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BUSINESS STRATEGY, TECHNOLOGY POLICY AND FIRM PERFORMANCE

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This paper presents a study of the relationships among select business strategy dimensions, technology policy dimensions, and firm performance. The research sought to identify how these variables interrelate at the bivariate and multivariate levels. Data were collected from 103 manufacturing-based firms representing 28 mature industries. Results show that technology policy choices vary widely across firms with different business strategies, and that business strategy affects the strength of the relationship between firm performance and particular technology policies.

As companies respond to global competition, there is a growing recognition of the pivotal role of technology in determining market success (Council on Competitiveness, 1991; Franko, 1989; Fusfeld, 1989; Mitchell, 1990). As a result of this recognition, companies have increased their adoption of advanced technologies and, also, their introduction of technologically sophisticated products. These changing practices have alerted companies to the need for developing technology policies that are consistent with or 'fit' business strategy (Clark and Hayes, 1985; Collier, 1985). This fit ensures the successful deployment of a company's technological capabilities and resources in pursuit of the goals of business strategy. Such effective deployment of technological resources helps to build a sustainable competitive advantage that enhances a company's financial performance (Porter, 1985).

However, despite the wide recognition of the importance of this fit, the relationship between business strategy and technology policy has not,

in general, been well documented empirically in the literature (Adler, 1989; Capon and Glazer, 1987). Consequently, little statistical evidence exists regarding how technology policy relates to business strategy and, ultimately, to company performance. More fundamentally, there is no agreement on the content of technological policies (Adler, 1989; Holt, 1989), which makes it difficult to evaluate their contribution as a source of competitive advantage. Finally, the bulk of the literature in this area is conceptual in nature (A. Miller, 1988), and empirical studies conducted to date have focused on the larger, powerful firms (or their divisions) rather than their smaller and more numerous counterparts. This shortcoming of the literature is alarming because of the importance of small companies to the U.S. economy in general (Bracker and Pearson, 1986) and to technological development in particular (MIT Commission on Industrial Productivity, 1989). Given the general paucity of comprehensive empirical studies on technology policy, especially those that relate to smaller firms, the generalizability of past findings may be questionable.

This paper describes a study of the business

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strategy–technology policy interface and its association with company performance. The study addresses three research questions. First, how strongly are various technology policy dimensions related to several generic business strategy dimensions? Second, to what extent do the dimensions of technology policy vary across firms with different business strategies? Third, does business strategy moderate the strength of the relationship between various technology policy dimensions and firm performance? Answers to these questions will provide a basis for selecting technology policies that fit specific competitive strategies, thereby leading to superior company financial performance.

This paper contributes to the literature in four ways. First, it offers a multidimensional conceptualization of technological policy—a much discussed topic in the literature (Adler, 1989), but rarely attempted empirically. Second, the study advances and tests specific hypotheses on the interface between business strategy and technological policy and how this interface influences company performance. This is a departure from prior studies which empirically addressed the interface between technology and strategy as a secondary issue. In contrast, this study is designed on the premise that the interface between technological and business choices is a major source of superior company performance. It suggests that high-performing companies will adopt a coherent set (gestalt) of technological choices that, taken together, create a competitive advantage.

Third, the study offers data on the dynamics of success and failure among small, specialized companies that compete in mature business environments. In this way, the study fills another void in the literature by responding to the call for empirical research that helps to increase our understanding of how specialized (Carroll, 1984), small firms (Covin and Slevin, 1989; Meredith, 1987) compete in today's marketplace. Fourth, and finally, the study examines several mature sectors of the U.S. economy in which technology plays an increasingly prominent role in strengthening the competitive position of companies. The results document the importance of the interface between technological and business strategy variables for company success—an important issue in view of the fierce global competition in today's markets (Bartlett and Ghoshal, 1991).

The remainder of this paper is divided into

five sections. The first reviews the relevant literature on the strategy–technology interface. It introduces a classification of past research in this area, aiming to position this study and its research questions within the literature. This section also introduces the business strategy and technology policy dimensions examined in the study. The second section details the rationale behind the specific relationships examined, and presents the study's hypotheses. The third section discusses the sample, measures, and analytical techniques. The results are presented in the fourth section which includes data and observations from extensive reviews of secondary sources and interviews with select company executives. Finally, the fifth section discusses the conclusions and implications of the research, and outlines future research directions.

THEORETICAL BACKGROUND

Past research

Business strategy defines the long-term plan of action a company may pursue to achieve its goals. Technology policy embodies the choices companies make about acquiring, developing and deploying technology to help reach the goals of their business strategy (Adler, 1989). The literature stresses the need for fit between business strategy and technology policy. Fit means that the choices in business strategy and technology will be compatible, thus reinforcing one another (Porter, 1983).

Most prior writings on the topic of the business strategy–technology policy interface have been prescriptive and conceptual or anecdotal in nature. To date, few studies have focused directly on the empirical relationships among technology policy and business strategy. As A. Miller notes:

Research actually documenting the relationships between technology, strategy, and performance has been slower to develop than our sense of the need for such research. Several streams of research exist which link bits of technology to pieces of strategy or performance, but too little effort has been given to integrating such works. The result of this disparity is that while we may feel certain that strategy and performance are strongly tied to technology, we probably feel uncertain as to how various links mesh with one another in some 'big-picture' sense. (1988: 239)

The dearth of empirical studies on the nature of technology policy and ways to integrate it with business strategy has been overshadowed by an abundance of conceptual models that purport to link these constructs. These conceptual models continue to proliferate, unfortunately without attention to the empirical validation of their claims. Although most models typically share the common objective of integrating the content (components or dimensions) of technological and strategic choices, they have diverse foci. To put the present study in perspective, Table 1 provides an overview of the major themes of research on the business strategy–technology policy interface.

Two factors underlie Table 1. The first is the *orientation* of the studies. Orientation refers to whether a study is empirical or purely conceptual. The second factor is the *scope* of the study. Scope refers to the number of technological dimensions assessed in the study. Studies that follow a unidimensional orientation stress only one technology policy variable that should be aligned with business strategy. Conversely, multidimensional investigations stress two or more components of technology policy and examine their relationships with dimensions of business strategy. Table 1 displays four cells that result from categorizing the literature according to the two factors of orientation and scope. The following paragraphs discuss the major themes and important findings from leading studies in each cell.

Cell 1. Research in this cell typically describes particular dimensions of technology policy that are normatively related to one or more dimensions

of business strategy. Technology dimensions discussed include: a firm's technological resources, types of R&D programs (Foster, 1986; Zahra and Fescina, 1991), R&D spending (Schoonhoven, 1984), internal vs. external sources of technology (Ford, 1988), and organizational policies for the development and use of technology (Camillus, 1984). Clearly, these studies have been influential in cataloging the important dimensions of technology policy that should fit a particular strategy. However, the bulk of this normative research fails to consider the gestalts of technology-related variables that may influence company performance with particular strategic types.

Cell 2. Several researchers have offered integrative, normative models that prescribe fit among different dimensions of technology policy and business strategy. Maidique and Patch (1988) offer the quintessential example of this conceptual research. First, they define a technology policy as consisting of six dimensions: type of technology, desired level of competence (closeness to the state of the art), internal vs. external sources of technology, R&D investment, timing of technology introductions, and R&D organization. The authors then classify business strategy into four types: first-to-market, second-to-market, late-to-market, and market segmentation. Finally, the authors propose technology policies that are compatible with business strategy. Porter (1983) follows a similar approach in prescribing links between technology policies and business strategies. Overall, these studies have been influential in shaping thought about the interface between technology and strategy. One reason for their

Table 1. An overview of past research on fit between business strategy and technology policy

| Orientation | Scope | |
|-------------|---|--|
| | Unidimensional | Multidimensional |
| Conceptual | Camillus (1984) Ford (1988) Foster (1986) Fusfeld (1989) | Maidique and Patch (1988) Porter (1983, 1985) |
| Empirical | Armour and Teece (1980) Hambrick <i>et al.</i> (1983) | Ettlie (1983) Ettlie <i>et al.</i> (1984) A. Miller (1988) |

wide success lies in their parsimony; after proposing multiple dimensions of technology policy, the authors typically relate them to a typology of business strategy. Still, empirical validation of the propositions underlying these studies has been minimal.

Cell 3. As Table 1 shows, several scholars have focused on examining empirical links between particular dimensions of technology policy and business strategy. An example is the study by Hambrick, MacMillan and Barbosa (1983) of the fit between the intensity of product innovation and business strategy (defined in terms of the Miles and Snow, 1978, typology). The study concluded that Prospectors emphasized product innovation more than Defenders. This and similar studies have moved the field forward by providing empirical tests of the performance implications of the fit between particular dimensions of technology policy and business strategy. A shortcoming of these studies is their emphasis on only one dimension of technology policy and the corresponding neglect of possible synergies among different dimensions.

