Organization Management Journal

Volume 11 | Issue 2 Article 5

4-3-2014

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Organization Management Journal, 11: 84–100, 2014

ISSN: 1541-6518 online
DOI: 10.1080/15416518.2014.927322

Routledge
Taylor & Francis Group

An Examination of Entrepreneurial Orientation in Dedicated Biotechnology Firms: Context Matters

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The goal of this article is to explore under what contexts do biotechnology firms exhibit an entrepreneurial orientation? To achieve this goal, we assess entrepreneurial orientation as a configuration and individual dimension across three contexts: organizational structure, location, and age. Analyses of survey data from U.S. biotechnology firms indicate that ownership structure was the only contextual factor to yield differences in biotechnology firms' entrepreneurial orientation when assessed as a configuration. However, the analysis identified differences at the multidimensional level within all three contexts. Both theoretical and practical implications of our findings are provided. *Organization Management Journal*, 11: 84–100, 2014. doi: 10.1080/15416518.2014.927322

Keywords biotechnology; entrepreneurial orientation; environment; survey; t-tests

INTRODUCTION

The evolution and assessment of a firm's entrepreneurial orientation (hereafter EO) has been inextricably linked to context. EO is the end result of a firm's strategy-making process that encompasses the range of activities that executives engage in to formulate and implement their firm's strategic goals and objectives (Dess, Lumpkin, & Covin, 1997). Context plays a critical role in the entrepreneurial strategy-making process. Consider that Miller's (1983) development of a construct to measure firm-level entrepreneurial behaviors coincided with the decline of the manufacturing industry in the United States. During that period in U.S. industrial history, "Japanese share of world exports in a number of key industries continued to expand throughout the 1980s, usually at the expense of Western manufacturers" (Bettis, Bradley, & Hamel, 1992, p. 7). Supporting the criticality of context, an early study of EO by Covin and Slevin (1989) explored whether small manufacturing firms would benefit from adopting an EO in hostile and benign environments. In their research, Covin and Slevin (1989) attempt to explore Porter's (1998) claim that the macro-level context or the industry in which a firm operates influences competition and in turn profitability.

A review of literature reveals that EO is often explored in mature industries such as manufacturing, retail, and banking (Barringer & Bluedorn, 1999; Lee, Lee, & Pennings, 2001; Richard, Wu, & Chadwick, 2009; Wiklund & Shepherd, 2005). As industries have evolved and new ones have emerged, scholars have begun to assess EO in firms located in a broad range of high-tech industries (Bierly, Damanpour, & Santoro, 2009; Hung & Chiang, 2010; Stram & Elfring, 2008) and small to medium-sized firms (Hughes & Morgan, 2007; Lumpkin, Brigham, & Moss, 2010; Naldi, Nordqvist, Sjöberg, & Wiklund, 2007). Although EO has been used to assess firms' entrepreneurial disposition across industry contexts, few empirical assessments of EO have been conducted in the biotechnology industry (Renko, Carsrud, & Brännback, 2009). We assert that the biotechnology context is different from the settings found in other high-technology industries. For several reasons, the biotechnology industry provides a unique opportunity to assess EO.

Developing a new human health drug might take a firm 10 years and cost $1.3 billion USD (Pharmaceutical Research and Manufacturers of America [PhRMA], 2013). Many dedicated biotechnology firms (hereafter DBFs) emerged from academic settings to commercialize scientists' research (Hsu, Roberts, & Eesley, 2007; Zucker & Darby, 1997), and employ business models that are ill equipped to meet the financial demands of supporting long-term research and development (R&D) product investments (Pisano, 2006). DBFs are those biotechnology firms that operate on the cutting edge of research by pushing scientific frontiers while exploring opportunities for commercialization (Momma & Sharp, 1999) and also lack the managerial, financial, and human resources to develop new therapies using their own resources (Madkadok & Osegowitsch, 2000). DBFs must collaborate in order to survive but have a high failure rate even with such collaboration (Gassman, Reepmeyer, & Zedwitz, 2004; Oliver, 2004). DBFs may benefit from developing an entrepreneurial disposition (Hughes & Morgan, 2007) to enhance their sourcing strategies (Pérez-Luño, Wiklund, &

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Cabrera, 2010), to foster a learning environment by maintaining adaptability (Li, Liu, Yi, & Li, 2008), and to gain an advantage by using knowledge resources (Wiklund & Shepherd, 2005).

