One of the most serious challenges facing an entrepreneurial company, particularly a high-technology firm, is knowing how to manage innovation as the organization evolves. Macro-level facilitators/inhibitors of innovation—i.e., organizational and environmental conditions of a firm that promote or restrain innovation such as the structure of an organization, its incentive system, resources provided by its environment, or its ways of analyzing firm-external information—and their relationship to the innovativeness of the firm are considered in this study.

Two basic arguments have been put forward previously as to why the innovativeness of an organization may change as it evolves. First, it has been suggested that facilitators of innovation change over time and so will firm innovativeness. That is, the relationship between the facilitator and innovation stays unchanged but the facilitator itself is transformed, causing changes in firm innovativeness as it develops. For instance, it has been suggested that mature firms become less innovative because their structure becomes overly formalized to perform other functions more efficiently, which then stifles innovative processes. Second, other researchers have proposed that the relationship between a facilitator and innovation changes as firms evolve; for instance a formal structure may support innovation in a younger firm because it allows the entrepreneur to focus her energy, whereas it may suppress innovation later since it inhibits an innovator’s interaction with other environments. The results of our analysis, using data from 326 U.S. firms in different stages of their development and involved in many kinds of high-tech industries, support the second theory.

However, the results for the relationships of the individual facilitators to innovation were not always as expected. We found that formally structured young firms were less innovative than informal ones and that in older organizations, formalization had no negative impact on innovation. This finding possibly can be explained with micro-level facilitators of innovation: younger firms may have more
entrepreneurial personnel whose ability for innovation is more inhibited through a formal structure than the more "seasoned" employees in older, larger firms. However, this finding implies that the concern for formal structures with respect to firm innovativeness does not necessarily apply as typically assumed.

Of similar significance was our finding with respect to the relationship between financial incentives and innovation. It has been suggested that younger rather than older firms use incentives such as equity to encourage an innovative environment. Results of this research, however, show that innovation is associated with stock incentives especially in older firms. This may be an indication for older firms to use differentiated incentives that reflect the individual's contribution to the firm to retain innovative personnel, whereas start-ups might rely on the excitement of working in a new venture as an incentive for innovative behavior.

More in line with expectations were the results for how firms process external information. Environmental scanning and data analysis were positively associated with innovation, and this more so in older firms, presumably because they have become more remote from developments outside the organization. This result confirms the notion that much innovation by a firm is initiated externally. However, the results also indicate that the conditions of the environment itself are of lesser importance to firm innovativeness than the firm's active pursuit of information from its environment. An often discussed implication of these findings is that the boundaries of a firm must be permeable, at least from the outside in, and systematic information gathering from customers, competition, research institutions, etc. may be necessary to the success of a firm that depends on its product development. This seems especially important for older firms.

As expected, the centralization of power in an organization also affected innovation. Centralization correlated positively with innovation in new ventures and negatively in older firms. This indicates the importance of the entrepreneur and strong leader in a start-up. It also suggests, though, that as the firm matures, this person has to give up some of her control and may have to relinquish the job at the head of the organization to someone else.

Finally, there are some more general implications of this work to managers involved with organizational innovation. First, reliance on past experience may be detrimental to future performance. Whereas a firm evolves through different stages, means that have facilitated innovation earlier may be detrimental to it now or tomorrow, and vice versa. Second, copying successful strategies for innovation from other firms may not necessarily work—not because their implementation was worse but because the conditions of the other firm, for instance its evolutionary stage or its micro-level facilitators, were different.

Researchers who study innovation should consider including life-cycle stage as a potential moderating variable. Factors that facilitate innovation at some point during an organization's evolution actually hinder it in another. Also, factors that were unimportant to innovation at the inception of a firm may facilitate it in later stages. This study supports the conclusion that the consideration of contingency factors, such as life-cycle stage, may enhance the development of a theory of organizational innovation.