Cell 4. Studies in this cell have been few, perhaps because of the methodological difficulties inherent in conceptualizing and testing multivariate relationships of fit between technology and strategy. A. Miller's (1988) study exemplifies this stream of research. Miller focused on the delineation of technology settings. In separating these settings, Miller considered three constructs: production methods, rate of innovation, and product sophistication. Cluster analysis revealed six technological settings. Miller then examined the variations in business strategy variables (e.g., advertising and promotion) across these settings. The study found that business strategy variables influenced company performance differently in different settings. This suggested a need to establish fit between particular dimensions of business strategy and technology policy to create successful performance.

Although studies in Cell 4 have increased our understanding of fit between technology and strategy, only a few studies have examined the implications of fit for company performance. Thus, the conditions under which this fit results in improved company performance are unclear.

Overall, past research on the fit between business strategy and technology policy suggests three conclusions. First, the bulk of the literature

is conceptual in orientation. Clearly, there is a need for empirical studies that document the associations between technology policy and business strategy. Second, although there is no agreement on the content of technology policy, there is a growing recognition of the need for multidimensional conceptualizations. Finally, the financial performance implications of fit between technology policy and business strategy are not well documented. Empirical evidence on the implications of this fit is necessary before prescriptions for managerial action can be substantiated.

To study attempts to remedy the above three shortcomings in the literature by: adopting a multidimensional definition of both business strategy and technology policy; testing the empirical associations among the dimensions of these constructs; and exploring the implications of fit between technology and strategy for company performance. Overall, the study builds on and extends the research in Cell 4 of Table 1. The following sections introduce the study's variables and hypotheses.

The business strategy dimensions

Four business strategy dimensions were examined in this research: commodity-to-specialty products, marketing intensity, cost leadership, and product line breadth. These dimensions were chosen for examination because they represent fundamental strategic choices that are meaningful in a wide variety of environmental settings (Buzzell and Gale, 1987; Hambrick and Lei, 1985; Oster, 1990). Moreover, these dimensions may relate to a firm's decisions regarding technology policy, albeit some more directly than others. The following paragraphs describe these dimensions in detail and offer examples of their use in the mature industries examined in this research.

Commodity-to-specialty products

Commodity products are generally low margin, nonunique products that are not usually suitable for high price market segments. These products are often marketed without regard to market segmentation variables. Historically, many of the firms in the U.S. textile industry have been commodity producers. However, besieged by fierce foreign competition in recent years, some

firms have opted to pursue a strategy of differentiation by offering specialty products. The advantage of these products is that they are typically high margin, unique products that are often targeted toward some clearly identified high price segment (Buzzell and Gale, 1987). Thus, product type can be conceptualized as a dimension ranging from commodity products to specialty products.

Marketing intensity

Firms vary significantly in their emphasis on marketing activities. Some firms view advertising as a primary and necessary revenue generating tool while others build their business strategy around other competitive tactics (Scherer, 1980; Shepherd, 1985). Similarly, creating strong brand identification within a market may have varying utility for different competitors, depending upon such factors as the degree to which the firm sees value in trying to leverage its visibility across product lines. In short, the intensity of a firm's marketing efforts is, and should be, recognized as a critical dimension of business strategy (Buzzell and Gale, 1987; D. Miller, 1988; Vanden Abele and Christiaens, 1986). The importance of this dimension of business strategy is evident today in many mature sectors of the U.S. industry. For instance, concerned with maintaining industry sales growth, home furniture, paperboard box and steel manufacturers have increased their spending on advertising.

Cost leadership

The concept of cost leadership has been popularized in Porter's (1980) writings on generic business strategies. According to Porter, a firm can gain a competitive advantage through achieving the lowest cost structure in the industry without neglecting other important areas such as service and product quality. As described by Porter (1980) and validated by Dess and Davis (1984), possible tactics associated with a cost leadership strategy include finding ways to reduce production costs, achieve high capacity utilization, offer competitive (low) prices, and establish efficient operations in terms of raw materials procurement, internal production processes, and product distribution.

Recent changes in the strategies of the U.S.

commodity textile producers illustrate the importance of this dimension of business strategy. To meet the challenge of global competition, these producers emphasized a strategy based on low costs and correspondingly low prices. To implement this strategy, companies shortened their product development cycle, held inventory low, used computerized product designs, refurbished their machinery to reduce waste, and used inexpensive raw materials.

Past studies have clearly shown that the low cost orientation represents an internally consistent construct, as evidenced by the empirical results reported in the literature (Dess and Davis, 1984; Fryxell, 1990; D. Miller, 1988). This perspective on cost leadership is adopted in this research. That is, to understand the implications of low cost leadership orientation for technology policy, this study joins other investigations that employ an overall measure, rather than separating the sources of advantage. Future researchers may wish to explore the specific associations between the tactics used to create low cost and particular aspects of technology policy.

Product line breadth

This dimension refers to the number and variety of items embodied in a company's product line (Buzzell and Gale, 1987). While larger firms often have broader product lines than smaller firms, the breadth or variety of products offered by a firm is a decision that can be affected by many variables including product life cycle considerations, top management's attitude toward risk, and potential economies of scope.

Product line breadth is a major variable in a firm's set of strategic choices. It influences the product mix, manufacturing operations and economics, required skills and capabilities, and many other organizational decisions. For example, in the 1970s and 1980s, most U.S. steel producers offered narrow product lines in the belief that there was little room for effective product differentiation. However, recent technological developments in the industry and fierce competition from international producers caused a major change in these companies' strategy. Today, many U.S. steel producers offer broader product lines than they did a decade ago. The opposite situation is currently occurring in the textile industry where, increasingly, companies

are being forced to specialize by limiting the items in their product lines. In both the steel and textile industries, changes in the breadth of product lines have resulted in changes in other dimensions of business strategy such as marketing intensity.

The above four dimensions of business strategy are not exhaustive in scope as they do not touch on functional area decisions regarding, for example, finances and human resource management. Nor do they fully reflect the breadth of the strategy construct as outlined by, for example, Venkatraman (1989a). Nonetheless, strategic choices on these four dimensions are widely considered fundamental to business strategy and can influence one another (Oster, 1990), resulting in distinct configurations of business strategy (Porter, 1980). These configurations should be empirically examined if the business strategy–technology policy interface is to be understood.

The technology policy dimensions

The literature presents diverse ‘lists’ of potentially important components of technology policy (see, for example, Maidique and Patch, 1988; Porter, 1983). As defined in this research, technology policy is the set of organizational decisions concerning (1) aggressive technological posture, (2) automation and process innovation, and (3) new product development. These three areas, with examples from mature industries, are discussed below.

Aggressive technological posture

This dimension refers to the firm’s preference for or propensity to use technology proactively in positioning itself (Oster, 1990). A firm that employs technology proactively aspires to be on the leading edge of technological change in the industry by building a reputation for being first in the industry to try new methods and technologies, being an industry leader in innovation efforts, and being an early industry entrant regarding innovation efforts (Adler, 1989).

Companies sometimes have diverse technological postures because of differences in technological know-how, differences in appreciation of the potential role of technology in organizational operations (Foster, 1986), and variations in

business strategy (Porter, 1983). Moreover, an aggressive technological posture can signal specific competitive initiatives and resource commitments by the firm (Porter, 1985). For example, aiming to establish themselves as world class manufacturers, many companies in the steel, textile, machine tools, and furniture manufacturing industries have adopted the latest computer technology in their operations and increased R&D spending on radically new products and product technology.

Automation and process innovation

This dimension of technology policy relates to the level of automation of plants and facilities, the adoption of the latest technology in production, and capital allocations for new equipment and machinery (Hayes and Wheelwright, 1984). These choices can show a strong proclivity toward having state-of-the-art process technology (or the opposite) that is a reflection of top management’s philosophy about the way technological considerations should be factored into the production process.

Automation and process innovation are among the important dimensions of technology policy (Thurow, 1987). Decisions on the appropriate level of automation can suggest areas of potential involvement for R&D scientists and engineers. If a firm chooses to develop its technology internally, this decision will also influence company R&D investment. Furthermore, automation and process innovation decisions cannot be made without considering a firm’s emphasis on technology as a source of competitive advantage. If the firm follows an aggressive technology policy, it must develop an up-to-date technological infrastructure (Hills, 1989) which facilitates continuous innovation and improved productivity. For instance, several U.S. steel companies have invested heavily in building new production facilities. Minimills have also adopted computer aided designs (CAD) and acquired technology from both domestic and international sources. Similarly, the paperboard box manufacturing industry’s spending on automation and computerization has increased significantly in recent years, resulting in major improvements in operations as well as cost savings. Clearly, automation is a major component of technology policy.

New product development

This dimension refers to the intensity of a firm's product development activities (Zahra, 1991; 1993). Companies that pursue intensive product development activities tend to surpass their counterparts in the number and rate of new product introductions (Cooper, 1987). An emphasis on these activities signals a firm's understanding that superior products are a key determinant of business success. This appreciation of new product development is prevalent today in almost every sector of the economy. As mentioned, textile, steel and paperboard producers have taken advantage of new technology by designing and introducing new products.

