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TECHNOLOGY STRATEGY AND SOFTWARE NEW VENTURES' PERFORMANCE: EXPLORING THE MODERATING EFFECT OF THE COMPETITIVE ENVIRONMENT

SHAKER A. ZAHRA
Georgia State University, Atlanta, GA

WILLIAM C. BOGNER
Georgia State University, Atlanta, GA

EXECUTIVE SUMMARY

Technology strategy (TS) is one of the most important aspects of any firm's strategic posture especially in dynamic environments such as the computer software industry. Not only do new ventures face the pressures that accompany all young companies (e.g., shortages of capital), but they also have to keep up with a rapid rate of technological change. Consequently TS, the sum of a firm's choices on how to develop and exploit its technological resources, can profoundly affect a venture's performance and survival.

This empirical study examines the relationships between TS and new venture performance (NVP). By focusing on TS variables and analyzing their performance outcomes, the study offers insights into the factors that can influence the success of new ventures in a fast-paced environment. This study also examines key environmental moderators, those external environmental forces, which can significantly impact the strength or direction of the relationship between a firm's TS and NVP.

Address correspondence to Dr. S.A. Zahra, Department of Management, College of Business Administration, Georgia State University, Atlanta, GA 30303, (404) 651-2894, (404) 651-2804 [fax].

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The study examines five TSs that can enhance NPV. The first is radicality, which means developing and introducing new products ahead of competitors. The second is the intensity of product upgrades, which refers to a venture's commitment to introducing more refinements and extensions of its products than its competition. The third is the level of R&D spending, which indicates a venture's strong investment in internal research and development activities. The fourth is the use of external technology sources (e.g., strategic alliances and licenses) to augment a firm's own R&D efforts. The final dimension is the use of copyrights and other means of protecting the venture's intellectual property.

Environmental moderators examined in this paper were: dynamism, price hostility, non-price hostility, and heterogeneity. Dynamism reflects the rate and continuity of change within an industry. Price hostility indicates the intensity of rivalry in an industry based on costs and reduced prices. Non-price hostility indicates an emphasis on product quality and service as the key to success in an industry. Heterogeneity indicates the diversity of the market segments in the new venture's industry; a heterogeneous environment typically has multiple segments with diverse needs and expectations.

To test the impact of environmental moderators on the efficacy of TS, data were collected from 116 U.S.-based software firms. NVP was measured by return on equity (ROE) and growth of market share (GMS). Overall, the results show that not all of the TS dimensions had a significant effect on NVP, and that the relationships of these dimensions with NVP were moderated by the venture's perceptions of the external environment. Three dimensions of TS were associated with both ROE and GMS: radical new products, frequent product upgrades, and the use of external technology sources. Further, only frequent product upgrades had a significant impact under all four moderating conditions on both NVP measures. New product radicality enhances both performance variables in dynamic environments; beyond that, it only has a significant negative interaction with price hostility. R&D, however, is generally not associated with strong short-term ROE performance except in heterogeneous environments. Yet, for GMS, R&D is a significant variable except under dynamism. External technology sources also have a strong association with NVP, being insignificant only in the case of GMS in situations of non-price hostility. Finally, the use of copyrights, patents and other means of protecting the company's intellectual capital is generally not associated with NVP under different environmental conditions. In a dynamic environment, copyrights (and other means of intellectual property protection) appear to speed up the diffusion of knowledge to rivals and therefore may not enhance venture performance.

The results also suggest that new ventures should pursue a formal technology strategy to achieve successful performance. Those ventures that match their technological choices with their external environments are better positioned to achieve superior performance. *© 1999 Elsevier Science Inc.*

INTRODUCTION

Technology plays a major role in determining the success of new ventures (Zahra 1996). Technology, the sum of a firm's knowledge and skills, determine the ability of new ventures to offer the products (services), gain market acceptance, survive, and achieve financial success. To develop effective technology strategy, executives need to analyze their ventures' competitive setting, (Bettis and Hitt 1995). This is important because although some technological capabilities can improve performance within certain environments, the same choices may lower performance in other environments (Iansiti 1995; Kodama 1995). The external environment, therefore, can moderate the relationship between a firm's technological choices and its performance (Kerin, Varadarajan, and Peterson 1992). Consequently, to be successful, a venture's technology strategy (TS) should be "customized" to match the conditions of its environment. Currently, there is little evidence on the nature of this moderating effect and how it impacts a firm's performance, a factor that has invited calls for empirical studies on this issue (e.g., Miller 1988; Zahra 1996).

To fill this gap in the literature, this study examines how new ventures' external

environments may moderate the relationship between their TS and performance in the U.S. software industry. Understanding this relationship is important because of the ventures' major role in creating technologies and giving life to growth industries such as software. New ventures, defined as firms that have been in existence for eight years or less (Zahra 1996), also make significant contributions to the economic progress of the U.S.

TS is important for new ventures' market survival and financial success. Developing new technologies, even breakthrough ones, is rarely sufficient to survive and achieve market success (McGrath 1994). New ventures, therefore, need also to employ effective technological strategies that allow them to financially benefit from their innovations (McGee, Dowling, and Meggison 1995). Presently, the contributions of a comprehensive TS to a venture's profitability and growth are not well documented (Lefebvre et al. 1992; Zahra 1996), a gap in the literature this study hopes to fill.

The remainder of this paper consists of three sections. First, the importance of understanding the relationship between a venture's environment and its TS is discussed. Next, hypotheses on the specific links between the dimensions of the venture's external environment, TS, and NVP are developed. This is followed by an empirical study that tested the hypotheses in the U.S. software industry. The study's findings and their implications for managerial practice and future research are discussed in the final section of the paper.

THEORY AND HYPOTHESES

Technological capabilities are among the most recognized determinants of the success of new ventures (McGrath 1994), as they allow these firms to pursue those strategic options that can best maximize their chances for survival and achieve superior performance (Zahra 1996). Developing these technological capabilities requires managers to formulate and implement a TS based on the venture's organizational and financial resources, market orientation (Dowling and McGee 1994), competitive goals (Zahra and Covin 1993), and external environment. This paper focuses on the relationship between a venture's external environment and its TS. Though the exact nature of this relationship remains unclear (Grant 1995), new ventures are usually more vulnerable to their industries' conditions than their established rivals. The evolution of the ventures' technological capabilities is also influenced by their external environments (Anderson and Tushman 1990; Pisano 1990). As new ventures analyze their industries, they usually become aware of the opportunities and threats that exist in their markets. Successful ventures are expected to invest in developing those technological capabilities that best position them in their industry (Nelson 1995). Therefore, this paper explores the impact of new ventures' external environment when selecting their TS is therefore an important research issue.

Managers' perceptions of the external environment are expected to moderate the relationship between a venture's TS and its financial performance. This means that the interactions of the environment with TS are expected to be significantly related to NVP. To maximize NVP, therefore, managers need to pursue technology strategies that best match the conditions of their firms' external environments. This is exceedingly difficult because different dimensions of the ventures' environments often impose conflicting demands on these young companies. Through the direct relationship between the external environment and company performance has been the subject of much discussion in

the literature (Boyd et al. 1993; Dess and Beard 1994), there is agreement that mangers' perceptions of their firm's environment significantly influences company performance (Grant 1995). Consequently, this study extends the literature by exploring the moderating effect impact of the environment on the TS-NVP relationship.

TECHNOLOGY STRATEGY

There are five key dimensions of a new venture's TS. Table 1 defines these dimensions and explains their importance for successful performance. Although the relationships between these dimensions are not well understood, some of these dimensions appear to be mutually supportive. For example, companies that spend heavily on R&D frequently introduce more products to their markets, often develop radically innovative products, and frequently obtain more patents and copyrights (see Buzzell and Gale 1987). One must be cautious, however, in making broad generalizations about the nature of the associations among the five TS dimensions. For example, heavy investments in R&D may not always lead to frequent product introductions as internal bureaucratic inefficiencies, poor selection of research projects, and lack of attention to technology commercialization can weaken the venture's ability to develop or market such products. Thus, several factors can confound the pattern of associations among a venture's TS dimensions and significantly impact their associations with NVP. This study, therefore, explores the moderating effect of the relationship between a venture's external environment and five key TS dimensions. This examination offers a basis for understanding the interactions between the dimensions of a new venture's TS variables.

PERCEPTIONS OF NEW VENTURE'S ENVIRONMENTAL CHARACTERISTICS

The study focuses on how managers' perceptions of the external environment can moderate the relationship of the TS dimensions with NVP. Although these perceptions do not always reflect what is seen as one "objective" characteristic of the environment (Boyd et al. 1993), they are the interpretation that direct the venture's TS choices (Adler 1989; Zahra 1996). Importantly, interpretive maps of the competition are developed and shared in industries. These maps reflect perceived "industry recipes" that represent "shared . . . metaphors [and the] taken-for-granted assumptions [that] most describe a cohesive industry's character" (Huff 1982: 125). These shared frameworks guide the formation of individual ventures' strategies (Porac, Thomas, and Baden-Fuller 1989; Reger and Huff 1993).

Researchers continue to disagree on the best way to conceptualize the environment (e.g., Boyd et al. 1993). Fortunately, the literature suggests three points that guided the design of the study. First, because environmental conditions vary significantly from one industry to another (Dess and Beard 1984), controls for these variations are necessary. This study accomplishes this by focusing on a single industry. Second, the nature of the environmental characteristics is inextricably linked to the stage of the industry's evolution (Porter, 1980; Smith, Grimm, and Gannon 1993). To minimize the confounding effects of these variations, therefore, the study examines the software industry at one point in time. Currently, this industry is at the growth stage, as software growth in shipments far exceeds the rate of growth in the national economy (*U.S. Industrial Outlook*

TABLE 1 Key Dimensions of Technology Strategy (TS) and their Implications for New Venture Performance

The literature highlights five dimensions, which are examined in this research: radicality, intensive new product upgrades, R&D spending, the use of external sources, and the use of copyrights and other means of intellectual capital protection. This table defines each of these dimensions and highlights its importance for NVP.

(1) Radicality. This dimension means that the firm will develop radically new product (or process) technologies and introduce them to the market ahead of the competition (Ali 1994). Radicality is evidenced usually in the newness of the technology itself (as in the case of breakthroughs or paradigm shifts), or in the newness of applications the technology offers to the customer. Radicality is important for competitive and market success during the growth stage of the firm's industry life cycle (ILC). Indeed, using the PIMS database, Buzzell and Gale (1987: 203) reported that 49% of the industries in their sample experienced "major changes in technology" during the growth stage of the ILC. However, offering radically new technologies (products) can be risky because customers may not accept these technologies. Firm must also invest heavily in educating customers. Also, there are no guarantees that the technology embodied in the product (or process) will become the industry's standard (Zahra et al. 1995). However, other companies can leapfrog their pioneering technology. Despite these limitations, developing and introducing radically new products can spell the difference between the success and failure of the new venture. Radicality can give the venture a basis to target lucrative market segments, build a favorable market image and strong brand recognition, develop and control access to distribution channels, and determine the key success factors in an industry.

(2) Intensive Product Upgrades. This dimension of TS refers to the large number of revisions or extensions of the venture's existing products. A company that scores high on this dimension is prolific in introducing frequent upgrades of its products, far surpassing its rivals in this regard. (Bell and McNamara 1991; Brown and Eisenhardt 1995; McGrath 1994). These upgrades are key gaining market share, maintaining customer loyalty (*U.S. Industrial Outlook* 1994), gaining access to distribution channels, and ensuring profitability (Buzzell and Gale 1987). Upgrades are important also for creating revenues to build a venture's competitive position. These upgrades also serve as a credible market signal to rivals by communicating the venture's commitment to its industry. Finally, a full product line reinforces the firm's reputation among its customers, perpetuates its leadership position, and enriches its performance.

(3) R&D Spending Levels. This variable refers to the intensity of the venture's investment in internal R&D activities (Adler 1989; Dowling and McGee 1994; Lefebvre et al. 1992; McCann 1991) by building the facilities, expertise, and skills needed for continuous innovation. As stated in the text, internal R&D ensures ownership and control of key knowledge and enables the venture to profitably exploit its innovations. It also build proprietary research platforms which lead to future success (Helfat 1994).

(4) External Sources. This TS dimension refers to the venture's use of strategic alliances, acquisitions, licensing agreements, and outright purchase of technology from outside sources (Adler 1989; Dowling and McGee 1994; Kotabe and Swan 1995; Shan 1990). These sources can give the venture access to a large pool of technological capabilities that are necessary to develop new products, offset weaknesses in the venture's R&D, expedite product development, and offer opportunities for learning (Dodgson 1993). Alliances and licensing also allow the firm to bundle its particular technological advantage with key product attributes (features) developed by other firms, and quickly bring a large number of new products to the market.