INTRODUCTION

Management scholars have long recognized the importance of innovation to organizations and the economy (Chandler 1962; Schumpeter 1934). Whereas the organization is considered an "inventor of innovation" (Kimberly 1986), attempts to identify factors that facilitate innovation (Damanpour 1991; Miller and Friesen 1982) have yielded equivocal and noncumulative results (Downs and Mohr 1976; Van de Ven, Angle, and Poole 1989). Therefore, researchers have now begun to ask whether environmental and organizational attributes that influence innovation change over the different stages of a firm's life (Kazanjian 1988). Still, although the notion of an organizational life cycle plays an increasingly important role in innovation theories (Kimberly 1980; Miller and Friesen 1984), its function remains unclear (Bamberger 1991; Miller 1987).
One of the most serious challenges facing organizations, particularly high-technology firms, is knowing how to manage innovation as the organization evolves (Van de Ven 1986). Some scholars believe that innovativeness will differ depending upon the organization's life-cycle stage simply because organizational attributes themselves shift over time (Galbraith 1982; Tushman and Nadler 1986). Others believe that the effect of organizational attributes on innovation is moderated by the life-cycle stage of the firm (Van de Ven 1986; Walsh and Dewar 1987). Despite the theoretical relevance, little empirical research has focused on these two major lines of argument. This study investigated whether life-cycle stage mediates the effects of the environment (resources and dynamism), information processing (scanning and analysis), and structure (formalization, centralization, and incentives) on product innovation, using a national sample of 326 high-technology firms.

The Organization Life Cycle

The concept of an organizational life cycle (OLC) is used to explain changes in a firm over time (Greiner 1972; Kazanjian 1988; Kimberly and Miles 1980; Quinn and Cameron 1983). Whereas the validity of the concept has been debated (Penrose 1952), its usefulness has repeatedly been demonstrated in empirical studies (cf. Milliman, Von Glinow, and Nathan 1991; Smith, Mitchell, and Summer 1985). In contrast with Miller and Friesen's (1982) suggestion that innovation is determined by a firm's strategy, whether entrepreneurial or conservative, life-cycle theorists believe that innovation tends to increase during the early stages of a firm, then slowly decreases during the later stages (Kimberly 1980; Quinn and Cameron 1983). Research has shown that organizational attributes change over the different stages of a firm's existence and that different management practices are needed at different stages (Kazanjian 1988; Miller and Friesen 1984; Sykes and Block 1989). Structural formalization, to give an example, is thought to facilitate organizational success during early stages of the organizational life cycle but to hinder success during later stages (Walsh and Dewar 1987). Other research has suggested that organizations at different stages should be assessed by different models of organizational effectiveness (Quinn and Cameron 1983).

This study uses a modified version of Kazanjian's (1988) four-stage model of growth in technology-driven ventures. The first stage, termed conception and development, involves the invention and development of a product or technology. The focus is on securing financial resources and developing a market. Structure and formal procedures are virtually nonexistent, and all activities are decided by the entrepreneur, typically an owner or founder. To manufacture a new product and establish a market, a company at the commercialization stage must create structures and task systems beyond product development. A company at the growth stage is characterized by high growth in both sales and number of employees. As it focuses on how to produce, sell, and distribute its products profitably, a hierarchy and functional specialization develop, and personnel become more professional and experienced. A company at the stability stage concentrates on developing next-generation products, establishing a market position, and seeking other growth opportunities. Although Miller and Friesen (1984) and others have questioned whether an orderly evolution across stages occurs, Kazanjian and Drazin (1989) have demonstrated that firms progress in a specific sequence, although the duration of the stages is unspecified and they may overlap. Kazanjian (1988) found that whereas an organization's external relations and organizational systems changed only marginally between the conception and development and commercialization stages and between the growth and stability stages, changes between the first two stages and the latter two stages were significant. For purposes of this study, we therefore used in our analysis only two stages: early and late.
Innovation

Innovation has been classified into product and process innovation (Utterback and Abernathy 1975; Damanpour 1991). We chose to study new product development because it is critical to an organization's evolution and long-term success (Capon et al. 1992; McCann 1991; Miller and Friesen 1984; Quinn and Cameron 1983). The factors that affect organizational innovation can be organized into micro-level and macro-level variables (Damanpour 1991; Kanter 1988). The former include characteristics of individuals, such as creativity and style of problem-solving and decision-making; the latter, various environmental and organizational characteristics, such as environmental complexity, organization size, and control. As the latter have been less studied, and because of confusion regarding macro-level variables that affect innovation and the possible mediating factors (Goes 1993), we focused on the relation of macro-level variables to product innovation.

FACILITATORS OF INNOVATION: RESEARCH HYPOTHESES

Environment

Life-cycle research suggests that environment, information processing, and structure are critical for the development of a firm (Miller and Friesen 1982). The environment encompasses external resources (e.g., financial resources and trained and educated personnel) and dynamism (the rate of product, market, and technological change in an industry). Research on innovation generally shows a positive association between resource availability and innovation (e.g., Damanpour 1991). Life-cycle and new venture research suggest, however, that early-stage firms lack financial and human resources (Kazanjian 1988; Quinn and Cameron 1983; Van de Ven 1980)—resources that are more critical in early phases of product development than in later phases (Utterback and Abernathy 1975; Van de Ven 1986). Also, in the early phases of the product life cycle there is little specialized labor available (Utterback and Abernathy 1975). Later-stage firms can develop extensive internal labor markets and train their own workers (Schuler 1989; Walton 1980), and may therefore have less need for external resources.