The uniqueness and complexity of the biotechnology context lead us to segment our research question into two parts. In the first part, our intention is to examine: Under what circumstances do DBFs exhibit EO? EO exists across a spectrum of behaviors, from entrepreneurial on one end to conservative on the other (Miller, 1983). The degree to which a firm is entrepreneurial depends, in part, on the extent to which it innovates, acts proactively, and is willing to take risks (Wang, 2008). A conservative orientation involves minimal technological and product innovation, a cautious posture, and top management's propensity to avoid risks (Covin & Slevin, 1989). As business environments become more complex and dynamic, empirical studies reveal that firms whose dispositions lie closer to the entrepreneurial end of the spectrum will outperform those firms whose behaviors can be classified as conservative (Covin & Slevin, 1989; Wiklund, 1999).

The dynamism of the business environment has led scholars to use different conceptualizations of EO to assess firm-level entrepreneurial behaviors. The most common and widely used conceptualization of EO is as a configuration. In this manifestation, an EO reflects a pattern of decision making that emerges over time as a firm solves problems related to survival and those answers become encoded as routines that guide top managers when they are creating a firm's strategy (Davis, Marino, Aaron, & Tolbert, 2011; Lumpkin & Dess, 1996). Specifically, the configuration perspective characterizes EO as a system of interdependent entrepreneurial behaviors. Conversely, the multidimensional approach proposes that some dimensions may be beneficial while others are not (Hughes & Morgan, 2007). The degree to which firm-level entrepreneurial behaviors manifest depends on a firm's situation (Lumpkin & Dess, 1996).

The different EO perspectives led us to the second part of our research question: In what contexts will the configurational or multidimensional form be more helpful to a DBF? We develop hypotheses that explore how contextual factors such as location, ownership structure, and age influence the manifestation of a firm's EO. First, there are close linkages between the entrepreneurial process and location (Malecki, 1997). Since the origin of the U.S. biotechnology industry, firms have been known to develop around centers of excellence (Chiesa & Chiaroni, 2005). Second, structure has long been considered a major contingency in organizational research (Burns & Stalker, 1961). Studies have found that ownership structure influences the strategic choices a firm's executives make regarding R&D investments (Shefer & Frenkel, 2005). Third, age highlights how young firms enter the market with new technology, business models, and processes that disrupt existing ways of doing things and displace existing firms (Schumpeter, 1934; Tripsas, 1997).

The contribution that our study makes is twofold. First, there has been a debate regarding whether EO was appropriately conceptualized as a multidimensional or gestalt construct (Covin, Green, & Slevin, 2006). Although both conceptualizations are considered appropriate forms, few studies have conducted a simultaneous comparison of the two conceptualizations. By utilizing both assessments of EO, this article provides data that can be used to draw insight regarding the situation under which one conceptualization may be more appropriate than the other.

Second, this study contributes to investigating entrepreneurial behavior in DBFs, which engage in long periods of entrepreneurial activity when attempting to create new therapies (Rothaermel & Deeds, 2006), but it is unclear whether those behaviors emerge from a general pattern of decision making or from individual entrepreneurial activities within the firm. Other than the Renko and peers (2009) exploratory assessment of EO in DBFs located in California and Sweden, an assessment of EO solely in DBFs has been limited. We believe our study provides a deeper examination of firm-level entrepreneurship by assessing DBFs across the United States, large and small, publicly traded and private, which reflects the actual population. Since failure in the biotechnology industry is commonplace, this study may deepen our understanding of how DBFs attempt to compete in a complex environment.

The structure of the article proceeds as follows. The next section provides a theoretical platform to develop the hypotheses in the third section. The fourth section summarizes the research methodology and presents the results. In the final section, we discuss the relevance of the findings, offer ideas for future research, and identify study limitations.

LITERATURE REVIEW

Who Is the Entrepreneur?

For decades, the study of entrepreneurship has been plagued by the following question: Who is the entrepreneur—the individual or the firm? The entrepreneur is the actor, who possesses "the dream and the will to found a private kingdom . . . and the joy of creating, of getting things done or simply of exercising one's energy and ingenuity" (Evans, 1949, p. 93). When assessing entrepreneurship, scholars used either the trait approach or the cognitive perspective, both of which focused on the individual as the entrepreneur. The former put forth the notion that some individuals are predisposed to becoming entrepreneurs because they possess specific traits (McClelland, 1961), and the latter suggested that some people are more sensitive to detecting change, understanding its significance, and recognizing its commercial potential (Kirzner, 1979). The development of methods to assess firm-level entrepreneurship stalled the debate.

