Are More Good Things Better, or Will Technical and Market Capabilities Conflict When a Firm Expands?

WILL MITCHELL
(School of Business Administration, University of Michigan, Ann Arbor, MI 48109–1234, USA)

This paper examines the effects on performance of possessing market and technically-related capabilities before entry into a new technical subfield of the imaging industry between 1954 and 1988. The study addresses cases in which technical change does not destroy the value of market-related assets of incumbent firms. I examine the survival, short term market share, and longer term market share attained by industry incumbents and entrants diversifying from other industries. I find that different resources contribute to different types of performance, and that the intuitively likely result—that possessing more technical and market-related resources leads to better performance—sometimes does not occur.

1. Introduction

Industry incumbents typically are viewed as slow to respond to major innovations and very much at risk of being displaced by newcomers following revolutionary technical change (Jewkes et al., 1958; Nelson and Winter, 1982; Reinganum, 1983; Tushman and Anderson, 1986). However, when a product that requires discontinuous changes in design technology causes little change in market segmentation, which Abernathy and Clark (1985) refer to as low transilience innovation, industry incumbents may enjoy significant advantages relative to new entrants. Many studies of corporate diversification have found that firms which expand into related markets often achieve strong performance in the new business (e.g. Rumelt, 1982; Montgomery, 1985). Mitchell (1989, 1991) shows that possession of a strong set of market-related supporting assets has allowed many incumbents of the medical diagnostic imaging industry to outperform most industry newcomers
over the past 40 years. But does performance climb more if a firm possesses technical capabilities as well as market resources? And if technical skills contribute to superior performance by industry incumbents when they expand into new technical subfields, will technical capabilities also contribute to the performance of industry newcomers?

In this paper, I examine the effects on performance of possessing market and technically-related capabilities before entry into a new technical subfield of the imaging industry between 1954 and 1988. A new technical subfield is a set of products that draw significantly from knowledge bases not required for traditional goods in the same industry (Mitchell, 1989). I examine the survival, short term market share, and longer term market share attained by industry incumbents and entrants diversifying from other industries. I find that different resources contribute to different types of performance, and that the intuitively likely result—that possessing more technical and market-related resources leads to better performance—may not occur.

2. Background

After more than a decade of focus in the strategy literature on the effects of industry structure, interest recently has revived in the contributions of a firm’s idiosyncratic capabilities to its strategies and performance. Explicitly or implicitly underlying much of the interest is the concept of transaction specific assets (Williamson, 1975, 1985). Initial attention to the strategic impact of transaction specific assets was to their influence on the location of organisational boundaries, particularly whether a firm would make or buy components (e.g. Eccles, 1981; Monteverde and Teece, 1982; Anderson and Schmittein, 1984; Walker and Weber, 1984). While fruitful research in this vein continues (e.g. Pisano, 1990; Shan, 1990; Mosakowski, 1991; Masten et al., 1991), we have also come to recognise that control of transaction specific assets underlies a firm’s superior financial performance and continued survival (Lippman and Rumelt, 1982; Teece, 1986; Barney, 1986; Rumelt, 1987; Mitchell, 1989, 1991). When discussing their contribution to firm performance, I will refer to transaction specific assets as specialised assets.¹

Specialised Supporting Assets

A specialised asset is a resource that is both required for production of a good or service and that cannot be replicated easily or cheaply. Specialised assets may be physical plant and equipment or they may be embodied in an

¹ A transaction specific asset earns significantly lower returns in its next best use (Williamson, 1975). Equivalently, a specialised asset requires significant expense to replicate.
individual’s knowledge or an organisation’s systems. Examples of organisational systems include R&D skills, manufacturing capabilities, and sales and service systems. Barriers to replication include legal restrictions, such as patents and copyrights, and knowledge limitations, such as secrecy and tacitness of know-how (Nelson and Winter, 1982; Levin et al., 1987).

The difficulty or cost of replication underlies the strategic importance of an asset. Because a replacement asset is difficult or costly to obtain, a firm must control its existing specialised resources in order to be profitable or otherwise achieve strong performance. At the same time, the difficulty and cost of replication create the potential contribution to superior performance as long as the resource continues to be necessary. Klein et al. (1978) argue that such short-term fixity creates economic rents. Similarly, proponents of the resource-based view of the firm argue that a firm’s profits are generated by assets that are scarce, imperfectly imitable, and imperfectly tradeable in factor markets (e.g. Wernerfelt, 1984; Barney, 1986; Dierickx and Cool, 1989; Conner, 1991).