(5) Copyrights and Other Means of Intellectual Capital Protection. Ventures can use several approaches to protect their intellectual capital, including copyrights and trade secrets (Levin et al. 1987; Nelson 1995; Teece 1986; Zahra et al. 1995). These approaches can sometimes delay the diffusion of information and give the venture a temporary monopoly over its discoveries. Copyrights are also among the venture's most valued assets because they enhance its reputation and strengthen its bargaining power with venture capitalists as well as generate the funds needed for R&D and new product commercialization (Bell and McNamara 1991).

Several problems arise when software new ventures attempt to use copyrights. First, applications for copyrights can leak information about the firm's discoveries (Grant 1995), which can lower the firm's competitive advantage. Information leakage can enable rivals to quickly respond to the venture's discoveries, a factor that reduces the innovative venture's lead time (Zahra et al. 1995) by enabling rivals to innovate around the copyright. Second, there is a debate on the types of software activities that can enjoy the protection of US copyright and patent laws (Zahra et al. 1995). Third, even when the venture obtains a copyright, the enforcement of the copyright laws is questionable (Liebeskind 1996). Companies and individuals sometimes copy licensed software products and use them for purposes other than those articulated in the licensing agreement (*The Economist* 1996).

TABLE 2 Dimensions of the External Environment and Their Link to Technology Strategy (TS)

Dynamism.	Dynamism reflects both the rate and unpredictability of change in the industry (Dess and Beard 1984). These changes result from the entry or exit of competitors, changes in customers' needs, and shifts in technological conditions (Boyd et al. 1993). These changes create opportunities and threats for new ventures and compel their managers to act by building and leveraging technological resources. The unpredictability of these changes can also influence managers' investment in introducing new products and timing of their release (Porter 1983). As Dess and Beard (1984: 56) conclude "Dynamism should be restricted to change that is hard to predict and that heightens uncertainty for key organizational members."
Hostility.	Hostility indicates an unfavorable business climate, such as the intense competition for resources or market opportunities (Edelstein 1992; Iansiti 1995). Hostility arises from the existence of too many competitors, unfavorable supply conditions, and strict regulation. Hostile environments are therefore resource-poor, lean environments (Aldrich 1979); they lack the abundance of resources and capacity needed to support a large number of companies (Dess and Beard 1984). Competition in these environments can be based on price or non-price factors (Grant 1995).
Heterogeneity.	Heterogeneity reflects the diversity of the market segments within an industry. This diversity results from the industry's natural conditions and from the choices the companies themselves make. As industries evolve, new segments emerge. Competing in these segments usually requires knowledge and expertise by the company, as it has to address a large number of environmentally interconnected sectors, a factor which can increase the managers' perceptions of the complexity of their environments. Heterogeneity increases also because of companies' strategic choices, especially the breadth of their served markets and product offerings. Frequently, this intensifies managers' perceptions of environmental complexity. Thus, the extent to which the firm views its external environment as being heterogeneous depends on the industry's variables themselves and thee company's strategic choices.

1994). Consequently, the study's hypotheses will focus on the growth stage of the software industry.

Third, three characteristics of the firm's external environment are acknowledged in the literature and emphasized in this study: dynamism, hostility, and heterogeneity. Although these characteristics reflect this industry's objective conditions or result from managerial enactment, the study emphasizes managers' perceptions of these characteristics because these perceptions activate TS choices (Zahra 1996) and other strategic actions (Boyd et al. 1993) Software new ventures are expected to vary significantly in their perceptions of their environments because of the wide range of software markets in which they compete as well as their different information processing capabilities, experiences, and resource endowments. Table 2 defines environmental munificence, complexity, and dynamism. The hypotheses suggested by the literature about the moderating impact of these variables on the associations between the different TS dimensions and NVP are discussed next.

Dynamism and the TS-NVP Relationship

The importance of environmental dynamism stems from the fact that both the rapid rate of technological change and the rising speed of diffusion of new ideas and technologies (Bettis and Hitt 1995) pose serious challenges to new ventures. However, ventures frequently lack the established product lines or the resources necessary to keep up with the speed of technological evolution. This is especially true in high technology industries such as software where new ventures need to build and leverage their technological

capabilities in order to achieve high NVP. Moreover, as Smith et al. (1993) observe, the uncertainty arising from dynamism is usually confounded by incomplete information about rivals' abilities and resources. Hence, "firms will often be forced to act and respond blindly, motivated by a fear of losing ground" (Smith et al. 1993: 126). These responses often entail considerable imitation. However, given the absence of dominant technological standards, the stakes are high for those ventures that hope to survive. New ventures must differentiate themselves from rivals, hoping to create an industry standard. Accordingly, as concluded by Porac and Thomas (1990), the competitive challenge facing software ventures is twofold: to differentiate themselves from the competition (to develop an industry standard) and to imitate (to avoid missteps with the market). This section outlines the TS choices expected to enhance NVP in a dynamic environment.

Radicality

Dynamic industries, such as software, usually encourage the development of radically new products and technologies (Ali 1994) in order to capture premium market segments, or preempt competitors' entry (Utterback 1994). Developing and introducing radically new products is a proactive, aggressive attempt to push out the edge of the technological frontier in an industry on a regular basis (Kerin et al. 1992). By developing and introducing radically new products, a new venture can influence its industry's evolution by shaping product design and configuration (Porter 1985), and establishing the rules of competition.

In a dynamic environment, a new venture should repeatedly develop and introduce radically new products, as any gains will quickly be diffused to rivals and its advantages lost. Indeed, those ventures that act as technological followers may have difficulty sustaining a high level of performance over time. Technological followers can sometimes gain the necessary knowledge to offer a viable substitute quickly, which reduces the costs of developing radically new products (Kerin et al. 1992). However, by the time the follower has reached the market the rapid pace of technological change will have pushed the frontier further out. Consequently, the speed with which the product is copied is usually offset by the speed with which that technology advances. Similarly, the occasional development and introduction of radically new products may produce only short periods of economic rents prior to diffusion, followed by a return to mediocre levels of performance. A TS based on second moving or the occasional introduction of radically new products therefore is better suited for a more stable environment (Miller and Friesen 1984). In a dynamic environment, however, developing and introducing radically new products on a regular basis is expected to improve NVP by enabling the venture to repeatedly target premium segments, build high market shares (Buzzell and Gale 1987), and achieve market leadership (Golder 1993; Tellis 1993). Despite the risks inherent in this strategy, the development and introduction of radically new products can improve profitability and GMS in a dynamic environment. Therefore:

> *H1a1:* In a dynamic environment, developing and introducing radically new products will be positively associated with a new venture's profits.

> *H1a2:* In a dynamic environment, developing and introducing radically new products will be positively associated with a new venture's GMS.

Intensive Product Upgrades

In a dynamic environment, the venture that introduces more products to the market can achieve superior NVP, despite the high costs associated with these activities. Some of these products may be radically new offerings as described above in H1a, or extensions or upgrades of existing products, the focus of this section. A large number of product upgrades can also increase the likelihood of having a successful product at any given time period. Over time, this stream of successful hits through successive upgrades assures steady profits, which generates the cash flow needed to support the venture's R&D efforts. Ventures with relatively few product hits can not sustain high NVP because, in a dynamic environment, few products last long as big money makers because of the rapid diffusion and imitation. As a result, the financial gains from any single new product introduction in a dynamic environment may be short-lived.

A lack of constant hits can also undermine the venture's bargaining power with down-stream channels that sometimes help maintain marginal products. These constraints are particularly critical for young firms which often lack established relationships or other assets that could be leveraged in lieu of a strong product line. Also, if several firms compete by offering a large number of new products through upgrades, the quantity of their competitive offerings may make it impossible for all firms to realize economic rents from this strategy. Thus, in a dynamic environment, frequent product upgrades and extensions are necessary to capitalize on the changes in a firm's industry and achieve profitability and GMS (Hambrick 1983; Iansiti 1995). Therefore:

H1b1: In a dynamic environment, intensive product upgrades will be positively associated with a new venture's profits.

H1b2: In a dynamic environment, intensive product upgrades will be positively associated with a new venture's GMS.

R&D Spending Levels

Dynamism also creates many opportunities for growth and profitability (Utterback 1994). Consequently, new ventures in dynamic industries need to develop and introduce many products to build market share and gain access to vital distribution channels. However, exploiting these opportunities requires strong and patient R&D investments (Porter 1985) as well as continuous innovation.

Strong R&D investments in maintaining state-of-the-art facilities and excellent researchers are especially important for building the venture's technological competencies, the keys to sustained profitability and GMS (Bogner and Thomas 1996). Internal R&D also ensures the venture's ownership and control of key knowledge, and gives the venture the ability to profitably exploit its technological developments and build proprietary research platforms that lead to future success. Internal R&D is important also because technological knowledge usually develops in a path-dependent way (Dosi 1988), and the knowledge gained at any one point in time becomes a foundation for later R&D efforts. If R&D investments in such platforms are nurtured and properly safeguarded over time, then NVP can increase.

The high speed with which technology shifts and the rapid pace of knowledge diffusion in a dynamic environment usually combine to require high investments in internal R&D activities (Dodgson 1991, 1993). Similarly, firms in dynamic industries also recog-

nize the possibility of rapid diffusion (Mansfield, Schwartz, and Wagner 1981), which can weaken the competitive position of those ventures that may not have built strong technological platforms. Unless new ventures invest heavily in internal R&D, their viability becomes questionable (Bell and McNamara 1991). Conversely, those ventures that invest heavily in R&D can establish a strong competitive position, gain market share, and achieve profitability.[1] Therefore:

H1c1: In a dynamic environment, R&D spending will be positively associated with a new venture's profits.

H1c2: In a dynamic environment, R&D spending will be positively associated with a new venture's GMS.

External Sources of Technology

Increasingly, new ventures that compete in dynamic environments are pressured to explore external sources of technologies (Shan 1990; Teece 1986). As noted in Table 1, new ventures can combine technologies secured from external sources with internal resources to offer radically new products or upgrade existing ones. This bundling of external and internal technologies can enhance the venture's capacity to introduce highly differentiated products quickly and economically (McGrath 1994). Further, given that rapid technological change increases results in rapid obsolescence, new ventures should make use of external sources. Besides, in this environment, the variety of internal resource bases found among new firms reduces the odds of a single firm being able to capture all or even many of the key thrusts that are occurring in a given market at any one time.

Although the use of external sources can sometimes reduce the profits earned on a given product (due to royalties or profit sharing with partners), this strategy can increase the regularity of generating product hits and ensure the stability of cash flow. This strategy also allows those new firms possessing a key piece of technology to plug into and pull out of alliances and other arrangements in response to changes in their market or the performance of their partners. This can give a new venture flexibility in meeting the demands of its external environment. Clearly, it is advantageous for new ventures to gain and seek access to a larger, more diverse pool of technological capabilities through external linkages and partnerships (Tyler and Steensma 1995).

The above observations support Link and Tassey's (1987) argument that environmental dynamism is conducive to the acquisition and licensing of externally-generated technologies. They also support Auster's (1992) finding that technological linkages are highest in emerging, dynamic industries. Likewise, they reinforce Hagedoorn's (1993) conclusion that alliances aimed at technological complementarity and shortening the

[1] The relationship between R&D spending and new venture profitability is complex. In a dynamic environment, low R&D spending does not support the firm's effort to create a sustainable competitive advantage. But as the new venture increases its R&D spending, its profits are likely to rise until a point of diminishing returns is reached and profits decline. Higher R&D investments do not always generate new products that can be quickly commercialized. Also, in a dynamic environment the odds are small that the firm will generate many products that will become huge money makers. Thus, a non-linear relationship might exist between R&D and profits. Therefore, to determine whether this non-linear relationship exists in the current data, the squared term for R&D spending was entered into the second step of the regression analysis for both ROE and market share growth. The results did not support this non-linear relationship. Still, because the results may be industry specific, future researchers should determine whether the relationship between R&D investment and venture performance is non-linear.

product development cycle are more prevalent in the dynamic than in stable environments. Hagedoorn notes that partnerships are especially important in the software industry as a means for gaining access to the multiple technologies necessary for the development of advanced applications. Besides broadening a venture's product offerings, external technology sources can offset weaknesses in the venture's internal R&D and give it major opportunities for learning about the competition (Dodgson 1993). Therefore:

H1d1: In a dynamic environment, the use of external technology sources will be positively associated with a new venture's profits.

H1d2: In a dynamic environment, the use of external technology sources will be positively associated with a new venture's GMS.