As the business climate grew more competitive, typologies arose that described firm-level entrepreneurship. Miles and Snow (1978) offered the "Prospector" as an entrepreneurial-focused strategic type who searched for opportunities to innovate. Mintzberg's (1973) entrepreneurial

mode of strategy-making also included some aspects of the entrepreneurial process. Then Miller (1983) examined how entrepreneurship occurred in different types of firms by specifically examining firm-level behaviors. This exploration represented a shift in entrepreneurial studies away from individual characteristics to a more firm-centric approach.

Miller boldly helped shift the debate away from individual to firm-level behaviors (Brown & Davidsson, 1998). However, a deeper examination of the construct reveals the significant influence of individuals (i.e., managers). The assessment of EO is not based on actual outcomes or activities, but rather involves managers' perceptions of the entrepreneurial process within their firm. Focusing on managerial opinions and perceptions draws attention to whether managers are assessing actual firm-level behaviors or their opinion of them. Although the role of managers in the assessment of EO may cause concern, studies have found that top management teams' perceptions and categorization play a critical role in the strategic issues that a firm addresses (Dutton & Jackson, 1987). We do know that firm-level entrepreneurship exists beyond top management teams' perceptions and a chief executive officer's (CEO) tenure.

For example, 3M, one of the world's largest corporations, has a long history of entrepreneurial behavior, transcending the tenures of CEOs and top management teams (cf. Barringer & Bluedorn, 1999, p. 422). The psychometric qualities of the scales may draw into question the extent to which managerial perceptions or firm-level behaviors are being assessed. However, EO does provide scholars with the means to assess firm-level entrepreneurial behaviors. The remainder of the literature review offers a more detailed assessment of EO and related research.

Entrepreneurial Orientation

EO emerged from a stream of literature that focused on the entrepreneurial process or "the methods, practice, and decision-making styles managers use to act entrepreneurially" (Lumpkin & Dess, 1996, p. 136). Miller (1983) examined how entrepreneurship occurred in different types of firms by specifically examining firm-level behaviors. Covin and Slevin (1989) refined Miller's entrepreneurial research, writing,

> The entrepreneurial choices made by the firm reflect its entrepreneurial posture, which is demonstrated by the extent to which top managers are inclined to take business-related risks, to favor change and innovation in order to obtain a competitive advantage for their firm. (p. 77)

Management literature contains many empirical studies that examined the entrepreneurial choices that firms enact to enhance their performance (Covin & Slevin, 1989; DeClercq, Dimov, & Thongpapanl, 2010; Li, Huang, & Tsai, 2009; Lumpkin & Dess, 2001; Stram & Elfring, 2008; Wiklund & Shepherd, 2003). However, EO does not always lead to increased firm performance (Hughes & Morgan, 2007). On the one hand, Miller (1983) originally conceptualized EO as a configuration, where innovativeness, risk taking, and proactiveness must positively covary in order for an EO to manifest (Covin & Wales, 2011). On the other hand, scholars have argued that the reason for the mixed performance is that the conceptualization of EO as a gestalt "neglects the individual influence of each dimension and assumes a universal and uniform influence by each dimension" (Hughes & Morgan, 2007, p. 652). Lumpkin and Dess's (1996) research on EO as a multidimensional construct drew attention to some concerns about the configurational approach. The scholars put forth the notion that depending on a firm's context, it may not be necessary or even efficient for it to possess all three dimensions and that each dimension can vary independently and might not be beneficial to a firm at different points in time.

The multidimensional approach is gaining traction among EO scholars. Rauch, Wiklund, Lumpkin, and Frese's (2009) meta-analysis of 51 EO studies revealed that 37 studies viewed EO as a one-dimensional construct and 14 studies viewed it as having three separate dimensions. The multidimensional conceptualization of EO is relatively new, but there is a growing stream of studies that have adopted the new approach to develop a detailed understanding of phenomena (Kollmann & Stöckmann, 2012; Pérez-Luño et al., 2010; Ramachandran & Ramnarayan, 1993).