Organizational innovativeness has been shown to be related to environmental dynamism in studies of both entrepreneurial and conservative firms (Kimberly and Evanisko 1981; Miller and Friesen 1982). Other research suggests that firms, particularly in early stages, will be innovative regardless of the type of environment (Utterback and Abernathy 1975). Indeed, the creation of a new firm may actually increase environmental dynamism in an industry. In contrast, later-stage firms may experience organizational inertia and thus may need the innovative "pull" of a dynamic, turbulent environment (Quinn and Cameron 1983). We propose the following two hypotheses (a summary of the study hypotheses can be found in Table 1).

H1a: The positive relationship between external resources and product innovation will be greater among early- than among later-stage firms.

H1b: The positive relationship between environmental dynamism and product innovation will be greater among later- than among early-stage firms.

Information Processing

According to diffusion theory, all innovative firms must be able to scan and evaluate information about environmental developments and opportunities (Bigoness and Perrault 1981), but recent research has revealed that early-stage firms may gather and process such information differently.
TABLE 1  Summary of Research Hypotheses

<table>
<thead>
<tr>
<th>Variables</th>
<th>Early-Stage Organizations</th>
<th>Later-Stage Organizations</th>
<th>Difference in Strength of Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H1a Resources</td>
<td>Positive</td>
<td>Positive</td>
<td>Greater in early than later stage</td>
</tr>
<tr>
<td>H1b Dynamism</td>
<td>Positive</td>
<td>Positive</td>
<td>Less in early than later stage</td>
</tr>
<tr>
<td>Information processing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H2a Scanning</td>
<td>Positive</td>
<td>Positive</td>
<td>Less in early than later stage</td>
</tr>
<tr>
<td>H2b Analysis</td>
<td>Positive</td>
<td>Positive</td>
<td>Less in early than later stage</td>
</tr>
<tr>
<td>Structure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H3a Formalization</td>
<td>Positive</td>
<td>Negative</td>
<td></td>
</tr>
<tr>
<td>H3b Centralization</td>
<td>Positive</td>
<td>Negative</td>
<td></td>
</tr>
<tr>
<td>H3c Stock incentives</td>
<td>Positive</td>
<td>No relationship</td>
<td></td>
</tr>
</tbody>
</table>

than later stage firms. In early-stage firms, employees typically are new to the firm and have tight external relationships with venture capitalists and the like, thereby helping to “incorporate” the environment into the organization (Miller and Friesen 1982). On the other hand, decision-makers in these firms often cannot systematically seek and analyze external information, because the environment may be changing rapidly, the firm may need to act quickly to beat larger firms to market (Miller and Friesen 1984), and time and resources are limited.

Later-stage firms, by contrast, may require systematic analysis of new opportunities and greater information about current market conditions as their original products mature and they refocus on product innovation (Miller and Friesen 1984; Mintzberg 1973; Quinn and Cameron 1983), because they tend to become internally rather than externally oriented and may lack an influx of new talent (Kazanjian 1988; Miller and Friesen 1982). Information may be processed more effectively by later-stage firms because specialized units for this task may exist within the organization. Knight (1989) found that start-ups or independent spin-offs lacked market research and other administrative skills likely to be necessary for environmental scanning and analysis, whereas corporate innovators in larger firms could draw on these specialized skills existing within their organization. Therefore, we expect that later-stage firms are not only more dependent on information processing to be innovative, but also that the tasks related to scanning and evaluation are performed better here than in early-stage firms because the necessary specialized skills are more likely to be available. We predict that:

\( H2a: \) The positive relationship between environmental scanning and product innovation will be greater among later- than among early-stage firms.

\( H2b: \) The positive relationship between analysis and product innovation will be greater among later- than among early-stage firms.