Patents, Copyrights, and Other Means of Protection of Intellectual Capital

Dynamism is expected to encourage a new venture to copyright or patent its innovations and safeguard them against abuses by rivals. Patents and copyrights can give the venture some control over the fate of its discoveries which it can exploit through licensing agreements or other means. They also enhance the venture's reputation, strengthen its bargaining power with venture capitalists, and obtain the funds necessary to support internal R&D (Bell and McNamara 1991). Patents and copyrights are useful also in joining strategic alliances, while protecting the venture's intellectual property, which increases the new venture's ability to gain market share and achieve growth.

However, some researchers argue that the legal protection of the venture's intellectual assets is time consuming and expensive and is of little value in fast changing industries such as software. The time and expense of obtaining such protection, the speed of technological diffusion (Liebskind 1996; Saxenian 1990), and the difficulty and expense of detecting infringement all cast doubts on the wisdom of this strategy (Mansfield et al. 1981; Rogers and Rogers 1984). Besides, both patents and copyrights are usually narrowly defined and have a limited life (Liebskind 1996). The present study, therefore, provides an opportunity to test the opposing views on the value of copyrights in a critical, dynamic industry. To ensure completeness, however, the hypothesis will be stated here (and in subsequent sections addressing other environmental moderators) following the conventional wisdom. Therefore:

H1e1: In a dynamic environment, the use of patents, copyrights and other means of protecting intellectual capital will be positively associated with a new venture's profits.

H1e2: In a dynamic environment, the use of patents, copyrights, and other means of protecting intellectual capital will be positively associated with a new venture's GMS.

Hostility and the TS-NVP Relationship

A second consideration in selecting the venture's TS is hostility (Iansiti 1995), which often pressures managers to pursue conservative choices. As noted in Table 2, hostile environments are characterized by limited resources and intense competition. They are lean, non-munificent environments (Dess and Beard 1984), where new ventures must work hard to achieve survival.

Hostility can manifest itself in two distinct ways: price and non-price competition. According to Grant (1995), during the early stages of the industry cycle, companies compete based on technological innovation (e.g., product radicality). However, as the industry becomes more established, competition usually shifts to price-related (Porter 1980) concerns where "[t]echnological competition may still be important, but the emphasis is on the use of technology to obtain low costs and quality advantage" (Grant 1995: 240). The nature of hostility, like other perceived environmental characteristics, varies by the stage of the firm's industry life cycle.

The distinction between price and non-price hostility is critical, as the venture's competitive responses and product features may vary considerably by the type of hostility that dominates the market (Porter 1980). When price-related hostility is high, customers typically demand product functionality and efficiency. Consequently, a venture's strategic responses will typically center on reducing costs or charging low prices, because successful NVP requires effective cost containment strategies (Grant 1995). By contrast, offering valued product features (e.g., image) will be more important than cost management when non-price hostility prevails. In this environment, an effective TS will typically center on building the skills that imbue those distinctive qualities that customers demand. Consequently, hostility will moderate the TS-NVP relationship, as discussed next.

Radicality

As environmental hostility rises, the development and introduction of radically new products will decline as new ventures will compete primarily as technological followers (Ali 1994; Kerin et al. 1992). One reason is that hostility usually reduces the resources available for the venture's radical product development activities (Miller and Friesen 1984). Also, since radically new products usually represent a major departure from existing and known product attributes, the high risks and high costs associated with their development might not be an acceptable risk to venture managers as the failure of these products can cause the demise of the young firm. Consequently, under these conditions, venture managers might conclude that developing radically new products is a high-risk strategy whose costs outweigh potential benefits.

The need to refrain from developing and introducing radically new products will grow as hostility rises. When price hostility is high, the combination of tight margins and limited cash flows will frequently discourage these efforts, as found by Ettlie and Bridges (1982) who reported a negative association between price volatility and radical product innovations. This decline may result from competitive price pressures that push excess profits in the industry to bid down to commodity levels. Likewise, in a market where strong non-price competition prevails, the demand for upgrades, enhanced service, and other value additions will increase a new venture's expenses. Even if higher prices can be obtained, the high costs incurred to ensure product differentiation through radical innovation will reduce the venture's profits. Therefore:

> *H2a1:* In an environment with high price hostility, developing and introducing radically new products will be negatively associated with a new venture's profits.
>
> *H2a2:* In an environment with high non-price hostility, developing and introducing radically new products will be negatively associated with a new venture's profits.

Besides reducing the profits to be gained from radically new products, hostility may

inhibit GMS. Price hostility lowers the venture's profit margins and reduces the cash available to develop and market radically new products. In the absence of radically new products, however, attempts to move competition away from a price-based rivalry and grow beyond the firm's current size will be stifled. High price-based hostility often signals that customers are not searching for significant qualitative differences among competing products. With their needs being satisfied by existing products, customers usually stress prices in making their purchasing decisions. In markets where non-price hostility prevails, however, the situation is reversed. Although the bulk of radical product innovation will be devoted to defending existing market positions, radicality can become a foundation for the firm's GMS as innovative products will be rewarded by those customers seeking non-price distinctiveness among competing product offerings. Therefore:

H2a3: In an environment with high price hostility, developing and introducing radically new products will be negatively associated with a new venture's GMS.

H2a4: In an environment with high non-price hostility, developing and introducing radically new products will be positively associated with a new venture's GMS.

Intensive Product Upgrades

To succeed in a hostile environment, a new venture should also upgrade its products by quickly modifying or extending its existing offerings (Iansiti 1995). Upgrades can enable the venture to maintain customer loyalty without incurring substantial costs in designing, testing, and developing radically new products. However, as noted earlier, even with frequent product upgrades, a new venture might not achieve significant gains in profits because product upgrades are costly. In this environment, the venture must work hard to simply remain afloat and will just as likely invest heavily in building its distribution channels, advertising or expanding its marketing activities (Porter 1980). For a young firm, however, this spending usually amounts to a higher percentage of sales than for its established rivals. In a market with high price hostility, these pressures create a "squeeze", as lower prices and increased expenses greatly reduce a venture's profit margins. These added expenses can lower a firm's net gains from upgrades (Brown and Eisenhardt 1995). However, such demand for product upgrades is often helpful to firms in a non-price-hostile environment, where upgrades allow firms to charge premium prices, retain customer loyalty, and capture additional market shares. Therefore:

H2b1: In an environment with high price hostility, intensive product upgrades will be negatively associated with a new venture's profits.

H2b2: In an environment with high non-price hostility, intensive product upgrades will be positively associated with a new venture's profits.

Growth in the venture's sales and market share will also benefit from offering frequent product upgrades, in both price and non-price hostile environments. When competition is price-based, introducing product upgrades that are fine tuned to variations in market preferences can add costs that reduce the venture's profits. However, these expenditures may be the only way by which the venture can achieve sales growth. In this environment, any price cuts to increase GMS will be quickly matched by rivals and, as argued above, radically new products are neither rewarded by the customers nor economically feasible. Similarly, the frequent introduction of product upgrades can increase the venture's share where non-price hostility is intense. Such upgrades will be

highly demanded and customers will reward those ventures that are quick to respond to market changes with GMS. Thus:

H2b3: In an environment with high price hostility, intensive product upgrades will be positively associated with a new venture's GMS.

H2b4: In an environment with high non-price hostility, intensive product upgrades will be positively associated with a new venture's GMS.

R&D Spending Level

Given the limited opportunities available in a hostile environment, managers are expected to lower their R&D investments. Believing that heavy R&D spending puts the venture at financial risk. This will be particularly true when hostility is price-based, profit margins are low, and the market does not reward radically new products. If the venture maintains an aggressive R&D program, then it risks diluting its resources without achieving satisfactory returns on its investments. Buzzell and Gale (1987) and Scherer and Huh (1992) have previously found this to be true among established companies competing in hostile environments. Consistent with these findings, new ventures in a hostile environment are expected to reduce their R&D spending in order to obtain higher profits. Similarly, in markets where non-price hostility prevails, incremental innovation is expected to replace developing radically new products as a primary means for gaining and maintaining customer loyalty (Utterback 1994; Prusa and Schmitz 1994). Thus, the overall relationship between the venture's R&D spending and profit should be positive in markets where non-price competition exists because customers usually reward innovation. Therefore:

H2c1: In an environment with high price hostility, intensive R&D spending will be negatively associated with a new venture's profits.

H2c2: In an environment with high non-price hostility, intensive R&D spending will be positively associated with a new venture's profits.

The relationship between R&D spending and a firm's GMS is also expected to vary by the type of the hostility a firm may experience. Price hostility scantly rewards R&D. As mentioned above, product upgrades are conducive to higher GMS in a price-sensitive market. Also, in this environment, all R&D expenditures come from pressured margins and may take funds away from the marketing and distribution efforts that can increase the venture's sales volume, the key to profitability in a low-margin business (Porter 1980). Thus, on balance, R&D spending will be negatively associated with growth in a market with high price hostility. The opposite is expected to be true with high non-price hostility, where R&D can promote incremental and radical product innovations as a means of ensuring customer satisfaction. Thus, under high non-price hostility, high R&D spending can promote GMS. Therefore:

H2c3: In an environment with high price hostility, intensive R&D spending will be negatively associated with a new venture's GMS.

H2c4: In an environment with high non-price hostility, intensive R&D spending will be positively associated with a new venture's GMS.

External Technology Sources

Although hostility usually pressures new ventures to lower their R&D spending, it may also encourage them to offset this with increases in their use of external sources of technology (Kotabe and Swan 1995). External sources can give the ventures quick access to multiple technologies (Dodgson 1993), shorten new product development cycles, and reduce the high risks associated with new product development efforts. External sources can also help new ventures safeguard against competence destroying changes in their industry (Tushman and Anderson 1986) by licensing technologies from other firms, instead of relying solely on internal R&D (Link and Tassey 1987). They can also reduce the uncertainty associated with technology development and quicken the ventures' responses to changing market conditions. When price hostility is high, customers become experienced and their expectations from all firms rise (Porter 1980). When the costs and risks of product development are shared with alliance partners, new ventures' profitability improves. Similarly, in markets where non-price competition is fierce, new ventures' can bundle their product traits with those of their partners, which can also increase profits. Therefore:

> *H2d1:* In an environment with high price hostility, the use of external technology sources will be positively associated with a new venture's profits.

> *H2d2:* In an environment with high non-price hostility, the use of external technology sources will be positively associated with a new venture's profits.

Technology partnerships can also positively influence a venture's GMS. Under conditions of high price competition, new ventures that find ways to share the costs of technology will have more free cash for building and supporting their distribution and marketing activities. Thus, the ventures' resources can be dedicated to broadening the sales base, building sales volume, cutting unit costs, and achieving further growth. Indeed, this is the "textbook" case of Porter's low-cost leadership advantage (1980). Under non-price hostility, new ventures that can lever-up their product attributes with those of their technology alliance partners will out-grow those firms that lack such partnerships. Alliances also enable new ventures to bring to their markets new products that few, if any, firms could develop and introduce on their own. Under high non-price hostility, customers usually reward such combinations and the ventures' market shares grow accordingly. Therefore:

> *H2d3:* In an environment with high price hostility, the use of external technology sources will be positively associated with a new venture's GMS.

> *H2d4:* In an environment with high non-price hostility, the use of external technology sources will be positively associated with a new venture's growth.

Patents, Copyrights, and the Protection of Intellectual Capital

In a hostile environment, rivals usually have an incentive to copy the new venture's products or reverse engineer them. Imitation of competitors' products can reduce the costs and risks associated with internal new product development. However, by using copyrights, patents, or similar approaches, the venture can reduce its rivals' ability to copy its products and control the conditions under which a competitor gains access to its technologies. In the software industry, having copyrights or patents can also give a

venture a temporary monopoly (Levin, Klevorick, Nelson, and Winter 1987) and enhance the venture's ability to introduce and profitably exploit its new technology. A new venture that holds a copyright can also license its technology to other firms and generate revenues, or enter strategic alliances and gain access to other firms' innovative technologies. However, as noted earlier, the high costs of both registration and enforcement of copyrights and other means of legally protecting their intellectual capital have led some to question the wisdom of this strategy (Liebeskind 1996). Also, the knowledge covered in these patents and copyrights are difficult to protect because it is difficult to detect its illegal use (Liebeskind 1996). In this environment, imitation of rivals' products is common (Porter 1980). Thus, the conventional wisdom should be tested in this study to establish if these efforts increase a venture's ability to build market share and offer distinctive products that improve performance.

When high price hostility exists, distinctive product features are not part of the competitive bundle and customers usually focus primarily on price in making their buying decisions. In this setting, copyright and patents can leak important information to the competition about the venture's innovations and, consequently, reduce the venture's overall profits. However, when non-price hostility is high, the situation becomes murkier, as those features and traits that enhance product differentiation become the key source of a venture's competitive advantage and profits. If patents and copyrights are effective, their use should increase a venture's profits. Therefore:

> *H2e1:* Under high price hostility, the use of patents, copyrights, and other approaches to protect the new venture's intellectual capital will be negatively associated with the venture's profits.

