Responding to Technology-Created Market Niches: Do Industry-Specialized Assets Facilitate or Hamper Entry?

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Abstract: Research suggests that fundamental changes in technology can destroy incumbent firms by damaging their capabilities. Research also suggests that lesser technological change can destroy incumbents by creating new market opportunities to which incumbent managers then fail to respond. Existing capabilities and experience cause incumbent managers to misperceive the value of these market opportunities and cause them to delay entry into emerging niches. As a result, incumbent firms fail to harness their existing advantages and perform poorly in the new niche. This "competence-trap" scenario, however, is inconsistent with predictions from other scholars who argue that industry-specialized assets and capabilities encourage incumbent managers to enter new market niches to capitalize on these capabilities.

In this study, we contrast these two theories by examining 20 years of data from the rigid hard drive industry. We find no evidence that existing capabilities delayed entry into these new market niches. Instead, we find that incumbents entered the emerging niche in a timely manner that reflected the value of pursuing success in the established niche.

(Disk Drives; Niche Innovation; Industry-Specialized Assets; Disruptive Technology; Strategy).

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1. Introduction

It is said that at the beginning of every war, generals try to fight the last one. Today business is often referred to as a battlefield, and much the same criticism is lain at the feet of its generals. Managers of established companies do not understand how technology changes the rules of competition, and thus they fight according to the rules of the last campaign. In this paper, we explore whether or not managers in one industry tried to fight the previous war and thereby failed to win battles in new market niches.

Research has long suggested that technological change can turn the capabilities of incumbents into liabilities and thereby cause entrants to replace incumbents (Schumpeter, 1950; Abernathy and Utterback, 1978; Abernathy and Clark, 1985). Scholars increasingly suggest, however, that managerial rigidities, rather than technological obsolescence, cause firms to fail during periods of technological change (Starbuck and Hedberg, 1977; Utterback and Kim, 1986; Christensen and Bower, 1996). For example, technological change can create market niches in which incumbents retain substantial capabilities, but to which managers must respond. If managers fail to act in a timely and effective manner, they squander their firm's capabilities. Previous research has suggested that biased information, misaligned incentives, and cognitive biases prevent managers of incumbent firms from understanding what capabilities retain their value in new market niches or from understanding the new rules of competition (Uttterback, 1995; Christensen and Bower 1996). As a result, managerial rigidities prevent capable firms from entering new niches or cause them to enter too late to compete effectively.

While interesting, the role of managerial rigidities in preventing incumbent firms from succeeding in new market niches remains incompletely confirmed. Many of the supporting studies use small samples and ex-post interviews (e.g., Starbuck, 1988; Christensen and Bower, 1996). In contrast, research employing other empirical methods finds less evidence of systematic

biases in managerial decisions (Iansiti, forthcoming; Mitchell, 1989; Thomas 1998). Mitchell (1989), for example, suggests that managers consider their organization's capabilities in deciding how to maximize their organization's profits and therefore make mindful decisions about whether and when to enter a new niche.

In this article, we investigate the interaction between organizational capabilities and managerial decisions. To avoid sample biases, we use the entire population of companies that produced a disk drive from 1976 to 1995. Rather than rely on interviews to obtain explanations of decision-making, we search patterns of behavior for hypothesized biases and errors. We find that patterns in firm entry, and the timing of entry, do not support predictions of systematic bias in managerial decision-making. Indeed, we argue that the evidence suggests that managers recognized the value of their firm's capabilities and used this in determining when to enter emerging niches.

2. Literature Review

Scholars have long investigated how firms respond to new technology. A central issue in this literature is the extent to which the effect of technological change is determined (1) by the direct influence on the organization's capabilities or (2) by the response of managers to the new technology. Abernathy and Utterback (1978) argue that one type of technological change destroys the capabilities of incumbents while another enhances existing capabilities. They label the former as "radical" and the latter as "evolutionary." Other scholars argue that the response of managers to technological change is centrally important (Cooper and Schendel, 1976). They argue that managers who aggressively invest in new technologies can help their companies survive a technological change. Foster (1986) links the two traditions by arguing that some changes in technology so harm the capabilities of incumbents that they can not effectively compete with new entrants, but that in other cases managers can harness existing capabilities and thrive in new markets.

Abernathy and Clark's (1985) transilience map of technology remains an important touchstone for the field. Abernathy and Clark (1985) argue that the effect of technological change is determined by the extent to which it harms market linkages or technological capabilities. If both are destroyed (architectural innovation), then the entire industry will be reshaped or recreated. If neither is destroyed, then incumbent firms are likely to survive. When incremental and capability sustaining technological change leads to the emergence of a new market niche (niche creation technological change), Abernathy and Clark argue that managerial decision-making is critical to the survival of a firm. Incumbent firms can survive so long as they act quickly.

Following Abernathy and Clark (1985), research has identified additional capabilities or assets that might be damaged by technological change. Henderson and Clark (1990) suggest that technological change may destroy competence embodied in organizational structures. They argue that relatively minor technological change may require a new way of combining existing technologies, or a new way of combining organizational elements. As a result, incumbent firms may fail even if the technological change appears relatively minor. Afuah and Bahram (1995) argue that technology can destroy incumbents by damaging the capabilities of their suppliers, customers, or complementary innovators. Tripsas (1997) argues that firms have complementary assets that may allow firms to survive — even if other assets are damaged.

Recent research has investigated why incumbent firms might fail in response to "niche creation." In "niche creation," incremental and capability sustaining technological change creates a new market opportunity. For example, Abernathy and Clark argue that the Sony Walkman was the result of capability-sustaining innovation in miniaturization and weight reduction, and that the Ford Model A was the result of existing technological capabilities in engine design and noise reduction. In "niche creation," Abernathy and Clark (1985) argue, managerial action is critically important. Entrenchment of existing companies (as in the case of the Walkman and Model A) is

likely to be "transitory." If they act quickly, other firms can catch up and make the transition to the new niche. Thus, in this quadrant, managerial rigidities are especially damaging, and recent research on the disk drive industry suggests that such rigidities may prevent many firms from adapting to the creation of new niches (Christensen, 1993; Christensen and Bower, 1996, Christensen and Rosenbloom, 1995).

Numerous studies have investigated why managers might fail to respond effectively to new technological or market challenges, and have argued that experience with existing technology and markets can impede managers from understanding new technologies or accurately valuing new markets. As a result, these theories suggest, managers make systematic errors in responding to new niches. Starbuck (1988) and Starbuck and Hedberg (1977) investigate the response of managers of Facit AB, a Swedish mechanical calculator company, to a new market niche (electronic calculators). Using a detailed case study, Starbuck and colleagues conclude that the managers of this incumbent firm were unable to effectively perceive the threat of the new niche and so failed to enter. Utterback and Kim (1986) argue that managers learn to maximize the performance of their products relative to a set of established criteria. If technological change opens a new niche, managers of incumbent firms systematically undervalue the niche because they fail to understand the new attributes that caused the new niche. For example, the existing niche for makers of stereo systems valued high fidelity, but the new niche for portable stereos emphasized light weight and portability. Viewed from the existing market, products in the new niche appear inferior and pose no possible threat (and represent little possible opportunity).