A specialised asset is sometimes embodied solely in a single product, such as a defendable patent to produce a particular good. More frequently, specialised assets provide superior ability to design, develop, manufacture, sell, and service a good. Much more than almost any individual product, it is the physical, knowledge-based, and reputational specialised supporting assets that contribute to a firm’s superior performance in a market.

Consider the example of implantable cardiac pacemakers (Mitchell and Nehrt, 1991). Medtronic, Inc. has been the global leader in the pacemaker industry since 1960. During the past 30 years, the company has built an unmatched international direct distribution and service system, cultivated a knowledgeable staff of personnel to work with prescribing physicians in their offices and operating theatres, and attained a reputation for superior overall quality of its pacemaker business. At the end of the 1980s, the company still held about 40% of the global pacemaker market (Smith, 1990, II-74), was highly profitable, and maintained this position despite competitive pressure from some of the world’s largest medical corporations.

The reasons for Medtronic’s ongoing success do not lie only in the capabilities of its pacemakers. Indeed, although the company’s pacers have usually been of high quality, competitors have frequently introduced better-quality units that Medtronic has then matched or improved. Instead, Medtronic’s long-term success derives from its technically-related abilities to match the innovations reasonably quickly, and its market-related abilities to sell and distribute the pacers. It is the hard-to-replicate supporting assets—the technical and market-related capabilities that support development, manufacture, and sale of the pacers—that underlie Medtronic’s long-term
success. Even companies as internationally sophisticated as Siemens AG and the General Electric Company have not been able to match the extent of Medtronic's supporting capabilities and to achieve its performance in the pacemaker industry.

It is useful to think of two types of specialised assets: market-related capabilities and technically-related capabilities. Although the two sets of resources are not mutually exclusive—knowledge of market usage will enhance design capabilities, for instance—the two types of skills tend to contribute to performance in different but complementary ways. In an industry in which products are undergoing technical change, market-related assets provide the cushion to support continued sales while a firm uses its technical resources to catch up to product innovators.

The distinction between market and technical capabilities becomes particularly important when a product that requires discontinuous changes in design technology causes little change in market segmentation. An industry incumbent's market-related assets will retain much of their value in such cases, because the new products will be sold to the old users. Thus, the technical innovation enhances the value of the firm's market-related competence (Tushman and Anderson, 1986). This case is similar to Henderson and Clark's (1990) concept of modular innovation, in which core concepts change but the link between core concepts and components remain unaltered. Even if an industry incumbent knows little about the technical demands of the new good when it is first introduced, the firm will often be able to support its position in the market while it acquires the technical capabilities.

Think, for instance, of IBM and the introduction of superfast computers. IBM knew little about parallel processing when Cray Computers introduced very fast computers. Nonetheless, IBM's market-related strength allowed it time to acquire supercomputing knowledge, by funding a venture initiated by one of Cray's engineers, and to become a player in the supercomputer market.

Such cases stand in sharp contrast to those in which major product innovation leads to major changes in market segmentation. The switch from mechanical adding machines to electronic calculators, for instance, created vast new markets outside the traditional office supply stores in which calculating instruments were sold (Majumdar, 1981). In these new markets, which ranged from traditional discount stores to newly established electronics outlets, the sales and service systems of the traditional adding machine manufacturers lost their value as supporting assets. By the time they had acquired the knowledge needed to produce electronic calculators, their entry had been blocked by industry newcomers such as Texas Instruments and Sharp. Technical innovation had destroyed the value of the firm's market-related competence (Tushman and Anderson, 1986).
Several studies in the corporate diversification literature examine the relationship between corporate performance and the market and technical similarity shared by a corporation’s businesses. Most analyses show that new ventures undertaken in fields having little relationship to a firm’s existing businesses often perform poorly, while expansion into related businesses often leads to strong performance (Rumelt, 1974, 1982; Bettis, 1981; Montgomery, 1985; Ramanujam and Vardarajan, 1989). Most diversification studies define relatedness mainly in terms of markets served, based on Standard Industrial Classification (SIC) or similar categories, but studies examining technical relationships more directly (e.g. Nathanson and Cassano, 1982) tend to find that technical similarity also is related to superior performance. However, no studies have examined the joint effects of market and technical relationships. Moreover, most diversification analyses examine performance at a single time in pooled businesses and industries that may be at different development stages. A fine-grained analysis of performance in new industry subfields needs to examine both market and technical effects, while controlling for the effects of subfield development.