> *H2e2:* Under high non-price hostility, the use of patents, copyrights, and other approaches to protect the new venture's intellectual capital will be positively associated with the venture's profits.

Patents and copyrights can also determine the growth of new ventures, depending on the type of hostility that dominates the market. When price hostility is high, the use of patents and copyrights only adds costs and takes the scarce cash resources that the venture's thin profit margins do provide away from investments in those capabilities that usually drive growth in such a market such as distribution systems. Conversely, conventional wisdom suggests that the way in which the cash flow that fuels GMS in hostile environment is through the aggressive protection of the venture's innovations (Liebeskind 1996). Therefore:

> *H2e3:* Under high price hostility, the use of patents, copyrights, and other approaches to protect the new venture's intellectual capital will be negatively associated with high GMS.

> *H2e4:* Under high non-price hostility, the use of patents, copyrights, and other approaches to protect the new venture's intellectual capital will be positively associated with high GMS.

Heterogeneity and the TS-NVP Relationship

As noted in Table 2, heterogeneity indicates the perceived complexity of the venture's external environment (Boyd et al. 1993), based on the multiplicity of the factors that

a venture must address. This section discusses heterogeneity's potential moderating impact on the TS-NVP relationship.

Radicality

A key source of perceived heterogeneity is the emergence of multiple segments in an industry because of changes in customer needs and expectations (Slater and Narver 1994), particularly during the introductory and growth stages of an industry's life cycle (Grant 1995; Porter 1980). The emergence of these segments may encourage new ventures to redefine their markets by pursuing aggressive radical product introductions. These innovations are likely to be profitable because the firm can target new customer groups and position its products as the "industry standard," which can also stimulate GMS. Therefore:

H3a1: In a heterogeneous environment, developing and introducing radically new products will be positively associated with a new venture's profit.

H3a2: In a heterogeneous environment, developing and introducing radically new products will be positively associated with a new venture's GMS.

Intensive Product Upgrades

In a heterogeneous environment, frequent incremental product upgrades can also help the venture capture new market segments and respond quickly to changes in the needs of its customers. A venture can offer frequent upgrades of its existing products or target new segments by using existing or revised products (Grant 1995), which can increase the venture's market shares. Product upgrades and extensions also permit the ventures to target new segments and achieve high profits and growth. Prior research, using data from established companies, has reached a similar conclusion (Miller 1987). Therefore:

H3b1: In a heterogeneous environment, intensive product upgrades will be positively associated with the venture's profits.

H3b2: In a heterogeneous environment, intensive product upgrades will be positively associated with the new venture's GMS.

R&D Spending Levels

A new venture that competes in an heterogeneous environment is expected to continue its innovation intensively and capitalize on emerging opportunities in an industry while maintaining the loyalty of its existing customers (Zahra et al. 1995). Continuous innovation also requires a new venture to invest heavily in internal R&D activities, and develop those products that can capture large enough segments that will support the venture's GMS objectives. Consequently, in this environment, strong investments in R&D can improve NVP by attracting new customers and retaining the loyalty of existing segments. For those ventures that compete through radical product innovation, strong R&D investments can improve profitability and GMS. Therefore:

H3c1: In a heterogeneous environment, R&D spending will be positively associated with a new venture's profits.

H3c2: In a heterogeneous environment, R&D spending will be positively associated with a new venture's GMS.

External Technology Sources

In a heterogeneous environment, a new venture needs to obtain new and diverse technological capabilities, which can be quickly and efficiently achieved by entering strategic alliances and using other external technology sources (Hagedoorn 1993). These sources gain importance as the environment becomes more heterogeneous, because no single firm can possess all required technologies to meet customers' needs. Given that heterogeneity makes learning a time consuming process (Nonaka and Takeuchi 1995), the use of external technology sources can also improve the venture's technological capabilities and quicken its responsiveness to the market. New ventures that make good use of external technology sources by creating new products or upgrading existing ones can acquire additional market shares and achieve higher profits. Therefore:

H3d1: In a heterogeneous environment, emphasis on the use of external sources of technology is positively associated with a new venture's profits.

H3d2: In a heterogeneous environment, emphasis on the use of external sources of technology is positively associated with a new venture's GMS.

Patents, Copyrights, and the Protection of Intellectual Capital

In a heterogeneous environment, any product—whether protected by copyright (or patented) or not—can command only a small portion of the market, which can limit the venture's financial benefits. A strong copyright or a patent can at best sustain a niche position, and the returns to the venture's copyright will be limited because of the narrow scope of the copyright. Even if the protected product is superior to its close substitutes, the percentage of the overall market made up of all substitutes will be small. Also, how rivals respond to the venture's copyrights (patents) will affect the gains a venture can achieve. In this environment, where the differences in product from one segment to another are relatively small, rivals have an incentive to imitate each others' products, which can lower the value of the copyright for the innovative firm. Yet, heterogeneity encourages competitors to direct their resources to one of the other segments in the market, instead of challenging the copyright holder's superior products. Thus, a small market might exist for each copyright holder, but there also is a reduced incentive for rivals to challenge that position. Although the outcomes of each competitive contest will be determined on a case-by-case basis, conventional wisdom would suggest that those ventures that hold copyrights (or patents) are likely to capture additional market shares and achieve higher GMS and profitability. Therefore:

H3e1: In a heterogeneous environment, the use of patents, copyrights, and other means of protecting intellectual property will be positively associated with a new venture's profits.

H3e2: In a heterogeneous environment, the use of patents, copyrights, and other means of protecting intellectual property will be positively associated with a new venture's GMS.

METHOD

The U.S. software industry offered an interesting setting in which to test the study's hypotheses, it has been one of the most prolific in new product development and introduction (Prusa and Schmitz 1994). The phenomenal growth of the industry has also encouraged the creation of companies that depend heavily on commercializing new products, which has spurred further innovation and encouraged market aggressiveness among companies. This union of technology and marketing has made the software industry one of the most dynamic and fiercely competitive arenas. Ventures have responded to these challenges by developing new markets and attracting new customers, which has further increased the perceived heterogeneity of the industry. The wide range of software markets offers a variety of competitive contexts, all within the confines of a single industry.

The software industry was also chosen for study because it is one of the key industries of the future. Companies and countries that dominate this industry can leverage their technological skills in other vital industries (*U.S. Industrial Outlook* 1994). Consequently, retaining a worldwide lead is crucial for strengthening the global position of the U.S. and its companies. Recently, Japan and Western European countries have increased their investments in the industry, aiming to dethrone U.S. companies. Understanding the technological strategies of U.S. companies, therefore, can be helpful in discovering the sources of their competitive advantage. Finally, despite the limitations of single-industry studies, focusing on one industry has the advantage of providing respondents with a common frame of reference and reducing the potentially confounding effects of diverse macro-environmental conditions (Dess, Ireland, and Hitt 1990).

Sample

To collect data, the software industry's two major trade associations were contacted to identify the names and addresses of new ventures. The Software Publishers' Association provided a list of 413 names, primarily of microcomputer software producers. The Computer Software and Services Industry Association's list contained 600 names. Major newspapers were also reviewed for articles published on new software ventures, which yielded 18 additional names. Together, these sources generated 1,031 software venture names.

Three criteria were then used to select the sample. First, only companies that were eight years or younger were included, which reduced the sample to 773. Second, the study targeted only those ventures that actually developed and marketed software products; ventures that provided only customer services (e.g., educational or training programs) were excluded in order to focus on new ventures that competed by creating software products. This further reduced the sample to 629 ventures. Finally, to control for macro environmental forces, the study examined only U.S.-based software ventures, which reduced the target sample to 581.

A mail survey was then used to collect data from the 581 ventures. Personalized letters accompanied each survey, encouraging participation in the research and assuring respondents of the confidentiality of their replies. Twenty-seven questionnaires were returned undelivered. Three mailings, over a period of two months, produced 127 completed replies, of which 116 were usable, for a response rate of 20.9%. This response rate compared favorably with the 11.1% achieved by other researchers from the same

general population (e.g., Gartner and Thomas 1993), and was above the 16% achieved by Price Waterhouse in its *Software Industry Business Practices Survey*, commissioned by the Massachusetts Computer Software Council, Inc. (1991).

Tests also determined the representation of the sample to the population from which it was drawn. Initially, the combined responses from the first and second mail waves were compared to the known attributes of non-responding companies. Given that the study's population included many privately owned small companies, data were not available for all observations for all non-respondents. *T*-tests indicated that responding and non-responding firms did not differ significantly in their age ($p < 0.41$), employees ($p < 0.23$) or return on equity ($p < 0.37$). Additionally, to examine response bias by location within the U.S., a ^{2} test was conducted but was not significant ($p < 0.41$), indicating the absence of such bias. The *t*-test also revealed that respondents to the first and second mailings were not significantly different in their age ($p < 0.71$), employees ($p < .83$), return on equity ($p < 0.41$), and sales growth ($p < 0.26$). These results indicated that the sample resembled its target population in several key attributes.

To ensure reliable data, the questionnaire was sent to a second senior manager in each responding venture ($n = 116$). Forty-nine of these managers responded and their replies were then matched with replies from the main survey. Simple correlations between the two sets of respondents showed significant interrater reliability on the study's variables, as will be presented in Table 5 later in the paper.

Measures

The data used in this paper are a part of a larger study of the software industry. For the current paper, the data covered a new venture's environment, TS, performance, and statistical controls.[2]

1. Competitive Environment

To measure venture managers' perceptions of their environments, the 12-item measure developed and validated by Miller and Friesen (1982) was used to gauge these perceptions. When subjected to factor analysis, with a varimax orthogonal rotation, these items yielded four significant factors (with eigenvalues above 1.0) that accounted for 61.2 percent of the variance. The results, which appear in Table 3, showed that the measures captured the original factors theorized by Miller and Friesen (1982), except that hostility emerged as having two dimensions: price and non-price. Even though the response format used in this study differed from the original format used by Miller and Friesen (1982), which might account for the separation of the price and non-price hostility factors, two previous studies that used the revised format (Zahra 1991, 1996) produced results that were consistent with Miller and Friesen's conceptualization, which would suggest that the current results are industry-specific. The two hostility types found in this paper might have reflected the conditions in the software industry where price wars were commonplace (*U.S. Industrial Outlook* 1994). Items that had absolute loadings of 0.50 or above were emphasized in constructing four factors:

[2] Data for all the study's measures were collected for the three-year prior to the survey administration.

TABLE 3 Factor Analysis: Measures of the New Venture's Environment

	Factors			
Items*	1	2	3	4
Must use different marketing approaches in its operations[a]	0.79	0.27	0.05	−0.01
Is diversified in its business operations[a]	0.76	0.05	−0.05	0.07
Targets many customer groups with different buying habits[a]	0.74	0.05	0.00	0.08
Must use many different production systems[a]	0.73	−0.11	−0.07	0.17
Rate of innovation[b]	−0.06	0.78	0.17	−0.10
Spending on R&D[b]	0.11	0.76	−0.02	0.13
Spending on advertising[b]	0.15	0.76	−0.10	0.18
Intensity of competition based on quality[b]	−0.12	0.05	0.91	0.02
Intensity of competition based on service[b]	0.05	−0.00	0.90	0.01
Intensity of price competition[b]	0.20	−0.11	0.12	0.83
Number of competitors[b]	0.02	0.11	−0.17	0.71
Rate of bankruptcy[b]	0.07	0.16	0.08	0.63
Eigenvalue	2.82	1.86	1.60	1.42
% of variance explained	23.5	15.5	13.3	11.8
Cronbach coefficient α	0.75	0.70	0.77	0.74

* All items were standardized before performing factor analysis;
[a] Items followed a 5-point response format (1 = very untrue vs. 5 = very true);
[b] Items followed a 5-point response format (1 = low vs. 5 = high).

Factor 1: Heterogeneity (4 items): This factor indicated the perceived complexity of a venture's environment and an attempt by the venture to respond to this complexity.

Factor 2: Dynamism (3 items): This factor indicated high perceived rates of change in the industry because of intensive R&D and advertising activities.

Factor 3: Non-Price Hostility (2 items): This factor reflected the perceived unfavorableness of a new venture's external environment, as evidenced by a high rate of bankruptcies and the venture's reliance on non-price variables in building the venture's market position.

Factor 4: Price-Related Hostility (3 items): This factor indicated the perceived intensity of rivalry in the industry, coupled with intense pressures to reduce prices.

2. Technology Strategy

Twenty items were extracted from the literature to capture TS (e.g., Cooper 1984a, 1984b; Lefebvre et al. 1992; Zahra and Covin 1993). When the 20 items were factor analyzed (with a varimax rotation), they produced five significant factors that, combined, explained 74.7% of the variance. These results are reported in Table 4 and described below.

