	0.362**	0.357**		
	(0.068)	(0.072)		
Rebrand dummy	0.088	0.101		
	(0.096)	(0.098)		
Engine manufacturer dummy	0.078	0.082		
	(0.066)	(0.068)		
Total number of models in market	-0.001**	-0.001**		
	(0.000)	(0.000)		
# firm's models in same dpi class	-0.005	-0.006		
	(0.007)	(0.007)		
# firm's models in same ppm class	-0.013	-0.015		
	(0.009)	(0.008)		
Constant	-0.576**	-0.595**		
	(0.128)	(0.128)		
/athrho	-1.210**	-1.117**		
	(0.319)	(0.333)		
N	3032	3032	3021	3021
Log L	-1579.69	-1579.27	-1116.23	-1105.05
FE	Class	Class		

Table 4: Effect of dominant entry on price

	Average price	**Relative price**
Variable	Coef. (Std. Err.)	Coef. (Std. Err.)
Dominant firm		0.1483
		(0.0823)
One dominant firm in class	-854.23	
	(501.85)	
Two dominant firms in class	-1,611.61	
	(885.17)	
Total # models in mkt	-4.73**	0.0002
	(1.77)	(0.0002)
Total # competing models in same ppm class	25.17**	-0.0022
	(5.70)	(0.0042)
Total # competing models in same dpi class	2.42	-0.0003
	(3.27)	(0.0007)
Total # competing models in same ppm-dpi class	-26.70	0.0001
	(15.39)	(0.0004)
Demand growth in class	-0.54	0.0003
	(0.63)	(0.0013)
Constant	4,934.96**	0.8927**
	(877.04)	(0.1462)
N	52	1154
Adj Rsq	0.3671	0.0217
FE	Year	Year Model's order of entry

Table 5: Effect of dominant entry on class entry and exit

	Model 1		Model 2	
Poisson of Y = # entering/exiting products in class	**Entry**	**Exit**	**Entry**	**Exit**
Variable	Coef. (Std. Err.)	Coef. (Std. Err.)	Coef. (Std. Err.)	Coef. (Std. Err.)
One dominant firm in class	0.513**	0.353**	0.333**	0.144
	(0.109)	(0.106)	(0.115)	(0.111)
Two dominant firms in class	0.578**	0.451**	0.458**	0.228*
	(0.129)	(0.114)	(0.141)	(0.119)
Total # models in mkt	-0.002**	0.012	-0.003**	0.004**
	(0.001)	(0.237)	(0.000)	(0.001)
Total # new models on mkt	0.006**	0.009	0.004**	-0.004**
	(0.001)	(0.382)	(0.001)	(0.001)
Total # competing models in same ppm class	0.003**	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Total # competing models in same dpi class	0.001**	0.005**	0.000	0.005**
	(0.001)	(0.001)	(0.001)	(0.001)
Total # competing models in same ppm-dpi class	0.006**	0.016**	0.008**	0.015**
	(0.002)	(0.002)	(0.002)	(0.002)
Demand growth in class			0.000**	0.000
			(0.000)	(0.000)
Constant	-0.013	-11.450	1.524**	-0.922*
	(1.002)	(300.639)	(0.223)	(0.522)
N	176	176	126	126
Log L	-439.752	-422.606	-336.753	-334.971