Christensen and his collaborators link this literature to Afuah and Bahram's (1995) discussion of the importance of suppliers' and customers' capabilities to explain the apparent failure of incumbent disk drive companies to respond to new market niches (Christensen, 1993; Christensen and Bower, 1996; Christensen and Rosenbloom, 1995). They argue that incumbent firms retain useful capabilities, but these capabilities cause managers to misunderstand or

undervalue the new market opportunity. They also argue that incumbent firms develop close and powerful relations with their existing customers. While these relations represent strategic assets in the existing market, they also restrict the information flowing to managers and distort their incentives. As a result, incumbent companies in larger drive sizes (e.g., 8-inch disk drives) often had the ability to make smaller drives and often made prototypes (e.g., the 5.25-inch drive), but then failed to enter new markets in a timely or effective manner. Incumbent firms failed unnecessarily, they argue, and point to the high failure rate in the industry as evidence (of 174 companies that ever made a drive, only 29 were producing in 1995).

The above literature suggests that biased information sources and cognitive limits often prevent managers from responding effectively to the emergence of new market niches, and thus technological change of the "Niche Creation" type may destroy incumbent firms — even though those firms retain important capabilities. This idea has both practical and scholarly importance. If incumbency narrows information channels, incumbents might wisely choose to emulate the structure of new entrants by creating nearly autonomous spin-offs. Alternatively, corporate managers could continually move managers among jobs so that their information channels remain diverse and fluid (Nystrom and Starbuck, 1984; Katz and Allen, 1982). If the decision-making of managers becomes ossified, the corporation might invest in consulting services or executive training. Social policy might govern the extent of creative disruption by providing public information sources.

However, the idea that managers make systematic errors in responding to new market niches contradicts research that suggests that experience enhances information acquisition and decision-making. Katz and Allen (1982) show that information channels and decision-making in new-product development improve, at least for a while, with experience. Cohen and Levinthal (1990) argue that the investments of incumbent firms in technological capabilities allow them to better understand and absorb new technologies. The same logic might hold for new technological

niches: the position of incumbents may allow them to better understand emerging market opportunities. Iansiti (forthcoming) suggests that experience allows incumbents to engage in "parallel experimentation" which is associated with technical performance and may allow the firm to better envision new relationships between technology and markets.

Other research suggests that apparent errors in management action may result from the rational attempt to maximize profits in light of existing resources and capabilities. Reinganum (1989) and Henderson (1993) observe that incumbents may fear that entering new markets will cannibalize their existing sales. Caves (1984) argues that incumbents need to make specific investments when entering a new market niche and so may rationally decide to enter markets after the demand and technological uncertainty is reduced. Mitchell (1989), in his investigation of whether and when incumbents enter emerging niches of the medical diagnostic imaging industry, proposes that managers consider the extent to which their firm possesses specialized assets to determine whether and when they should enter. Managers act to preserve these capabilities, he argues, in light of potential competition from other companies. In contrast to theories that capabilities paralyze incumbents, he finds that "the more industry specialized assets a firm possesses, the more likely it is to enter an emerging subfield" (1989, p. 224).

In this article, we test these conflicting predictions by investigating how incumbent firms in the disk drive industry responded to new market niches. We use patterns in entry and entry timing to reveal whether existing capabilities caused systematic biases in managerial decisions, or whether managers appear to have considered how best to use these capabilities to maximize future profits. We then reflect on the implications of our findings for theory and practice.

2.1. Hypotheses

In this paper we seek to better understand managerial decision-making in response to new technology-created market niches. We use observed patterns in action to reveal these decisions,

and thereby infer if managers made decisions that destroyed or enhanced their company's capabilities. As discussed above, managerial decisions are particularly important in the case of "niche" innovation. That is, technological change creates a new market niche, but incumbent firms retain capabilities that can be used in that niche. Christensen and Bower (1996) argue that technological change in the disk drive industry was indeed of this type, but prudence suggests empirically validating this claim. From 1976 to 1995, the industry went through several market changes. Computers changed from mainframes to minicomputers, to desktops, to portables. Disk drives also changed dramatically. It is possible that these transitions so destroyed the capabilities of incumbents that they were actually disadvantaged relative to new entrants and thus management decision-making was largely a moot issue. Thus, we first must test to see if we have an example of "niche creation."

Assumption 1: Capabilities from existing market niches facilitate success in emerging market niches.

If capabilities transfer from one market niche to the next, do managers of incumbent firms act to harness these advantages or do they squander them? We will first propose explanations for why incumbency might cause systematic biases in managerial decisions and so cause them to squander their firm's advantages. Then we will hypothesize how managers might act if they attempt to harness their existing capabilities to facilitate success in emerging markets.

Scholars propose that incumbency narrows information channels and so causes managers of incumbent firms to make decisions based on biased data (Christiansen and Bower, 1996). Following Utterback and Kim (1986), Christensen and Bower (1996) suggest that new and emerging market niches differ in the criteria of performance. For example, buyers of 5.25-inch drives prized capacity and speed, while buyers of 3.5-inch drives prized durability and light

weight. By listening to their existing customers, managers gain a biased impression of consumer demand. Based on the consumer criteria of their existing customers, the new products look inferior, and incumbent managers choose not to compete with these inferior products.

Incumbent firms may also fall into a capability trap that impedes their success (Leonard-Barton, 1992; Starbuck, 1988; Lant and Mezias, 1992; Levitt and March, 1988). Such traps can be at the individual or organizational level. For individuals, success may breed complacency and inertia. For example, managers may develop theories that link their current practices with success and become increasingly unwilling to change what is tried and true (Miller, 1993; Levinthal and March, 1981). Alternatively, success may create organizational systems which then bias decision-making, or create contexts that exert subtle pressures to continue with past strategies (Milliken and Lant, 1991).

For example, Christensen and Rosenbloom (1995) note that managers are often rewarded based on the satisfaction of existing customers. Because these incentives under-reward success in future markets, managers have little incentive to act proactively. Christensen and Bower (1996) argue that incumbent firms pursue the development and elaboration of capabilities needed for their best customers, and this pursuit then prevents them from recognizing the "down-market" threat from emerging niches. For example, they argue, incumbent firms continued to develop denser, higher capacity drives in the existing drive size and so failed to recognize the threat from emerging form factors (smaller drive sizes). These smaller drives were not valued by the incumbents' current customers (who instead valued high capacity drives). As a result of these very capabilities in the manufacture of dense drives, management of the incumbent firms failed to immediately enter the emerging market and thus entered later than other firms, or never at all. Following Mitchell (1989), we call such capabilities "industry specialized capabilities". The above literature suggests that these capabilities will delay entry.