Structure

Various structural devices, such as formalization, centralization, and incentives, can also facilitate innovation. Recent research suggests that the effects of formalization and centralization on organizational innovation vary with the life-cycle stage of the firm. An empirical analysis of a national sample of 118 high-tech manufacturers and software developers, for example, showed that small firms that were formalized made better choices of new products (Pavia 1991). Formalization enables early-stage firms to focus limited resources and to concen-
trate efforts, thereby promoting effectiveness, improving morale, and increasing innovation (Van de Ven 1980, 1986; Walsh and Dewar 1987). By contrast, "the older, larger, and more successful organizations become, the more likely they are to have a large repertoire of structures and systems that discourage innovation" (Van de Ven 1986: 596). As the organization evolves, it becomes more formalized, primarily because of a need for increased efficiency, "power games" by firm managers, and external institutional influences (DiMaggio and Powell 1983; Walsh and Dewar 1987). Moreover, it becomes increasingly difficult for a firm to innovate and adapt to a changing and expanding environment as it moves outside its core business (Sykes and Block 1989).

As with formalization, the effects of centralization on innovation change over time. In an early-stage firm, the entrepreneur, typically an owner or founder, is often the chief innovator (Mintzberg 1973; Smith, Mitchell and Summer 1985; Van de Ven 1980). Centralized power and the absence of a hierarchy allow the entrepreneur greater freedom to be assertive and to commit resources (Miller 1987). Among later-stage firms, a hierarchy develops and power becomes decentralized. As a result, idea generators at the bottom of the hierarchy who deal with the external environment have greater opportunity to innovate (Miller and Friesen 1984; Normann 1971; Schuler 1989).

Many innovative companies such as high-technology firms use rewards and incentives to attract and retain creative people (Balkin and Gomez-Mejia 1985, 1987a, 1987b; Ettlie 1983; Galbraith 1982; Schuler and MacMillan 1984). "To encourage innovation, organizations must base rewards on actual performance and make innovation an important dimension of individual and group performance" (Tushman and Nadler 1986, p. 85). Because of undercapitalization, early-stage firms tend to give managerial and technical personnel lower salaries in exchange for equity (Balkin and Gomez-Mejia 1985). Workers in older, larger firms are more frequently seen as being motivated by the need for security; therefore compensation tends to be in the form of salary (Balkin and Gomez-Mejia 1987b). We therefore predict that:

\[ H_{3a}: \text{Formalization will be positively related to product innovation among early-stage firms and negatively related among later-stage firms.} \]

\[ H_{3b}: \text{Centralization will be positively related to product innovation in early-stage firms and negatively related among later-stage firms.} \]

\[ H_{3c}: \text{Stock incentives will have a positive association with product innovation among early-stage firms but not among later-stage firms.} \]

METHOD
Organizations and Respondents
Data for the study were collected from 326 U.S. high-technology firms randomly selected from Corporate Technology Information Services’ 1991 directory, which lists U.S. high-technology firms by SIC code and by CorpTech major code (e.g., advanced materials, chemicals, defense, medical, telecommunications, and test and measurement). Because the objective of the study was to assess how determinants of innovation differ among firms at different stages of evolution or development, it was important to use an industry with a number of firms at different stages. To select the sample, we used a two-step approach. First, in keeping with Kazanjian’s (1988) breakdown of life-cycle stages by firm age, we divided the firms into three strata according to the year in which the firm was founded: 1989–1991, 1986–1988, and before 1986. Second, to ensure adequate representation of firms in the early- and mid-life-cycle stages, we sampled
younger firms disproportionately. Random samples of 400, 300, and 300 were drawn from the three strata, respectively, for a total of 1000 firms.

The unit of analysis was a single nondiversified firm or, alternatively, a single Strategic Business Unit (SBU) of a diversified firm. As it is widely believed that top administrators can provide reliable information about basic environmental and organizational characteristics of their organizations (Hrebiniak and Snow 1980; Mintzberg 1985; Seidler 1974), we mailed questionnaires and cover letters to the chief executive officers of the 1000 firms in the sample. From this, 326 usable surveys were returned, for a response rate of 32.6%—a rate typical for research using CEOs as respondents (Milliken 1990). Nonresponding firms did not differ significantly from responding firms in number of employees (t = 1.40, df = 934, NS), sales revenue (t = 1.44, df = 922, NS), annual percentage growth in number of employees (t = 0.49, df = 859, NS), or age (χ² = 5.5, df = 2, NS).