HYPOTHESES

The preceding discussion suggests that the business strategy–technology policy relationship should be examined at two levels. First, to understand how specific business strategy dimensions relate to particular technology policy dimensions, the strength of the bivariate strategy–technology relationships should be examined. Second, to determine how the business strategy and technology policy dimensions collectively interrelate, variations in technology policy should be examined across firms with different configurations of business strategy dimensions. The following sections develop these two themes.

Business strategy–technology policy relationships

Commodity-to-specialty products

Of the three technology policy dimensions, the aggressive technological posture dimension would seem to have the most obvious theoretical relationship with the commodity-to-specialty products dimension. This is because specialty product firms may benefit more than commodity product firms from technological aggressiveness and, accordingly, more readily adopt such a posture. For example, it may be easier for producers of specialty products to sustain a competitive advantage by being early industry entrants and leaders in industry innovation efforts (Stobaugh, 1988). However, for commodity producers, any advantage gained through 'first-mover' status is

typically short lived due to price competition which can quickly erode these companies' market share.

Hypothesizing that specialty producers will adopt an aggressive technological posture leads to a second prediction. These companies will emphasize continuous product innovation to safeguard against potential obsolescence.

To appreciate the validity of the above predictions, consider Burlington Industries, a leading textile producer and one of the companies in the current sample. As with other companies in its industry, Burlington faced fierce competition from foreign and domestic producers. As a result, Burlington decided to focus on specialty fabric making. This decision led to several changes in the company's technology policy. Most notable was the adoption of an aggressive posture where Burlington chose to be on the cutting edge of its industry by introducing innovative designs. Further, to transform its commitment to specialty fabrics into reality, the company refocused its R&D to encourage applied projects in its newly defined fields. In this way, Burlington attempted to meet the changing needs of its markets through continuous product innovation.

The automation and process innovation dimension of technology policy has the least obvious theoretical linkage with the commodity-to-specialty products dimension. The level of a firm's automation and capital investment in the latest production technology may be relatively independent of the firm's product type(s). It is easy to conceive of both commodity and specialty products being manufactured using new or old technology. For instance, commodity and specialty textile producers alike have invested heavily in automation and process innovation (*Survey of Current Business*, 1986–1991). Thus, it is hypothesized:

H1: An emphasis on offering specialty products is positively associated with the aggressive posture and new product development dimensions of technology policy, and not significantly associated with the automation and process innovation dimension.

Marketing intensity

Aggressive marketing programs often aim to build a company's name recognition, promote a

company's brands and products, position the firm relative to its rivals, discourage entry into the company's segment, and erect mobility barriers (Shepherd, 1985). The benefits of such programs are often more readily sustained when accompanied by an aggressive technological posture (Geroski and Murfin, 1990). The active pursuit of product development is frequently central to such a posture. More specifically, firms that engage in extensive product development generally also undertake aggressive marketing, otherwise their new products will go unnoticed. Furthermore, when a firm emphasizes the building of strong brand identification, a key component of marketing intensity, it creates a situation in which new products are more readily accepted by the market (Clark and Hayes, 1985). This, of course, would be particularly critical among firms that rely heavily on new product development as a basis for creating and sustaining a competitive advantage.

As with the commodity-to-specialty products dimension, it is difficult to envision a strong association between the automation and process innovation dimension of technology policy and marketing intensity. A firm's level of automation and reliance on state-of-the-art production technology would seem to be poor predictors of marketing intensity, and vice versa. This possibility is indirectly supported by research from the PIMS data base where a correlation of $r = 0.13$ was found between 'plant newness' (defined as investment in new facilities and equipment divided by total plant and equipment) and marketing expenditures as a percent of sales (Buzzell and Gale, 1987). It is hypothesized:

H2: The marketing intensity of a firm's business strategy is positively associated with the aggressive posture and new product development dimensions of technology policy, and not significantly associated with the automation and process innovation dimension.

Cost leadership

Firms that emphasize the cost leadership dimension of business strategy usually seek to surpass their competitors on a key factor that often leads to a sustainable competitive advantage: a low cost position. Similarly, firms that adopt an aggressive technological posture usually try to

create a situation where they can, through their proactiveness, achieve a unique competitive position based on their technological prowess. As such, while these two concepts—cost leadership and aggressive technological posture—differ in their specific manifestations, they may be part of a larger construct that reflects a firm's desire to achieve a unique market status. Of course, it is just as logical that an aggressive technological posture will take the form of an emphasis on new product introduction as an emphasis on cost minimization. Nonetheless, an aggressive technological posture is predicted to be positively associated with a strategic thrust of cost leadership.

Past empirical research suggests that cost leadership depends on the successful use of process technology to achieve economies of scale (Dess and Davis, 1984). Thus, a positive association is also predicted between the cost leadership and automation and process innovation dimensions. Finally, past research also suggests that firms often achieve cost leadership positions by refining their existing products or models (Dess and Davis, 1984). This finding suggests that low cost companies will have product lines that consist primarily of established, rather than new, models or brands.

H3: The cost leadership dimension is positively associated with the aggressive posture and automation dimensions of technology policy, and not associated with the new product development dimension.

Product line breadth

Firms that emphasize product development do not necessarily have broad and diverse product lines (Horwitch and Thietart, 1987). These firms can, for example, regularly replace their mature products with new products and, consequently, keep their product lines at a manageable breadth. It seems likely, however, that firms with active product development programs generally will have broader, more diverse product lines than firms without such programs. Breadth enables these companies to copy successful innovations from one line of business to another, thus reducing the overall probability of failure. Breadth also gives companies a basis for building on the commonalities among their products in introduc-

ing new brands. Armour and Teece's (1980) work supports the possibility of a positive association between the breadth of a firm's product line and its emphasis on product development activities.

The linkages between product line breadth and the other technology policy dimensions are somewhat less clear. Most notably, product line breadth may not be strongly associated with a firm's reliance on automation and process technology innovations. For instance, firms with broad product lines could understandably benefit from any efficiencies that might be gained through the employment of advanced process technologies. This is because the potential for production inefficiencies tends to grow with the number of product lines offered by a firm. However, broad and widely varying product lines may not permit the widespread standardization of advanced process technology across a firm's operations. Thus, firms with broad and diverse product lines may not be the most likely users of automated facilities and state-of-the-art production technology.

A similar scenario can be advanced about the potential association between line breadth and the aggressive technological posture dimension of a firm's technology policy. For instance, as the number of business lines multiplies, a firm may adopt different technological postures for each, depending upon the specific market and competitive conditions faced by the firm. Thus, a proactive posture may prevail in certain markets while a defensive posture may exist in others. Such differences along different business lines make it difficult to predict the pattern of association between product line breadth and many technology policy dimensions. Clearly, these relationships should be empirically examined. Toward this end, it is hypothesized:

H4: Product line breadth is positively associated with the new product development dimension of technology policy, and not significantly associated with the aggressive posture and automation dimensions.

Business strategy patterns and technology policy choices

The preceding section outlined the predicted associations between individual business strategy

and technology policy dimensions. Such a bivariate perspective on relationships between associated constructs can facilitate an understanding of specific linkages. This is arguably a meaningful endeavor because of the dearth of information on how technology policy is associated with business strategy, as noted in our review of past research and Table 1. Yet, this approach ignores the possibility of conflicting alignments between multiple dimensions of both competitive strategy and technology policy (Venkatraman and Prescott, 1990).

To avoid the shortcomings of the reductionistic approach to the study of complex phenomena, a holistic perspective is necessary. In the context of the current study, such an approach could involve an examination of the technology policy of firms with different business strategy patterns. Proponents of the configuration approach suggest that a firm's strategic choices form overall 'gestalts' or patterns that combine these decisions (Miller and Friesen, 1984). Therefore, given the anticipated relationships between the individual business strategy and technology policy dimensions discussed above, it seems reasonable to extend the underlying logic and expect variations in technology policy across firms with different strategy configurations. Because the likely characteristics of empirically-derived strategy patterns are difficult to state *a priori*, the following general hypothesis is offered:

H5: The three technology policy dimensions will significantly vary across firms in different business strategy clusters.

Business strategy–technology policy interface and company performance

Not all technology policy decisions will be equally or strongly associated with high company performance. These dimensions vary in their ability to create a competitive advantage (Oster, 1990; Porter, 1983). One variable that theoretically moderates this ability or, more specifically, the relationship between technology policy decisions and firm performance is business strategy. That is, certain technology policies may be most effective when linked to particular strategic choices (Porter, 1985). For example, the employment of automation and advanced process technology may be most strongly related

to performance among firms that have cost leadership as a significant dimension of their competitive strategies. Accordingly, it seems appropriate to empirically investigate the performance-related consequences of adopting a particular technology policy when pursuing a particular business strategy. Such an examination would be useful in identifying appropriate dimensions of technology policy that enhance companies' performance within specific strategic contexts. Thus, it is hypothesized:

H6: The range of correlations between the individual technology policy dimensions and firm performance will significantly vary across firms in different business strategy clusters.