Factor 1: Internal R&D Investments (5 items): This factor captured the venture's heavy investment in internal R&D and indicated that the venture was committed to maintaining a highly professional staff, having state-of-the-art R&D facilities, and providing strong financial support for R&D.

Factor 2: External Sources (4 items): This factor indicated the venture's reliance on external sources of technology, and showed that the venture was either active in technology-based alliances or licensed technologies from other companies.

TABLE 4 Factor Analysis: Technology Strategy Dimensions

Items	Internal R&D Investments	External Sources	Product Upgrades	Radically New Products	Copyrights
Average annual spending on R&D as a percent of company sales (past 3 years).	0.88	0.16	0.11	0.31	0.19
Has one of the largest R&D groups in the industry.	0.81	−0.18	0.23	0.26	0.07
Has one of the most productive R&D groups in the industry.	0.74	0.23	0.11	0.27	0.04
Spends more on R&D than the competition.	0.63	−0.09	0.02	0.31	−0.11
Spends more on R&D than the industry average.	0.61	0.18	0.04	0.23	0.12
Uses joint ventures for R&D.	0.30	0.76	−0.21	−0.06	0.08
Is heavily engaged in strategic alliances.	−0.16	0.74	0.23	−0.09	−0.07
Collaborates with universities and research centers in R&D.	0.28	0.70	−0.16	−0.12	−0.03
Contracts out a major portion of its R&D activities.	−0.09	0.63	0.07	−0.11	0.05
Introduces more new products than the competition.	0.26	−0.21	0.74	0.08	0.17
Introduces products to the market faster than competitors.	0.31	0.16	0.71	0.07	0.08
Has reduced the time between the development and market introductions of new products.	0.23	0.08	0.68	0.13	0.21
Introduces many new products to the market.	0.09	0.26	0.65	0.02	0.13
Is well-known for introducing breakthrough-type products.	0.25	−0.18	0.21	0.70	0.15
Is this industry's leader in introducing new products.	0.12	−0.30	−0.22	0.68	0.06
Is usually among the first to introduce new products to the market.	0.23	0.11	0.03	0.55	0.08
Holds important patent rights.	0.27	0.08	0.12	0.13	0.65
Has more patents than its key competitors.	0.21	0.17	0.03	−0.27	0.58
Uses licensing agreements extensively to sell its products.	0.22	0.18	0.15	0.11	0.54
Has increased its patenting efforts over the past three years.	0.24	0.25	0.13	0.08	0.51
Eigenvalue	3.53	2.58	2.27	1.82	1.53
% variance explained	22.30	17.03	14.98	12.01	10.11
Cronbach coefficient α	0.74	0.73	0.71	0.72	0.71

Factor 3: Intensity of Product Upgrades (4 items): This factor indicated the venture's strong commitment to introducing a large number of product modifications or extensions, surpassing their key competitors.

Factor 4: Radicality of New Products (3 items): This factor indicated the venture's commitment to introducing radically new products (technologies) and showed a strong disposition by the venture to be among the first in its industry to introduce new products.[3]

Factor 5: Copyrights, Patents and Protection of Intellectual Capital (4 items): This factor showed a venture's interest in, and use of, patenting and other means (e.g., trade secrets) to protect the fruits of its innovation.

3. NVP: Profitability and Market Share Growth

Measuring NVP has been the subject of debate in the literature (e.g., Chandler and Hanks 1993). Yet, there is agreement that the complexity of the NVP construct requires the use of both growth and profitability measures because of the tradeoffs that might exist between these measures (Brush and VanderWerf 1992). Profitability was measured by the average of its three-year ROE, which indicated a venture's success in using its resources effectively to make a profit. Still, ROE was affected by the owners' salaries and other cost items that were frequently not disclosed to the public.

To overcome the limitations of ROE, two objective measures of growth were considered: sales growth and growth in market share (GMS). Sales growth showed the market acceptance of a venture's products and, therefore, was a key indicator of market success (Chandler and Hanks 1993; Cooper et al. 1989; Dowling and McGee 1994). However, Tsai et al. (1991: 14) suggested that GMS "may be the best measure of new venture performance available". GMS, which shows a venture's progress in building a strong market base at a rate greater than the overall industry growth, is a predictor of profitability. Consequently, the survey asked managers to report the percentage growth in their firm's market share over the past three-year period. However, this measure was difficult to interpret because software companies varied widely in their market definitions. Given that the sales growth and GMS measures were highly correlated ($r = 0.87$), only the results based on GMS were reported in this paper.

Data for performance measures were collected through the survey for two reasons. First, many firms were privately owned and did not publish performance results. Second, the performance of corporate venture firms were not separated from their sponsoring corporations. Data for ROE for a subset of 41 privately-owned venture were significantly correlated with secondary survey data, ($r = 0.74$, $p < 0.001$). We did the same for a subset of corporate sponsored companies and the correlation was also significant ($r = 0.69$, $p < 0.001$). Combined with the significant interrater data reported in Table 5, these results increased our confidence in the study's NVP measures. However, because validation analyses were conducted using subsets of data, caution is necessary.

[3] One of the items that loaded significantly on this factor, "Is the industry's leader in introducing new products", might conceptually overlap with the domain of the "intensity of product upgrade" factors. To test this possibility, we reran the factor analysis to force the radicality and upgrade factors into a single factor by specifying a four-factor solution. The results, however, indicated that the two factors were still distinct and that the "industry leader" in new product loaded significantly on the radicality factor. These results led us to believe that the respondents might have associated industry leadership in new product introductions with being a pioneering firm that offered many new products. Of course, the results might be industry specific.

4. Statistical Control Variables

The study also controlled for the venture's age, size, origin, and business scope. These variables affected the venture's ability to obtain and deploy resources (Bell & McNamara 1991) and TS choices (Bogner and Thomas 1996; Zahra 1996). A limitation of the study, however, was failing to explore the direct effect of these variables on the profit and NVP relationships.

Venture Size. The study controlled for the venture's size because larger ventures might have possessed more resources that allowed them to support R&D and introduce more new products than smaller ventures. The natural log of employees was used as the measure of company size.

Venture Age. The study also controlled for a venture's age because younger ventures might have pursued more radical innovations than older ventures (Rosen 1991). Age was measured by the number of years the venture had been in existence.[4]

Market (Business) Scope. Ventures that competed in a broadly defined market were expected to spend more on R&D and introduce more new products (Buzzell and Gale 1987) than ventures that defined their markets narrowly.[5] To control for differences in market scope, executives' reports on the number of market segments their company pursued were used as a control variable.

Venture Origin. The analysis also controlled for the venture's origin, whether it was created by an independent entrepreneur (coded 0) or an established company (coded 1). Origin served as a proxy for the venture's access to different resources. Corporate sponsored ventures typically had greater access to their parent company's financial, marketing, and technological resources (Zahra 1996), which allowed them to pursue more aggressive TS. Independent ventures, which were often more constrained in their resources, might pursue different TS from corporate ventures. It should be noted that corporate ventures studied here were either divisions or subsidiaries of established companies and, therefore, were subject to their managerial and strategic control. Consequently, performance data for corporate ventures were not readily available in secondary sources, as noted earlier.

Analysis

Table 5 presents the results for interrater agreement, measured by the simple correlations between the two sets of data received from executives in 49 companies. It also

[4] To explore the implications of the venture's age for TS, the sample was split into two groups: very young ventures (3 years or younger) and older ventures (4 years and older). Both the *t*-test and discriminant analysis were used to pinpoint the differences between these two venture groups in TS. The two tests yielded identical results; both show that younger ventures had significantly higher scores than older ventures on two variables: product radicality and R&D spending. Older companies (4 years and older), however, had significantly higher scores on product upgrades and use of external sources. Venture scores for the use of copyrights and patents were not statistically different between the two groups.

[5] Some past research suggests that business scope (breadth) might impact the ventures' TS. To examine this possibility, ventures were split at the mean into two groups: focused versus broad scope. *T*-tests indicated that ventures with broad market scope had significantly higher scores than focused ventures in three variables ($p < 0.05$): R&D spending, upgrades, and use of external sources. No statistically significant differences were found between the two groups in radicality or the use of patents and copyrights.

TABLE 5 Means, Standard Deviations, and Intercorrelations*

Variables	Inter Rater	x	SD	Variables												
				1	2	3	4	5	6	7	8	9	10	11	12	13
1. Dynamism	0.63	2.84	1.47	—												
2. Price Hostility	0.66	3.16	1.3	0.23	—											
3. Non-price Hostility	0.61	3.01	1.67	0.31	0.26	—										
4. Heterogeneity	0.58	2.64	1.89	0.20	0.16	0.09	—									
5. Radicality	0.74	2.94	1.81	0.27	−0.31	0.21	0.19	—								
6. Intens. Product Upgrades	0.66	2.99	1.75	0.33	−0.26	0.16	0.24	0.31	—							
7. R&D Investments	0.70	3.07	1.89	0.29	−0.11	0.15	0.27	0.27	0.34	—						
8. External Sources	0.81	3.16	1.54	0.31	0.26	0.07	0.18	0.21	0.23	0.28	—					
9. Copyrights	0.77	2.69	1.88	−0.20	0.10	0.11	0.16	0.19	0.21	0.22	0.17	—				
10. ROE	0.88	9.31	12.00	0.08	−0.08	0.09	−0.14	0.13	0.29	0.30	0.26	0.18	—			
11. GMS	0.86	22.61	26.78	0.05	0.02	−0.13	0.25	0.11	0.27	0.26	0.29	0.08	0.21	—		
12. Number of Employees	0.89	47.19	33.23	0.16	−0.16	0.12	0.18	0.23	0.16	0.26	0.11	0.14	0.18	0.12	—	
13. Age	0.94	4.71	1.83	0.11	0.04	−0.03	−0.09	−0.02	0.08	0.03	0.09	0.12	0.05	0.08	0.28	—
14. Market Scope	0.73	3.11	1.29	0.09	−0.02	0.04	0.21	−0.04	0.07	0.25	0.19	0.19	0.16	0.14	0.23	0.11

* For $n = 116$, simple r must be at least 0.16 to be significant at $p < 0.05$.

shows the means, standard deviations, and the intercorrelations among the study's variables. There was no evidence of multicolinearity among the independent variables. Consequently, moderated regression analysis was used to test the hypotheses (Cohen and Cohen 1983). In Step 1, each NVP measure was regressed on the control variables. In Step 2, each NVP measure was regressed on the control variables and the five TS factors. In Step 3, interactions of the TS factors with the four environmental dimensions were added to the control and independent variables already in the equation, and the analysis was re-run. Interaction terms were created by multiplying each of the four environmental dimensions by the five TS factors.

To maintain sufficient degrees of freedom, four separate regression analyses were performed for each NVP measure. In the first run (Step 3.1), only the interactions of dynamism with the five TS factors were added to the equation. In the second and third runs (Steps 3.2 and 3.3), the interaction terms for price and non-price hostility were entered into the analysis, respectively. The final run (Step 3.4), interaction terms formed by multiplying heterogeneity and TS factors, were added to the equation. This procedure was appropriate because the hypotheses focused on the impact of specific interactions on NVP, rather than examining all the interactions between a venture's external environment and TS factors. The results for ROE appear in Table 6, while the results for GMS appear in Table 7.

RESULTS

ROE

As Table 6 shows, neither the regression equation nor the four control variables were significant in Step 1. The equation explained a modest 3% of the variance in ROE. In Step 2, when the five TS measures were entered as a block, the equation became significant ($p < 0.05$) and had an adjusted R^2 of 11%. Radicality, product upgrades, and external sources were positively and significantly associated with ROE ($p < 0.05$ or better).

The results for dynamism appear under Step 3.1 (Table 6), where the equation was significant. Three dynamism*TS interaction terms were also significant and positive: radicality, product upgrades, and external sources. Step 3.2, which focused on price hostility, was also significant. When the price hostility*TS interactions were considered, the coefficient for the external sources was positive and significant, but the coefficient product upgrades were negative and significant. Step 3.3, which examined non-price hostility, was significant and the coefficients for product upgrades and the use of external sources were positive and significant. Finally, in Step 3.4, the equation for heterogeneity was significant and the interaction of heterogeneity with R&D spending, product upgrades, the external sources, and the use of copyrights had positive and significant coefficients.[6]

[6] To validate the results reported above, moderated regression analysis was re-run for ROE and the market share growth measures. In these analyses, all the 20 interaction terms (constructed by multiplying the 4 environment dimensions by the 5 TS factors) were entered simultaneously as a block in Step 3. The regressions explained 29.6% of ROE and 32.9% of market share growth, respectively. Significant interaction terms in these regression were similar to those found in Tables 6 and 7.

