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THE ROLE OF FIRM RESOURCES AND ORGANIZATIONAL ATTRIBUTES IN DETERMINING ENTRY TIMING: A CROSS-INDUSTRY STUDY

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We investigate the factors that influence the timing of entry of firms into new industries based on new technology. Consistent with previous research, it is hypothesized that firm resources and organizational attributes influence entry timing. Unlike previous research, there is specific consideration of how industry setting—specifically, the extent to which it offers first mover advantages—influences the ability to predict timing of entry. The ability to explain entry timing differed across industries, with success occurring in the industry with strong first mover advantages. Two categories of resources, technological and marketing, were found to be associated with early entry. The organizational attributes that influenced early entry were commitment to a threatened market and (surprisingly) greater size. © 1998 John Wiley & Sons, Ltd.

INTRODUCTION

In a changing world, new industries based upon new technologies are constantly emerging. Firms that are considering entry into an emerging industry are faced with developing a multidimensional entry strategy. These dimensions include when to enter, how to enter (mode and scale of entry), and how to compete once the market has been entered (Day, 1986; Green and Ryans, 1990). Each of these dimensions plays a role in determining the entrant's eventual success.

This paper will focus on the first of those dimensions—the timing of a firm's entry into an emerging market. While the great majority of the research in this area has focused on the relationship between entry timing and subsequent firm performance, this paper will address a much less researched question: what factors determine when an existing firm enters a new market. In doing so, we build upon the few previous empirical studies of this topic by developing and testing a model that includes both industry and firm characteristics as determinants of entry timing.

BACKGROUND: PRIOR RESEARCH ON THE DETERMINANTS OF ENTRY TIMING

The question of why firms enter industries when they do has received relatively little attention in the literature. This is surprising because decisions about entry timing are clearly of great strategic interest. There have been a number of studies that have examined the relationship between entry timing and subsequent performance (Robinson and Fornell, 1985; Lambkin, 1988; Mascarenhas, 1992; Brown and Lattin, 1994; and Huff and Robinson, 1994). The growth of this research stream gives some indication of the extent to which researchers and managers feel that timing

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matters. However, to date, there have been only three published studies that have empirically investigated the factors that affect entry timing.

The most comprehensive theoretical and empirical statement on the determinants of entry timing came from Mitchell (1989). Mitchell proposed that specialized assets are the major determinants of whether and when industry incumbents would enter an emerging subfield of the industry. Specialized assets are assets that have an idiosyncratic value in the new product/market. Reasoning that only industry incumbents would possess specialized assets, Mitchell only tried to predict the entry time of incumbents into the new subfields.

Strong support was found for two of the hypotheses; increased rivalry and threatened core products led to earlier entry by incumbents. Only one of the three specialized asset proxies (possession of a direct sales force) was significantly related to entry timing.

Another empirical attempt at determining what factors influence entry timing came from Robinson, Fornell, and Sullivan (1992), who tested competing hypotheses on the subject. The authors found support for the 'comparative advantage hypothesis,' which stated that possession of particular resources and capabilities should lead a firm to select an entry timing strategy. Specifically, the authors found two factors were related to pioneering: strong finance skills and internal mode of entry. They also found that entrants with strong marketing skills and small parent corporations with significant brand name capital tended to be later entrants. Surprisingly, sizable investments in research and development were not found to influence entry timing.

Thomas (1996) published the only other empirical investigation of the determinants of entry timing. He focused his investigation on the effect of brand capital on entry order in the ready-to-eat cereal industry. Thomas found that firms with larger stocks of brand capital, operationalized as the total number of cereal brands sold by a firm, were more likely to enter a new market segment early with a new brand.

In reviewing these studies on entry timing one point clearly stands out: the effect of industry differences has been virtually ignored. Mitchell did control for one industry-level difference by including a measure of potential rivalry in each subfield in his model. However, he purposely chose a relatively homogeneous industry to control for other potential differences between submarkets. Thomas also restricted his analysis to an industry with homogeneous market segments that also had few, if any, outside entrants. Robinson *et al.* used the PIMS start-up data base, which includes companies from a variety of industries. No controls for industry differences were included in their analysis. Based upon these previous studies, we might be tempted to conclude that certain firm-specific factors influence entry timing, regardless of the market setting. However, as will be developed below, there is good reason to believe that there will be substantial variations across industries and that this, in turn, will influence the ability to predict entry timing.

THEORETICAL DEVELOPMENT

This study is limited to firms that were in existence prior to their entry into the emerging market, with start-up companies excluded. While entrepreneurial start-ups play a vital role in the development of many emerging industries, we are looking at factors that affect the timing of entry of *existing* firms into a new market. Our particular concern is with understanding how firm characteristics (specifically what will be termed firm resources and organizational attributes) influence decisions about entry timing. This is consistent with the growing stream of research that considers how firm resources affect strategic decisions (Wernerfelt, 1984; Barney, 1991; Chatterjee and Wernerfelt, 1991; Mahoney and Pandian, 1992; Montgomery and Hariharan, 1991; Robins and Wiersema, 1995).

Lieberman and Montgomery (1988) presented the most complete treatment of the incentives and disincentives associated with early market entry. They proposed that an environmental change creates an opportunity for first mover advantages to be obtained. Potential entrants will, of course, assess the technological and market uncertainty associated with a new market as they weigh the risks of early entry. If first mover advantages appear to be substantial, then there is an incentive to attempt to enter early. However, these first mover advantages can only be realized if the first mover possesses the capability (Lieberman and Montgomery term it 'proficiency') to capitalize

on this opportunity. Borrowing from Lieberman and Montgomery, we believe that both the industry setting, more specifically the opportunities to build a first mover advantage, and the resource position of the entrant will affect entry timing.

Furthermore, other characteristics of the firm, which shall be termed 'organizational attributes,' will also affect entry timing. These attributes do not correspond to particular capabilities or proficiencies. Rather, they affect entry timing by influencing the speed with which decisions are made in the firm or through the incentives that the firm might have to enter early.