Hypothesis 6 suggests that the fit between technology policy and business strategy will impact firm performance. If this is true, then one would expect high- and low-performing firms to exhibit different patterns of associations between the individual technology policy and business strategy dimensions. The set (gestalt) of technology policy choices that theoretically fit best with the individual business strategy dimensions were detailed in Hypotheses 1 through 4. Firms that pursue a set (gestalt) of technology choices that fit the mandate of their business strategy will likely achieve higher levels of performance. Taken together, H1 through H4 suggest a gestalt of effective technology-strategy choices. Thus it is hypothesized:

H7: The relationships predicted in Hypotheses 1 through 4 will be more characteristic of high-performing firms than of low-performing firms.

METHODS

The sample

A questionnaire was mailed to 368 companies in 28 four-digit SIC codes. The questionnaire was directed to the CEO or the highest ranking official because of this individual's direct involvement in formulating company strategy and policy. Consistent with the study's focus on business-level strategy, only companies that generated at least 70% of their revenue in one of the 28 industries were contacted for this research. Using the 70% cutoff point was consistent with Rumelt's

research (1974), as well as subsequent research practice (Dess, 1987; Lawless and Finch, 1989). By focusing on 'dominant' or 'single' business firms, it was possible to control for the potential effects of diversification on company strategic and technological choices and financial performance. Completed questionnaires were received from 103 companies, for a response rate of 28%. (21 other questionnaires were received but excluded from the analysis because of missing data.) Telephone calls to 15 of the responding companies verified the direct participation of their most senior executives in providing data for this study.

The sampled companies compete in mature industries which include: textiles, metal household furniture, setup paperboard boxes, paving mixtures and blocks, blast furnaces, and steel mills. These industries were chosen because industry maturity poses many challenges for organizational survival (Grant, 1991; Porter, 1980). Importantly, these industries have actively adopted new technologies to varying degrees (Council on Competitiveness, 1991). Coupled with a focus on smaller firms, the current study attempted to add to the literature on small companies' survival in hostile environments (Covin and Slevin, 1989). This hostility arises from stable (and sometimes declining) demand, customer switching and intense competition, all of which characterize the industries examined here.

Companies in the sample have an average sales revenue of \$117.9 million (S.D. = 38.79) and a mean age of 56.90 (S.D. = 27.54) years. On average, the businesses in the present sample are somewhat smaller than those in, for example, the PIMS data base which tend to be 'among the top oligopolists in the industries in which they compete' (Beard and Dess, 1981: 635). However, the MIT Commission on Industrial Productivity studies (1989) has noted that most of the companies in the industries examined here are quite small by nature.

Collecting data on technology and strategy from a single key executive, typically the CEO, is consistent with the prior research on smaller or specialized firms (Bracker and Pearson, 1986; Hall, 1992). CEOs are the persons most knowledgeable of their firms' overall strategies (Birley and Westhead, 1990; Hambrick, 1981; Hrebiniak and Snow, 1980) and technological choices (Kazanjan and Drazin, 1992). Nonethe-

less, additional data were collected from a second senior respondent within a subset of the sampled firms to determine the reliability and accuracy of the survey data. These additional data, which will be discussed later, support the reliability of the data collected from the CEOs.

The measures

Multi-item indices were used to measure business strategy, technology policy, and company performance, as described in the following paragraphs.

The business strategy scales

Business strategy was operationalized along the four dimensions of commodity-to-specialty products, marketing intensity, cost leadership, and product line breadth. The Appendix presents the scales used to measure these dimensions. The items were grouped to create overall indices, following past research (Dess and Davis, 1984; D. Miller, 1988). In each case, the mean response to scale items was used as the firm's score on that measure. A firm's scores on the measures were derived by adding the responses for each item of the scale, then dividing by the number of items in the scale.

As the Appendix shows, the scales are anchored in reference to a firm's key competitors, an approach that has two advantages. The first is its recognition of the fact that strategy is a comparative term (Snow and Hambrick, 1980). By comparing a firm's emphasis on a particular variable relative to that of its key rivals, an accurate evaluation can be made of the firm's competitive commitment in its industry. This approach has been widely used in the strategic management literature (e.g., Buzzell and Gale, 1987; Calori and Ardisson, 1988; D. Miller, 1988). Another advantage of referring to competition in the measurement of strategy constructs is the fact that this method controls for the potentially confounding effect of industry variables on the observed relationships in the data (Dess, Ireland and Hitt, 1990). Still, a potential shortcoming of this approach is the possibility that it can downplay the level of a dimension's importance within an industry. Future studies could use other anchors to investigate the significance of this possibility.

The technology policy scales

Technology policy was operationalized along the three dimensions of aggressive technological posture, automation and process innovation, and new product development. The Appendix displays the scales for these dimensions. In each case, the mean response to the scale items was used as the firm's score on that measure.¹

The use of questionnaires to collect data on competitive strategy and technological choices has a long, established tradition in the strategic management literature. Many researchers have used surveys to collect data on different dimensions of competitive strategy (e.g., Conant, Mokwa and Varadarajan, 1990; Dess and Davis, 1984; Hall, 1992; D. Miller, 1988; Venkatraman, 1989a). Similarly, researchers have relied on questionnaires to gauge different dimensions of a firm's technology policy (Hall, 1992; Hitt, Ireland and Palia, 1982; Snell and Dean, 1992), including aggressive technological posture (e.g., Ettlie, 1983; Maidique and Zirger, 1984; Powell, 1992); automation and process innovation (Ettlie, 1983; Ettlie, Bridges and O'Keefe, 1984; McDougall, Deane and D'Souza, 1992; Rosenthal, 1984) and new product development (Cooper, 1987; Ettlie *et al.*, 1984; Khan and Manopichetwattana, 1989; Miller and Friesen, 1982; D. Miller, 1988).

Moreover, collecting data from CEOs on both strategy and technology, as was done in this study, has several advantages. First, there is mounting evidence in the literature that managerial attitudes and perceptions influence a company's technological investments and choices (Ginsberg and Venkatraman, 1992; MIT Commission on Industrial Productivity, 1989). Thus, it is important to capture senior executives' views of technological choices. Using data provided by CEOs on technological choices also helps to overcome a limitation of secondary data sources. Specifically, these sources do not provide detailed information about the various components of a

¹ To assess the validity of responses and determine whether the scale scores were artifacts of the method used, we reexamined the patterns of relationships in the data to see if an 'upward' bias existed. We reasoned that if systematic bias existed, higher scores would be consistently associated with performance. An examination of Tables 5 and 6 revealed that this was not the case. Still, it might be advantageous for future researchers to explore the usefulness of different response formats.

firm's technology policy. For instance, little can be found in secondary references on the extent of a firm's focus on process innovation, except brief cases that do not allow an accurate measure of this important dimension. A similar situation exists for aggressive technological posture measure. Thus, collecting data from CEOs on these dimensions of technology policy provided a reliable proxy of organizational efforts in this regard.

Still, to ensure the accuracy of the survey measures, we correlated the strategy and technology measures with data from other sources, using two approaches. In the first, we contacted a second group of executives (other than respondents to the mail survey) by phone and secured the collaboration of 31 in responding to the items covering the strategy and technology dimensions. All these individuals had worked continuously for their firms for the past 5-year period. The executives were asked to rate their companies' emphasis on each item at the year of initial data collection. Responses from this group were matched with those from their firm's CEOs. The *t*-test was then used to determine if significant differences existed between the two sets of respondents on the technology and strategy measures. No significant differences were found between the two groups ($p > 0.05$). These results provided support for the proposition that CEO responses represented the views of other members of the top management team.

The second approach to validating the measures required correlating survey measures and secondary data on selected dimensions of technology and strategy. As mentioned, secondary sources do not contain data for all of the study's measures. However, secondary data on two measures of strategy and two measures of technology policy were available for some firms. Focusing on strategy variables, data were available for 78 firms on advertising spending as a percent of company sales. This measure correlated positively with the survey-based index on marketing intensity ($r = 0.67$, $p < 0.001$). Data were also gathered by phone from the 31 executives mentioned above on 'the number of items in your company's product line three years ago.' These figures correlated significantly with the 'product line breadth' measure ($r = 0.62$, $p < 0.01$).

Validation of the technology policy measures

proceeded in two steps. In the first, data on companies investment in R&D were collected from secondary sources. Data were available for 81 firms. R&D figures were then multiplied by 0.25. Past research has shown that companies typically devote about 75% of their R&D to product development and the remaining 25% to process innovations (Scherer, 1989: 36). Therefore, to develop an approximation of a firm's commitment to process R&D and automation (one of our measures), we multiplied R&D spending as a percent of company sales by 0.25. The product of this procedure was then correlated with the survey-based measure of 'automation and process innovation.' The two measures were significantly associated ($r = 0.67$, $p < 0.001$). Finally, through phone interviews and secondary sources, data were available on the number of new products introduced to market for 41 companies. These data were significantly correlated with the new product development scale ($r = 0.59$, $p < 0.01$). Overall, the above analyses supported the accuracy of the survey measures.