H1: The more a firm has industry specialized capabilities, the less likely it will enter an emerging market niche.

Other scholars have proposed that industry specialized capabilities or assets may actually encourage entry. For example, Mitchell (1989) proposes that the possession of specialized assets is an important factor in determining whether an incumbent will enter. Specifically, Mitchell proposes that the more specialized assets the incumbent has relative to other potential competitors, the more likely it is to enter the emerging subfield. Specialized assets are a necessary condition for entry by incumbents, because if the assets are freely available or easily imitated it would make little sense for the incumbent to enter. Moreover, if assets are specialized, they then have lower value in other industries. As a result, companies with more industry specialized capabilities or assets should enter to protect the full value of these assets.

The capabilities of incumbent firms are not constant. Firms continue to develop capabilities in their existing markets, and these capabilities can then provide competitive advantage in emerging niches. For example, a company growing in an existing market may be able to develop a logistics system, a sales force, or skills in operations management. They may be able to gain product development skill or form strategic alliances. For example, Iansiti (forthcoming) demonstrates that cumulative experience and knowledge generated by incumbents' parallel experiments (technical experiments in the semiconductor industry) were associated with higher performance at the project level. Rational managers of incumbent firms will change their decisions about when to enter an emerging niche based on these changing capabilities.

H2 The more a firm has industry- specialized assets, the more likely it will enter an emerging market niche.

Hypotheses 1 and 2 do not predict how the timing of entry of incumbents will compare to that of new entrants. Research suggests that early entry into an emerging niche facilitates success, but this does not mean that an incumbent should try to enter a new niche earlier than an entrant. The incumbent may have less incentive to initiate or support the creation of a new niche since it may cannibalize their sales. Thus, they may delay opening a new niche until a new entrant forces their hand. Of course, managers may also engage in a strategic game in which they attempt to assess the entry of other companies and then time their entry accordingly (Fudenberg and Tirole, 1985, 1991). Alternatively, incumbents may gain marginally less benefit from early entry (Reinganum 1989). Mitchell (1991) suggests that two different clocks exist for incumbents and for new entrants. New firms need to enter earlier to establish credibility and name recognition, while incumbent firms already have these assets and so can enter later. By letting entrants go first, Mitchell argues, incumbents can observe what investments are needed in emerging niches and so avoid making costly errors. Other scholars suggest that incumbents should enter at least as early as new firms (Christensen and Bower, 1996), and that failure to do so partially explains the failure of incumbent firms. By not entering earlier, the logic goes, incumbents allow new entrants the opportunity to gather strength. By entering later than new firms, incumbents damage their existing capabilities.

3. Research Method

The disk drive industry provides an excellent setting to explore the decision-making of incumbent managers in response to new technology-created market niches. From 1976 to 1995, the industry went through several market changes. The size of the average drive at the beginning of the period was 14 inches and 4 megabytes. At the end it was 3.5 inches and 400 megabytes. The history of the industry also seems to clearly exhibit irrational decision making on the part of incumbent firms. Of 174 companies that ever made a drive, only 29 were producing in 1995. A new entrant was the first entrant into both the 5.25- and 3.5-inch disk drive market and IBM, the

largest drive maker, did not enter within the first two years. Post-hoc interviews and analysis of the industry suggest that the information sources and decision-making of incumbents were biased by their customer base (Christensen and Bower, 1996).

3.1. Sample

To test our hypotheses, we collected data for all firms producing a rigid hard drive for the time period 1976 to 1995. The data were obtained from *Disk / Trend Report*, a highly reliable and complete source of industry data (Christensen, 1997; Lerner, 1997; Christensen and Bower, 1996). The population consisted of 208 business units representing 174 distinct organizations.

From this panel data, we constructed a listing of each organization and whether each organization produced a drive in each disk drive size (also called a *form factor* or *category*: 14", 10", 9", 8", 5.25", 3.5", 48cm, and 1.8"). To determine the histories of each organization and to determine major reorganizations, we searched the Lexis/Nexis files for reports of reorganization, mergers, changes in ownership, and name changes. We also collected unit sales for each disk drive category, total disk sales for each organization, and total corporate sales for each organization.[1] We linked the Disk/Trend data to the Compustat database to confirm the sales data of public companies and to determine (1) the nation of ownership for each company and (2) whether the disk drive company was part of a larger electronics company that used disk drives.

To indicate entry into a niche, we created a dependent variable that indicated (with a 1) if firm produced a drive in each category in each year (and 0 otherwise). We chose to evaluate entry into the four main drive sizes (14, 8, 5.25 and 3.5). Smaller drives had only recently arrived on

[1] *Disk / Trend Report* only reports sales above a certain *de minimus* level (which changed from year to year but averaged about 200 units). Thus, we used the *de minimus* level of shipments for each company whose sales were not reported in each year. In 12 cases (out of 3497 or 0.3%), missing data were interpolated, as per the following example: 1985 sales of 164,000 units; 1986, *de minimus*; 1987, 184,000 units. After using Lexis/Nexis, company reports, Compustat, and *Disk/Trend Reports* to verify that the company did not temporarily exit the market, we assigned 174,000 units to 1986.

the market by the end of our sample, so for this round of analysis, we excluded them. We also excluded the 9- and 10-inch drive. These form factors never became important market niches. Only three firms ever made a 10-inch drive, and only eight made a 9-inch drive. With the remaining drives, we have no left censoring (the first 8-inch drive was not commercialized until 1978 and the others not until after that). We have, however, right censoring because our sample stops in 1995 and some producers continued to manufacture 8-, 5.25-, and 3.5-inch drives after that.

3.2. Variables

Hypothesis 1 and 2 propose that the probability of entry is affected by industry-specialized capabilities or assets. For our industry, two such assets seem particularly important. Christensen (1997) argues that the ability to make dense drives provides success in existing markets but discourages entry into future markets. We created a measure of this technological capability by estimating the maximum density for any drive sold by the firm in that year (*Disk / Trend Report* provided technical information about each drive produced; see also Lerner, 1997). Since we are interested in relative capabilities, we constructed a measure of the normalized deviation of this density relative to the maximum densities for all other firms in that year. Thus, if this measure has a value of 1.00, that company's most dense drive was one standard deviation higher than the most dense drive sold by other firms in that year.

We also measured technological capability using an index of the degree to which a company had adopted the dominant design (Christensen, Suarez, and Utterback, 1998) each company incorporated into its drives. This measure was correlated with maximum density at 40%, did not qualitatively change any results, and did not seem to be conceptually as related to technical capabilities as maximum density. Thus, we have reported results using maximum density.