Thus, there are two key properties of the model. First, it is expected that there are *intra*industry differences in the resources and attributes of early and later entrants. Put differently, firms that have made different resource allocation decisions in the past will differ in their resources and organizational attributes. Thus, it should be possible to model (as Mitchell did) the determinants of entry timing. Second, there are *inter*industry differences in the resources needed to be an early entrant or in the benefits accruing from early entry. Industries vary in the extent to which first mover advantages may be present and this bears upon the incentives for incumbent firms to try to enter the developing industries as early as they can. As will be developed later, we believe that the relationship between firm resources and attributes and subsequent entry timing will be strongest in industries with clear first mover advantages. When there are weak incentives to enter early, entry timing may not be closely tied to firm resources and attributes, and may reflect idiosyncratic factors not considered in this research.

The magnitude of particular resources needed to enter an industry (reflecting the barriers to entry) may also influence whether there are systematic relationships between firm resources and entry timing. For instance, if little in the way of R&D capabilities is needed to enter a new industry, then even firms with weak R&D would be able to enter early.

Firm resources and entry timing

Certain resources may make it possible for the firm to move forward quickly. Firms lacking these resources may not be able to beat competitors to the market, regardless of their desire to do so. Examples would be an R&D organization capable of developing the needed products or financial strength that supports an aggressive effort. Additionally, firm resources may affect entry decisions by increasing the potential reward associated with a particular timing strategy. If a firm has the resources that make it possible to capitalize upon early entry (for instance, by building switching costs through the use of computer-based ordering systems), then it will have a greater incentive to keep entry lag to a minimum.

Chatterjee and Wernerfelt (1991) placed firm resources into three categories: physical, intangible, and financial. This paper will examine the latter two categories. Intangible resources can take on many different forms—for this study we will concentrate on technological and marketing resources.[1]

Technological resources

Possibly the most straightforward argument concerning the relationship between any class of resources and entry timing can be made for technological resources. Technological resources refer to the commitment that a firm makes to research and development (Mahoney and Pandian, 1992). Clearly, a firm that makes a significant, consistent investment in R&D has the capability to create an innovation or be an early follower. Taking a slightly different perspective, Mansfield (1986) has shown that pioneers generally incur greater R&D costs than do their rivals. Therefore, greater technological resources should increase the probability of pioneering and, thus, reduce entry lag:

> *Hypothesis 1: A larger research and development intensity will lead to earlier entry.*

Marketing resources

The marketing resource that we will focus our attention on is the firm's investment in a direct sales force.[2] There appear to be two compelling

[1]This does not imply that physical resources can have no effect on entry timing. Factors related to physical resources such as manufacturing flexibility and excess production capacity could influence entry timing, but they could not be measured with available data.

[2]We intended to investigate the relationship between another marketing resource (brand name capital) and entry timing, but were unsuccessful due to limited data on firms' advertising expenditures.

reasons to expect that possession of a direct sales force should be related to earlier entry. First, a direct sales force can play a large role in user education, especially in the case of complex products and in markets where sales are made directly to users. Second, assuming that the new product/market is at least somewhat related to the firm's present ones, using an already established sales force to push a new product is one way to enhance the productivity of that resource. Empirical evidence from Mitchell (1989) indicated that incumbent firms that possessed a direct sales force, which he considered to be a specialized asset in the diagnostic imaging industry, did tend to be earlier entrants:

Hypothesis 2: Possession of a direct sales force will lead to earlier entry.

Financial resources

The amount and availability of financial resources may influence a firm's likelihood of pioneering. However, there are contrasting arguments as to whether greater financial resources will make an existing firm more or less likely to be an early entrant. On one hand, troubled, poorly performing firms (which should possess fewer financial resources) should be more likely to be risk seekers in attempts to improve their position. Bowman (1982) and Fiegenbaum and Thomas (1986) both support the view that weaker firms tend to be risk seekers. This line of reasoning, based on prospect theory (Kahneman and Tversky, 1979), would lead one to expect that firms with fewer financial resources should enter a new market quickly.

In contrast, Bourgeois (1981) and Moses (1992) both relate the presence of slack financial resources to a firm's willingness to experiment with new products. These slack resources provide a buffer that keeps a failed new product entry from endangering the firm's survival. Additionally, Mansfield (1986) and Knight (1967) have both demonstrated that high costs accompany the development of innovations. In turn, early followers generally must outspend later entrants on R&D to keep abreast of recent developments so that they can be ready to enter the market quickly after the pioneer. Thus, it is likely that only financially secure firms will be able to afford the costs of early entry.

We only expect internal financial resources (available cash and unused debt capacity) to influence timing of entry. A number of studies have argued that external funds (new equity and high risk debt) are typically not used for developing/launching a pioneering product (Robinson *et al.*, 1992; Himmelberg and Peterson, 1994):

Hypothesis 3: Greater internal financial resources (larger current ratio and smaller debt/equity) will lead to earlier entry.

Organizational attributes and entry timing

Organizational attributes differ from firm resources. Firm resources form the building blocks of firm capabilities (Teece, Pisano, and Shuen, 1997), which are the basis for a firm's ability to compete against rivals. In contrast, organizational attributes (such as presence in a threatened market, size, or diversity) may be common to many firms and are not considered to be inherently advantageous. Rather, they are attributes that seem likely to influence the speed with which decisions are made and implemented or the incentive to incur the risks of early entry. As with firm resources, their importance may vary with industry setting.

Commitment to threatened market

The threat that a new product presents to a firm's current businesses should affect how long it waits before entering the new market. If a major portion of its business base is threatened by an emerging market, the firm may hesitate to cannibalize existing sales through aggressive commitments to the emerging market. On the other hand, it has a major incentive to protect its revenues and to safeguard its existing customer relationships. Additionally, firms with experience in a related business may have an easier time becoming early entrants since they already possess many of the necessary skills and capabilities needed to compete in the related field (Brittain and Freeman, 1980; Cooper and Smith, 1992). This provides a related firm the opportunity to enter the new business without engaging in the time-consuming process of developing complementary resources. Empirically, Mitchell (1989) and Cooper and Smith (1992) found that firms threatened by new

products entered these areas more quickly than other firms. This suggests that concerns about cannibalization should, on the average, be outweighed by desires to protect revenues and to take advantage of the complementary assets already in place which facilitate early entry into the related market:

Hypothesis 4: Firms that have greater commitments to threatened markets will be earlier entrants.