Propositions and Research Issues

Let us continue the discussion in the context of an industry undergoing discontinuous technical change, but selling in a market undergoing little change in segmentation. Will market-related and technically-related know-how contribute to superior performance when a firm enters a new technical subfield of the industry? Each of the following propositions and research issues is conditioned on the context of discontinuous technical change and market stability.

Drawing from the arguments and results described in the earlier section of the paper, we expect that industry incumbents will often be able to enter new technical subfields successfully because their market-related capabilities will provide them with time in which to acquire the technical skills needed to produce the new goods. This leads to several initial propositions. If we assume that the extent of an incumbent’s market-related specialised assets are reflected in its industry market share, then the stronger the market position of an incumbent, the better its performance in the new subfield. The analysis considers three types of performance: survival, short term market share, and longer term market share.²

² Market share is a common performance measure. Survival is used less frequently, but recently has been viewed as a performance measure of interest to shareholders, managers, workers, and communities. Both market share and survival complement profitability measures of performance. This is consistent with a growing recognition that managers must consider many criteria when evaluating the long-term
Proposition 1. The greater an incumbent’s prior industry market share, the better its performance in a new technical subfield of the industry:
   a) the longer the survival;
   b) the greater the short term subfield market share attained immediately after entry;
   c) the greater the longer term subfield market share attained.

But what of the market-related skills of industry newcomers? After all, many firms that introduce new products are major players in other markets, sometimes markets with similarities to those served by the new goods. Medtronic, for instance, has expanded from the implantable pacemaker industry to the implantable vascular graft industry in the medical sector. Many pharmaceutical manufacturers have expanded into medical equipment industries. Will the near-market capabilities of such firms contribute to their success in a new industry?

The obvious answer is, yes, of course! Relative to companies diversifying from unrelated markets and to startup ventures, at least, firms diversifying from related markets should do well. It is possible, however, that an expanding firm’s traditional market and the new market are just similar enough to cause problems, rather than create benefits. For instance, pharmaceutical companies might try to use drug marketing methods for equipment sales, only to find that different purchase criteria are used in the drug and equipment markets. Therefore, we present the question as a research issue, rather than as a proposition.

Research issue 1. Will diversifying entrants that possess near-market experience prior to entry achieve longer survival, greater short term market share, or greater longer term market share than entrants that do not?

Now, what of related technical experience possessed by incumbents and newcomers before they begin to develop new goods? Many industry incumbents possess none of the new technical skills required when a new product is first introduced and must acquire them externally, by hiring new personnel or acquiring other companies. Some incumbents are likely to possess some of the relevant new technical skills when the good emerges, however, and so will need to acquire only part of the necessary design know-how. When video cassette recorders were introduced in the consumer electronics industry, for instance, many television manufacturers possessed some of the new potential of their businesses (Eccles, 1991). It would be useful to include measures of profitability performance but it is not possible to do so. Part of the problem with measuring profitability stems from the longitudinal nature of the study, because it is difficult to compare profitability at different times and in different contexts. In addition, many businesses in the sample are either privately held companies or divisions of large firms, that either do not report profits or do not separate division-level profits.
skills needed to design and manufacture VCRs. For many diversifying entrants, meanwhile, related technical skills provide the entry route to the industry. The aluminum producer Alcoa, for example, entered the metal container industry as an early producer of aluminum cans.

Again, the obvious answer is, yes, of course firms that possess relevant technical skills will outperform those that do not! Acquiring tacit technical know-how may be difficult and uncertain (Dosi, 1988), while technical complexity may hinder interfirm knowledge transfer (Mowery, 1983). Therefore, firms that already possess some of the know-how needed to create a new type of good should have significant advantages. The in-house knowledge will help a firm initiate a project, and may also provide it with a base of know-how needed to acquire necessary external knowledge (Mowery, 1990). But, once more, the obvious answer may not apply.

In the same way that near-market experience may distort actions needed in a new market, so may near-technical know-how distort product development efforts. The 'not-invented-here' syndrome is often cited as a reason for a firm's reluctance to meet a competitor's innovation. Just as powerful, though, is the 'invented-here' syndrome. Henderson and Clark (1990) note that incumbents often mistake the demands of seemingly similar markets when core concepts change. Once a firm has established a product development trajectory, it is difficult to dislodge the efforts and switch to another path (Sahal, 1981). If a firm has enough knowledge to start product development, but not enough knowledge to start on the right path, it may find itself locked into a flawed design. Firms that start from scratch, meanwhile, may be more likely to choose a technical trajectory based on the forecasted development of the new good, rather than the historical evolution of the old knowledge.