Other scholars have suggested that cumulative experience, market share, or sales represent a useful capability (or asset) for the firm. Cumulative experience in production should measure the advantage a firm has in manufacturing, while market share might represent industry power. In this analysis, we use industry experience (cumulative design-years of experience in each drive size). We found that the three measures were highly correlated in this sample. Of the three, market share seemed the least reliable. Market share is highly correlated with, but "noisier" than, sales. This is because in the early years of a new niche, market share is highly volatile. A company with almost no sales can have 100% market share during the early years of a market niche and then disappear. As the market develops, sales and market share become much more correlated. In the end, we chose to present our finding using discounted cumulative experience to measure industry specialized experience because we thought it best captured our construct. We also performed identical analysis with market share and log annual unit sales and obtained consistent findings.

Obviously experience does not remain valuable forever. To correct for the aging of experience, we used Baum and Ingram's (1998) method to construct a "discounted experience" variable. For each drive size for each company, we discounted the value of prior years' sales. Discounted experience equals:

$$Experience_i = \sum_{j=i,\,y} \frac{\ln(unitsales)_j}{(i-j+1)}$$ where

j = year of sales

unitsales = total production for the company

i = year in which experience is measured

y = year of first sales

Thus, the log of the prior year's sales was added to the log of sales two years previous divided by two, three years prior divided by three, etc. We performed a sensitivity analysis of our results by using different methods for constructing an experience variable. We constructed experience

using different discount rates, and by using a straight summation of years of experience (cumulative experience). We found very similar results.

Scholars have also suggested other factors that might influence entry. For example the market density of the niche market might signal the value of the new niche and thus encourage entry. To account for this effect, we created a measure of the number of firms in each market. Scholars have also suggested that vertically integrated firms might operate differently than non-vertically integrated firms. To account for this effect, we include a dummy variable indicating whether the firm used disk drives in its own products or not. Other scholars have begun to surmise that there may be a home country effect to entry patterns (Chesbrough, 1999; Chesbrough, forthcoming). To control for this, we constructed dummy variables for whether the firm was from Japan, or whether the firm was from the rest of the world besides Japan and the U.S. We also tested our findings with U.S. firms only and obtained even stronger results.

For this investigation, we used several statistical techniques suited to exploring each hypothesis. These techniques included OLS regression to examine cumulative sales and entry timing, random-effects logit to examine whether incumbents entered, and accelerated hazard rate analysis to examine which incumbents entered early. These models will be discussed below as part of the discussion for each hypothesis.

The variables included in this study are summarized in Table 1, with descriptive statistics given in Table 2.

Insert Tables 1 and 2 Here

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4. Results

The history of disruption and failure in the disk drive industry might suggest that technological and market changes transformed the capabilities of incumbents into liabilities. As shown in Table 3, we first investigated whether existing capabilities facilitated success in emerging disk drive market niches. As shown in Table 3, we predicted the future sales in emerging niches based upon the capabilities in the pre-existing niche in the year of entry. We did the analysis for two different groups, (1) all firms and (2) only for entering incumbents. As shown in Table 3, we found that discounted cumulative experience predicted success in all cases. Density of the companies drive predicted success in the 5.25 inch market when the sample included all firms. However, when we only considered the incumbent firms, density did not exhibit a significant effect. We suspect that this demonstrates that some new entrants had superior capabilities in designing high density drives that facilitated their success.

Insert Table 3 Here

Thus, we find, as described by our Assumption 1, that the value of discounted experience transferred from one niche to the next, and that we can indeed classify disk drive form factor changes as "niche-creating" in the Abernathy and Clark (1985) sense. According to a former CEO in the industry, one of the most important capabilities that incumbents retained was in "knowing how to produce a product on time and on budget." More experienced firms also retained substantial skills in logistics, supply chain relations, and consumer confidence.[2] Perhaps for this reason, by 1985 seven companies produced 94% of the 3.5 inch disk drives. Six out of the seven were incumbents from 5.25 inch. Four of these firms had made a 14 inch drive!

[2] In this analysis, we predict future sales, but we could also measure success by trying to predict failure (exit) in each drive size. Such analysis delivers very similar results.

Our analysis also provides moderate evidence that early entry into emerging markets facilitated sales in that niche. Because the significance of this effect is lost when the sample is constrained to incumbent firms, one might assume that entry timing had a differential effect for incumbent and new firms. To test this, we added an interaction term between entry timing and incumbency to test if the value of early entry varied between entrants and incumbents. We found no statistically significant difference. Thus, we found no evidence of a differential effect for early entry for incumbents and new entrant firms.

4.1. Mapping Patterns in Entry Decisions

Hypothesis 1 suggests that the accumulation of industry-specialized assets will delay entry into the emerging niche. Hypothesis 2 suggests just the opposite. These hypotheses cut directly at the issue of how capabilities influence managerial decision-making. Does the pursuit and elaboration of capabilities prevent understanding and expansion into existing markets, or do these capabilities encourage managers to enter emerging markets?

To test these contrasting hypotheses, we used a fully non-parametric discrete-time logistic regression technique (Yamaguchi, 1991; Martin and Mitchell, 1998). Martin and Mitchell (1998) cite four main benefits from this method, three of which are salient to our study. The first is the ability to handle right-censored data. The second benefit is the ability to handle "ties," multiple events that occur in the unavoidably large periods of one year. Both are important to our investigation. They also note that discrete-time logit analysis allows time-varying independent variables — a useful feature for our analysis. The final benefit, the ability to handle repeated events, is not a factor in this study. Once a firm has entered a new niche we stop our analysis.

The form that the logistic regression takes is as follows:

$$ln\,(p_i/(1-p_i)) = a + \beta X_i,$$

where p_i is the probability that firm *i* will produce a drive in that category. For example, when examining who entered the 8-inch drive category, it is the probability that firm *i* will produce an 8-inch drive. The vector of independent and control variables X presumably influence this probability. Thus, we seek to investigate whether, for example, discounted experience in the 14-inch drive category influenced the probability of a firm's entry into the 8-inch drive category.

As shown in Table 4, we find support for Hypothesis 2 rather than Hypothesis 1. If Hypothesis 1 were true, we would expect that relative drive density or cumulative experience would discourage entry. In each transition, we do not find that capabilities in making dense drives discouraged or encouraged entry. We do find, however, that experience in the existing market (Relative Discounted Experience) was statistically significantly associated with entry.[3] Therefore, our evidence disconfirms Hypothesis 1, and supports Hypothesis 2. More industry specialized experience increased the likelihood of entry.[4]

Insert Table 4 Here

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[3] The results do not change qualitatively when we use the cumulative or the discounted experience measured in either years or sales. Furthermore, the results do not change when we include the year as a control variable.