The firm performance scale

Data were collected from secondary sources (COMPUSTAT, Ward's Directory and company annual reports) and phone calls to companies regarding their return on sales (ROS) for a 3-year period *following* the survey data collection. ROS is one of the most widely used measures of company performance at the SBU and single-business level of the analysis (Lawless, Bergh and Wilsted, 1989). Using an objective performance measure *following* the survey data collection allowed us to make inferences regarding the effects of technology and strategy choices on company performance.

The analytical techniques

The first step of the data preparation focused on adjusting the study's variables to reflect interindustry variations in technological innovation (Kamien and Schwartz, 1988) and financial performance. Overlooking such interindustry variations can result in misleading findings (Dess *et al.*, 1990). Therefore, the procedure suggested by Sousa de Vasconcellos e Sa and Hambrick (1989) to control for industry variations was

used. Briefly, a firm's score was subtracted from its industry average and the difference was divided by the industry mean. The result of this process was then multiplied by 100. The adjusted score reflects how well a company performs compared to its industry. Because the scales had different response formats, the final step of data preparation was to standardize the data (e.g., Hambrick, 1984).

The testing of Hypotheses 1 through 4 required that a correlation matrix of the business strategy and technology policy variables be computed and evaluated for consistency with the hypotheses. H5 required that the firms be grouped according to similarity in their strategy patterns. Ward's method of hierarchical cluster analysis was used for this purpose (Everitt, 1974). Ward's method minimizes intracluster differences and maximizes intercluster differences on the clustering variables, in this case the four business strategy scales. One-way analysis of variance (ANOVA) and contrast tests were then used to determine whether the technology policy dimensions differed across the resulting clusters.

H6 implies that the technology policy dimensions will vary significantly in their correlations with company performance across firms with different business strategy patterns. Accordingly, as the test for H6, a modified Fisher Z transformation statistic (Schmidt, Hunter and Pearlman, 1981) was employed to determine if each technology policy dimension's correlation with performance was significantly different for the clusters of firms with the most positive and least positive (or most negative) coefficients.

Finally, the testing of H7 required that the sample be divided into high- and low-performing subgroups. This was accomplished by splitting the sample at its median performance (ROS) value (Hambrick, 1984). Hypotheses 1 through 4 were then tested within each subgroup.

As a supplement to the quantitative analysis reported in conjunction with the seven hypotheses, we reviewed trade and business publications and corporate documents on some of the sampled firms and contacted several executives. The purpose was to gain a better appreciation of how companies' strategic and technological choices influenced their performance. Observations from these secondary sources will be summarized, together with statistical results, in the following section.

RESULTS

Table 2 presents the summary statistics for the study's variables. All scales have alpha coefficients that exceed the value of 0.60 suggested by Van de Ven and Ferry (1980). Accordingly, the scales are sufficiently reliable for data analysis purposes.

Associations among business strategy and technology policy variables

Table 3 displays the intercorrelations among the study's variables. Correlations between the technology policy and business strategy variables range from -0.23 to 0.46 . The wide range of observed correlations for these measures suggests that business strategy and technology policy are distinct theoretical constructs. To further explore the appropriateness of this conclusion, we employed the diagnostic tests suggested by Neter, Wasserman, and Kutner (1989). These tests determine the extent of multicollinearity among measures. The results showed that multicollinearity was not a serious problem in the present data base, thus further supporting the distinctiveness of the business strategy and technology policy scales.

Hypotheses 1 through 4

Support for the first four hypotheses emerges from examining the data in Table 3. Consistent with Hypothesis 1, the commodity-to-specialty products scale is positively correlated with the aggressive technological posture ($p < 0.001$) and new product development ($p < 0.001$) scales, but is not significantly correlated with the automation and process innovation scale ($p > 0.05$).

Hypothesis 2 is largely supported by the data in Table 3. The results show that marketing intensity is significantly correlated with the aggressive technological posture and new product development scales, both at $p < 0.001$. However, contrary to expectations, the marketing intensity measure is negatively associated with the automation and process innovation scale ($p < 0.05$).

The data also partially support Hypothesis 3. As anticipated, the cost leadership scale is positively associated with the aggressive technological posture ($p < 0.001$) and automation and

Table 2. Summary statistics for the research variables (based on adjusted, standardized data)

| Variables | Mean | S.D. | Alpha |
|---|--------|------|-------|
| Commodity-to-specialty products | − 0.86 | 0.35 | 0.63 |
| Marketing intensity | − 0.63 | 0.43 | 0.74 |
| Cost leadership | 0.76 | 0.26 | 0.84 |
| Product line breadth | 0.98 | 0.38 | 0.82 |
| Aggressive technological posture | 0.82 | 0.39 | 0.75 |
| Automation and process innovation | 1.05 | 0.67 | 0.89 |
| New product development | 0.65 | 0.33 | 0.86 |
| Firm performance (return on sales, ROS) | 0.99 | 0.47 | — |

process innovation scales ($p < 0.001$). However, the cost leadership scale is also positively, although more modestly, associated with the new product development scale ($p < 0.05$).

Hypothesis 4 is also partially supported by the data. As predicted, the product line breadth scale is significantly and positively correlated with the new product development scale ($p < 0.001$), but not significantly associated with the automation and process innovation scale ($p > 0.05$). However, contrary to expectations, product line breadth is positively and significantly associated with the aggressive technological posture scale ($p < 0.05$).

Overall, the data are consistent with the theory behind the study’s hypotheses, if not the precise expectations of the hypotheses. In each case where a positive correlation was predicted between a business strategy variable and a technology policy variable, one was found. In those cases where significant correlations between two variables were not anticipated but were found (e.g., between product line breadth and aggressive technological posture), the magnitudes of these correlations were relatively low. These results support the argument that a predictable linkage exists between business strategy and technology policy.

Hypothesis 5

The testing of Hypothesis 5 proceeded in two steps. The first involved the derivation of empirically-valid clusters of firms with similar business strategies. The second step involved the examination of variations in the three technology policy dimensions across the strategy clusters. Both steps are described below.

A. Cluster results The results of the cluster analysis of the four business strategy scales suggested that a five-cluster solution best fits the data. This conclusion is based on an examination of changes in the squared euclidean distance between various cluster solutions as well as an examination of the dendrogram which depicts the cluster separation points. Table 4 presents the means and standard deviations of the business strategy variables in each cluster. The one-way ANOVA F -ratios for each business strategy dimension are also displayed to verify that there are overall intercluster differences in this regard. In addition, Duncan’s range test was used to aid in interpreting cluster differences through pairwise comparisons of cluster means, as summarized in Table 4. The following paragraphs describe the five clusters based on the information in Table 4.

Cluster 1: Undifferentiated, Low Marketing Intensity Firms ($n = 23$). Firms that offer the most commodity-like products are represented in this cluster. The firms’ mean score on this variable is significantly lower than the remaining four strategic clusters ($p < 0.05$). This low score accounts for the cluster’s ‘undifferentiated’ label. Cluster 1 firms also show low intensity in their advertising and marketing efforts, in all cases well below firms in the other clusters ($p < 0.05$). Cluster 1 firms appear to be least concerned with cost leadership as a strategic thrust. A moderately broad product line is also typical of these firms, as evidenced by these companies’ relatively high scores on the ‘breadth’ scale.

Cluster 2: Middle-of-the-Road Firms ($n = 21$). The label given to this cluster stems from the fact that compared to other clusters, these companies have modest scores on the four

Table 3. Intercorrelations among the study's variables

| | Variables | | | | | | | |
|------------------------------------|-----------|---------|---------|---------|---------|--------|--------|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1. Commodity-to-specialty | | | | | | | | |
| 2. Marketing intensity | 0.40*** | | | | | | | |
| 3. Cost leadership | 0.43*** | 0.41*** | | | | | | |
| 4. Product line breadth | −0.22* | 0.35*** | −0.17 | | | | | |
| 5. Aggressive technology posture | 0.41*** | 0.46*** | 0.40*** | −0.20* | | | | |
| 6. Automation & process innovation | −0.16 | −0.23* | 0.45*** | 0.16 | 0.38*** | | | |
| 7. New product development | 0.33** | 0.40*** | 0.21* | 0.38*** | 0.48*** | 0.10 | | |
| 8. Return on sales (ROS) | 0.28** | 0.31** | 0.42*** | −0.24* | 0.28* | 0.35** | 0.32** | |

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 4. Means and standard deviations of the business strategy variables in each cluster

| Variables | Cluster ^a Means/S.D.s | | | | | F | Duncan results* |
|------------------------|----------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------|-----------------------------------|
| | 1 (<i>n</i> = 23) | 2 (<i>n</i> = 21) | 3 (<i>n</i> = 26) | 4 (<i>n</i> = 19) | 5 (<i>n</i> = 14) | | |
| Commodity-to-specialty | −6.19 0.32 | 0.56 0.16 | 0.66 0.29 | 2.10 0.44 | −0.99 0.20 | 17.13*** | 1 < 2,3,4,5 4 > 2,3,5 |
| Marketing intensity | −4.98 0.66 | 0.70 0.30 | 0.78 0.28 | 2.66 0.70 | −2.39 0.20 | 36.09*** | 1 < 2,3,4,5 4 > 2,3,5 3 > 5 |
| Cost leadership | 0.04 0.28 | 0.45 0.12 | 0.98 0.33 | 1.25 0.38 | 0.48 0.25 | 21.17*** | 4 > 1,2 |
| Product line breadth | 0.94 0.73 | 0.87 0.29 | 0.40 0.25 | 2.65 0.63 | 0.29 0.40 | 50.12*** | 1 > 3,5 4 > 1,2,3,5 |

*Cluster labels: 1 = Undifferentiated, low marketing intensity firms, 2 = Middle-of-the-road firms, 3 = Prudently aggressive, medium-breadth firms, 4 = High profile, specialty firms, 5 = Low profile, narrowly-focused firms.
* $p < 0.05$, *** $p < 0.001$.

business strategy variables. These companies: (1) offer products that are marginally more specialty-like than commodity-like, (2) engage in moderate marketing and advertising, (3) place average emphasis on actions designed to create a cost leadership position, and (4) offer a moderately broad line of products.