The problem of conflict between old technical knowledge and new technical demands may be stronger for industry incumbents than for diversifying entrants. Industry newcomers that possess related technical knowledge typically enter the subfield because they have the related know-how. In many cases, therefore, a newcomer may be able to launch its development on a reasonable trajectory. While it may fail for market-related reasons, due to lack of understanding of the usage demands of a new market, the newcomer has a reasonable chance of attaining technical success.

Research issue 2a. Will diversifying entrants that possess related technical capabilities prior to entry achieve longer survival, greater short term market share, or greater longer term market share than diversifying entrants that do not possess technically-related experience.

Many incumbents that possess related technical skills, meanwhile, will bring those skills to bear on the new product as reactions to the competitive
entry of newcomers rather than as part of internally-devised product development opportunities. There is more chance that such an incumbent will use the skills inappropriately, owing to incomplete understanding of the technical demands of the new good. This problem may be compounded if conflict emerges between its market-related resources and its technical capabilities. During the 1960s, for instance, vacuum tube producers attempted to develop and introduce transistors in reaction to innovation by industry newcomers. Despite possessing some relevant electronics-based technical capabilities, most incumbents were signally unsuccessful in the transistor subfield, in part because they were bound by their existing patterns of tube design and use.

Research issue 2b. Will industry incumbents that possess related technical capabilities before the emergence of a new technical subfield achieve longer survival, greater short term market share, or greater longer term market share than entrants that do not?

3. Methods

Data

The medical diagnostic imaging equipment industry comprises firms that manufacture equipment used by physicians and other health care workers to nonintrusively examine organs and physiological activity within live beings. Since the early 1950s, several new technical subfields of the imaging equipment industry have emerged to substitute for and complement earlier conventional x-ray imaging devices. The subfields of the industry are listed in Table 1. Despite the major changes in product technology, most imaging devices in the United States market continue to be purchased by hospital radiology departments or by radiology outpatient clinics that are often

<table>
<thead>
<tr>
<th>Technical subfields (year of US introduction)</th>
<th>Computed tomography (1973)</th>
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<tbody>
<tr>
<td>Ultrasound (1957)</td>
<td></td>
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</table>

Industry US sales (1988 constant $; deflated by the Producer Price Index)

1954: $150 million 1988: $2.7 billion

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affiliated with hospital radiology personnel, while other hospital departments and physicians in private practice purchase a much smaller proportion of equipment. Total imaging equipment sales in the American market rose from about $150 million in 1954 to about $2.7 billion in 1988, reported in constant 1988 dollars. These figures represented almost half of total world sales for diagnostic imaging systems.

The participation and market share data for this study were gathered from an extensive archival search of academic, industry, and government sources, supplemented by interviews with industry and academic participants. The participants include all identifiable manufacturers of human diagnostic imaging equipment systems that sold devices, either directly or through distributors, in the US market at any point during the 1954–1988 period. I excluded firms that manufactured only imaging components or only distributed imaging systems manufactured by other companies.

The study includes 314 entrants to the five technical subfields of the industry that have emerged since 1954. The analysis was conducted at the parent-firm rather than the organisational subunit level of analysis, owing both to difficulty in assigning subunit level exit dates and to the presence of potential parent-level influences on strategy and performance. At this level, an exit was recorded if a corporation sold its imaging equipment subunit to another firm.

Of the 314 entrants, 98 were incumbents of the existing imaging industry. Incumbents were defined as firms that operated in the traditional conventional x-ray equipment subfield or in one or more of the new subfields before entering a new subfield. Of the remaining entrants, 100 were startup firms and 116 had prior experience in other industries, including other medical equipment industries, the pharmaceutical industry, and the aerospace sector.

Variables

**Dependent variables.** The analysis focussed on three measures of performance in the new subfields of the industry. The first is the number of years that an entrant participated in the subfield before exiting, with the count starting at 1 for firms that entered and exited during the same calendar year. For firms that were still participating in the industry at the end of the study, the length of participation was defined as the number of years between their entry and 1988. A right-censor 0–1 dummy variable distinguished between those that had exited and those that remained.