[4] Note about sample selection. The findings reported in Tables 4 and 5 compare only incumbents with other incumbents. We also ran the same statistical tests with different sample selection criteria. For example, we put firms that were alive (such as 3M) whether they had entered the market, or all firms that were working on disk drives whether they had actually produced a drive. We even tried an extreme assumption: all firms, even those not yet incorporated, were considered at risk. These alternative formulations produced *stronger* results, i.e., the effect of discounted experience was even statistically stronger than reported here. We could not run disk density in the prior size with these alternative formulations, as the sample was thus expanded to include entrants.

To make sure our analysis was robust to different formulations of the model, we also used an accelerated failure time analysis to predict the waiting period prior to entry into the new niche for disk drive manufacturers. The accelerated failure time technique is suited specifically for entry analysis and is very general in allowing time-varying independent variables, different distributions of the errors, multiple ties (due to one-year intervals), and right-censored cases. The waiting periods are assumed to be distributed according to a parametric distribution that would be in effect when the independent variables are equal to zero (Mitchell, 1989). The independent variables then influence the "baseline" waiting period in a multiplicative fashion:

$$ln\ T_i = a + \beta X_i + se_i$$

where T_i is the waiting period for firm *i*, ß is the coefficient vector for the independent and control variables, *a* is the intercept, *s* is the variance scaling factor, and *e* is the error vector which is distributed according to the assumed parametric distribution (Mitchell 1989; Allison 1995). A positive coefficient implies a lengthening of the waiting period and a negative one implies a shortening.

The accelerated failure time technique needs the distribution to be explicitly specified. The standard distributions recommended by Allison (1995) are the exponential, Weibull, lognormal, log-logistic, and generalized gamma. We ran all of these using the method recommended by Allison. In the log-likelihood analysis, the Weibull distribution had the lowest log-likelihood in two of the three niche transitions, -36.46, -46.24, and –50.27, respectively. The only lower log-likelihood value was using the log-logistic distribution in the transition to the 5.25-inch drive, with a value of –42.63. The goodness-of-fit test would then be (46.24-42.63)*2 = 7.22, which

can be examined as a chi-square statistic with one degree of freedom, which would suggest rejecting the Weibull ($p<0.01$). The results reported here are therefore for the Weibull distribution, except the transition into 5.25, in which we used the log-logistic. The use of the other distributions did not qualitatively affect the results; in fact, the exponential distribution (whose log-likelihood value was slightly lower but whose goodness of fit could not be rejected) gave even stronger results than those reported here.

As shown in Table 5, we again find that more relative experience encouraged entry. In this case, relatively more experience reduced the time to entry.

Insert Table 5 Here

Simple descriptive statistics also provide compelling evidence in favor of Hypothesis 2 over Hypothesis 1 (see Appendix 1). Of 56 incumbents with any appreciable sales in the existing market, 42 entered the emerging market. Moreover, some incumbents that did not enter the emerging market do not seem to have missed the opportunity, rather they seem to have considered their relative position and chose to follow an "end-game" strategy. For example,

> "Atasi Technology... is following an end-of-life strategy, acquiring the rights to manufacture older disk drive designs and manufacture them as long as demand holds up. Atasi Technology started by purchasing rights to manufacture Priam's 5.25-inch drive 190 and 380 MB drives..."[5]

Other successful incumbents were prevented from entering emerging niches not because they lacked the recognition of the importance of these new niches, but because cash-flow problems prevented entry:

> "After great success in the second half of the 1970s as the leader in plug-compatible disk drives, STC's management ...launched expensive programs to build mainframe computers and optical disk drives and acquired firms in other areas with extensive bank borrowing. In Oct 1984, the bankers wouldn't wait, and the company was thrown into Ch. 11."[6]

Earlier, we reviewed several predictions for how the entry patterns of incumbents would compare to those of new firms. If incumbents entered after new firms, it might suggest that incumbency delays entry, even though capabilities, as we have shown, do not. Such delayed entry might also provide credence to the idea that incumbent managers squandered the capabilities of their firms by entering a new niche too late to have a good chance of success. To evaluate if incumbents entered after new firms, we used simple OLS to compare the years of entry for all incumbents and new firms. We compared the entry timing only for those incumbents that actually entered. In each case, at least 20 companies never entered the emerging niche (50, 20, and 32 respectively). This remaining pool of incumbents allows us to make the comparison with entrants without fear that the finite population of possible entrants might skew the results. If this population did not exist, one might fear that our results could be caused by random action within a finite population (incumbents) compared with that within an infinite population (possible entrants). As shown in Table 6, in all three transitions, incumbents as a group entered each drive earlier than new entrants. Incumbents entered the 3.5-inch disk drive almost 23 months ahead of entrants. They entered the 5.25-inch market 21.6 months ahead, and the 8-inch market 22 months ahead. These results are consistent with Thomas (1998). The effect is, however, rather noisy, suggesting wide variance and discretion among both incumbents and new firms.

Insert Table 6 Here

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[5] 1991 *Disk/Trend Report*, p. MFGR-4, October, 1991.
[6] 1985 *Disk/Trend Report*, p. MFGR-20, October, 1985.

To make sure that the incumbents did not miss out on a munificent period at the very beginning of each niche, we created a dummy variable for early entry which indicated if the firm entered the new niche within the first two years.[7] We then reran our analysis from Table 3 with this additional variable. While statistically insignificant for all three transitions, the sign for the coefficient was negative for two of the transitions. Thus, we found no evidence that such early entry predicted future success.

5. Discussion

Our results show that industry capabilities gained through experience encourage managers to enter emerging niches. Why do our findings differ from previous studies of the disk drive industry? One reason is that previous studies seem to have assumed different criteria for success. Christensen and Bower (1996), for example, argue that Seagate's attempt to enter the 3.5-inch market was a failure, while Quantum's attempt to enter was a success. The logic for this distinction seems to be that the market share for Quantum grew relative to their 5.25- and 8-inch drives, while the market share for Seagate fell. In our view, however, Seagate also successfully entered the 3.5 inch market because their total sales were second only to Quantum, their market share was about 20%, and their total sales increased dramatically each year (see Figure 1). Our analysis suggests that the capabilities that both companies gained by producing prior-sized drives helped them succeed in the 3.5-inch market.

Insert Figure 1

Another explanation for our different findings arises from our means of evaluating managerial action. Our research also compares the outcome of decision-making, rather than the decision-

[7] We also created a similar variable indicating if the firm was among the first 30% to enter, and obtained similar findings.

making itself. Since we only observe the outcome of entry decisions, it remains possible that incumbency and pre-existing capabilities temporarily or marginally delayed entry decisions, but then allowed more rapid implementation of entry. For example, incumbents with existing capabilities may have more easily obtained the financing necessary to enter the emerging niche.

It is also possible that previous research correctly identified sources of delayed decision-making among incumbents, but underestimated the existence of similar pathologies among entrants. It seems possible that new firms also experienced difficulty in deciding how to approach a new market niche, and that these difficulties were actually greater than those within incumbents. Indeed, Cohen and Levinthal (1990) and Iansiti (forthcoming) suggest that incumbent firms obtain useful experience that then aids them in recognizing and adopting technology. By comparing numerous firms, our research shows that incumbency and pre-existing experience do indeed provide a relative advantage.