Figure 1: Number of Firms and Products in Marketplace

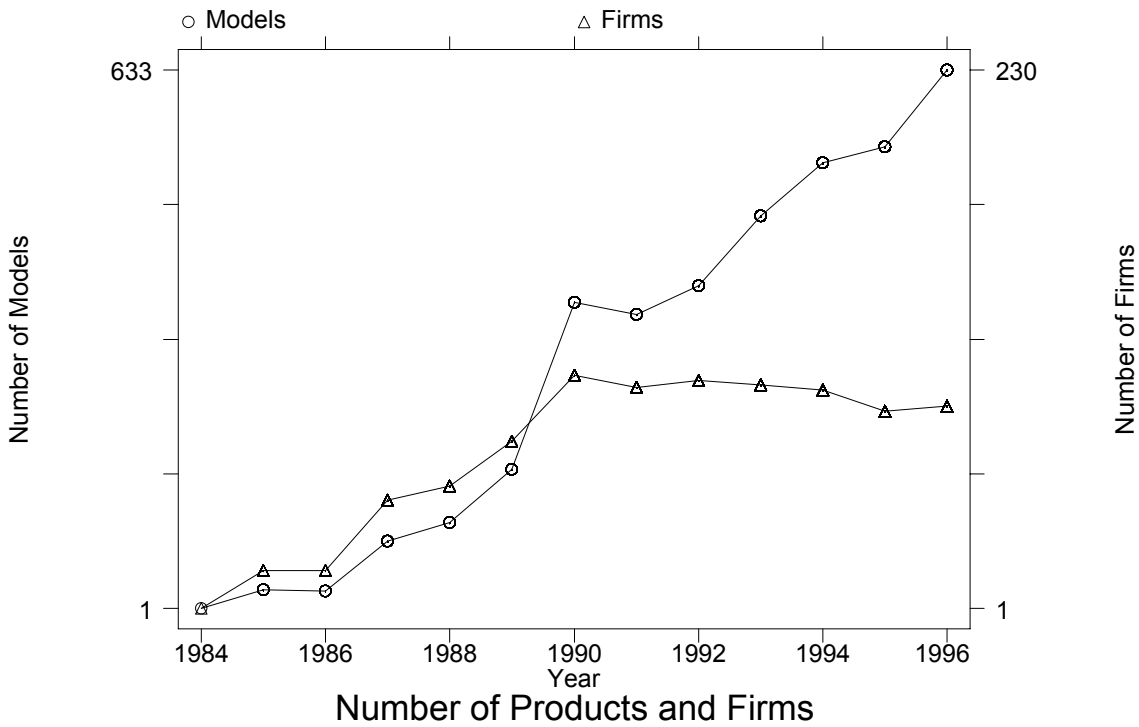


Figure 2: Product Entry and Exit

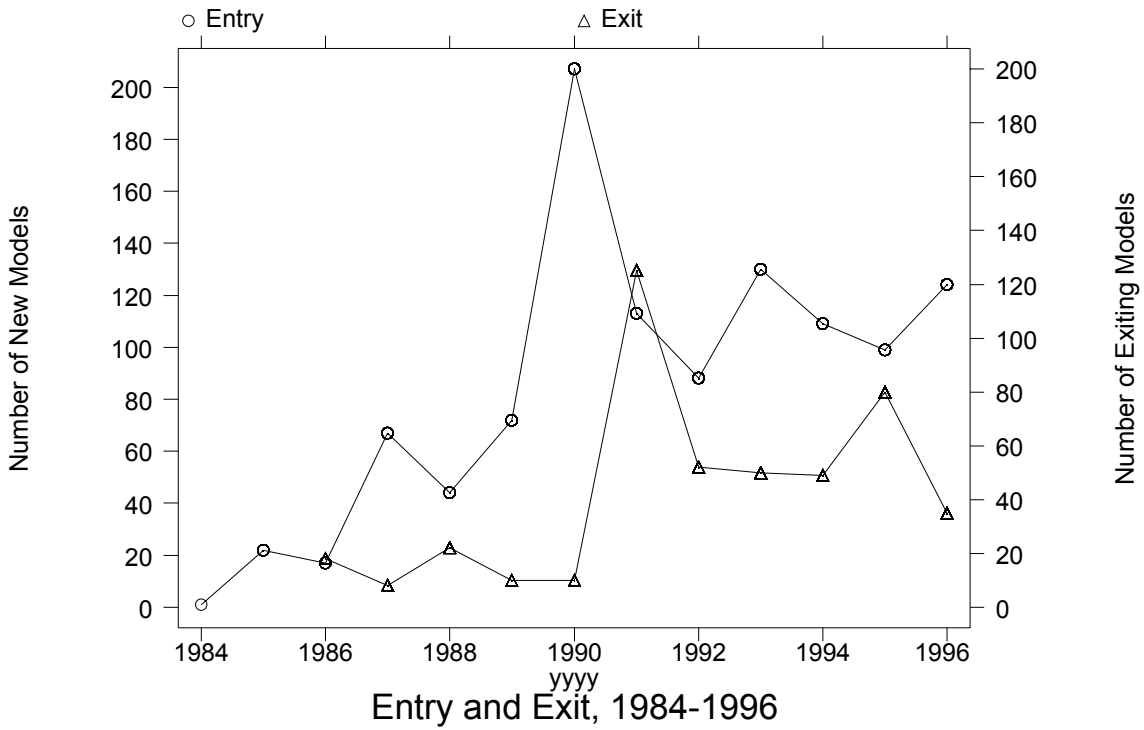