The firms spanned a broad spectrum of industries, from the “hard” (e.g., computers, turbines, and subassemblies and components) to the “soft” (e.g., software, artificial intelligence, biotechnology, and photonics). Over half the firms employed fewer than 50 workers and reported annual sales revenues of less than $5 million. Approximately 20% of the firms had sales revenues of $5 to $500 million and employed 50 to 499 workers. Only 3% employed over 5000 workers and had sales volumes of over $500 million. Over half the firms (62.9%) were exporters. On average, the firms had a 22.6% annual growth rate in the number of employees. Most (74.9%) were private firms; a minority (24.9%) were operating units of larger corporations. In sum, we believe that our stratified randomly selected sample is reasonably representative of the population of U.S. high-technology firms.

Measures

Life-Cycle Stage

Life-cycle stage was measured through the scale developed by Kazanjian (1984) and described earlier. Because his model “positions stages as a contextual variable rather than an organizational variable” (Kazanjian and Drazin 1990), it avoids confounding the life-cycle variable with the organizational variables considered here. Respondents were asked to indicate which of four descriptions best characterized their firm at the time that the survey was completed; for analysis, the four stages were amalgamated into two.

Environmental Variables

Milliken (1990) and Yasai-Ardekani (1986) both believe that environmental uncertainty (dynamism) is a perceptual phenomenon, inasmuch as organizations respond to what they perceive, and unnoticed environmental events might not affect organizational decisions and actions. On the assumption that decisions are determined by perceptions of organizational contingencies, not objective properties (Duncan 1972), we employed two perceptual measures of environment. We measured environmental dynamism (the rate of market, product, and technological change in the external environment over the past three years) using a composite four-item, five-point Likert scale adapted from the work of Miller and Friesen (1982). The reliability coefficient was 0.65. Resource availability or abundance has been viewed alternatively as an environmental (Aldrich and Mindlin 1978) or structural variable (Miller and Friesen 1982). For purposes of this research, we considered abundance an important environmental variable. Innovation requires resources (Miller and Friesen 1982), and the environment limits
what an organization can do by limiting the resources available to it. Because high-technology firms are commonly defined on the basis of level of investment in human capital (Baharami and Evans 1987; Felsenstein and Bar-El 1989), we used two items adapted from the work of Miller and Friesen (1982) to measure labor resources. Respondents rated the abundance of skilled labor and managerial resources on a five-point scale. The alpha coefficient was 0.61. The employment of these environmental variables in the analysis is also assumed to at least partially control for possible industry effects on innovation, which were not controlled for directly.

**Information Processing**

To measure environmental scanning, we used nine items developed by Miller and Friesen (1982). Respondents were asked to rate on a five-point scale how often their firm used various methods to gather information about their environment, including: routine gathering of opinions from clients; special market research studies; forecasting of sales, customer preferences, technology, and so forth; and explicit tracking of the policies and tactics of competitors. The alpha coefficient was 0.76. Analysis in decision-making, signifying the extent to which thought and analysis enter into key decisions about strategic alternatives, was scored on the basis of three items adopted from the work of Miller and Friesen (1982). Using a five-point scale, respondents reported, among other things, the extent to which the firm engaged in a formalized, systematic search for and evaluation of opportunities for acquisitions, new investments, and new markets. The reliability coefficient was 0.58.

**Organization Structure**

We employed Hage and Aiken's (1969) composite five-item measure of perceived formalization (rules and procedures). This measure, anchored on a five-point Likert scale, had a reliability coefficient of 0.73. We also employed Miller and Friesen's (1982) composite seven-item measure of perceived centralization (concentration of authority). Respondents indicated on a five-point scale which level of management (from all employees to topmost management only) is responsible for making seven different types of decisions, including capital budgeting, new product introduction, entry into major new markets, and pricing of major product lines. This measure exhibited an alpha coefficient of 0.75. To measure stock incentives we asked respondents the following question: "Approximately what percentage of all employees (including top management) is eligible to receive stock or stock options?"

**Innovation**

Innovation in product lines, services, and programs was measured through paired statements adopted from the work of Miller and Friesen (1982) (e.g., "More than half of our new lines of products/services or programs were introduced in the past three years" and "No new lines of products/services or programs were introduced in the past three years"). This measure has recently been validated by Khan and Manopichetwattana (1989) and Jennings and Young (1990), who found a strong correlation between this perceptual measure and an objective measure of innovation. The three-item composite measure, anchored on a five-point scale, had an alpha coefficient of 0.66. In sum, the alpha coefficients reported here are generally at an acceptable level for research purposes (Nunnally 1967).
Since firm size (cf. Kimberly 1976) has been shown to influence organizational characteristics, a measure of this variable was included in the study. Size, defined as the number of employees, was obtained from the CorpTech database. CorpTech uses the following coding categories: (0) under 10 employees; (1) 10 to 24 employees; (2) 25 to 49; (3) 50 to 99; (4) 100 to 249; (5) 250 to 499; (6) 500 to 999; (7) 1000 to 2499; (8) 2500 to 4999; (9) over 5000 employees. We chose this measure because much empirical research has used it (Hitt and Tyler 1991) and because high-technology firms have high levels of investment in human capital (Felsenstein and Bar-E1 1989).