TABLE 6 Results of Moderated Regression Analysis for Return on Equity (ROE)

			Step 3			
Variables	Step 1	Step 2	3.1	3.2	3.3	3.4
Constant	−4.09	−3.61	−2.97	−2.81	−2.51	3.01
Size	−0.02	−0.04	−0.03	−0.01	−0.07	−0.08
Age	0.13	0.11	0.10	0.10	0.04	0.08
Scope	−0.12	−0.12	−0.11	−0.04	−0.05	−0.17
Origin (IV = 1)	0.02	0.03	0.02	0.01	0.04	0.02
Radicality		0.26*	0.27*	0.21*	0.29*	0.24*
Intensive Product Upgrades		0.23*	0.29*	0.29*	0.31*	0.22*
R&D Spending		−0.09	−0.18	−0.07	−0.02	−0.03
External Sources		0.41**	0.43**	0.53***	0.48**	0.45***
Copyrights		0.11	0.03	0.03	0.05	0.03
Dynamism						
• Radicality			0.49***			
• Intensive Product Upgrades			0.23*			
• R&D Spending			0.08			
• External Sources			0.18*			
• Copyrights			0.01			
Hostility (price)						
• Radicality				−0.06		
• Intensive Product Upgrades				−0.33*		
• R&D Spending				0.04		
• External Sources				0.26*		
• Copyrights				−0.01		
Hostility (Non-Price)						
• Radicality					−0.06	
• Intensive Product Upgrades					0.31**	
• R&D Spending					0.02	
• External Sources					0.19*	
• Copyrights					−0.13	
Heterogeneity						
• Radicality						0.02
• Intensive Product Upgrades						0.31*
• R&D Spending						0.33*
• External Sources						0.38**
• Copyrights						0.23*
F-value	0.91	2.37*	4.81**	3.83**	3.59**	3.71**
Adjusted R^2	0.03	0.11	0.22	0.19	0.22	0.25

* $p < 0.05$;
** $p < 0.01$;
*** $p < 0.001$.

GMS

Moderated regression analysis was also performed using the new venture's GMS as the dependent variable. The three-step procedure described under ROE was repeated here. The results in Table 7 show that the equation and the four control variables were not significant in Step 1, explaining only four percent of variance. In Step 2, where the TS variables were included in the analysis, the equation was significant ($p < 0.01$) and had an adjusted R^2 of 15 percent. Four TS variables were positive and significant: radicality, product upgrades, external technology sources, and the use of copyrights.

The equation for dynamism (Step 3.1) was significant. The interactions of dyna-

TABLE 7 Results of Moderated Regression Analysis for New Venture Market Share Growth (GMS)

			Step 3			
Variables	Step 1	Step 2	3.1	3.2	3.3	3.4
Constant	2.47	1.91	1.31	1.77	1.69	2.03
Size	0.09	0.09	0.12	0.07	0.13	0.05
Age	−0.07	−0.11	−0.14	−0.09	−0.08	0.03
Scope	0.05	0.07	0.13	0.11	0.15	0.11
Origin (IV = 1)	0.11	0.09	0.05	0.11	0.10	0.07
Radicality		0.22*	0.29*	0.22*	0.29*	0.29*
Intensive Product Upgrades		0.21*	0.25*	0.22*	0.29*	
R&D Spending		−0.10	−0.14	−0.09	−0.03	−0.11
External Sources		0.39**	0.37**	0.31*	0.36**	0.28**
Copyrights		0.20*	0.21*	0.23*	0.21*	0.23*
Dynamism						
• Radicality			0.28*			
• Intensive Product Upgrades			0.49**			
• R&D Spending			0.05			
• External Sources			0.38**			
• Copyrights			0.02			
Hostility (Price)						
• Radicality				−0.27*		
• Intensive Product Upgrades				0.19*		
• R&D Spending				−0.21*		
• External Sources				0.23*		
• Copyrights				−0.02		
Hostility (Non-Price)						
• Radicality					0.09	
• Intensive Product Upgrades					0.38**	
• R&D Spending					0.21*	
• External Sources					0.05	
• Copyrights					0.09	
Heterogeneity						
• Radicality						0.07
• Intensive Product Upgrades						0.21*
• R&D Spending						0.49**
• External Sources						0.37**
• Copyrights						0.03*
F-value	1.14	2.71**	3.97*	2.89*	2.69*	4.95**
Adjusted R^2	0.04	0.15	0.21	0.25	0.24	0.26

* $p < 0.05$;
** $p < 0.01$.

mism with the following variables were also positive and significant: radicality, upgrades, and external technology sources. The analysis for Step 3.2 was also significant. The interactions of price hostility with product upgrades and the use of external technology were positive and significant, whereas the interactions for radicality and R&D spending were negative and significant. When non-price hostility was considered (Step 3.3), the equation was significant, and the interactions terms for R&D spending and product upgrades were positive and significant. Finally, the equation for heterogeneity was significant. Three of the interactions of heterogeneity with the five TS measures were positive and significant (in Step 3.4): R&D spending, product upgrades, and the external sources of

technology.[7] These results and their implications for theory and practice are discussed in detail in the following section.

DISCUSSION

The effect of technology strategy on new venture performance has been the subject of much interest in the literature. This study shows that a new venture's TS can significantly impact its performance and that the external environment moderates the TS-NVP relationship. These results also help to identify the factors that lead to the success or failure of young, high technology companies. This section reviews the study's major findings.

THE ASSOCIATION OF TECHNOLOGY STRATEGY WITH NVP

Three observations are evident from the results on the TS-NVP relationship. First, a formal TS is significantly associated with the venture's ROE and GMS. While the modest adjusted R^2 values found in both equations indicate that other organizational variables (e.g., structure, resources, and culture) and competitive choices (e.g., manufacturing) may influence performance, the venture's TS positively and significantly impacts NVP. Second, three technological choices are significantly associated with both the venture's ROE and GMS: radicality of the firm's new products, frequent product upgrades, and the use of external technology sources. These results support the importance of the radicality of the venture's new products (Kerin et al. 1992), frequent upgrades (Dodgson 1993), and the use of the external sources of technology (Leonard-Barton 1995) for achieving superior performance. Though most past research on these variables was conducted in established companies, the results corroborate these findings in the context of young software companies.

Other results, however, were generally inconsistent with expectations. Specifically, the ventures' use of patents and copyrights was only significantly and positively associated with GMS ($p < 0.05$), but not with ROE. Perhaps, software ventures use their copyrights to achieve goals other than increasing their short-term profits, such as entering into beneficial strategic alliances to market and distribute their products.

THE COMPETITIVE ENVIRONMENT AS A MODERATOR OF THE TS-NVP RELATIONSHIP

The results of the interactions between the TS dramatize and the external environmental moderators give further insights into the drivers of NVP in the U.S. software industry.

[7] Given the range of the age of new ventures presented in the sample, we conducted additional analyses to determine the robustness of the study's findings. We reasoned that the early years of a venture's life cycle (say, before year 3), focus will center on acquiring resources and building the ventures' market network and linkages. To identify the differences associated with the ventures' age, we analyzed the data for the following four groups: 3–8, 4–8, 5–8, and 6–8 years. Overall, the results indicated that the relationships between the ventures' TS and performance (using both ROE and GMS) were not significantly related in the earlier years (3–8 and 4–8 age groups). However, for ventures in the 5–8 age range or later, the results mirrored those reported in the text, with two notable exceptions. The effect of R&D and external sources on ROE and GMS became stronger over time, which is consistent with the literature on technological learning (Dodgson 1993; Helfat 1994; Zahra 1996). These results appeared to suggest that new ventures became more proficient in transforming their own R&D as well as external sources of technological know how into a source of competitive advantage.

TABLE 8 Regression Results on Hypothesized Relationships between Emphasis on a Strategic Dimension and a High Level of an Environmental Moderator

	Environmental Moderators			
		Hostility (2)		
Strategy Dimension	Dynamism (1)	Price	Non-Price	Heterogeneity (3)
Radicality (a)				
ROE	Significant + as predicted	Predicted − association found but not significant	Predicted − association found but not significant	Predicted + association found but not significant
GMS	Significant + as predicted	Significant − as predicted	Predicted + association found but not significant	Predicted + association found but not significant
Intensive Product Upgrades (b)				
ROE	Significant + as predicted	Significant − as predicted	Significant + as predicted	Significant + as predicted
GMS	Significant + as predicted	Significant + as predicted	Significant + as predicted	Significant + as predicted
R&D Spending (c)				
ROE	Predicted + association found but not significant	Predicted − not found; instead + sign but insignificant observed	Predicted − found; + but insignificant association observed	Significant + as predicted
GMS	Predicted + association found but not significant	Significant − as predicted	Significant + as predicted	Significant + as predicted
External Technology (d)				
ROE	Significant + as predicted	Significant + as predicted	Significant + as predicted	Significant + as predicted
GMS	Significant + as predicted	Significant + as predicted	Predicted + association found but not significant	Significant + as predicted
Patenting (e)				
ROE	Predicted + association found but not significant	Predicted − association found but not significant	Predicted − association found but not significant	Significant + as predicted
GMS	Predicted + association found but not significant	Predicted − association found but not significant	Predicted + association found but not significant	Predicted + association found but not significant

To ensure clarity, Table 8 summarizes the study's results relative to the hypotheses. The results are discussed below.

Dynamism

The results support three of the five sets of hypotheses (H1a, H1b, and H1d) on the moderating effect of dynamism, as shown by the positive and significant associations

found between both measures of NVP and the measures of product radicality, product upgrades, and external sources of technology. The results, therefore, reinforce the importance of radical new products, frequent product upgrades (Prusa and Schmitz 1994), and the use of external technology sources (Dodgson 1993) for high NVP in a dynamic competitive environment.

The results do not support H1c1 and H1c2, which suggest a positive association between R&D spending and NVP. Although R&D has the expected positive signs, it is not significant in the regression analyses. Thus, although R&D spending is important for frequent product upgrades, it may not in itself lead to short-term financial or market share gains in a dynamic environment, which supports prior research (Link and Tassey 1987; Zahra et al. 1995). In some dynamic markets, new ventures may have to spend heavily on R&D to simply achieve short-term competitive parity and keep up with the rapid pace of technological change.

Contrary to H1e1 and H1e2, a venture's use of patents and copyrights is not significantly associated with the two NVP measures. Thus, when the environment is dynamic, some ventures may not benefit financially from aggressively pursuing patents (copyrights) to protect their discoveries. This finding is consistent with the study (Rogers and Rogers 1984) of Silicon Valley hardware manufacturers which concluded that, in this dynamic environment, some firms believed that the use of patents (copyrights) actually quickened the speed with which competitors imitated their innovations. In the dynamic software industry, radically new products and upgrades are being introduced at a breathtaking pace, which makes the use of copyrights a futile activity for new ventures that do not always have the resources to obtain these copyrights. Obtaining legal protection of the firm's intellectual property might take years to complete, which can further weaken the value of this approach to protecting a new venture's competitive advantage (*U.S. Industrial Outlook 1994*). Consequently, in some dynamic industries, traditional approaches to protecting intellectual property are becoming less effective (*The Economist* 1996), while their costs remain high. Thus, using copyrights may be ineffective in dynamic industries such as software.

In summary, these results partially supported the predicted moderating effect of venture's dynamic environment on the TS-NVP relationship. The results also highlighted some of the limits of conventional theory when applied to software new ventures. This point is further reinforced by the results on hostility, as discussed next.

Hostility

The study also helped to sort out the contradictory findings reported in past research on the moderating effect of perceived hostility on the TS-NVP relationship. They showed that hostility moderates the relationship between a venture's TS and its performance, albeit in ways that sometimes differed significantly from the hypotheses derived from conventional theory. Perhaps, the separation of hostility into two factors: price and non-price, provided an opportunity to untangle the specific associations of those variables with a venture's TS. The results were understandable given the study's focus on new ventures in a young industry, in contrast to past research that examined established companies in mature industries (e.g., Zahra and Covin 1993). Either way, the results offered a richer view of the impact of the interaction of hostility with TS on NVP.

The results offered limited support for H2a1 and H2a2, showing that offering radically new products is negatively associated with ROE in environments dominated by

price and non-price hostility. Although not significant in either environmental setting, these negative signs were consistent with theoretical expectations that intense hostility in these markets might make aggressive gambling of new ventures' limited financial resources by offering radically innovative products a poor strategic choice. These results also supported the literature (Slater and Narver 1994).

The results for GMS were a bit more compelling than those reported above for the ventures' ROE. In support of H2a3, there was a negative and significant association between offering radically new products and GMS when price-based hostility was high, possibly because of the drain radical product innovations might place on the venture's limited resources. In partial support of H2a4, offering radically new products was positively associated with GMS in a non-price hostile environment, although the regression coefficient was not significant.