Size

There are differing opinions as to the effect that organization size has on timing. (In this study, an organization's size refers to number of employees; this measure seems particularly relevant when considering influences upon the speed of decision making.) The phenomenon of structural inertia leads one to expect that increased size should delay entry. The causes of the resistance associated with structural inertia (increased bureaucracy, political infighting, etc.) will detract from a large firm's ability to pioneer a new market.

By contrast, Schumpeter (1950) argued that larger firms should be more innovative. First, larger firms should have capability advantages in areas like R&D management and product development. Second, larger firms can more readily appropriate the gains associated with innovations due to superior capabilities in production and marketing. While the so-called 'Schumpterian' hypothesis spawned an impressive number of empirical and analytical tests, the results of these studies are inconclusive. Because the focus of our research is on timing of entry (vs. innovativeness in general) the inertia argument that bureaucracy will slow down entry seems more relevant and compelling.

Hypothesis 5: Larger firms will be later entrants.

Firm diversity

No prior research exists on the specific relationship between initial firm diversity and entry timing in new industries. However, in a somewhat related study, Hitt, Hoskisson, and Ireland (1990) considered the relationship between acquisitions and managerial commitment to innovation. They theorized that acquisitive growth serves as a substitute for growth through innovation. They posit that acquisitions use up managers' time and energy and can alter their risk orientation. Similarly, Hitt *et al*. (1991) did find that acquisitions negatively affected patent intensity. Therefore, we expect that less diversified firms will be more likely to identify and pursue opportunities for entry into newly emerging industries:

Hypothesis 6: Increased firm diversity will lead to later entry.

Why should industry matter?

The concept of first mover advantages and disadvantages provides a rationale for why we expect profiles of early and later-entering firms to vary across industries. Lieberman and Montgomery (1988) argue that first mover advantages arise from three sources: technological leadership (experience curve; patents and inimitable technology), the preemption of scarce assets, and switching costs. First mover disadvantages include the potential of followers to 'free-ride' on the investments of pioneers, uncertainty surrounding the choice of the eventual 'dominant design' (Teece, 1986) of the end product, and potential shifts in technology or consumer needs after the first mover has made its commitments. A key point is that industries differ in the degree to which any of the different forms of first mover advantages or disadvantages apply. Lieberman and Montgomery (1988) also note that first mover advantages are partially the result of firm proficiencies. Not all firms possess the skills required to build specific first mover advantages. Firms possessing the skills needed to build first mover advantages in a particular market have a greater incentive to enter that market earlier. Thus, in some industries possession of strong technological resources may drive the decision to enter early; in other industries, possession of a direct sales force may be most important. Thus, we expect some differences across industries in the models that predict entry timing.

How should the presence or absence of first mover advantages bear upon the entry timing decisions of firms? When first mover advantages are strong, there should be major incentives for firms to move quickly to enter developing mar-

kets. If these advantages are widely recognized, then all firms might be expected to move to enter the new market as quickly as their resource positions and organizational attributes make it possible for them to do so. In such settings, it should be possible to model entry timing with confidence. Firms which are well positioned to enter markets early would do so, and those which are less well endowed would lag behind. It should be noted that most of the empirical research to date has been conducted in industries where first mover advantages appear to be strong.

What will determine entry timing in industry settings in which first mover advantages are not strong? Under such conditions, there is less incentive for firms, whether strongly endowed or not, to confront the risks of early entry. Early entrants may have been unusually proficient in the specific technology, or 'lucky' in their R&D efforts so that they are ahead of rivals (Lieberman and Montgomery, 1988). There may also be firms with 'champions' for the new technology who were more effective in securing organizational commitment to these projects than their counterparts in other organizations (Burgelman, 1983). These factors, none of which are in our model, may lead to an idiosyncratic pattern of entry, such that prior firm resource positions or organizational attributes bear no systematic relationship to timing of entry:

> *Hypothesis 7: Firms with large R&D intensities, that possess a direct sales force, and that have greater internal financial resources will be earlier entrants in industries with significant opportunities to build first mover advantages. In industries lacking first mover advantages there will be no systematic relationship between entry timing and resource position.*

The influence of organizational attributes upon entry timing may also vary by industry setting. A strong commitment to a threatened market may tend to lead to early entry, but this tendency may be lessened if the needed resources (often already possessed by the threatened firm) can be easily acquired by others or if first mover advantages are perceived to be small. Organizational size may slow decision making, but, in some industry settings, the scale of resources needed to enter may prevent or delay the entry of smaller firms so that larger firms may be among the first to be able to enter. Firm diversity may often be associated with lower R&D intensity and thus delayed entry; however, firms which have diversified from a common technological core may have R&D capabilities permitting early entry into a closely related new industry. We present no hypotheses relating to how the interaction between these attributes and industry setting would bear upon entry timing. However, we do acknowledge that their importance may vary by industry setting.

METHODOLOGY

Empirical setting

The empirical setting for this study is composed of two segments of the broadly defined computer industry: the minicomputer industry and the personal computer industry. These industries seem particularly attractive for a study of the determinants of entry timing for several reasons. The first is data availability. Both industries were founded and developed recently enough that the required data are still available. Secondly, both industries are mature enough that entry over a significant portion of their life cycles could be tracked. In addition, these industries offer the further attraction that they seem to differ in the extent to which they offer first mover advantages. Opportunities for building first mover advantages were much greater in the minicomputer industry than they were in the personal computer industry. This permits us to test the seventh hypothesis that considers how interindustry differences in first mover advantages influence the ability to predict entry timing.