The other two dependent variables are measures of market share attained in the subfield: short term and longer term market share. Short term market share was defined as the average annual market share that an entrant achieved
in its first full four calendar years of participation in the subfield. If a firm survived less than four years, the short term market share variable recorded the participant's average share for the one to three years it did participate. Longer term market share was defined as the market share attained during a firm's sixth full year of participation in the subfield. This variable was included because of the interest in comparing influences on firms' ability to compete successfully in the short and long run. Firms that did not survive for at least seven years were dropped from the longer term market share analysis.  

**Independent variables.** Four independent variables were defined in order to operationalise the market-related and technically-related concepts referred to in the propositions and research issues. For industry incumbents, the imaging industry market share held during the year before entry into a new subfield was treated as an estimate of the extent of its market-related capabilities. For diversifying entrants, experience in other medical sector industries was defined as near-market experience. A 0–1 dummy variable distinguished between entrants that had prior experience in medical sector industries and those that did not. Summary statistics and product-moment correlations are reported in Table 2.

Two technical experience variables were defined, one each for industry incumbents and industry newcomers. Relevant technical experience for each new subfield was judged in a fashion consistent with that used in Mitchell (1989). Table 3 reports the basis used to classify such experience.

Seven independent variables that were used in Mitchell (1991) were used as control variables for this study. A subfield growth variable recorded the increase in total subfield sales in the year following a firm's entry divided by subfield sales during the year of entry. A corporate sales variable recorded an entrant's total sales during the year before its entry into an imaging subfield, including sales of its parent if the imaging equipment manufacturer was part of a larger corporation. Corporate sales were deflated by the 1982 Producer Price Index. An entry by acquisition 0–1 dummy variable recorded cases in which a firm entered a subfield by purchasing a previous participant. A 0–1 dummy variable recorded whether an entrant was a majority-owned American firm. A 0–1 dummy variable recorded whether an entrant was a startup venture.  

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1. The short term and longer term measures may appear to be very close in time, at four and six years. However, the short term measure is the average of at most four years of performance and so is weighted by performance in the early years of participation, whereas the longer term measure is based on only the sixth year of participation. A later year was not chosen for longer term share in order to retain as many participants as possible (Mitchell, 1991). Analyses that used later years for longer term share produced qualitatively similar results.

4. Although it is also conceptually desirable to measure the effects of corporate age, the correlation between age and size was so high that independent information was not added to models including an age variable (there was no significant increase in the model loglikelihood).
Table 2. Summary Statistics and Product-moment Correlations

<table>
<thead>
<tr>
<th>Variables</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
<th>8.</th>
<th>9.</th>
<th>10.</th>
<th>11.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incumbent ind. share</td>
<td>1.0</td>
<td>0.37</td>
<td>-0.16</td>
<td>-0.11</td>
<td>-0.24</td>
<td>0.07</td>
<td>-0.08</td>
<td>0.04</td>
<td>0.66</td>
<td>-0.26</td>
<td>0.28</td>
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<tr>
<td>Incumbent tech. exp.</td>
<td>1.0</td>
<td>-0.15</td>
<td>-0.11</td>
<td>-0.23</td>
<td>-0.03</td>
<td>-0.15</td>
<td>-0.11</td>
<td>0.30</td>
<td>-0.32</td>
<td>0.29</td>
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<tr>
<td>Div. near-market exp.</td>
<td>1.0</td>
<td>0.40</td>
<td>-0.31</td>
<td>-0.04</td>
<td>-0.06</td>
<td>0.19</td>
<td>0.01</td>
<td>0.04</td>
<td>-0.26</td>
<td>-0.19</td>
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<tr>
<td>Div. tech. exp.</td>
<td>1.0</td>
<td>-0.22</td>
<td>-0.01</td>
<td>0.06</td>
<td>-0.04</td>
<td>-0.03</td>
<td>-0.22</td>
<td>-0.19</td>
<td></td>
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<tr>
<td>Startup firm</td>
<td>1.0</td>
<td>-0.05</td>
<td>0.34</td>
<td>-0.18</td>
<td>-0.29</td>
<td>0.06</td>
<td>-0.39</td>
<td></td>
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<tr>
<td>Market growth</td>
<td>1.0</td>
<td>0.07</td>
<td>-0.20</td>
<td>-0.07</td>
<td>-0.21</td>
<td>0.06</td>
<td>-0.22</td>
<td>-0.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American firm</td>
<td>1.0</td>
<td>-0.16</td>
<td>0.27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Entry by acquisition</td>
<td>1.0</td>
<td>0.06</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Company sales ($100M)</td>
<td>0.51</td>
<td>0.10</td>
<td>0.17</td>
<td>0.10</td>
<td>0.32</td>
<td>2.8</td>
<td>0.68</td>
<td>0.18</td>
<td>20.5</td>
<td>3.4</td>
<td>0.64</td>
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<tr>
<td>Log total entry rank</td>
<td>1.46</td>
<td>0.50</td>
<td>0.38</td>
<td>0.29</td>
<td>0.47</td>
<td>22.4</td>
<td>0.47</td>
<td>0.39</td>
<td>48.3</td>
<td>1.2</td>
<td>1.11</td>
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<tr>
<td>Log inc. entry rank</td>
<td>0.32</td>
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<tr>
<td>Summary statistics</td>
<td>10.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>279.0</td>
<td>1.0</td>
<td>1.0</td>
<td>279.5</td>
<td>5.1</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Conflicts When a Firm Expands
TABLE 3. Classifications for Technically-related Experience Variables