Consistent with H2b1, frequent product upgrades were negatively and significantly associated with lower ROE when price hostility was high. These upgrades were positively associated with ROE when non-price hostility was high, which supports H2b2. For GMS, the results supported both H2b3 and H2b4. Thus, regardless of the impact on ROE, offering more product upgrades had a significant and positive impact on the new ventures' GMS. Managers should note that two of the three positive associations were in non-price hostile settings, where product line extensions and upgrades would be key tools in the venture's TS (Grant 1995). This suggested that in price-hostile environments frequent product upgrades were positively associated with GMS, but might reduce ROE. Consequently, the long-term versus short-term implications of product upgrades might be significant considerations for managers in price-hostile competitive settings where the pursuit of short-run returns can backfire (Iansiti 1995).

The relationship between R&D spending and NVP may be more complex than previously portrayed in the literature. Consistent with H2c3, when price hostility was high, R&D spending was significantly and negatively associated with GMS, but there was an insignificant positive association with ROE—which failed to support H2c1. In this environment, ROE and R&D were expected to be negatively associated. The results also showed that when non-price hostility was high, R&D spending was positively associated with GMS, which supported H2c4. Under high non-price hostility, the associations between R&D and ROE was positive but not significant, which contradicts H2c2. Although this positive sign was in the predicted direction, it is not significant. Because the results may be industry specific, research was needed to validate the findings. Meanwhile, the results emphasize the importance of R&D spending for acquiring market share where non-price competition existed, where such spending could fuel a venture's market share growth.

The results generally supported the expected positive associations between a venture's use of external sources of technology and NVP. Three of the four regression coefficients were significant and positive, as predicted. These the results support H2d1, H2d2, and H2d3, but failed to support H2d4 which suggested a positive association between the use of external sources and GMS. Although the interaction of external sources and non-price hostility was positive, it was not significantly associated with GMS. However, when hostility was high, those ventures that linked with external technology sources reported higher NVP, which was consistent with some prior findings (Dodgson 1993).

Hypotheses 2e1–4, which specified the nature of the associations between protecting the venture's intellectual property and NVP when hostility was high, were not

supported. Although three of the four regression coefficients were in the predicted direction, none of them was significant. Interestingly, the negative signs observed in H2e1 through H2e3 were consistent with expectations. These signs might have reflected the high cost of copyrights, the time it took the venture to obtain copyrights, and the possibility that copyrighting the venture's products does not preclude imitation by rivals. Those ventures that were effective patenting their innovations might even risk leaking information quickly to their rivals. Consequently, consistent with some recent writings (Grant 1995), spending a venture's resources on obtaining copyrights (patents) might be counterproductive when environmental hostility is high. Overall, although hostility significantly moderated the TS-NVP relationship, this moderating effect appeared to work in different ways in different contexts (price vs. non-price hostility). These interactions also varied significantly from the general patterns suggested by research that examined the TS used by established companies.

Heterogeneity

The results also highlighted the role of perceived environmental heterogeneity as a significant moderator of the TS-NVP relationship. As indicated in Table 8, three of the five predicted sets of associations between TS and NVP in this environment were supported. As reported earlier, the interactions of heterogeneity with product upgrades (H3b1 and 2), R&D spending (H3c1 and 2) and the use of external technology sources (H3d1 and 2) were positively and significantly associated with the venture's ROE and GMS. Success in a heterogeneous environment, therefore, appeared to depend on the venture's ability to fund and maintain a strong program of research that leads to frequent product upgrades (Miller 1987), while making extensive use of external technology sources (Hagedoorn 1993).

The results also showed that the new venture's use of copyrights (patents) was significantly associated with ROE, which supported H3c1. Consequently, H3e was partially supported, indicating that software new ventures that were active in copyrighting (or patenting) their technologies might benefit significantly from this effort. These benefits were not as strong as those gained from other TS dimensions, because any single patent might be narrow in scope and its potential impact on the venture's financial or market share gains might be limited.

The hypothesized positive association between new product radicality and NVP in a heterogeneous environment (H3a1 and 2) was not supported. Specifically, product radicality had positive but insignificant signs in the regression analyses for both ROE and GMS. Thus, radicality *per se* may not impact short-term NVP in a heterogeneous environment as strongly as theory would suggest (e.g., Kerin et al. 1992). Perhaps, the financial benefits from product radicality were greater for the industry's early entrants than for newcomers. As new segments of software users emerge, the early entrants' known names and established channels might enable them to retain any competitive advantages derived from offering radically new products (Zahra et al. 1995). This possibility should be examined in future research.

Limitations

Although the above findings provide several new insights, they also showed a need for further research on the moderating impact of a venture's environment on the relation-

ship between its TS and performance. Moving beyond this study's cross-sectional sample, future researchers can longitudinally explore the causal relationships among the TS and NVP within specific environments. Further, data from other industries, analyzed in the same way, can add significantly to the general nature of the findings. Researchers should also recognize the limitations of the data provided by the CEOs, as these data might suffer from survivor bias.

One of the study's limitations was that it did not directly examine the direct effect of a venture's resources on TS or on the TS-NVP relationships. The venture's tangible (e.g., marketing) and intangible (e.g., reputation and culture) resources can determine to the strategic options available to the new venture (Bogner and Thomas 1996), and influence the commercialization of new products (technologies), which influences a venture's competitive advantage. Rare and inimitable resources can allow the venture to create and introduce highly differentiated products, thereby protecting a venture's competitive advantage. The abundance of slack resources (e.g., excess capital) can also promote the development of radically innovative products. Intangible resources (e.g., social capital) can also improve the odds of successful technology commercialization. Consequently, by ignoring the direct effect of resources, this study might have overlooked a key determinant of the venture's TS. Further, since resources can temporarily buffer the venture from adverse environmental conditions the type and size of these resources can influence the moderating influences of the environment on the TS-NVP relationships.

Finally, as noted earlier, data were collected for the same three year period preceding the administration of the survey, limiting our ability to infer cause-effect relationships among the study's variables. Therefore, the results are best interpreted as suggesting associations among these variables at one point in time. Despite these limitations, the results suggest several possible managerial actions, as follows.

IMPLICATIONS FOR MANAGERIAL ACTION AND FUTURE RESEARCH

Managerial Implications

As the results indicate, new ventures in growth industries such as software can benefit greatly from developing and pursuing a comprehensive TS. This is evident from the fact that several dimensions of TS are significantly related to both the venture's ROE and GMS. Entrepreneurs and venture managers, however, frequently forget that having a good product or a sophisticated technology alone does not always guarantee success in the marketplace (Bell and McNamara 1991; McGrath 1994). TS must be a part of a comprehensive strategy to manage that technology as an ongoing, living resource that must fit the venture's particular competitive environment.

The results also indicate that a key part of a TS for entrepreneurs and managers is the interaction of that strategy with the ventures' external environment. This requires the active scanning and monitoring of the venture's different sectors of the environment and collecting data about their conditions. Managers must also interpret relevant environmental forces and forecast how each may impact the venture's TS choices. To ensure accurate interpretations, managers need to monitor and scan their environments and analyze their competition. These analyses can help to align managers' views with the objective conditions of their environment and markets, thus setting the stage for tech-

nology and strategic planning premises. Only after such a thorough analysis of the environment is completed can managers choose those technological capabilities that can best enhance their venture's performance. Failure to conduct an effective analysis of the environment or excessive reliance on informal means of collecting data about the industry can jeopardize the venture's technological strategies, which might be misaligned with the needs of the market.

The study also suggests that the technological capabilities that must be considered in assessing the fit between the venture's strategy and environment is not limited to the firm's internal resources. Managers need to tap both the internal and external sources of technological capabilities when managing environmental challenges. Yet, entrepreneurs and venture managers sometimes fail to cultivate the external sources of technology and use them to create new products (technologies). Despite the benefits of developing the venture's internal sources, it unrealistic to expect a young company to possess all the technological capabilities it needs to compete in a dynamic industry. Given the rapid pace of obsolescence, therefore, a venture should complement its capabilities by using external sources of technology.

Managers need also to recognize both the contributions and serious limitations of legal means of protecting their intellectual capital. As noted previously, the value of patents and copyrights appears to vary significantly from one environmental setting to another. New ventures should use trade secrets and other means to protect the venture's innovations. Constant innovation is another viable approach to protecting the venture's innovative technologies.

Finally, managers need to recognize that the various dimensions of TS interact with each other in a dynamic sense. Given this interconnectedness, a change in one variable therefore can change the nature of the competitive setting in which a venture finds itself. Firms, therefore, have to deal with the environment as a whole cannot simply alter only one variable in isolation. Future researchers therefore would benefit from adopting a holistic view of the interactions among the TS dimensions.

FUTURE RESEARCH DIRECTIONS

In addition to the refinements already suggested throughout this paper, the study draws attention for additional research on new ventures' TS. As many industries owe their existence to the foresight and innovation of new ventures, understanding how these ventures use their technological capabilities to gain a competitive advantage is fast becoming a worthwhile research issue. Future studies can further clarify the relationships between the dimensions of TS and NVP and document the changes that may occur in this relationship over time.

This study has added to our understanding of the associations of a new ventures technology strategy. Results show that some of these dimensions support one another. Examples include radical new products and R&D investments, strong R&D spending, and the use of external resources. This is important because new venture managers can capitalize on the interdependencies among the dimensions of the venture's TS and build an effective competitive approach using their firms technological capabilities. Theoretically this study shows that we should not presume *a priori* that TS dimensions will conflict with one another requiring managers to make significant tradeoffs.

Future empirical research on the relationship between the ventures' TS and NVP is needed also to identify the contextual variables that affect the payoff from technological

choices. Researchers need to track new ventures over time and examine their technological choices in different stages of growth (e.g., Hamilton and Singh 1992) or across the different stages of an industry's life cycle (e.g., Auster 1992). Longitudinal analyses can help to document evolutionary patterns in new ventures' TS. Previous researchers (e.g., Helfat 1994; Kotabe and Swan 1995; Singh 1992) who have called for such dynamic analyses of TS variables and relate them to changes in NVP. These studies can help also in identifying the side effects of the venture's use of external technology sources.

Another issue to consider in future studies is the moderating role of the breadth (scope) of the venture's business on the TS-NVP relationships in different environments. Although this study has treated business scope as a control variable, Porter (1980, 1983) suggests that it shapes the firm's strategic choices, especially TS. Scope also influences the venture's performance (Grant 1995).[8]

The nature of interactions among the TS variables should be further explored. As pointed out in the previous section, environmental conditions leading to such interactions among the variables are not only anticipated, they are likely inevitable. Only by developing a richer understanding of these interactions can the full impact of the prescriptions for each TS variable be understood.

Finally, as noted earlier, most new ventures have resource constraints that might influence their TS choices. Although this study has used venture origin as a proxy for differences in resource endowments, researchers should consider more direct measures of venture capitalization and explore the effect of this variable on TS. Researchers need also to link a venture's resource pool to its TS choices within different environments and clarify the effective interplay between a firm's resources, strategy and performance in different environments.

Measuring the tangible and intangible resources of a new venture is a demanding task. In this study we have explicitly measured R&D resources. Understanding how a new venture uses its technological resources to build a competitive advantage is an important issue that requires careful analysis and direct measures of these resources in future studies.

Given that the current study's results are based on reports by managers of their perceptions of the environment, there is a need to further explore the link between the objective qualities of the environment and the ventures' TS; managers' perceptions of their environments do not always reflect the objective attributes of their markets and industries. By examining the impact of the environment's objective qualities (Dess & Beard 1984) and managers' perceptions, researchers can establish the relative contributions of these two sets of variables on TS or explore the effect of the mismatch between these objective qualities and perceptions on the payoff from the venture's TS. Such mis-

[8] To gain a better appreciation of the moderating role of business scope on the study's hypotheses, the sample was split at the median into narrow versus broad business scope. Separate analyses were rerun for each subgroup. In terms of dynamism, the results showed that those ventures with broad scope had higher coefficients than ventures with narrow scope on the following hypotheses: H1b1, H1b2, H1c1, and H1d1. Ventures with narrow scope had significantly higher coefficients than ventures with broad scope in the case of H1d2. In terms of hostility, narrow scope ventures had a significantly higher coefficient with regard to H2a1 (more negative effect), H2b1 (more negative effect), H2d2, and H2d4. Ventures with broad scope had significantly higher coefficients than ventures with narrow scope on the following: H2b1, H2b2, H2c3, and H2d1. Finally, the results for heterogeneity indicated that ventures with broad scope had significantly higher coefficients than the other ventures on: H3b1, H3c1, H3c2, H3d1, and H3d2. The opposite was true in the case of H3a1 and H3a2, where the coefficients for ventures with narrow scope were higher than those with broad scope.

match, which may arise from ineffective competitive analyses, poor environmental analyses, managers' cognitive biases, or managerial hubris, can lead ventures to pursue ineffective TS, a factor that cause the demise of new firms.