Cluster 3: Prudently Aggressive, Medium-Breadth Firms ($n = 26$). These companies stress the building of strong brand identification through the marketing and advertising of products that are typically more specialty-than commodity-like. The label 'prudently aggressive' is given to these firms because of this greater emphasis on marketing efforts and the fact that cost leadership is a more prominent strategic thrust than found in Clusters 1 and 2. The product lines offered by firms in this cluster are moderate or similar in breadth to those of their competitors.

Cluster 4: High Profile, Specialty Firms ($n = 19$). Firms in this cluster exhibit the highest scores on the four business strategy variables. Specially, these firms strongly emphasize the marketing of a broad line of specialty-type products. They exhibit an equally strong interest in creating and sustaining efficient operations, as is suggested by their high cost leadership score.

Cluster 5: Low Profile, Narrowly-Focused Firms ($n = 14$). Like the firms in Cluster 1, those in Cluster 5 place little emphasis on advertising and marketing activities. However, whereas firms in Cluster 1 have moderately broad product lines, Cluster 5 firms have relatively narrow product lines. An undifferentiated product is also typical of firms in this cluster, as is a modest emphasis on actions designed to result in a cost leadership position for the firm.

B. Analysis of variance The second step in testing Hypothesis 5 required the use of multivariate analysis of variance (MANOVA). In this analysis, the five strategic clusters served as the 'independent' variables and the three technology measures as the 'dependent' variables. The MANOVA was significant ($F = 47.13$, $p < 0.001$), suggesting that strategic cluster membership is significantly associated with variations in the technology policy measures.

Two analyses followed MANOVA: ANOVA and Duncan's range test. Both tests helped in determining variations in each technology dimension as a correlate of strategic cluster

membership. Table 5 displays cluster means, standard deviations, F -values, and Duncan's results.

Table 5 shows that each technology policy variable exhibits an overall difference across the five clusters of firms (all at $p < 0.001$). The univariate ANOVA results are corroborated by Duncan's tests of paired comparisons that pinpointed significantly different group means ($p < 0.05$). Overall, Hypothesis 5, which suggests that the three technology policy dimensions will vary across firms with different business strategy configurations, is strongly supported by the data.

Hypothesis 6

This hypothesis suggests that the relationships between the three technology policy dimensions and firm performance vary across firms with different business strategy patterns. The results also strongly support this hypothesis. Specifically, the last row in Table 5 shows the results of an ANOVA where ROS (return on sales) was treated as the 'dependent variable' and the strategic clusters were treated as the 'independent' variable. The ANOVA is significant ($F = 8.94$, $p < 0.001$). Table 5 shows that firms in Cluster 1 have significantly lower ROS scores than firms in the other four clusters. Firms in Cluster 2 have significantly lower ROS scores than those in Clusters 3 and 4. Finally, firms in Cluster 4 have significantly higher ROS scores than those in Cluster 5. These differences in ROS suggest that, owing to different foci, the strategic clusters achieved different levels of financial performance.

Simple correlations between the three technology policy dimensions and ROS were also examined within each cluster, as summarized in Table 6. The technology policy variables are associated differently with ROS in the five strategic clusters. The aggressive technological posture dimension is positively associated with ROS in Clusters 3, 4 and 5, negatively associated with ROS in Cluster 1, and not significantly associated with ROS in Cluster 2. A different pattern exists for the automation and process innovation dimension. It is significantly and positively associated with ROS in four of the five clusters; the exception is Cluster 3 where it has a significant negative coefficient. Finally, the new product development scale is positively associated with ROS in Clusters 3, 4 and 5, and

Table 5. Means and standard deviations of the technology policy variables and firm performance in each cluster

| | Cluster ^a Means/S.D.s | | | | | F | Duncan results* |
|----------------------------------|----------------------------------|----------------|---------------|---------------|---------------|----------|--|
| | 1 (n = 23) | 2 (n = 21) | 3 (n = 26) | 4 (n = 19) | 5 (n = 14) | | |
| Aggressive technological posture | - 1.92 0.30 | - 0.92 0.22 | 2.80 0.66 | 3.17 0.40 | 0.80 0.29 | 26.31*** | 1 < 2,3,4,5 2 < 3,4 5 < 3,4 |
| Automation & process innovation | - 1.68 0.50 | - 0.90 0.41 | 4.30 0.82 | 2.11 0.88 | 0.77 0.90 | 11.74*** | 1 < 2,3,4,5 2 < 3,4 4 < 3 5 < 4,3 |
| New product development | - 1.67 0.26 | - 2.25 0.18 | 2.15 0.57 | 3.87 0.28 | 0.97 0.77 | 10.23*** | 1 < 3,4 2 < 3,4,5 |
| Return on sales (ROS) | - 2.61 0.53 | - 0.67 0.12 | 2.13 0.60 | 2.88 0.64 | 1.86 0.49 | 8.94*** | 1 < 2,3,4,5 2 < 3,4 4 < 5 |

^aCluster labels: 1 = Undifferentiated, low marketing intensity firms, 2 = Middle-of-the-road firms, 3 = Prudently aggressive, medium-breadth firms, 4 = High profile, specialty firms, 5 = Low profile, narrowly-focused firms.

* $p < 0.05$ *** $p < 0.001$.

not significantly associated with ROS in Clusters 1 and 2.

Consistent with Hypothesis 6, for each technology policy variable there is a significant variation ($p < 0.05$) in the range of its correlation with company performance across the strategy clusters. If technology-strategy ‘fit’ is defined as the strength of the technology–performance relationship in specific strategic contexts, then the results clearly suggest that each of the technology policies fit better with some business strategies than with others.

In order to integrate the results of the study, Tables 4, 5 and 6 should be examined jointly. To further clarify the meaning of the statistical results, we examined the practices of the two most and two least successful companies in each cluster. Through analysis of secondary data and discussions with company executives, we were able to more fully interpret the relationships of interest in this subset of the sampled firms. The collective results are discussed below.

Cluster 1. In this cluster (‘undifferentiated, low marketing intensity’ firms), the technology policy variables that significantly correlate with performance are automation and process innovation ($p < 0.01$) and aggressive technological posture ($p < 0.05$). As discussed above, Cluster 1 firms offer moderately broad lines of relatively commodity-like products. It is understandable how these firms which employ automated facilities

and advanced process technologies would tend to excel. The possibilities for achieving a competitive advantage based on internal production efficiency are greatest under conditions where advanced technology is used to manufacture a wide variety of unsophisticated products, which commodity-type products tend to be.

The significant negative correlation between aggressive technological posture and ROS in Cluster 1 suggests that being technologically proactive is not an effective option for these firms; such proactiveness is inconsistent with these companies’ strategic thrust. These companies tend to de-emphasize marketing and are relatively apathetic over cost leadership issues. Collectively, the results presented in Tables 4, 5 and 6 suggest that firms which are least likely to employ an aggressive technological posture are also least likely to benefit from such a posture.

The experience of the two top performing companies in this cluster further clarifies the statistical results in Table 6. Convinced that their industries are saturated and that their products are increasingly becoming commodity-like, these companies stressed adopting new process innovations to reduce costs and establish low-price market positions. This could explain the modest attention to new product development and the absence of statistical significance between company performance and the new product development measure in this cluster. The two lowest-performing firms in the cluster had a

Table 6. Zero-order correlations between the technology policy variables and firm performance (ROS) in each cluster

| Variables | Cluster ^a | | | | |
|-----------------------------------|----------------------|---------------|---------------|---------------|---------------|
| | 1 (n = 23) | 2 (n = 21) | 3 (n = 26) | 4 (n = 19) | 5 (n = 14) |
| Aggressive technological posture | – 0.60* | 0.33 | 0.64* | 0.58* | 0.78* |
| Automation and process innovation | 0.70** | 0.68* | – 0.58* | 0.60* | 0.66* |
| New product development | – 0.20 | – 0.26 | 0.67* | 0.77* | 0.81* |

^aCluster labels: 1 = Undifferentiated, low marketing intensity firms, 2 = Middle-of-the-road firms, 3 = Prudently aggressive, medium-breadth firms, 4 = High profile, specialty firms, 5 = Low profile, narrowly-focused firms.
* $p < 0.05$ ** $p < 0.01$.

different strategy. According to discussions with CEOs, they emphasized product innovation over production efficiency as the basis for achieving competitive advantages. These observations are consistent with the study's general finding that success in Cluster 1 hinged upon making effective use of process-type innovations to reduce costs and achieve efficiency. Together, case histories and the statistical results showed that extensive and aggressive product innovation was not rewarded by the market.