We can demonstrate that the magnitude of first mover advantages differed across these industries in three ways.[3] First, considerable anecdotal evidence exists showing that the opportunities for

[3]It can be argued that managers may have difficulty forecasting the extent to which first mover advantages will develop in an emerging market. Although this is difficult to assess *ex post*, we would suggest that these factors were perceived by managers as they contemplated entry into these developing markets. As Abell (1978) suggests, assessing future market conditions is one of management's most important tasks when planning market entry. Furthermore, for firms that were not among the initial entrants, their managers did have some opportunity to observe the developing market's initial competitive conditions.

building pioneering advantages were much greater in minicomputers than they were in PCs. Nowhere is that more evident than in the area of switching costs. Customers had to invest a great deal of time in training their employees how to use a particular manufacturer's minicomputer and spend considerable resources on developing software tailored to that machine. Thus, it was highly unlikely that customers would be willing to change brands when it became time to upgrade, due to incompatibility between minicomputers manufactured by different firms:

> Like the mainframe companies that proceeded them, each minicomputer manufacturer developed its own custom processors and software. There was no compatibility with what other manufacturers were doing. When customers bought a mini they were hooked for life unless they were willing to undergo a painful and costly transition. (McClellan, 1984: 166)

> mainframe and minicomputers were initially only able to run software developed for a specific machine family . . . The advantage to the computer manufacturers was that the high switching costs incurred by a user for changing to a competitor's system effectively locked their users into the supplier's future products. (Steffens, 1994: 117)

The situation in PCs stands in contrast to the emergence of the minicomputer market. Switching costs, which were so dominant in mainframes and minicomputers, were much lower. This is evidenced by a higher degree of compatibility that developed between PCs. The investment that a user (or group of users) made in learning to use a microcomputer was usually not seriously diminished when moving to a competitor's machine:

> whereas mainframe and minicomputers had a fairly long period of incompatibility between systems at both the hardware and software levels, personal computers started from an entirely different position that was known as horizontal software compatibility . . . The impact of this situation is significant, yet paradoxical, since in one respect it reduces the industry barriers to entry for a manufacturer, by removing the costs of software development. On the other hand, it also removes a source of product differentiation. This is due to the fact that if one manufacturer's product runs CP/M [an early operating system] and a particularly popular applications program, then that same program should also run on another CP/M based machine, thus effectively reducing the switching costs to the customer.[4] (Steffens, 1994: 118–119)

While the most obvious example of how competition differed between the evolving PC and minicomputer markets is associated with switching costs, differences in other first mover effects exist as well. One is the influence of patents and tacit knowledge on the ability of followers to enter the market. In the PC industry, it was much more common for entrants to act as assemblers of outside vendors' parts. Most PC makers bought the 'guts' of their machines, the microprocessor, from other firms. This reliance on outside vendors made it easier for followers to copy pioneers' machines. Additionally, PC makers published specifications to their machines to facilitate software development by independent firms. Once again, this made the imitator's job much easier (Asbrand and Bozeman, 1992). Both of these examples illustrate an attitude toward product secrecy that made entry timing less important in PCs.

Preemption of market position was another form of first mover advantage that appeared to be more important in the minicomputer industry. By contrast, PCs could be used in the home, classroom, and at work. Only the last was feasible for the minicomputer. These market niches represented additional gateways for PC makers to use when entering this industry. Further discussion on the magnitude of first mover advantages and other characteristics of industry structure in these two industries can be found in Adams (1982), McKenna (1989), and Grove (1990).

The second method of demonstrating that first mover advantages were more significant in the minicomputer industry is through the use of a survey of industry experts. This can provide an independent verification of the anecdotal evidence cited above. These experts were asked to evaluate the importance of various first mover advantages and disadvantages to the competitive development

[4]This does not imply that flexibility between using different manufacturers' machines was limitless. For instance, the actual software or data diskette could not be transported between different machines. Instead, the applications software was developed to run on different machines. This meant that time spent learning popular applications programs was not necessarily wasted if the user changed brands. One must also remember that there were a few competing operating systems, which also limited flexibility. However, this in no way compared to the incompatibility that existed between different brands of minicomputers.

of each segment. A summary of the results of this survey is presented in Appendix 1.

The experts confirmed the anecdotal evidence. The minicomputer segment provided early entrants a much greater opportunity to build switching costs (a first mover advantage), while early entrants in the PC industry faced higher technological uncertainty (a first mover disadvantage). Additionally, the experts reported that overall first mover advantages were significantly higher in the minicomputer segment ($p < 0.004$). In fact, in the minicomputer industry, six of the seven variables considered to be possible first mover advantages were rated to be at least moderately influential (4.0 on a 7-point scale) and the seventh approached 4. For the PC industry, only two of the seven variables were considered to be moderately influential.[5] (See Appendix 1 for additional details.)

To provide a final confirmation of the difference in first mover advantage across these industries, data were gathered on the relationship between timing of entry and subsequent market share. This provides a measure of whether early entrants, in fact, enjoyed superior performance. The correlations between entry timing and subsequent market share indicated advantages for early entrants in the minicomputer industry, but not for the PC industry.[6] These correlations, the expert ratings, and the anecdotal evidence all provide assurance that the industries are sufficiently different to allow for the seventh hypothesis to be tested. This test will be performed by estimating the model in each industry. Substantially different results across industries would provide support for Hypothesis 7.

Sample

As was stated in the above section, the sample for this study comes from the minicomputer and PC industries. Only domestic firms that were publicly held at the time of entry are included in our sample. This purposely excludes three categories of firms: foreign firms, privately held firms, and start-ups. The first two categories are excluded because the data required for our analysis were not available. Start-up firms necessarily lie outside of the scope of our model—we are attempting to explain factors that effect the timing of an *existing* firm's entry into a different market. These criteria limited our sample to 108 entrants: 58 in the minicomputer segment and 50 in the PC segment. Obviously, hundreds of firms entered each industry, but only 108 were publicly held, domestic firms at the time they entered these industries.[7,8] This focus upon the more visible firms means that we are excluding those which were very short lived or had negligible impact within these industries.

Various sources were utilized in identifying the entrants to each industry. For years prior to 1984, the *EDP Industry Report*, published by the International Data Corporation, provided an annual listing of all computer manufacturers by industry as well as the date that each firm installed/sold its first system. The *EDP Industry Report* was considered to be the most comprehensive source of market information on the computer industry and data from it has been used in several academic studies of the computer industry (Romanelli, 1989; Phister, 1979). This report discontinued its comprehensive annual listing of

[5]For established firms entering a new field, brand name recognition may not depend on time of entry if the established firm leverages an existing brand name. For such firms, it may not function as a 'first mover advantage' as it would for firms seeking to establish customer recognition of new brand names for the first time. Thus, firms such as IBM, Hewlett-Packard, or Texas Instruments already had brand recognition, based upon their visibility in previous fields. Brand name recognition, while important, may not depend very much upon when *established* firms enter a new market. Furthermore, for firms which intend to leverage their established brand names, there may be an incentive to delay entry until risk has declined (Robinson *et al*., 1992: 612). We thank Bill Robinson for this insight.