Christensen and Bower (1996) seem to suggest that late entry harmed incumbents and this explains the failure of leading firms. Would incumbents have performed better if they had entered sooner? Our results reveal a rational reason to delay entering. In Table 3, the effect of discounted experience is much larger than that for entry timing (even if entry timing is normalized), suggesting that capabilities better facilitated future success. Thus if managers thought they could obtain more capabilities by "sticking with their knitting" in the existing market, they might reasonably decide to delay entering an emerging niche (cf. Peters & Waterman, 1982).

Consider for example the history of Quantum. Quantum entered the 3.5-inch market in 1987. Of the top seven companies in the 3.5 inch disk drive market in 1995, this put Quantum tied for last in entry timing. However, by 1995, they had the largest market share. Why did they delay for 6 years before entering the 3.5 inch niche? One reason may be that they had not gained enough

industry experience until that date. They did not have measurable sales (more than 200 drives) of the 8-inch drive until 1982. They did not sell over 1000 5.25-inch drives until 1983, and their 5.25-inch sales did not peak until 1986. In 1987, Quantum entered the 3.5-inch market. Our analysis suggests that they may have been wisely gathering useful capabilities before making the jump to the 3.5-inch market.

Thus, our research suggests that managers face a complex multi-attribute decision when evaluating when to enter a new niche. They must consider the extent to which capabilities from their existing market can transfer to the emerging markets, and trade this off against the extent to which entry into the emerging market can improve the chances of success. They must evaluate whether entering the emerging market will damage the rate with which they gather capabilities in the existing market, and the potential risk of entering before capabilities are fully developed. Our current research does not demonstrate that they perfectly balanced these conflicting issues. It does show, however, that existing capabilities did not differentially discourage entry. As a result, managers were able to guide incumbents through multiple generations of new market niches.

Not all managers succeeded in guiding their firms through these transitions. Of the top 10 selling companies in 5.25-inch drives, only 50% of them made the top 10 list for 3.5-inch drives. Seagate fell from number 1 to number 2. IBM fell from number 2 to number 3. Other incumbents moved up to take their place. Quantum moved from number 14 to number 1. Maxtor moved from number 8 to number 5. Our research suggests, however, that this reshuffling is not simply the result of managerial failure to recognize and enter new market niches. New markets damaged existing links to customers and partially damaged existing experience, technology, and skill. Incumbents still had the advantage, but the changes lowered barriers enough that a few smaller incumbents could grow, and a few entrants could survive.

6. Conclusion

In this study, we find evidence that incumbent firms indeed have capabilities that can allow them to be successful in emerging markets. Success in previous markets strongly predicted success in future ones. Although theory predicts that incumbency causes managers to squander these capabilities, we found no evidence to support this. Indeed, patterns of entry strongly suggest that managers were aware of these capabilities when choosing whether and when to enter emerging markets. We also find no evidence that incumbent firms failed to enter in a timely manner and so squandered the opportunity to new, more nimble firms. Indeed, incumbents entered earlier than new firms.

Our research may uncover potential contingencies in existing theory. The disk drive industry differs greatly from the auto, cement, glass, and printing industries where other scholars have found rigid managerial behavior. Those industries were far more stable and innovations came much less frequently. The disk drive industry is more similar to the computer software industry where Mitchell (1991) also found mindful managerial behavior. We suspect that differences in the industry environment might explain why incumbent firms in the disk drive industry responded relatively quickly to emerging market niches. As part of the computer industry, managers of incumbents could hardly fail to recognize technological trajectories toward smaller, lighter, faster equipment. Each generation of computers exceeded the last, and each expanded the market. We suspect that the industry's social and technological environment also encouraged communication and interaction. Managers in the United States moved fluidly among different incumbent firms and consulting companies often provided temporary assistance and help. This fluid environment must have exposed managers to numerous sources of information and numerous perspectives. Not surprisingly, executives from existing firms founded almost all of the new entrants.

Research on information channels and decision-making provides a theoretical basis for why such change and fluid inter-relations might improve information transfer and prevent biased decisions. Katz and Allen (1982), for example, suggest that there is a curvilinear relationship between experience and effectiveness. At first, experience allows individuals to acquire useful information channels and gather more information. For a while these information channels remain flexible and are continually tested. After a while, however, people begin to take these information channels for granted, and they develop an unreasoned resistance to information from outside — the "Not Invented Here Syndrome." Katz and Allen suggest frequent changes to the organization can keep information channels and decision-making fresh and effective. Just such change was an annual part of the disk drive industry.

The theories of technological change tested in this paper seem to assume that firms have progressed to the stage where their information channels are rigid and obsolete, and their decision-making has become routine. As a result, managers of incumbent firms, despite their experience, are unable to acquire the right information and make appropriate decisions. This theory is probably correct when technological or market changes are infrequent. If such change is frequent, however, it may prevent incumbents from becoming inflexible.

Thus, we propose that the frequency of change in an industry may influence the effect of any single change. Technology changes which are widely spaced might destroy firms. The same changes, when spaced more closely together, might have little effect. Interestingly, this theory matches recent research into natural ecological systems (Holling, 1986). Periodic events like fires do not damage grassland species because they occur frequently and these species retain the capacity to regrow after each fire. Indeed, fire may trigger the growth of certain species. In contrast, the same fire in an old oak forest would cause devastation because oak trees are designed for efficiency, not for rapid regrowth.

Of course, in the disk drive industry there are managers who receive information and make decisions about how to respond to changes in their environment. The degree to which they can effectively respond to these changes is determined both by their organizations' systems for gathering information and their own ability to make decisions. What we have demonstrated here is that these organizations and their managers retained the capacity to respond to environmental change. We suspect that frequent "fires" keep managers and organizations on the alert. It may also suggest that frequent change causes firms to retain the dynamics capabilities needed to respond to future change. It is even possible, as in the case with grasslands, that organizations cause (purposely or accidentally) the rapid environmental change that maintains environmental conditions in which they can best survive.[8]

In future research, we hope to study the generalizability of the results of this study to other industries. By comparing the response to technological change in other information-intensive, rapidly evolving industries to the response in more mature and slower growing industries, we hope to better understand when industry's generals systematically continue to fight the last war and when they prepare for the future ones.

[8] Grasslands burn easily, thereby transferring the effect of lightening strikes etc. Also, where traditional peoples are present, they usually burn the grassland to keep down more efficient species and provide forage for game.