Cluster 2. In this cluster ('middle-of-the-road' firms), the single technology policy variable that positively correlates with performance is automation and process innovation ($p < 0.05$), a variable that also correlates with performance in Cluster 1. The strategic and technological context within which the employment of advanced process technology promotes firm performance is, of course, somewhat different in Cluster 2. The overall difference, nonetheless, appears to be one of degree. As such, the same rationale could hold in explaining why this variable correlates with ROS in Cluster 2. In fact, when the strategic actions of the top two performing firms in this cluster were contrasted with the two lowest performing companies, the patterns and conclusions were very similar to those pertaining to Cluster 1.

Cluster 3. The aggressive technological posture and new product development dimensions are significantly associated with the financial performance of companies in this cluster, the 'prudently aggressive' firms. It appears that the selectivity that characterizes these firms' strategic choices pays off by improving company performance. In fact, the two most successful firms in this cluster reported extensive interest in pioneering technological developments and introducing new products in their segments, surpassing the levels reported by the two lowest performing firms in the cluster.

The results (Table 6) show that automation is negatively associated with ROS in Cluster 3, suggesting that the winners among this group achieve success through product innovation rather than through internal efficiencies. However, it is possible that some companies invest heavily in automating their facilities to accommodate the demands of new product innovation and technological development. These huge investments may reduce ROS. Analysis of the two best and

two lowest performing companies supported this proposition. The annual reports of successful companies frequently cited investments in upgrading production facilities and adopting new technology as a means of establishing technological leadership and ensuring new product development.

Cluster 4. Table 6 suggests that the aggressive technological posture, automation and process innovation, and new product development dimensions of technology policy all exhibit a significant correlation with company performance ($p < 0.05$) in this cluster ('high profile, specialty' firms). These results are consistent with the strategic thrust of this group. The utilization of automation and process innovations would seem to maximally benefit firms with a cost leadership posture or a broad product line, both of which apply to Cluster 4 firms. Similarly, an aggressive technological posture accompanied by an emphasis on new product development is consistent with a strategic thrust involving the aggressive marketing of specialty products. In short, it is easy to see how the technology policy choices that best promote performance in cluster 4 are intuitively supportive of these firms' strategic postures. Consistent with these points, analysis of secondary data and discussions with executives suggested that strong commitments to broadly-defined technology-based competencies (both product and process) are considered essential for survival in this cluster.

Cluster 5. All three technology policy variables are significantly and positively correlated with company performance in Cluster 5 ('low profile, narrowly-focused' firms). Although firms with narrow product lines would generally not be expected to strongly emphasize new product development activities, the current results suggest that the more they emphasize new product development, the better they perform. Similarly, Cluster 5 firms appear to benefit from an aggressive technological posture although marketing intensity is relatively low among these firms. Perhaps commodity producers, like Cluster 5 firms, can excel through technological aggressiveness without employing intensive marketing programs. Finally, Cluster 5 firms generally perform best when automation and process innovation are stressed. Therefore, even among firms without a broad product line and a strong cost leadership emphasis, the use of automated

facilities and advanced process technology may significantly promote firm profitability.

Supplementary analysis of the two highest and two lowest performing companies in Cluster 5 provided additional insights into the associations shown in Table 6. Specifically, the two high performing companies, in the belief that there was room for achieving uniqueness in their product offerings, proceeded aggressively to rejuvenate their niches. Their technological initiatives focused on internally-generated product and process improvements. The less successful firms were in some ways equally aggressive from a technology perspective, but attempted to import technologies, processes and innovations that proved successful in other businesses. As such, case studies suggest that technological leadership (vs. technological followership) may be particularly effective among firms that offer a narrow line of products.

Hypothesis 7

Table 7 shows the correlations between the technology policy and business strategy variables within the high- and low-performing subgroups. Consistent with Hypothesis 7, the first four hypotheses are more strongly supported in the high- than in the low-performing subgroup. In fact, 11 of the 12 hypothesized relationships (92%) are supported in the high-performing subgroup, while none of the hypothesized relationships are supported in the low-performing subgroup. Moreover, in 11 of the 12 cases, there is a significant difference ($p < 0.05$) in the strength of the individual correlations between the high- and low-performing subgroups. These results supplement those relating to Hypothesis 6 in highlighting the strong performance implications of achieving technology-strategy fit.

To recap, Table 8 presents the study's hypotheses and shows the empirical support for each. Overall, the data support the hypotheses relating to the correlations between individual technology policy and competitive strategy variables (H1 through H4) as well as H5 that relates to variations in technological choices across strategic types. The results also show that strategic choices moderate the association between technology policy variables and company performance, thus supporting H6. Finally, as indicated in Table 8, the results show that high- and low-performing

companies have different gestalts of technology-strategy links.

DISCUSSION

Three observations emerge from this study's results. First, technology policy tends to align with business strategy in a comprehensible, intuitively meaningful, and often predictable manner. Not only were the individual business strategy dimensions correlated, for the most part, as expected with the technology policy dimensions, but the multivariate strategic patterns were also associated with internally-consistent technology policy choices. This finding suggests that technology policy decisions should be evaluated in terms of their collective fit with business strategy rather than as independent decisions.

Second, business strategy moderates the relationship between technology policy and firm performance. This conclusion follows from the finding that the strength of the relationships between the technology policies and performance varies across firms with different business strategy configurations (H6). It also follows from the finding that high- and low-performing companies have different gestalts of associations between their technology policy and business strategy choices (H7). As such, consistent with the premise of this research, technology policy's fit with business strategy is a significant predictor of firm performance. This suggests a need to align business strategy and technological choices as a precondition for superior firm performance.

The technological dimensions whose alignments with business strategy are predictive of firm performance, as demonstrated in this research, vary on a strategy-by-strategy basis. Although there are several ways to conceptualize 'fit' (Venkatraman, 1989b), the technology policies that should be aligned with (i.e., fit) a particular business strategy can be operationally identified as those which significantly correlate with performance among firms with those strategies. When a technology policy is not significantly associated with performance among firms with a particular strategy type, that policy's fit with that business strategy would cease to be a managerial concern. This is because firms with these strategies will, by definition, perform roughly at their

Table 7. Comparison of high- and low-performing subgroups

| | Commodity-to Specialty | | Marketing Intensity | | Cost Leadership | | Product Line Breadth | |
|-----------------------------------|------------------------|---------|---------------------|---------|-----------------|---------|----------------------|---------|
| | Low | High | Low | High | Low | High | Low | High |
| Aggressive technological posture | 0.04 | 0.78*** | 0.26 | 0.66*** | 0.17 | 0.61*** | 0.53*** | − 0.17 |
| Automation and process innovation | − 0.37** | 0.01 | − 0.48*** | 0.04 | 0.22 | 0.59*** | 0.38* | 0.14 |
| New product development | 0.16 | 0.50*** | 0.17 | 0.61*** | 0.53*** | − 0.29* | 0.16 | 0.58*** |

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

Table 8. Summary of the research results

| | Hypothesized (H) and Found (F) Correlations | | | |
|--|---|---|-----------------------------------|-------------------------|
| | Aggressive technological posture | | Automation and process innovation | New product development |
| | H | F | H | F |
| H1: Commodity to specialty | + | + | ns | + |
| H2: Marketing intensity | + | + | ns | + |
| H3: Cost leadership | + | + | + | ns |
| H4: Product line breadth | ns | + | ns | + |
| Percentage of correctly hypothesized relationships = 75% | | | | |
| Hypotheses 5 through 7: | | | | |
| H5: 'The three technology policy dimensions will significantly vary across firms in different business strategy clusters.' | | | | |
| Supported: For each of the technology policy variables there is significant variation ($p < 0.001$) in its score across the five business strategy clusters. | | | | |
| H6: 'The range of correlations between the individual technology policy dimensions and firm performance will significantly vary across firms in different business strategy clusters.' | | | | |
| Supported: For each of the technology policy variables there is significant variation ($p < 0.05$) in the range of its correlation with performance across the five business strategy clusters. | | | | |
| H7: 'The relationships predicted in Hypotheses 1 through 4 will be more characteristic of high-performing than low-performing firms.' | | | | |
| Supported: 92% of the technology-strategy correlations are consistent with H1 through H4 in the high-performing subgroup. None of the correlations are consistent with H1 through H4 in the low-performing subgroup. | | | | |

current level regardless of their decisions on the technology policy in question.