EO Dimensions

There are three agreed-upon dimensions of EO: innovativeness, proactiveness, and risk taking. First, innovativeness reflects a firm's desire to support new ideas and foster creativity when developing new products (Walter, Auer, & Ritter, 2006). Research suggests that EO supports (a) learning and innovation outcomes by triggering resource and knowledge mobilization to generate an advantage (Li, Huang, & Tsai, 2009), (b) the development of exploration and exploitation innovations (Kollmann & Stöckmann, 2012), and (c) the sourcing of innovation (Pérez-Luño et al., 2010). Second, the proactive dimension refers to a posture of anticipating and acting on future wants and needs in the marketplace, thereby creating a first-mover advantage (Lumpkin & Dess, 1996). Empirical research has documented that pioneering firms may achieve first-mover advantages (Lieberman & Montgomery, 1988) in hostile industries (Covin, Slevin, & Heeley, 2000). Clausen and Korneliussen's (2012) examination of incubator firms revealed that EO positively influenced a firm's ability to commercialize technology and bring it to market. Finally, risk taking represents a willingness to commit resources to implement projects, activities, and solutions that inherently contain a high level of uncertainty regarding the likely outcomes (Lumpkin & Dess, 1996). Prior research reveals mixed results when assessing the relationship between risk and performance. Hughes and Morgan (2007) investigated the relationships between the EO dimensions and product and customer performance in young firms located in incubators. The analysis found

that risk taking positively influenced product innovation but negatively influenced customer retention. A study conducted by Wiseman and Catanach (1997) suggested that innovative performance is context specific—it was beneficial in certain contexts and detrimental in others.

Contexts

Lumpkin and Dess's (1996) argument supporting the multidimensionality of EO draws attention to the situatedness of firm operations. The authors proposed that the entrepreneurial process manifests in firms based on their context. In some situations, a firm may need a general pattern of decision making to be entrepreneurial, but in another context a firm may be entrepreneurial with the existence of one dimension. Initially, we argued that context determines the form and the situation in which EO will manifest. These situational factors include factors that are internal or external to the firm, such as technology, structure, size, age, environment, management practices, industry trends, or business cycles (Lyon, Lumpkin, & Dess, 2000). In the next section, we put forth age, location, and ownership as three contextual factors that influence how EO shows up in firms.

HYPOTHESES

Does Age Matter Regarding EO?

Innovation is the heart of entrepreneurship (Drucker, 2002). Theories of entrepreneurship often characterized firms as entrepreneurial because they enter the market and innovate by developing novel resource combinations, which instigates the demise of the old way of doing things and brings forth new methods, markets, and potential for profits (Schumpeter, 1934). Scholars have proposed that new firms tend to have a higher EO than existing firms because the potential to attain entrepreneurial profits leads new firms to be more innovative, risk taking, and proactive than their mature counterparts (Zhao, Li, Lee, & Chen, 2011). Although the premise that young firms might be more entrepreneurial than existing firms might be relevant in most industries, the biotechnology industry is different. Consider this fact: Transforming an invention into an innovation is a decade-long process that costs nearly US$1.3 billion (Herper, 2012) and underlies a 90% new firm failure rate (Scarmoutzos, 2006). Given the resource-intensiveness of innovation, we argue that existing firms will have the resources to out-innovate, in terms of bringing a product to market, their younger peers.

New DBFs—those firms less than 8 years old (Eisenhardt & Schoonhoven, 1990)—may have weak EOs because they lack critical resources and managerial experience. First, DBFs emerged with the promise and potential to revolutionize drug development (Kaplan, Murray, & Henderson, 2003; Zucker & Darby, 1996) with commercial applications of recombinant DNA and molecular genetics technology (Audretsch & Feldman, 2003). Unfortunately, the revolution was contained to the early stage of the drug-development value chain. Downstream activities remained unchanged, to the benefit of existing firms that possess expertise in clinical trials, marketing, and production that are dedicated to marketing the new product (Rothaermel & Deeds, 2004). Many young DBFs lack the multidisciplinary capabilities that are necessary to create new drugs (Madhok& Osegowitch, 2000). New DBFs sparked the revolution, but existing firms with vast financial and human resources and late-stage expertise will benefit from their inventions.