<table>
<thead>
<tr>
<th>New subfield</th>
<th>Prior technically-related experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear imaging</td>
<td>Radiopharmaceutical, non-imaging nuclear medical, computing (before nuclear computer entry)</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>Industrial ultrasound</td>
</tr>
<tr>
<td>Computed tomography</td>
<td>Medical or industrial x-ray</td>
</tr>
<tr>
<td>Magnetic resonance</td>
<td>Industrial spectroscopy</td>
</tr>
<tr>
<td>Digital radiography</td>
<td>Medical or industrial x-ray, computed tomography</td>
</tr>
</tbody>
</table>

Consistent with previous research (Mitchell, 1991), two entry order variables were defined. One measured an entrant's overall rank order of entry, relative to all entrants to the subfield. Another measured an industry incumbent's rank order of entry to the subfield, relative to other incumbents. Industry newcomers were credited with the mean value of the incumbent entry order variable. Log values of the entry order measures were used, in order to taper the effects of late entry.

Statistical Methods

Normally-distributed maximum likelihood linear regression was used to carry out the market share analyses. The equations took the following functional form. In the equation, $X$ and $\beta_1$ are vectors of independent variables and related coefficients, $\alpha_1$ is an intercept, and $\epsilon_1$ is a parametrically-distributed error.

$$ [1] \text{MarketShare} = \alpha_1 + \beta_1 X + \epsilon_1 $$

Log-linear maximum likelihood accelerated event-time regression (Kalbfleisch and Prentice, 1980; Cox and Oakes, 1984) was used for the survival analyses. The accelerated event-time models were estimated with the PROC LIFEREG procedure of SAS (SAS Institute, Inc., 1985). The accelerated event-time models took the following functional form.

$$ [2] \text{Ln(LIFE)} = \alpha_2 + \beta_2 X + \sigma \epsilon_2 $$

In this equation, $X$ and $\beta$ again are vectors of independent variables and related coefficients, $\alpha_2$ is an intercept, $\epsilon_2$ is a parametrically-distributed error, and $\sigma$ is a variance-related scale parameter. A loglogistic distribution was employed as the baseline parametric assumption, because its fatter tails are suited to organisational studies in which many firms tend to exit both
early and late. The accelerated event-time result was robust to the Weibull and normal parametric specifications.

The accelerated event-time model treats coefficient effects as log-linear accelerations or decelerations to a baseline distribution of event times that would be found if all independent variables were equal to zero. The principal advantage of the method is that it permits us to include the information that a firm was still participating at the end of the study. If such right-censored cases were treated as though they had exited or were omitted, as would have to be done with conventional regression methods, the results would be seriously biased. The model incorporates the information that a firm has not exited by including nonsensored events in the calculation of the probability density function (the probability that an event happened at a specific time) and censored cases in calculation of the survival function (the probability that an event will happen sometime after a specific time).

4. Results

The results of the analyses are reported in Table 4. Two models are reported for each analysis, one containing only the influences of market-related and technically-related capabilities, the second controlling for other possible influences. Including the control variables, the influence of which is discussed by Mitchell (1991), had little qualitative effect on the market-related and technically-related influences estimated in the simpler models.

As predicted in proposition 1, industry market share is strongly associated with survival, short term subfield market share, and longer term share. In the more complicated models, each percent of industry market share held before entering a new technical subfield provides a survival multiplier of about 1.3, a short term subfield market share increase of about 1.8%, and a longer term market share advantage of about 2.2%. The results shown by the industry share coefficients in columns 1–6 are consistent with analyses reported in earlier studies (Mitchell, 1991).