Field studies using self-report, cross-sectional data are particularly susceptible to errors resulting from consistency, priming, and problems associated with common method variance (Podsakoff and Organ 1986). Factual data of which the respondent possesses direct knowledge pose less serious problems, because such data are in principle verifiable. Some of the data collected in the present study (such as percentage of employees receiving stock or stock options) were of this type. Also, archival data were used, including the year the firm was formed and the size of the firm. As a result, problems of common method variance should be attenuated.

ANALYSIS OF RESULTS AND RESEARCH FINDINGS

Data on the distributional characteristics of the scaled variables for the total sample and by life-cycle stage are given in Table 2.

Correlational Analyses

Table 2 presents the simple bivariate relationships (correlations) among the scaled variables for the total sample without controlling for the effects of other variables. With a few exceptions, our correlations were consistent with those reported in earlier research. Innovation correlated negatively with formalization and size, a finding that is consistent with research by Fredrickson (1986) and Miller and Friesen (1982). Innovation also correlated positively with scanning, a finding that is consistent with the basic assumption of diffusion theory (Bigoness and Perreault 1981). Scanning was positively related to resources and formalization, indicating that resources and the use of formal procedures can enhance systematic decision processes (Langley 1989).

Unexpectedly, formalization and centralization failed to correlate with each other, perhaps because technology-driven enterprises use a less formalized structure than more traditional organizations (Kazanjian and Drazin 1990). Formalization and centralization correlated positively with resources (labor). This finding runs contrary to the assumption that nonformal structures are best suited to resource-rich environments (Lawrence and Dyer 1983). Analysis in decision-making correlated positively with scanning and centralization, a finding that is consistent with research by Miller and Friesen (1982). Other correlations shown in Table 2 indicate that stock incentives were negatively related to formalization and analysis.

The bivariate results dealing with firm size generally conformed to expectations. Size correlated negatively with dynamism and centralization and correlated positively with formalization; large-scale operations are marked by stable environments, decentralization, and formalization of procedures. These findings agree with earlier research by Child (1973) and Keats and Hitt (1985). Size also correlated positively with environmental scanning, a finding
### TABLE 2  Descriptive Statistics and Correlations

<table>
<thead>
<tr>
<th>Variables</th>
<th>Early-Stage Mean (SD)</th>
<th>Later-Stage Mean (SD)</th>
<th>Total Sample Mean (SD)</th>
<th>Zero-Order Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n = 172$</td>
<td>$n = 154$</td>
<td>$n = 336$</td>
<td></td>
</tr>
<tr>
<td>1. Innovation</td>
<td>4.0 (.74)</td>
<td>3.6 (.82)</td>
<td>3.8 (.85)</td>
<td>1.00</td>
</tr>
<tr>
<td>2. Resources</td>
<td>3.4 (1.0)</td>
<td>3.4 (.90)</td>
<td>3.4 (.92)</td>
<td>0.03 1.00</td>
</tr>
<tr>
<td>3. Dynamism</td>
<td>3.1 (.68)</td>
<td>3.1 (.55)</td>
<td>3.1 (.62)</td>
<td>0.05 0.05 1.00</td>
</tr>
<tr>
<td>4. Scanning</td>
<td>3.0 (.59)</td>
<td>3.2 (.63)</td>
<td>3.1 (.65)</td>
<td>0.12* 0.23* 0.08 1.00</td>
</tr>
<tr>
<td>5. Analysis</td>
<td>2.5 (.62)</td>
<td>2.7 (.57)</td>
<td>2.6 (.64)</td>
<td>0.02 0.26* 0.04 0.61*</td>
</tr>
<tr>
<td>6. Formalization</td>
<td>2.4 (.79)</td>
<td>3.0 (.66)</td>
<td>2.7 (.83)</td>
<td>-0.14* 0.15* 0.03 0.31*</td>
</tr>
<tr>
<td>7. Centralization</td>
<td>4.4 (.52)</td>
<td>4.2 (.68)</td>
<td>4.3 (.53)</td>
<td>0.08 0.12* 0.12 -0.11</td>
</tr>
<tr>
<td>8. Stock incentive</td>
<td>47.9 (43.5)</td>
<td>26.4 (41.2)</td>
<td>39.9 (43.0)</td>
<td>0.24* 0.09 -0.08 0.06</td>
</tr>
<tr>
<td>9. Size</td>
<td>1.0 (1.5)</td>
<td>3.0 (2.5)</td>
<td>1.8 (2.4)</td>
<td>-0.17* 0.00 -0.11* 0.30*</td>
</tr>
</tbody>
</table>

*p < .05.