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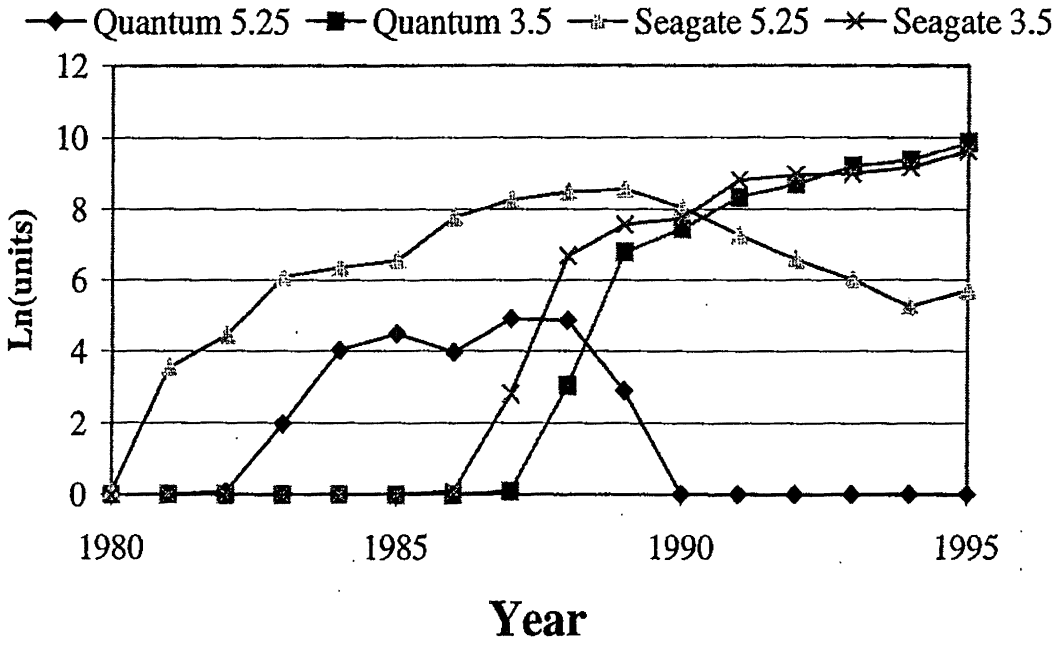

Figure 1- Quantum and Seagate transition to the 3.5 inch drive.

Table 1. Construction of variables

Construct	Variable	Construction
Dependent Variables (also used as independent in some tests)		
Success in the Market Niche	Total Sales in Niche	Log of the sum of all sales in that niche for all years.
Entry timing in each category	Year	The actual calendar year
Whether a firm is producing a drive in a certain niche	Producing	dummy = 1 if the firm is producing a disk drive of the current niche in the current year
Waiting period	Time to Entry	The number of years "at risk:" the time entered into the prior drive size to the time of entry
Independent Variables		
Industry Specialized Capabilities		
Capability in making high density drives	Density Deviation	Normalized deviation of the maximum density for each firm for each category in each year
Experience in drive manufacture	Relative Discounted Experience	Normalized deviation of the sum of discounted experience
Other independent variables		
Incumbent	Incumbent	dummy = 1 if the firm manufactured a drive prior to entering each category
Market density	Market Density	The number of firms actively competing in each category in each year
Internal market for drives	Captive	dummy = 1 if SBU of larger computer company
International Company	Japan	dummy = 1 if company is headquartered in Japan
	ROW	dummy = 1 if company is headquartered outside of US and Japan

Table 2. Descriptive statistics

Variable	N	Mean	Std. Dev.	Min	Max
Total Sales in 8	52*	1.49	2.02	0.05	6.60
Total Sales in 5.25	90	1.89	2.68	0.10	10.10
Total Sales in 3.5	72	2.89	3.69	-0.05	10.90
Market Density of 8	52	21.83	7.56	11	31
Market Density of 5.25	90	33.37	11.13	3	47
Market Density of 3.5	72	29.11	10.91	1	41
Discounted Experience in 14 on entry into 8	28*	0.18	1.29	-0.65	5.49
Discounted Experience in 8 on entry into 5.25	34	-0.21	0.72	-0.68	1.88
Discounted Experience in 5.25 on entry into 3.5	35	0.06	1.05	-0.69	2.78
Discounted Experience overall on entry into 8	52	-0.01	1.08	-0.69	5.49
Discounted Experience overall on entry into 5.25	90	-0.27	0.70	-0.69	2.32
Discounted Experience overall on entry into 3.5	72	-0.17	0.91	-0.72	2.78
Density Deviation in 14 on entry into 8	28	0.20	0.92	-1.38	1.12
Density Deviation in 8-10 on entry into 5.25	34	-0.04	1.06	-1.98	1.62
Density Deviation in 5.25 on entry into 3.5	35	-0.09	1.00	-1.30	3.39
Density Deviation overall on entry into 8	52	0.47	0.88	-1.44	1.66
Density Deviation overall on entry into 5.25	90	-0.06	1.01	-1.24	3.55
Density Deviation overall on entry into 3.5	72	-0.14	1.01	-1.42	2.32
Incumbent before 8	50	0.58	0.50	0	1
Incumbent before 5.25	90	0.32	0.47	0	1
Incumbent before 3.5	72	0.44	0.50	0	1
Producing in 8	185*	0.13	0.34	0	1
Producing in 5.25	273	0.11	0.31	0	1
Producing in 3.5	463	0.06	0.25	0	1
Captive	174*	0.172	0.379	0	1
Japan	174	0.161	0.369	0	1
ROW	174	0.247	0.433	0	1

*There were 174 firms that produced a rigid hard drive between 1976 and 1995. 52 firms made an 8 inch drive, 90 made a 5.25 inch, and 72 made a 3.5 inch. Of these, 28, 34, and 35, repectively, were incumbents. There were 185, 273, and 463 firm-years in each respective drive size. Control variables' descriptive statistics are shown for the entire sample, even though they were restricted in each subsample.

Table 3. Predicting the cumulative sales in each category

	OLS regression					
	Total Sales In 8	Total Sales In 8	Total Sales In 5.25	Total Sales In 5.25	Total Sales In 3.5	Total Sales In 3.5
Discounted Experience in prior	0.80*** (0.27)		2.49*** (0.53)		2.43*** (0.52)	
Discounted Experience overall		1.02*** (0.21)		1.31*** (0.25)		1.86*** (0.47)
Density Deviation in prior	0.04 (0.37)		0.24 (0.37)		0.49 (0.51)	
Density Deviation overall		-0.09 (0.26)		0.62** (0.25)		-0.65 (0.43)
Year	-0.36 (0.21)	-0.13* (0.07)	-0.09 (0.12)	-0.20*** (0.07)	-0.66 (0.54)	-0.29** (0.15)
Market density	0.03 (0.05)	-0.02 (0.03)	0.02 (0.03)	-0.03 (0.02)	0.15 (0.11)	0.08** (0.04)
Captive	1.44** (0.69)	0.68 (0.50)	1.26 (0.74)	-0.05 (0.62)	1.45 (1.11)	1.63 (1.03)
Japan	1.71 (0.84)	1.24* (0.62)	2.08** (0.97)	-0.08 (0.62)	-0.72 (1.22)	-1.50 (0.93)
ROW	-0.53 (0.92)	-0.76 (0.59)	-0.25 (0.95)	-0.03 (0.60)	-1.10 (1.37)	-1.99** (0.92)
constant	715.33 (421.35)	257.07* (148.56)	177.98 (230.41)	393.62*** (145.00)	1318.25 (1072.30)	576.74* (300.13)
R-squared	0.695	0.502	0.644	0.394	0.569	0.378
Adjusted R-squared	0.588	0.422	0.549	0.342	0.457	0.310
Obs.	28	52	34	90	35	72