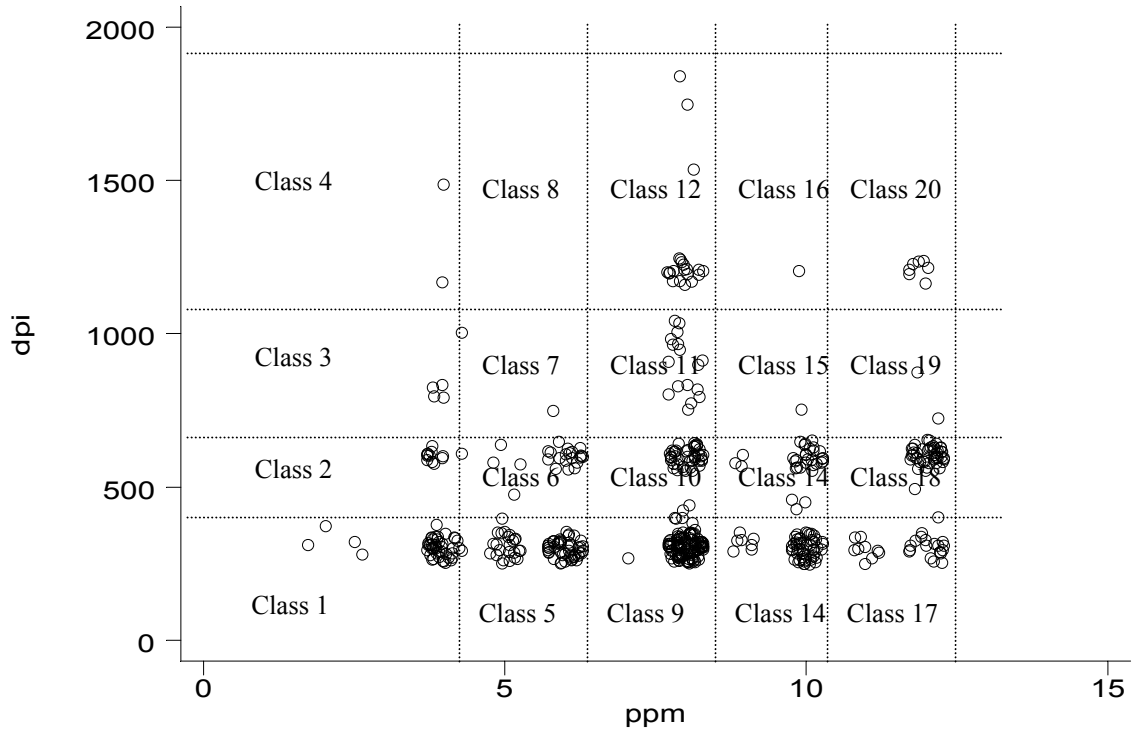


Figure 3: Product Distribution and Classes



Note: Each small circle represents a printer.