*p < .01.
consistent with previous work by Miller and Friesen (1982). Last, size correlated negatively with stock incentives and positively with analysis.

Results: Research Hypotheses

To test the research hypotheses, we calculated the correlations between the facilitators (environment, information processing, and structure) and product innovation, while controlling for the effects of size (see Table 3). To assess differences in the strength of correlations between early- and late-stage firms, we used Fisher's Z transformation, a procedure developed by Miller and Friesen (1982) and outlined by Cohen and Cohen (1983). We used .10 alpha level of significance, which has been applied in similar studies (Damanpour 1991; Miller and Friesen 1982).

Environment

Hypotheses 1a and 1b predicted that among both early- and late-stage firms, innovativeness would correlate positively with resources and dynamism. Resources did correlate positively with innovativeness among late-stage firms; however, the relationship between innovation and resources was unexpectedly stronger in later-stage than early-stage firms. Dynamism failed to correlate with innovativeness, providing no support for Hypothesis 1b.

Information Processing

Hypotheses 2a and 2b predicted that innovativeness would correlate positively with scanning and analysis. Confirming Hypotheses 2a, scanning correlated positively with innovativeness among both early- and late-stage firms, and the relationship was greater among later than among early-stage firms. Systematic analysis in decision-making correlated positively with innovativeness among late-stage firms, providing partial support for Hypothesis 2b, but among early-stage firms the relationship was weak and negative.
Structure

Hypotheses 3a and 3b predicted that formalization and centralization would correlate positively with innovativeness among early-stage firms and negatively among later-stage firms. Contrary to Hypothesis 3a, formalization correlated negatively with innovativeness among early-stage firms. On the other hand, as Hypothesis 3b predicted, centralization correlated positively with innovation among early-stage firms; for later-stage firms the correlation was negative but not significant. Last, Hypothesis 3c predicted that stock incentives would exhibit a positive relationship with innovativeness for early-stage firms, and a negative relationship, or none, for later-stage firms. Contrary to this hypothesis, stock incentives showed a significant positive correlation for later-stage firms, although the correlation was not significantly greater than the (nonsignificant positive) correlation found for early-stage firms.

DISCUSSION

Our findings confirmed previous assertions by Van de Ven (1986) and Walsh and Dewar (1987) that the effects of organizational and environmental attributes on innovation are moderated by the firm's life-cycle stage. The correlations between product innovation and three facilitators of innovation varied substantially from early- to late-stage firms. In addition, the patterns of differences varied from variable to variable, in sometimes unexpected ways.

For example, organizational life cycle moderated the effects of formalization on innovation, but in a direction opposite to what theory would predict, having a negative association with innovativeness in early-stage firms and a positive but nonsignificant association in later-stage firms. One explanation for this finding is that the creativity and inventiveness of risk-taking, younger personnel common among younger firms is suppressed by the formalized and structured environment characteristic of later-stage firms (Amabile 1988; Balkin and Gomez-Mejia 1987a; Ettlie 1983). It is also possible that the effects of formalization on innovation may be moderated by the type of organization—not examined in this study—because formalization has been found to be negatively related to innovation in manufacturing firms and positively related in service firms (Damanpour 1991).

Surprisingly, stock incentives had a positive association with innovation among later-rather than early-stage firms. In order to retain innovative personnel and prevent them from moving to emerging companies, and to support a viable internal labor market, older firms must offer employees differentiated incentives that reflect the individual's contribution to the firm (Balkin and Gomez-Mejia 1987b; Sykes and Block 1989). Because of typically large capital investments and minimal revenue, start-ups may offer individuals fewer financial incentives in exchange for the opportunity to learn and share in the excitement and commitment associated with an entrepreneurial venture (Walton 1980).