[6]We collected market share data for entrants 1 (MS1) and 3 years (MS3) after they entered each industry. In the minicomputer market, the correlation between entry timing and MS1 was –0.213 ($n = 103$; $p < 0.03$); between entry timing and MS3 it was –0.338 ($n = 87$; $p < 0.001$). In the PC industry, the correlation between entry timing and MS1 was 0.051 ($n = 73$; $p < 0.66$); between entry timing and MS3 it was 0.050 ($n = 30$; $p < 0.789$). Basically, what these correlations show is that late entrants into the minicomputer industry were penalized with reduced market shares. In the PC industry, no such penalty existed. Finally, please be aware that the sample used to determine these correlations does not exactly correspond to the sample used in this study. There are two reasons for this. First, some of the firms for which we have market share data lie outside the scope of this study (start-ups, privately held, etc.). Second, we do not have market share data for every entrant into the PC segment 3 years after entry.

[7]Twenty-five additional entrants met our criteria but had to be excluded from our analysis because of missing data.

[8]A comparison of the publicly held firms in our sample and those firms excluded from our sample (start-ups, etc.) does not show any substantial difference between these groups in terms of timing of entry.

computer manufacturers after 1983. From 1984 on, we used the *Wall Street Journal Index*, other trade publications like *Datamation*, annual reports, and telephone interviews to identify firms that entered each industry after 1983 (as well as their time of entry).

Operationalization of variables

Data required to measure firm resources and organizational attributes were gathered from the COMPUSTAT data base and firm annual reports and 10-Ks. A thorough reading of the history of these industries and conversations with industry experts helped us to identify the PDP-5, first installed by Digital Equipment Co. in September 1963, as the first minicomputer, and Apple Computer as the first maker of the PC, selling its first machine in May 1977.[9,10] The dependent variable in the model, *entry timing*, was operationalized in two ways. The first method was to use the number of months between the sale/installation of the first minicomputer (or PC) and the month that the firm in question sold/installed its first minicomputer (or PC). Measuring entry timing in months has the advantage of more likely reflecting strategic decisions about the time period when a firm sought to enter the industry.

The second operationalizaton was order of entry. This reflects the number of competitors that had already entered the industry when the firm entered the market. It also has the practical advantage of reducing the disparity in the mean and variance of the dependent variable across the two industries.[11]

For the most part, both firm resources and organizational attributes are fairly straightforward to operationalize. These operationalizations are shown in Table 1.

Table 1. Description of independent variables

Label	Variable name	Operationalization
TIMING	Entry timing	Number of months since first entry
ORDER	Entry timing	Rank order of entry
RDI	R&D intensity	R&D expenditures/sales
DSF	Direct sales force	Indicator variable (1—firm possesses a direct sales force; 0—firm does not)
CR	Current ratio	Current assets/current liabilities
DE	Debt-to-equity	Long-term debt/owners' equity
THREAT	Commitment to threatened market	Percent of firm sales attributable to a threatened industry
SIZE	Firm size	Log (no. of employees)
DIV	Firm diversity	Weighted index (Caves *et al.*, 1980)

Note: The formula for the weighted index is:

$$\mathrm{DW} = \sum_{i=1}^{n} p_i d_i$$

where

p_i = proportion of the firm's sales in industry i (industry = 3-digit SIC code);

d_i = 'distance' between industry i and the base;
- = 0 if the industries are within the same 3-digit code;
- = 1 if the industries within the same 2-digit code but different 3-digit codes;
- = 2 if the industries are in different 2-digit codes.

A value close to two for DW signifies a highly diversified firm with many unrelated businesses. A value close to zero signals the opposite. One minor alteration of this measure must be presented. The 4-digit SIC code corresponding to the computer industry is classified as heavy machinery rather than electronic equipment, which is more appropriate. Therefore, we will treat the code for computers and office equipment as if it were included in 367X (electronic components and accessories).

RESULTS

Correlation matrices for all variables for both industries are presented in Table 2. Although several of the measures for organizational attributes appear to be highly correlated, additional diagnostic tests provided little evidence that multicollinearity presented a problem.

The hypotheses were tested using multiple regression analysis.[12] Separate regression models

[9]Some computer industry authors argue that MITS Computer Co. sold the first PC in 1975. However, MITS, and several other firms, actually sold kits and not complete, assembled systems.

[10]While DEC and Apple can be considered to be the founders of these two industries, neither firm is included in our sample. In both cases, these firms were not publicly traded when they introduced these revolutionary products.

[11]Given that the minicomputer industry has been in existence much longer than the PC industry, this disparity is unavoidable.

[12]On the surface, it may appear that accelerated event–time analysis may be the preferred method to test these hypotheses (Mitchell, 1989; Morita, Lee, and Mowday, 1993). However, this technique is appropriate when a phenomenon known as

Table 2(a). Sample statistics and correlations for the minicomputer industry

Variable	Mean	SD	ORDER	TIMING	RDI	DSF	CR	DE	THREAT	ln (SIZE)	DIV
ORDER	29.34	16.84	1.0								
TIMING	124.4	60.23	0.99*	1.0							
RDI	0.056	0.04	–0.26*	–0.28*	1.0						
DSF	0.78	0.42	–0.38*	–0.37*	–0.21	1.0					
CR	2.14	0.83	–0.06	–0.22*	0.10	0.25*	1.0				
DE	0.58	0.71	0.09	0.08	–0.01	0.09	–0.11	1.0			
THREAT	0.30	0.43	–0.17	–0.16	0.30*	–0.16	–0.20	–0.17	1.0		
ln (SIZE)	7.92	2.73	–0.35*	–0.26*	–0.26*	0.54*	0.13	0.04	–0.38*	1.0	1.0
DIV	0.36	0.43	–0.12	–0.15	–0.32*	0.21	0.21	–0.05	–0.43*	0.54*	1.0

*$p < 0.05$

Table 2(b). Sample statistics and correlations for the personal computer industry