*p < 0.10, **p<0.05, ***p<0.01, std errors in parentheses

Table 4. Predicting whether a company entered a certain category in each year

logistic regression, random-effects			
	entry into 8	entry into 5.25	entry into 3.5
Discounted Experience in prior drive	1.05** (0.48)	0.71* (0.40)	2.78*** (1.02)
Density Deviation in prior drive	0.06 (0.34)	-0.02 (0.22)	0.80 (0.50)
Market density	0.09* (0.05)	0.03 (0.02)	0.21*** (0.08)
Captive	0.35 (0.67)	-0.26 (0.52)	1.84 (1.61)
Japan	2.37** (0.94)	2.00** (0.77)	3.53* (2.05)
ROW	0.66 (1.01)	-0.31 (0.72)	-0.39 (1.62)
Constant	-4.43*** (1.38)	-2.97*** (0.89)	-10.62 (3.42)
Wald χ^2	11.17	8.76	9.71
Prob > χ^2	0.0832	0.1875	0.1373
N (obs)	185	273	463

*p < 0.10, **p<0.05, ***p<0.01, std errors in parentheses

Table 5. Predicting the entry timing into each category for disk drive companies

	Accelerated failure-time form		
	Time to entry into 8	Time to entry into 5.25	Time to entry into 3.5
distribution	Weibull	Log-logistic	Weibull
Discounted Experience in prior drive	-0.37** (0.16)	-8.53** (3.78)	-0.95*** (0.31)
Density Deviation in prior drive	-0.01 (0.19)	0.25 (0.24)	-0.20 (0.25)
Captive	-0.26 (0.34)	0.00 (0.52)	-.71 (0.54)
Japan	-1.23** (0.48)	-0.53 (0.71)	-1.33** (0.58)
ROW	-0.09 (0.51)	0.28 (0.58)	0.06 (0.53)
constant	3.02*** (0.73)	-1.46 (1.57)	4.57*** (0.83)
LR χ^2	16.07	16.69	33.01
Prob > χ^2	0.0134	0.0105	0.0000
N (obs)	171	253	408

*p < 0.10, **p<0.05, ***p<0.01, std errors in parentheses.

Note: There are fewer observations than in Table 4 because firms entering after the first year of the sample require two observations to calculate the waiting period.

Table 6. Predicting the entry timing into each category for disk drive companies

	OLS regression		
	year into 8	year into 5.25	year into 3.5
incumbent	-1.84**	-1.72**	-1.90***
	(0.86)	(0.87)	(0.71)
captive	1.07	-0.06	-0.46
	(0.91)	(1.00)	(0.92)
japan	-1.57	-1.00	-0.66
	(1.11)	(0.98)	(0.81)
row	-0.96	1.50	2.15***
	(1.13)	(0.98)	(0.78)
constant	1981.90***	1984.08***	1987.31***
	(0.70)	(0.58)	(0.56)
R-squared	0.155	0.121	0.274
Adjusted R-squared	0.083	0.081	0.232
N	52	90	72

*p < 0.10, **p<0.05, ***p<0.01

Appendix 1. Incumbents and their entry patterns into the subsequent category: firms with substantial sales vs. firms that never had substantial sales (through peak year of that category)

14 to 8 (through 1984)			
Substantial sales in 14		De minimus sales in 14	
Entry (9)	No entry (3)	Entry (14)	No entry (14)
Century Data	Okidata	BASF	Alpha Data
Control Data	Storage Technology	Burroughs	Ampex
Fujitsu	Xerox/Diablo	Data General	Applied Peripheral
Hitachi		DEC	Ball Computer
IBM		Disc Tech One	Dastek
Memorex		Hokushin	IBIS
Pertec		HP	ISS/Univac
Priam		Kennedy	Microdata
Shugart		Mitsubishi	Ohio Scientific
		NEC	Philips Data Systems
		Nippon Peripherals	Siemens
		Northern Telecom	Sperry
		Pertec	Tecstor
		Toshiba	Western Dynex

8 to 5.25 (through 1989)			
Substantial sales in 8		De minimus sales in 8	
Entry (14)	No entry (2)	Entry (13)	No entry (10)
Century Data	Hokushin Electric	Disc Tech One	(DDC) Pertec
Control Data	Northern Telecom	Disctron	3M
Fujitsu		HP	Amcodyne
Hitachi		Magnum	Cerplex
IBM		Matsushita	Data General
Int'l Memories		Memorex	Data Peripherals
Micropolis		Newbury Data	Hightrack
Mitsubishi		Nippon Elec Indust	Kennedy
NEC		Nippon Peripherals	Megavault
Priam		Olivetti	Vermont Research
Quantum		Rodime	
Seagate		Sequel	
Shugart		TI	
Toshiba			

5.25 to 3.5 (1985+).			
Substantial sales in 5.25		De minimus sales in 5.25	
Entry (19)	No entry (8)	Entry (19)	No entry (21)
Control Data	Atasi	Alps Electric	Atasi
DEC	BASF	Brand	Century Data
Fujitsu	Computer Memories	Elebra	CII Honeywell Bull
Hitachi	Intl Memories	Goldstar	Cogito
HP	Nippon Elec Indus	Josephine County	Cybernex
IBM	Siemens	Magtron	Data-Tech
Maxtor	Shugart	Matsushita	Digirede
Micropolis	Vertex	Microlab	DZU
Microscience Int'l		Miltope	Edisa
Miniscribe		Multidigit	Ezi
Mitsubishi		Newbury Data	Gigastorage
NEC		Olivetti	Hyosung
Nippon Peripherals		Orca	Itautec
Priam		Seiko Epson	Magnum
Quantum		Shinwa Digital	Memory Systems
Rodime		Sony	Otari
Seagate		TEAC	Qualitron
Tandon		Tokiko	Sagem
Toshiba		Xebec	Sequel
			Toyo Soda
			Tulin

TOTAL
Entry (42), No entry (13) for those that ever had substantial sales
versus
Entry (46), No entry (45) for those incumbents that never had substantial sales.