In keeping with earlier research by Damanpour (1991), our results suggest that certain macro-level attributes, in particular information processing and structure, facilitate the innovativeness of organizations. Environmental scanning was positively associated with innovativeness among both early- and late-stage firms, whereas systematic analysis was positively associated with innovativeness among late-stage firms. Taken together, these results support a suggestion by Quinn and Cameron (1983) that after an original entrepreneurial idea is commercialized, firms that wish to remain innovative will need to continually acquire and analyze information from the environment. Because a detailed and structured decision-making process may limit innovation by conserving resources and by decreasing the time devoted to product development (Drucker 1970; Miller and Friesen 1982), start-up firms may deempha-
size systematic analysis to ensure a continued focus on innovative goals and an entrepreneurial vision. Centralization had a significant positive relationship with product innovation among early-stage firms, as we expected, and a negative although statistically insignificant relationship with innovation among later-stage firms. This relation is consistent with the contention by Mintzberg (1973) and others that entrepreneurs are critical to the effectiveness and success of young ventures.

It was not clear why environmental dynamism was unrelated to product innovation. This may in part reflect a restriction-of-range problem, because high-technology industries in general have high levels of dynamism (Eisenhardt 1989). Like Miller and Friesen (1982) and Khan and Manopichetwattana (1989), we found little correlation between external resources and innovation, perhaps because the measure we used was human resources. Our findings seem to reflect the problem that older, established firms have in attracting creative personnel (Balkin and Gomez-Mejia 1987b).

**IMPLICATIONS AND CONCLUSION**

One implication of this study is that researchers who present results of studies of innovation without considering the life-cycle stage of the firm as a potential moderating variable hide important differences, a fact that may help explain why some previous studies have failed to find significant relationships between innovation and resources, analysis, and centralization (e.g., Aiken and Hage 1971; Cohn and Turyn 1980). It is therefore suggested here to disaggregate data when pursuing related research questions on organizational innovation. The aggregated data of the present study, for instance, shows no correlation between centralization and innovation caused by a positive correlation for the early-stage sample and a negative, though insignificant, correlation for the later-stage sample. Opposite signs of the correlations for a variable in different stages may disguise any association in aggregated analyses. In general, this study supports Damanpour's (1991) conclusion that the consideration of contingency factors, such as life-cycle stage, may enhance the development of a theory of organizational innovation.

Although the sample used in the study was generally satisfactory as to size, the results may not be generalizable beyond the firms sampled because they represent only one type of organization. On the other hand, the findings suggest that results relating to innovativeness based on Fortune 500 firms, which typically are in later life-cycle stages, may not be generalizable to younger enterprises. Researchers need to use more heterogeneous samples. Although our use of archival data in addition to questionnaire data and our stratification of the sample according to life-cycle stage represent an improvement over mono-method studies, it will require longitudinal data to determine how and why innovation changes over the different stages of a firm's life.

Our study is limited to examining product innovation. The literature on organizational innovation organizes innovation into product and process innovation (Utterback and Abernathy 1975) and according to radicalness (Damanpour 1988). “Some innovations change the entire order of things, making the old ways obsolete and perhaps sending entire businesses the way of the slide rule or the buggy whip. Others simply build on what is already there, requiring only modest modification of the old world view” (Van de Ven 1993; p. 286). Future research is suggested to investigate the moderating effects of the life-cycle stage of a firm on process along with product innovation and on radical along with incremental innovation.

Of particular interest to managers may be our finding that, on average, late-stage firms used fewer equity incentives. According to earlier work, this may not have an effect on the
innovativeness of mature firms. Our results, however, suggest quite the opposite: In late-stage firms, the correlation between incentives and innovation is quite high. This implies that there may be an unused potential for later-stage firms to increase innovativeness through differentiated financial incentives. Another implication of this work is that overreliance on previous experience can lead to unintended outcomes (Sykes and Block 1989). Factors that facilitate innovation at the inception of a firm may actually hinder it in later stages. The reverse may also be true—factors that were unimportant to innovation at some point during an organization's evolution may facilitate it at another. For example, centralized leadership may contribute to innovativeness in a firm's early stages but may have little impact in later stages. Decreased innovativeness may be one outcome of the leadership crisis predicted by Greiner (1972) to occur during an organization's life cycle if leaders do not adjust their management style to the changing character of the organization as the firm matures.

Innovation is central in terms of the strategic management of organizations, and is of concern both from a practitioner point of view, as firms attempt to compete in an increasingly technologically competitive environment, and from a theoretical point of view, as scholars add to their understanding of the theory on innovation. The results of our study suggest that practitioners and scholars should both consider including the potentially important effects of the life-cycle stage of a firm for organizational innovation.

REFERENCES