Variable	Mean	SD	ORDER	TIMING	RDI	DSF	CR	DE	THREAT	ln (SIZE)	DIV
ORDER	25.18	14.52	1.0								
TIMING	51.2	25.57	0.96*	1.0							
RDI	0.070	0.06	0.27*	0.22	1.0						
DSF	0.71	0.46	0.09	0.04	–0.14	1.0					
CR	2.34	1.01	0.28*	0.31*	0.07	0.14	1.0				
DE	0.01	2.26	0.01	–0.09	–0.02	0.24	0.03	1.0			
THREAT	0.43	0.44	0.10	0.15	0.18	0.13	0.31*	0.11	1.0		
ln (SIZE)	7.89	2.60	–0.02	–0.06	–0.32*	0.33*	–0.15	0.12	–0.24*	1.0	
DIV	0.31	0.39	–0.21	–0.29*	–0.30*	0.35*	–0.23*	0.13	–0.34*	0.41*	1.0

*$p < 0.05$

were estimated for each industry. The models estimated were of the form:[13]

$$\text{TIMING} = \beta_o + \beta_1\text{RDI} + \beta_2\text{DSF} + \beta_3\text{CR} + \beta_4\text{DE} + \beta_5\text{THREAT} + \beta_6\text{SIZE} + \beta_7\text{DIV} + \epsilon$$

Remember that the operationalization for TIMING is the number of months between the entry of the firm being observed and the first firm that entered the emerging industry. Therefore, since the second hypothesis predicts that increased technological resources should reduce TIMING, we expect that β_1 will be negative. Similarly, β_2, β_3, and β_5 are expected to be negative while β_4, β_6 and β_7 are predicted to be positive. The results of the regression analysis are shown in Table 3.[14]

As one can see from Table 3, the regression models vary greatly across the two industries.

'right censoring' occurs. In the context of entry timing, this would occur when a sample consists of a fixed set of firms, only some of which would enter the new industry during the time of the study. In Mitchell's study, his sample consisted of all medical diagnostic imaging firms; he was interested in testing whether each of these firms would enter a new subfield of this industry and, if so, when. Some of these firms would not choose to enter the new subfield during the observed time period, thus, they were 'right censored.' In our study, the sample was open to all publicly traded firms, regardless of industry, which entered these two industries during the time of the study. The focus was not upon a particular initial population of firms. Therefore, the use of event–time analysis, with its consideration of an initial population, was not appropriate.

[13]During the course of the analysis, a dummy variable representing mode of entry was included (direct entry vs. acquisition, joint venture, etc.) in the model as a control variable. It was found to have no effect on the results.

[14]No evidence of heteroscedasticity was found in any of the models. An examination of studentized residuals and Cook's *D* revealed several outliers. In four cases, the outliers had extremely high research and development intensities; one firm had a research and development intensity of 2590 percent! Further investigation disclosed that these outliers were typically start-up firms that went public prior to their initial shipment. Therefore, they had virtually no sales, which caused some of the values for the independent variables to have little meaning. These outliers were dropped from the sample.

Table 3(a). Regression models for the minicomputer and PC industries (dependent variable: timing of entry)

	Predicted sign	Minicomputer industry		PC industry	
		b	*t*-value	*b*	*t*-value
Intercept	N/A	237.52	7.94***	18.41	1.03
R&D intensity	–	–408.26	–2.85***	94.42	1.44
Direct sales force	–	–47.85	–2.56***	8.03	0.90
Current ratio	–	6.63	0.71	7.18	1.96*
Debt/equity	–	4.52	0.50	5.38	0.69
Commit. to threat. market	–	–35.53	–2.04**	–2.46	–0.27
ln (Firm size)	+	–6.61	–1.98**	0.92	0.59
Firm diversity	+	–18.55	–0.98	–10.49	–0.92
F-value		4.65***		1.42	
Sample size		58		50	
R^2		0.40		0.19	
Adjusted R^2		0.31		0.06	

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$

Table 3(b). Regression models for the minicomputer and PC industries (dependent variable: order of entry)

	Predicted sign	Minicomputer industry		PC industry	
		b	*t*-value	*b*	*t*-value
Intercept	N/A	61.55	7.00***	6.57	0.64
R&D intensity	–	–130.54	–3.11**	67.29	1.79*
Direct sales force	–	–13.50	–2.47***	3.92	0.76
Current ratio	–	2.16	0.81	3.29	1.57
Debt/equity	–	2.22	0.84	1.38	0.31
Commit. to threat. market	–	–10.08	–1.98**	–1.58	–0.30
ln (Firm size)	+	–1.97	–2.03**	0.71	0.80
Firm diversity	+	–5.38	–0.98	–6.97	–1.06
F-value		4.79***		1.35	
Sample size		58		50	
R^2		0.40		0.18	
Adjusted R^2		0.32		0.05	

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$

The model estimated using data from the minicomputer segment is highly significant, while the model estimated using data from the PC segment is not. This provides support for Hypothesis 7. However, this hypothesis can be more formally evaluated through the use of a Chow test (Chow, 1960). Basically, the Chow test checks whether the coefficients from the two regression models are equal. In this case, the Chow test reveals that the coefficients from the minicomputer and PC samples are different at the 0.01 level. Therefore, Hypothesis 7 is accepted.

Within the minicomputer industry, several of the other hypotheses are supported. The coefficients associated with RDI, DSF, and THREAT are all negative and significantly related to TIMING. This is in accordance with Hypotheses 1, 2 and 4. Firms that possess greater technological

resources, have developed their own direct sales force, and are threatened by the emergence of a new market are more likely to enter that market earlier than other firms. Financial resources and diversity appear not to be related to entry timing. Contrary to expectations, increased firm size is related to earlier entry.[15] Therefore, Hypotheses 3, 5 and 6 are rejected.

Clearly, the model does not explain the determinants of entry timing in the PC industry. The overall model is not significant and, based on its adjusted R^2, it explains only 6 percent of the variance of the dependent variable. Only one variable, CR, is significant and its sign is opposite to what was hypothesized. One of the variables considered, possession of a direct sales force, may have been relatively less important in the young PC industry. While direct sales forces were used by many entrants that sold to the corporate segment, other methods of distribution (retail stores, direct mail) were utilized by entrants that targeted other segments of the market (Steffens, 1994). Thus, the lack of a direct sales force would not necessarily put a new entrant at a disadvantage when entering this industry.