Figure 4: Speed of printers by Firm Type by Year

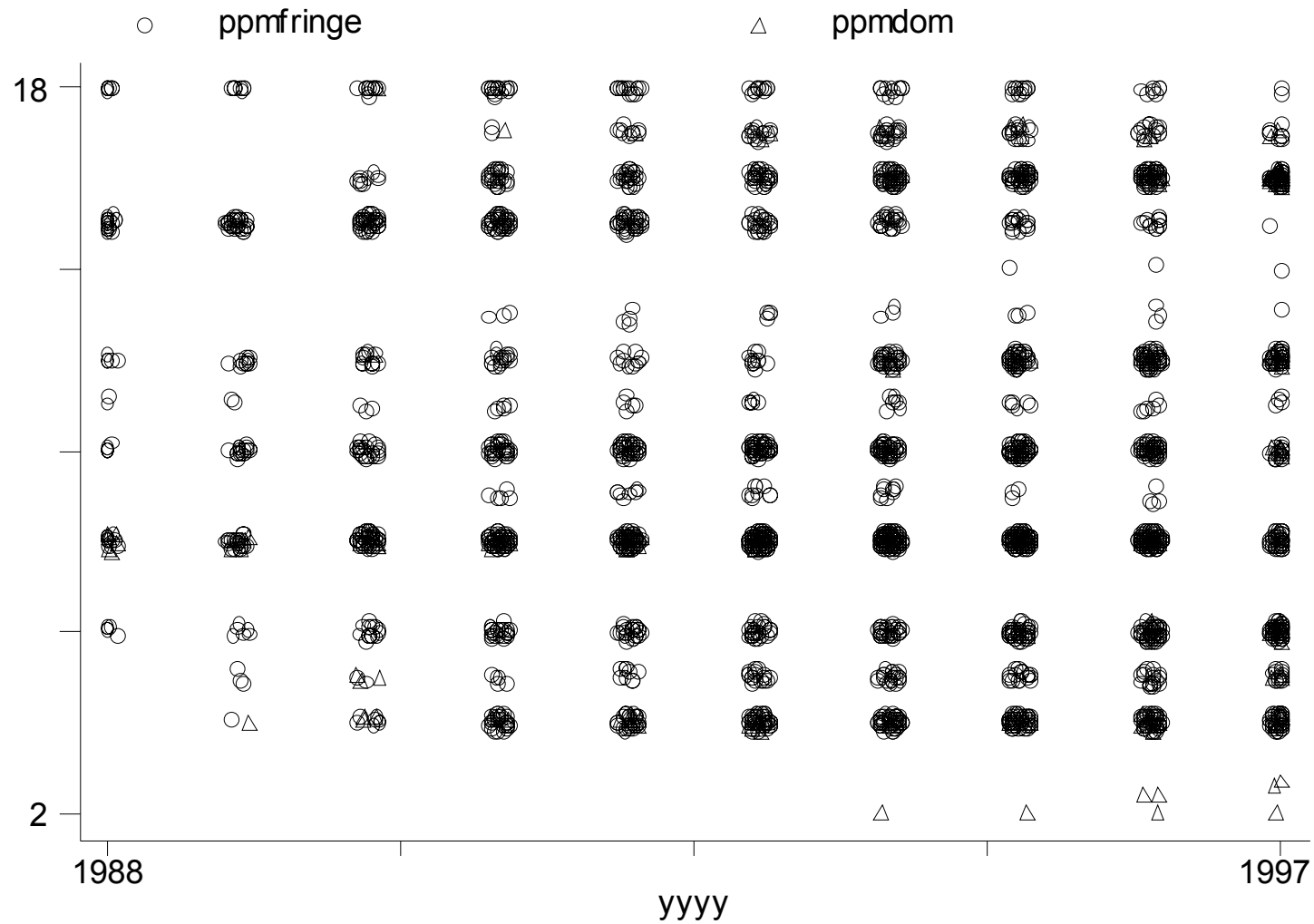


Figure 5: Resolution of printers by Firm Type by Year