It might, therefore, be argued that technology–strategy fit is achieved in Cluster 1 (Undifferentiated, Low Marketing Intensity Firms) and Cluster 2 (Middle-of-the-Road Firms) in the current sample when these firms utilize automation and advanced process innovation. Cluster 1 firms also excel when they adopt nonaggressive technological postures. Cluster 3 firms (Prudently Aggressive, Medium-Breadth Firms), on the other hand, realize a better technology–strategy fit when they emphasize an aggressive technological posture and new product development, but deemphasize automation and process innovation for achieving competitive advantage. Finally, all of the technology policy variables correlate significantly with ROS in Clusters 4 (High Profile, Specialty Firms) and 5 (Low Profile, Narrowly-Focused Firms). This is true despite the fact that these clusters have markedly different strategic thrusts.

A third observation from this study is that firms whose strategies are primarily built on technological competencies can run the risk of ‘technological myopia’ and possibly over-invest in developing those competencies. This occurs when these firms neglect other equally critical competencies. This would appear to be a possible explanation of the results relating to firms in Cluster 3. Therefore, the automation and process innovation dimension of technology policy, which reflects a firm’s reliance on advanced process technology, is negatively correlated with firm ROS. Yet, these firms are also highly reliant on automation and process innovation; more so, in fact, than firms in any of the other clusters. Perhaps executives are more easily deluded into believing in the inherent virtue of high technological investments when they recognize that technology is a significant determinant of success in their industries.

Comparison with other studies

The above observations suggest that four points distinguish the current research from past empirical efforts, especially those published studies that used the PIMS data base. First, this study advances a more encompassing operationalization of technology policy, unlike PIMS studies which have tended to focus on only one or two technological dimension(s). For example, most

PIMS studies have focused on product or process innovation issues and ignored the aggressiveness dimension of a company’s technology policy (an exception is the study of A. Miller, 1988). However, technological aggressiveness is an important consideration in understanding how companies position themselves through their utilization of technology. This research contributes to the literature by showing when technological aggressiveness is or is not associated with financial performance.

Second, unlike PIMS-based research, the current study identifies distinct gestalts of technology policy dimensions in different strategic settings. The identification of these technological gestalts is important because competitive advantage may result from the synergy achieved among the dimensions of technology policy. Such focus on technological gestalts can also help in building typologies of technological choices which could advance research on the link between competitive and technology strategies and their implications for company performance.

Third, the present study focuses on companies smaller than those typically found in the PIMS data base. These companies do not enjoy the market power and visibility of their PIMS counterparts, but may be more representative of the populations of firms in their industries. Accordingly, the present results can help to clarify how a ‘typical’ firm might compete effectively—through strategic and technological choices—in a mature and possibly hostile environment. As mentioned, to date only a few studies have been conducted on this issue.

Finally, the current results are based on data collected from fairly specialized firms. Most PIMS-based studies did not control for the diversification of companies in their samples or for interindustry differences, thus ignoring the possibility that synergy in the overall corporate portfolio (Porter, 1985) might confound the reported relationships between technology, strategy, and performance.

IMPLICATIONS AND FUTURE RESEARCH DIRECTIONS

Implications for executives

The current results have several implications for practicing executives. Clearly, technology policy

provides a viable means to promote successful company performance. While the influence of technology policy on company performance is not always consistent, companies may gain a great deal from developing and pursuing a well-defined set of technology policies. Accordingly, executives should carefully design the process through which these policies are developed and implemented. Such a process should ensure fit between a company's strategic and technological choices. Without coordination between these decisions, investments in R&D, automation efforts, and product innovations and introductions may not lead to superior financial performance. Conversely, when fit is achieved, a firm can employ its technological investments and capabilities to create a competitive advantage that supports its strategic goals and posture.

The results also suggest that while technology policy, strategic choices, and the fit between them are of crucial importance for financial performance, an emphasis on technology cannot singularly ensure high performance. The current results reinforce the findings by the MIT Commission on Industrial Productivity (1989). The Commission studied corporate America's responses to international competition in the chemical, steel, consumer electronic, and textile industries. Findings from these multi-industry efforts are consistent with those found here: There are limits to what companies can expect from investments in technology. To thrive in mature industries (such as those we studied), companies should pursue strategic options (Harrigan, 1985) that complement their technological initiatives.

The current study also suggests that an aggressive technological posture can be financially rewarding, although the pay-off from this orientation is not always guaranteed (MIT Commission, 1989). In particular, companies with close alignments between their competitive and technological choices are more apt to gain from pursuing aggressive postures than those without such alignments (Porter, 1983). Thus, companies with strong positive associations between performance and both technological aggressiveness and new product development, such as those in Clusters 3, 4 and 5, have probably achieved this fit and are profiting from it. Moreover, the moderate overall correlations between aggressive technological posture and firm performance

($r = 0.28$) and new product development and firm performance ($r = 0.32$) suggest that a pioneering approach to the development and use of technology may have particular merit in mature industries. This result stands in contrast to the frequent results of technological pioneering in more dynamic, technology-based industries. In these latter settings, technological pioneering has had a much less definite association with company performance (Lieberman and Montgomery, 1988), perhaps because of the greater general preparedness of competitors to quickly follow the pioneer's lead.

Finally, our results suggest that, in mature industries, executives should also stress technologies that have clear implications for automating production processes. Indeed, the current results document a moderate overall correlation between ROS and automation and process innovation ($r = 0.35$).

Implications for future research

The study highlights several possibilities for future empirical research on the strategy–technology interface. Future studies should examine the sources of advantage derived from specific combinations of competitive and technological choices. For example, firms may achieve cost leadership using very different approaches. Consequently, future studies would add precision to our understanding of strategy–technology links if they explore the sources of advantage that undergird different approaches to the achievement of particular strategic postures, like cost leadership. Future studies should also explore the specific objectives emphasized by firms pursuing different technology policies. Companies following different policies may set different objectives for their R&D endeavors, for example. By gauging the specific objectives of R&D, our understanding of fit between business strategy and technology policy is likely to improve.

Another potential focus for future studies is the process by which the content of technology policy is defined and its linkages with business strategy are established. Indeed, there is a paucity of empirical studies on these issues. Case studies (e.g., Burgelman, 1991) and field research can help to fill this void in the literature. Clearly, there is much yet to be learned about how technological policies are formulated, how fit

between business strategy and technology policy is established and maintained, and how companies can effectively deploy their technological assets when pursuing their competitive goals.

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APPENDIX

The Business Strategy Scales

The following instructions accompanied each of the business strategy scales, except where otherwise specified:

Rate the extent to which your firm (division or unit) focuses on the following in comparison to your major competitors. Circle the appropriate number.

| | | | | | | |
|---------------|-------|-------------------|---------|--------------------|--------|----------------|
| Much Lower | Lower | Slightly Lower | Neutral | Slightly Higher | Higher | Much Higher |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Commodity-to-specialty Products Scale

| | | | | | | | |
|--|---|---|---|---|---|---|---|
| Uniqueness of your products | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Targeting a clearly identified segment | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Offering products suitable for high price segments | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Offering specialty products | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

How would you rate your current product line or mix? Circle the appropriate number.

| | | | | | | | | |
|------------|---|---|---|---|---|---|---|-------------|
| Low Margin | 1 | 2 | 3 | 4 | 5 | 6 | 7 | High Margin |
|------------|---|---|---|---|---|---|---|-------------|

Marketing Intensity Scale

| | | | | | | | |
|--|---|---|---|---|---|---|---|
| Intensity of your advertising | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Intensity of your marketing efforts | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Emphasis on building strong brand identification | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Cost Leadership Scale

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Level of capacity utilization | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Level of operating efficiency | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Efficiency in securing raw materials | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Offering competitive prices | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Emphasis on finding ways to reduce cost of production | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Efficiency of your distribution channels | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Product Line Breadth Scale

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Offering a broad line of products | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| How would you rate your current product line or mix? Circle the appropriate number. | | | | | | | |
| Limited Variety | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Wide Variety | | | | | | | |

The Technology Policy Scales

The following instructions accompanied each of the technology policy scales, except where otherwise specified:

Rate the extent to which your firm (division or unit) focuses on the following in comparison to your major competitors. Circle the appropriate number.

| | | | | | | |
|------------|-------|----------------|---------|-----------------|--------|-------------|
| Much Lower | Lower | Slightly Lower | Neutral | Slightly Higher | Higher | Much Higher |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Aggressive Technological Posture Scale

| | | | | | | | |
|---|----------|---|---|---|---|---|---|
| Building a reputation for being first in the industry to try new methods and technologies | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| How would you classify your company's innovation efforts? Circle the appropriate number. | | | | | | | |
| Type: | Leader | 1 | 2 | 3 | 4 | 5 | 6 |
| Timing of entry: | Early | 1 | 2 | 3 | 4 | 5 | 6 |
| | Follower | | | | | | 7 |
| | Late | | | | | | |

Automation and Process Innovation Scale

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Level of automation of plants and facilities | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Using the latest technology in production | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Capital investment in new equipment and machinery | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

New Product Development Scale

| | | | | | | | |
|--|---|---|---|---|---|---|---|
| Emphasis on new product development | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Rate of new product introduction to market | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Number of new products offered | 1 | 2 | 3 | 4 | 5 | 6 | 7 |