The near-market experience of industry newcomers, which was the subject of research issue 1, also has at least weakly positive influence on performance in a subfield of the imaging industry. Both survival and longer term market share are significantly associated with a diversifying firm’s near-market experience, while the estimated positive influence short term market share approaches significance. However, near-market experience is much less useful than industry market share, having only as much impact as possession of about one percent industry market share before entry into a new subfield.

\[ \text{Recall that the survival model is log-linear. Therefore, the survival accelerator is calculated by taking the exponential value of the survival coefficient, } e^{27}. \]
<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Survival (1)</th>
<th>Survival (2)</th>
<th>Survival (3)</th>
<th>Survival (4)</th>
<th>Survival (5)</th>
<th>Survival (6)</th>
</tr>
</thead>
</table>

**Incumbents**

Market position (share)  
0.31***  
(0.09)  
Technical experience  
-0.14  
(0.25)  

**Diversifying firms**

Near-market experience  
0.30*  
(0.17)  
Technical experience  
-0.03  
(0.21)  

**Other influences**

Market growth  
0.002  
(0.003)  

Short term share (4 year average)  
1.97***  
(0.45)  
1.60  
(2.17)  
8.90***  
(2.26)  

Longer term share (year 6)  
1.77***  
(0.54)  
-0.91  
(2.15)  
4.56**  
(2.21)  
0.03  
(0.03)  

2.74***  
(0.36)  
3.30*  
(1.97)  
4.90**  
(2.11)  
0.003  
(0.020)  

Conflicts When a Firm Expands
<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Startup firm</td>
<td>0.24</td>
<td></td>
<td>0.88</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td></td>
<td>(1.62)</td>
<td>(1.87)</td>
</tr>
<tr>
<td>American firm</td>
<td>−0.52***</td>
<td>1.25</td>
<td>2.34*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.17)</td>
<td></td>
<td>(1.30)</td>
<td>(1.39)</td>
</tr>
<tr>
<td>Entry by acquisition</td>
<td>−0.36**</td>
<td>3.69**</td>
<td>3.28**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.17)</td>
<td></td>
<td>(1.56)</td>
<td>(1.65)</td>
</tr>
<tr>
<td>Corporate sales ($100M)</td>
<td>0.004</td>
<td>−0.02</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td></td>
<td>(0.02)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>Log entry rank</td>
<td>0.15**</td>
<td>−3.84***</td>
<td>−1.78***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td></td>
<td>(0.53)</td>
<td>(0.58)</td>
</tr>
<tr>
<td>Log incumbent entry rank</td>
<td>−0.02</td>
<td>−0.30</td>
<td>−0.79</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td></td>
<td>(0.62)</td>
<td>(0.66)</td>
</tr>
<tr>
<td>Intercept</td>
<td>1.99***</td>
<td>1.80***</td>
<td>2.03***</td>
<td>14.29***</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td>(0.27)</td>
<td>(0.74)</td>
<td>(2.39)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.80)</td>
</tr>
<tr>
<td>Distribution scale</td>
<td>0.58</td>
<td>0.56</td>
<td>10.76</td>
<td>9.70</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.43)</td>
<td>(0.39)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.43)</td>
</tr>
<tr>
<td>Model χ²</td>
<td>23.8###</td>
<td>52.6###</td>
<td>39.6###</td>
<td>105.0###</td>
</tr>
<tr>
<td></td>
<td>(df)</td>
<td></td>
<td></td>
<td>(df)</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td></td>
<td></td>
<td>(11)</td>
</tr>
<tr>
<td>Entrants (exited)</td>
<td>314 (161)</td>
<td>314</td>
<td>168</td>
<td></td>
</tr>
<tr>
<td>Assumed distribution</td>
<td>Loglogistic</td>
<td>Normal</td>
<td>Normal</td>
<td></td>
</tr>
</tbody>
</table>

* P < 0.10, ** P < 0.05, *** P < 0.01 (two-tailed test).

# P < 0.10, ## P < 0.05, ### P < 0.01 (one-tailed test).
The influence of technical experience, the subject of research issue 2, was much more mixed. For industry incumbents, possession of related technical capabilities did not lead to increased survival. Indeed, the estimated effects on incumbent survival were negative, although at insignificant statistical levels. Nor did technical experience lead to greater short term market share for incumbents. For those incumbents that survived in the new subfield for more than six years, however, prior technical experience did provide longer term market share advantages, with somewhat greater impact than the longer term influence of industry market share.