When the dependent variable is changed to order of entry (Table 3b), the results remain basically unchanged. The only change in either of the industries comes in the PC segment. The coefficient associated with R&D intensity becomes moderately significant ($p < 0.10$, but with the opposite sign) while the current ratio's coefficient loses its significance. Thus, the results are reasonably consistent regardless of which dependent variable is used. This reduces the possibility that the wide difference in results across industries is simply driven by the inter-industry difference in the dependent variable when *timing* is used.

DISCUSSION AND CONCLUSIONS

By far the most striking result of the data analysis is the enormous difference in the ability of the model to explain the determinants of entry timing across the two industries. In considering the substantial literature on the determinants of entry timing and the relationship between entry timing and performance, the findings reported here suggest that we should be cautious about generalizing across industries. Industries vary in the nature and magnitude of the advantages available to first movers. Thus, it should not be surprising that our ability to predict entry timing based upon firm resources and organizational attributes varies across industries. Differences in the development patterns of the industries considered here illustrate the extent to which managers will be making entry decisions under very different circumstances. This difference was not addressed in the earlier studies of the determinants of entry timing and this finding extends this earlier work.

The minicomputer industry developed much more gradually than the PC industry did. During the first 6 years that minicomputers were sold, only 13 domestic, publicly held firms entered the market. Contrast that with nearly three times as many domestic, publicly held entrants (35) into the PC industry over the same amount of time. Additionally, while a number of foreign firms and start-ups made and sold minicomputers, this number was dwarfed by the hordes of firms (both new and established) that entered the PC industry. This difference can be attributed, in part, to significantly higher entry barriers that protected the minicomputer industry relative to the PC industry.[16] For the developing PC industry, technological uncertainty was high, creating significant disincentives to try to rush to market. In addition, switching costs were perceived to be moderate, suggesting that late entrants would not be at a great disadvantage on this dimension. Thus, the relative ease of entry into this industry, the greater uncertainty associated with its early development, and the apparent lack of sustainable advantages for early entrants contributed to a more haphazard, and therefore less predictable, pattern of industry entry.

Within the minicomputer segment, the model worked relatively well. Four of the six variables were significantly related to entry timing, although the coefficient associated with firm size was not in the expected direction. It is interesting

[15]Lambkin and Day (1989) reported that the relationship between entry timing and firm size may have an inverted-U shape (early and late entrants being relatively small). We altered our model to include a $(SIZE)^2$ term; it proved to be very small and insignificant in both samples.

[16]This is to be expected, given that first mover advantages were much greater in this industry. In many ways, first mover advantages can be thought of as entry barriers.

to assess the magnitude of some of these results. For instance, a 1 percent increase in a firm's research and development intensity is only associated with a 4–5-month shorter entry lag. Possession of a direct sales force is much more significant, cutting entry timing by nearly 4 years. Similarly, a firm whose existing sales are completely threatened by the development of the emerging market is likely to enter that market 3 years earlier than a firm that is experiencing no threat.

In the case of firm size, it appears that the capability and appropriability advantages of large firms tend to outweigh bureaucratic effects and, therefore, facilitate earlier entry. Measures of financial resources were not related to entry timing in the minicomputer industry.[17] One explanation for this could be that entry into a new field is costly regardless of when it is attempted. Therefore, only financially stable firms can afford entry, and one should not expect much difference between early and late entrants on this dimension. Interestingly enough, two of the variables that led to earlier entry in this market (technological resources, a direct sales force) do not correspond to factors that Robinson *et al*. (1992) found were associated with earlier entry in their PIMS study (finance skills and internal mode of entry).

In the PC market, pioneers appeared to have some advantages, particularly in regard to the learning curve and brand name recognition. (However, these were not significantly greater than in the minicomputer industry.) Despite this, the incentives to enter the PC industry early were not great enough to cause firms with strong firm resources and favorable organizational attributes to move as quickly as they could. The high level of technological uncertainty, the moderate level of switching costs, and the relatively low levels of other potential first mover advantages removed the incentive for firms to enter this industry quickly. Even 'commitment to threatened market,' which might be expected to be an incentive under all conditions, was not systematically related to entry timing. It may be that, when first mover advantages are weaker, a threat to an existing line of business provides less incentive to enter the new market early. Thus, there were no strong incentives for resource-rich firms to enter early, when risks were high. However, the relatively low barriers to entry permitted many companies, including start-ups and established firms lacking strong resource positions, to enter. As noted earlier, under these circumstances, such idiosyncratic factors as the presence of 'champions' for the new technology may influence timing.

The 'comparative advantage' hypothesis confirmed by Robinson *et al*. (1992) implied that entry timing might be related to the particular resources possessed by individual firms. Our results provide qualified support for this view, in that we find certain resources lead to early entry in markets where first mover advantages are significant. (Robinson *et al.* did not expect or test whether industry effects would moderate this relationship.) However, this study does not cast much light on whether later entrants have different strengths than earlier entrants, primarily because data were gathered only on resources thought to be associated with early entry.

Most of the work to date on timing of entry, both theoretical and empirical, has dealt with industry settings in which first mover advantages and barriers to entry are relatively high. These were the conditions which prevailed in the minicomputer industry, where systematic relationships between firm resources and entry timing were found. As noted earlier, when first mover advantages are low, there is less incentive to incur the risks of early entry. When barriers to entry are low, many firms may be able to enter and, furthermore, may be able to do so with limited resources at risk. In such settings, entry timing may be difficult to predict. Clearly, these results underscore the importance of caution in assuming that previous studies that relate firm resources to entry timing are universally applicable.

There are several limitations to this research. One was touched on above—restricting our sample to publicly held, domestic firms that existed prior to their entry into the new industry left out many entrants and restricted our sample size. This is somewhat troublesome in these industries, given that so many of the entrants into these industries were privately held or start-ups. Rep-

[17]Entry timing may be related to the absolute level of financial resources rather than the relative level, as reflected by the current ratio and debt/equity ratio. If so, this would be a reason why larger firms were earlier entrants into the minicomputer industry. However, we reanalyzed the data, entering net current assets and owners' equity one at a time (after removing firm size, which was very highly correlated with both). Neither variable approached significance in either industry, indicating that the absolute level of financial resources was not systematically related to entry timing.

licating this study in a different setting may alleviate these problems, although the difficulty associated with collecting data on this phenomenon raises problems in itself.