The process by which new ventures develop and deploy their TS is another area that requires additional research to answer several basic questions: How are the various aspects of TS integrated to create a competitive advantage? How are the firm's perceptions of the competitive environment factored in making these choices? How are adjustments in the venture's TS made over time and by whom? Answering these questions can be useful in documenting the evolutionary changes that may occur in the firm's TS. The longitudinal studies prescribed above can be especially helpful in this regard.

New ventures have contributed significantly to the technological progress of the U.S. by creating and commercializing innovative products, services, and goods. Gaining an enduring competitive advantage from these products requires new ventures to pursue technology strategies that match the conditions of their external environment. Further empirical research is needed to determine the precise nature of the interactions between the new ventures' environments and technological strategies, and how these interactions may influence these firm's performance. We hope that the current results will encourage further research on these issues.

REFERENCES

Adler, P. 1989. Technology Strategy: Guide to the Literature. In R.S. Rosenbloom and R.A. Burgelman, eds., *Research on Technological Innovation, Management and Policy.* Greenwich, CT: JAI Press, 1–25.

Ali, A. 1994. Pioneering Versus Incremental Innovation: Review and Research Propositions. *Journal of Product Innovation Management* 11:46–61.

Anderson, P. and Tushman, M.L. 1990. Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change. *Administrative Science Quarterly* 35(4):604–633.

Auster, E.R. 1992. The Relationship of Industry Evolution to Patterns of Technological Linkages, Joint Ventures, and Direct Investment Between U.S. and Japan. *Management Science* 38(6):778–792.

Bell, C. and McNamara, J. 1991. *High-Tech Ventures: The Guide for Entrepreneurial Success.* Reading, MA: Addison-Wesley Publishing Company, Inc.

Bettis, R.A. and Hitt, M.A. 1995. The New Competitive Landscape. *Strategic Management Journal* 16:7–9.

Bogner, W.C. and Thomas, H. 1996. From Skills to Competencies: The "Play-Out" of Resource Bundles Across Firms. In R. Sanchez, A. Heene, and H. Thomas, eds., *Dynamics of Competence-Based Competition.* London, UK: Pergamon, 101–117.

Bogner, W.C. and Thomas, H. 1994. Core Competence and Competitive Advantage: A Model and Illustrative Evidence from the Pharmaceutical Industry. In G. Hamel and A. Heene, eds., *Competence Based Competition.* Chichester: John Wiley and Sons, Ltd., 111–144.

Boyd, B.K., Dess, G.G., and Rasheed, A.M.A. 1993. Divergence Between Archival and Perceptual Measures of the Environment: Causes and Consequences. *Academy of Management Review* 18(2):204–226.

Brown, S.L. and Eisenhardt, K.M. 1995. Product Development: Past Research, Present Findings, and Future Directions. *Academy of Management Review* 20:343–378.

Brush, C. and VanderWerf, P. 1992. Comparison of Methods and Sources for Obtaining Estimates of New Venture Performance. *Journal of Business Venturing* 7(2):157–170.

Buzzell, R. and Gale, B. 1987. *The PIMS Principles.* New York, NY: Free Press.

Chandler, G. and Hanks, S. 1993. Measuring the Performance of Emerging Businesses: A Validation Study. *Journal of Business Venturing* 8(5):391–408.

Cohen, J. and Cohen, P. 1983. *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences.* Hillsdale, NJ: Erlbaum.

Cooper, A.C., Woo, C., and Dunkelberg, W. 1989. Entrepreneurship and the Initial Size of Firms. *Journal of Business Venturing* 4:317–332.

Cooper, R.G. 1984a. How New Product Strategies Impact on Performance. *Journal of Product Innovation Management* 2:5–18.

Cooper, R.G. 1984b. New Product Strategies: What Distinguishes the Top Performers? *Journal of Product Innovation Management* 2:151–164.

Dess, G.G. and Beard, D.W. 1984. Dimensions of Organizational Task Environments. *Administrative Science Quarterly* 29(1):52–73.

Dess, G.G., Ireland, D., and Hitt, M. 1990. Industry Effects and Strategic Management Research. *Journal of Management* 16:7–27.

Dodgson, M. 1991. Technology Learning, Technology Strategy and Competitive Pressures. *British Journal of Management* 2:133–149.

Dodgson, M. 1993. *Technological Collaboration in Industry: Strategy, Policy, and Internationalization in Innovation.* London: Routledge.

Dosi, G. 1988. Sources, Procedures, and Microeconomic Effects of Innovation. *Journal of Economic Literature* 26:1120–1171.

Dowling, M.J. and McGee, J.E. 1994. Business and Technology Strategies and New Venture Performance: A Study of the Telecommunications Equipment Industry. *Management Science* 40(12):1663-1677.

Ettlie, J. and Bridges, W. 1982. Environmental Uncertainty and Organizational Technology Policy. *IEEE Transactions on Engineering Management*, EM-29, 2–10.

Gartner, W.B. and Thomas, R.J. 1993. Factors Affecting New Product Forecasting Accuracy in New Firms. *Journal of Product Innovation* 10:35–52.

Golder, P. and Tellis, G. 1993. Pioneer Advantage: Marketing Logic or Marketing legend? *Journal of Marketing Research* 30(May): 160–174.

Grant, R.M. 1995. *Contemporary Strategy Analysis: Concepts, Techniques, Applications*, second edition. Cambridge, MA: Basil Blackwell, Inc.

Hagedoorn, J. 1993. Understanding The Rationale of Strategic Technology Partnering: Interorganizational Modes of Cooperation and Sectoral Differences. *Strategic Management Journal* 14:371–385.

Hambrick, D.C. 1983. High Profit Strategies in Mature Capital Goods Industries: A Contingency Approach. *Academy of Management Journal* 26(4):687–707.

Hamilton, W. and Singh, H. 1992. The Evolution of Corporate Capabilities in Emerging Technology. *Interfaces* 22(4):13–23.

Helfat, C. 1994. Evolutionary Trajectories in Petroleum Firm R&D. *Management Science* 40: 1720–1747.

Hill, C. W. and Jones, G. 1992. *Strategic Management, An Integrated Approach*, 2nd ed. Boston, MA: Houghton Mifflin Company.

Huff, A. 1982. Industry Influences on Strategy Reformulation. *Strategic Management Journal* 3:119–131.

Iansiti, M. 1995. Shooting the Rapids: Managing Product Development in Turbulent Environments. *California Management Review* 38(1):37–58.

Kerin, R.A., Varadarajan, P.R., and Peterson, R.A. 1992. First-Mover Advantage: A Synthesis, Conceptual Framework, and Research Propositions. *Journal of Marketing* 56:33–52.

Kotabe, M. and Swan, K.S. 1995. The Role of Strategic Alliances in High-Technology New Product Development. *Strategic Management Journal* 16:621–636.

Lefebvre, L., Langley, A., Harvey, J., and Lefebvre E. 1992. Exploring the Strategy-Technology

Connection in Small Manufacturing Firms. *Production and Operations Management* 1:269–284.

Leonard-Barton, D. 1995. *Wellsprings of Knowledge.* Boston, MA: Harvard Business School Press.

Levin, R., Klevorick, A., Nelson, R., and Winter, S. 1987. Appropriating the Returns for Industrial Research and Development. *Brooking Papers on Economic Activity* 3:783–820.

Liebeskind, J. 1996. Knowledge, Strategy, and the Theory of the Firm. *Strategic Management Journal* 17 (special issue):93–107.

Link, A.N. and Tassey, G. 1987. *Strategies for Technology-based Competition: Meeting the New Global Challenge.* Lexington, MA: Lexington Books.

Mansfield, E., Schwartz, M. and Wagner, S. 1981. Imitation Costs and Patents: An Empirical Study. *Economic Journal* 91:907–918.

McGee, J.E., Dowling, M.J., and Megginson, W.L. 1995. Cooperative Strategy and New Venture Performance: The Role of Business Strategy and Management Experience. *Strategic Management Journal* 16:565–580.

McGrath, M.E. 1994. *Product Strategy for High-Technology Companies: How to Growth, Competitive Advantage and Increased Profits.* Burr Ridge, IL: Irwin.

Miles, R. and Snow, C. 1978. *Organizational Strategy, Structure and Process.* New York: McGraw-Hill.

Miller, A. 1988. A Taxonomy of Technological Settings, with Related Strategies and Performance Levels. *Strategic Management Journal* 9:239–254.

Miller, D. 1987. The Structural and Environmental Correlates of Business Strategy. *Strategic Management Journal* 8:55–76.

Miller, D. and Friesen, P. 1982. Innovation in Conservative and Entrepreneurial Firms: Two Models of Strategic Momentum. *Strategic Management Journal* 3:1–25.

Miller, D. and Friesen, P. 1984. *Organizations: A Quantum View.* Englewood Cliffs, NJ: Prentice Hall.

Nonaka, I. and Takeuchi, H. 1995. *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation.* New York, NY: Oxford University Press.

Pisano, G. 1990. The R&D Boundaries of the Firm: An Empirical Analysis *Administrative Science Quarterly* 35:153–176.

Porac, J.F., Thomas, H., and Baden-Fuller, C. 1989. Competitive Groups as Cognitive Communities: The Case of Scottish Knitwear Manufacturers. *Journal of Management Studies* 26:397–416.

Porac, J. and Thomas, H. 1990. Taxonomic Mental Models in Competitor Definition. *Academy of Management Review* 15:224–240.

Porter, M.E. 1980. *Competitive Strategy.* New York, NY: The Free Press.

Porter, M.E. 1985. *Competitive Advantage.* New York, NY: The Free Press.

Prusa, T.J. and Schmitz, Jr., J.A. 1994. Can Companies Maintain Their Initial Innovative Thrust? A Study of the PC Software Industry. *The Review of Economics and Statistics* 76(3):523–540.

Reger, R. and Huff, A. 1993. Strategic Groups: A Cognitive Perspective. *Strategic Management Journal* 14:103–124.

Rogers, E.M. and Rogers, J.K. 1984. *Silicon Valley Fever.* New York, NY: Basic Books.

Rosen, R. 1991. Research and Development with Asymmetric Company Sizes. *Rand Journal of Economics* 22:411–429.

Saxenian, A. 1990. Regional Networks and the Resurgence of Silicon Valley. *California Management Review* Fall: 89–112.

Scherer, F. and Huh, K. 1992. R&D Reactions to High-Technology Import Competition. *Review of Economics and Statistics* 74:202–212.

Shan, W. 1990. An Empirical Analysis of Organizational Strategies by Entrepreneurial High-Technology Firms. *Strategic Management Journal* 11:129–139.

Singh, H. 1992. The Evolution of Corporate Capabilities in Emerging Technologies. *Interfaces* 22(4):13–23.

Slater, S.F. and Narver, J.C. 1994. Does Competitive Environment Moderate the Market Orientation-Performance Relationship? *Journal of Marketing* 58(1):46–55.

Smith, K.G., Grimm, C.M., and Gannon M.J. 1993. *Dynamics of Competitive Strategy*, Newberry Park, CA: Sage.

Software Industry Business Practices Survey. 1991. Massachusetts Computer Software Council, Inc.: Price Waterhouse.

Teece, D.J. 1986. Profiting From Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy. *Research Policy* 15:285–305.

Tsai, W. M-H., MacMillan, I.C., and Low, M.B. 1991. Effects of Strategy and Environment on Corporate Venture Success in Industrial Markets. *Journal of Business Venturing* 6:9–28.

Tushman, M. and Anderson, P. 1986. Technological Discontinuities and Organizational Environments. *Administrative Science Quarterly* 31:439–465.

Tyler, B.B. and Steensma, H.K. 1995. Evaluating Technological Collaborative Opportunities: A Cognitive Modeling Perspective. *Strategic Management Journal* 16:43–70.

U.S. Industrial Outlook. 1994. Washington, DC: Department of Commerce.

Utterback, J. 1994. *Mastering the Dynamics of Innovation.* Cambridge, MA: Harvard Business Press.

Zahra, S. 1991. Predictors and Financial Outcomes of Corporate Entrepreneurship: An Exploratory Study. *Journal of Business Venturing* 6(4):259–285.

Zahra, S. 1996. Technology Strategy and Performance: A Study of Corporate-sponsored and Independent Biotechnology Ventures. *Journal of Business Venturing* 11(4):289–321.

Zahra, S. and Covin, J. 1993. Business Strategy, Technology Policy and Company Performance. *Strategic Management Journal* 14:451–478.