For incumbents, technical capabilities appear to be a mixed blessing. Although related technical experience may provide longer term market share advantages, it may also trap some firms on such inappropriate technical trajectories that they are forced to leave the subfield. Only those that guess right, or can successfully switch designs after guessing wrong, survive long enough to reap the technical benefits.

For diversifying firms, technical experience has similarly weak influence on survival. A nonsignificant negative effect was found in the simpler of the two survival models (column 1) and a nonsignificant positive effect was estimated in the more complicated model (column 2). Diversifying firms, like incumbents, appear to face significant difficulties when attempting to apply technical knowledge.

Technical experience does provide both immediate and longer term market share advantages for diversifying firms. Many diversifying firms that possess prior related technical experience immediately achieve relatively strong market positions, realising about as much benefit as industry incumbents do from industry market share of 2.6% in the full model (column 4). The prior technical experience also provides longer term share advantages for diversifying firms.

The longer term influence of diversifying firm technical capabilities is somewhat weaker than the short term impact. This likely indicates that the need to acquire and develop market-related capabilities slows most diversifying firms, and allows others to catch up. Market-strong industry incumbents that survive early technical problems in the new subfield are especially likely approach or surpass the early leaders.

5. Discussion and Conclusion

This analysis compares the effects of market-related and technically-related specialised assets on the performance of industry incumbents and diversifying

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6 This figure results from dividing the diversifying firm near-market experience coefficient by the incumbent industry share coefficient in the full model for short term share (column 4 in Table 4).
entrants to new technical subfields of an industry. The study addresses cases in which technical change does not destroy the value of market-related assets of incumbent firms, which Abernathy and Clark's (1983) refer to as low-transilience innovation. The paper supports arguments that nonreplicable specialised assets are key sources of superior performance (Lippman and Rumelt, 1982; Teece, 1986). As expected, market-related capabilities provide industry incumbents with significant survival and market share advantages. Capabilities acquired through near-market experience also provide diversifying firms with some advantages, but only to the extent of holding one percent of industry market share.

Technically-related skills are much more of a mixed blessing, particularly for industry incumbents. Prior technically-related experience has no significant impact on survival or short term market share. If anything, the technical impact tends to be negative. It is possible that incumbents possessing technically-related capabilities bring them to bear as a reaction to innovation by other firms, and often make mistakes in the process. Such mistakes may damage the firms' attempts to enter the new subfield.

If an incumbent possessing technically-related skills before its entry survives, meanwhile, the capabilities do appear to provide longer term market share advantages. Incumbents that do not make early mistakes, and those that are able to recover from errors, appear able to benefit from their greater internal understanding of the technical demands of the new goods. Consistent with Nelson and Winter's (1982) arguments, it appears that firms that draw effectively on their prior experience can adjust to changing markets. Although successful adjustment may take several years, technical skill is a competitive evolutionary advantage for firms that survive the adjustment period.

For diversifying firms, technically-related capabilities provide no more of a survival advantage than for incumbents. However, the technical skills do provide both immediate and longer term market share advantages. Particularly in the short term, the market share benefits provided by technical skills outweigh those provided by any near-market experience.

The results lead to suggestive implications regarding what types of incumbents and diversifying firms will be most likely to fare well in a new technical subfield. For incumbents, the major early criterion is prior market-related strength in the industry. In the longer term, technical capabilities come into play for incumbents. Most minor incumbents that attempt to expand into new subfields will perform poorly, but those possessing relevant technical skills may be able to expand and prosper.

The diversifying firms that are most likely to survive and prosper are those possessing both near-market experience and technically-related capabilities.
The market-related experience provides survival advantages, while the technical experience leads to increased market share. Many diversifying firms possessing only technical experience will suffer relative to firms diversifying from near-market sectors, because they will not survive the attempted entry. An industrial ultrasound manufacturer that introduced medical ultrasound products, for instance, would be likely to perform poorly relative to an ultrasound entrant with medical sector experience but no prior technical skills.

In general, both market-related and technically-related capabilities may contribute to longer-term superior performance. In the short term, however, the two types of capabilities may conflict. At best, firms possessing both market and technical experience tend to realise short term benefit from only one set of capabilities, while the effects of the other set of skills remain dormant initially until emerging later. Only firms that survive the early trials of entry into a subfield tend to realise the two-fold benefits of market and technical capabilities.

Acknowledgements


References