Another limitation has to do with the measurement of firm resources. Resource-based theory has been and continues to be a very useful paradigm for understanding many strategic issues such as the sustainability of competitive advantage and others. However, it has been of lesser value in empirical studies. Simply put, strategy researchers need better measures of firm resources. Reports from financial statements of resource allocations may be too coarse to adequately examine differences across firms. While some promising advances have been made on the measurement of some resources (Henderson and Cockburn, 1994), more work needs to be done in this area.

The final limitation relates particularly to the role of IBM in the PC industry. It is clear that IBM's entry into the industry had an enormous impact, both in regard to setting industry standards and in establishing the credibility of the product with many potential users. The delayed entry of this giant firm may have affected the PC industry in ways that would not show up in other industries.[18]

A new look at the relationship between performance and entry timing is an obvious extension of this work. Previous studies of entry timing and performance have not been tested to see if this relationship is consistent across firms and across industries. This study has shown that differences exist across industries in terms of the advantages and incentives that accrue to early entrants. Therefore, it may be inappropriate to assume that the timing–performance relationship is consistent across industries.

The organizational attributes considered here are relatively broad. Further research might also examine how organizational structure, the nature of performance measurement and reward systems, and the backgrounds of key executives bear upon decisions about entry timing.

[18]The data were reanalyzed with IBM omitted and the results were unchanged. The PC market was also reanalyzed restricting the sample solely to firms that entered after IBM. Once again, this did not result in any significant findings.

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APPENDIX 1

To adequately test Hypothesis 7, we needed to empirically verify that the two industries differed with respect to first mover advantages. To do so, we mailed a questionnaire to 21 expert consultants that were very familiar with the different industries of the computer industry. (These consultants were identified using *The Computer Industry Almanac* (Juliussen and Juliussen, 1991) and were contacted prior to being sent the survey.) These experts were asked to assess the extent to which each of the following first mover advantages affected the development of each industry:

- learning curve advantage
- patents
- brand name recognition
- preemption of key inputs
- preemption of market position
- switching costs
- technological certainty (respondents were actually asked to assess the degree of technological uncertainty, a first mover disadvantage; their responses were reverse coded to obtain the score for technological certainty)

These advantages were taken from Lieberman and Montgomery (1988) and described for the respondents. Each respondent assessed each advantage on a 7-point scale (1—not influential; 7—very influential).

Nine of the 21 experts responded to the survey; this constitutes a response rate of 43 percent.

Table A1. Summary information for questionnaire responses

Survey item	Mini	PC	Reliability
Learning curve	4.00	6.00	0.709
Patent	4.38	3.00	0.846
Brand name recognition	5.50	6.12	0.792
Preemption of inputs	4.50	3.12	0.765
Preemption of market position	4.50	2.50	0.975
Switching costs**	6.38	3.88	0.930
Technological certainty*	3.87	1.62	0.677
Total first mover advantages**	33.13	26.24	0.703

*$p < 0.08$; **$p < 0.004$

Table A1 lists the average scores for each industry for each item and the associated reliabilities.

Because of the small number of observations, parametric tests for differences between the sample means would be inappropriate. Instead, a nonparametric approach, the Wilcoxon signed-rank test, was used to assess whether significant differences existed between the two industries. The PC industry was found to be more technologically uncertain ($p < 0.08$), while the minicomputer industry was found to have higher switching costs and total first mover advantages ($p < 0.004$). None of the other dimensions were found to be significantly different. Additional details on the survey, the reliability analysis, and the nonparametric tests can be obtained from the first author.

APPENDIX 2

Table A2. List of firms in sample

Minicomputer	Months after intial entry	Personal computer	Months after initial entry
Xerox	19	Compucorp	1
Sperry	27	Zilog/Exxon	1
Honeywell	29	Commodore	5
Control Data	45	Computer Data	6
Beckman Instruments	47	Perkin Elmer	13
Hewlett Packard	50	Billings Computer	22
Collins Radio	52	IMS International	25
Data Technology	60	NCR	25
Microdata	64	Zenith	29
Data General	65	APF Electronics	30

Table A2. Continued

Minicomputer	Months after intial entry	Personal computer	Months after initial entry
Sanders Associates	66	Texas Instruments	30
Cincinnati Milicron	70	Hewlett Packard	32
Varisystems	71	Digilog Business Systems	40
Lockheed	77	M/A Com	42
Minicomp	81	North Atlantic Industries	44
Texas Instruments	81	Xerox	46
Wang	84	Onyx Systems	47
GTE	87	Computek	49
Nuclear Data	88	Ontel	49
Mohawk Data Sciences	91	Sperry-Univac	49
Bunker Ramo	93	Lanier	50
IBM	98	Televideo	52
Apeco	105	IBM	53
Foxboro	105	Zentec	53
Northrup	105	Convergent Technologies	54
Rockwell	108	Burroughs	54
Burroughs	114	Facet/Dataroyal	55
Harris	124	Monroe Systems	55
Q1	125	Advanced Micro	56
Keronix	127	Digital Equipment Co.	56
Perkin Elmer	131	SCI Systems	56
Anderson Jacobson	135	Kaypro	58
Ball Computer	141	Fortune Systems	59
Pako	141	Corvus Systems	60
Decision Data	143	C3 Inc.	62
Jacquard Data	143	Lexicon	64
NCR	144	Basic Four	65
Compucorp	148	Datapoint	66
Datum	150	Teleram Computer	68
Mylee Digital	152	Access Matrix	73
Computer Consoles	153	Honeywell	73
Applied Digital Data	154	Harris	74
Telefile	165	Data General	75
Ampex	176	Coleco	77
Reynolds & Reynolds	177	Computer Devices	84
SCI Systems	177	Tandon	86
Lear Siegler	181	ATT	87
Keydata	187	Alpha Microsystems	107
Applied Data Processing	189	AST Research	107
Astrocom	189	CPT	107
Moore	195		
Onyx	200		
Intersil	202		
McDonnell Douglas	213		
Ultimate	218		
Interactive Systems	229		
Pertec	229		
Molecular Computer	237		