Second, many young DBFs are led by scientist-managers (Holcomb, Holmes, & Connelly, 2009) who have academic backgrounds and lack the capabilities required to effectively develop and manage a commercial research enterprise (Niosi, 2003). Executives play a critical role in a firm's ability to manifest an EO (Covin et al., 2006; Wales et al., 2011), which reflects executives' biases toward making firm-level decisions regarding innovation, proactiveness, and risk taking. To make optimal entrepreneurial decisions, "managers need to know the context or framework that indicates the rules of the game, the appropriate resources (means), and the index of value (ends)" (Gaglio, 1997, p. 533). Scientist-executives may not understand the business of commercializing basic science. Consequently, with weak resource and knowledge endowments, new firms may be unable to make full and effective use of an EO (Hughes & Morgan, 2007).

Conceivably, existing DBFs have made the transition from an owner-manager to professional managers (Cooke, 2001) who have industry experience and understand all phases of the drug-development value chain. Professional managers should have knowledge of industry and the commercialization process that will enable a DBF to develop its inventions, appropriate returns from them, and identify and exploit other value-creating opportunities. Given these insights:

- Hypothesis 1: Existing DBFs will possess a higher level of EO than do new DBFs.

EO dimensions. Successful innovation involves invention as well as commercialization (Lee et al., 2010). For several reasons, new DBFs often focus solely on the research part of R&D that involves creating new inventions because DBFs can easily access or develop resources that support knowledge creation (early-stage development). For one reason, new DBFs maintain strong ties to academia to gain access to scientific and technological knowledge (George, Zahra, & Wood, 2002). University discoveries are a critical source of new knowledge for biotechnology firms (Prevezer, 1997). DBFs can use university knowledge, in the form of inventions and prototypes, to expand their R&D portfolios (Stuart, Ozdemir, & Ding, 2007).The ability to leverage their resources in order to gain legitimacy is another possible reason that DBFs focus on early stage research. Since there is a high level of uncertainty associated with early-stage research, collaborating with a high status partner such as a university can help new DBFs enhance their attractiveness as potential alliance partners by signaling the quality of their science and establishing their legitimacy (Stuart,

Hoang, & Hybels, 1999). Drug development is a resource- and knowledge-intensive process that occurs within a network of economic actors (Owen-Smith & Powell, 2004). To gain entrée to those networks, new DBFs use their scientific expertise to demonstrate the quality of their science, which enhances their attractiveness as possible collaboration partners and provides them with an opportunity to gain access to the knowledge and resources they need to support further research efforts.

While new DBFs use their inventions to establish the legitimacy of their science, existing DBFs search for opportunities to exploit their existing R&D assets through commercialization or licensing (Stuart, Ozdemir, & Ding, 2007). Existing DBFs are focused on the commercialization process by gaining access to complementary downstream capabilities that are needed to create new therapies (Rothaermel & Deeds, 2004). In the biotechnology industry, commercialization requires the skills and capabilities of for-profit, nonprofit, and government entities (Chesbrough, 2006). It may be beneficial for existing firms to develop a proactive disposition. Research has found that proactive firms gain access to developing diverse alliance portfolios (Marino et al., 2002) and internetwork ties (Stram & Elfring, 2008) that allow them to secure partners with the complementary skills and resources required to commercialize the DBF's R&D projects.

Regardless of the stage of the R&D project—research or development—drug development is a risky endeavor. On the one hand, new firms focus on invention but only 1 out of 10,000 compounds will become commercialized products (Rothaermel & Deeds, 2004). In addition, these firms encounter risks when acquiring university inventions because these technologies are often licensed at an early stage of development when it is difficult to assess the commercial potential of an invention (Jensen & Thursby, 2001). On the other hand, existing firms often have low bargaining power when engaging in development alliances with large pharmaceutical firms because they lack the financial and other capabilities to manage the commercialization and are at risk of falling prey to opportunistic behavior when all they bring to an alliance is the technology (Alvarez & Barney, 2001; Lerner & Merges, 1998). The risk may be greater for new DBFs because there is a possibility they will acquire a university invention and spend resources to develop it, only to find out that there are few commercial applications for it. In development alliances, existing DBFs have assets they can sell or develop. Thus:

- Hypothesis 1a: Innovativeness scores of existing DBFs will be higher than those of new DBFs.
- Hypothesis 1b: Proactiveness scores of existing DBFs will be higher than those of new DBFs.
- Hypothesis 1c: Risk-taking scores of new DBFs will be higher than those of existing DBFs.

EO as a Geographically Based Phenomenon

Agglomerations are spatially bounded concentrations of economic activities (Boshuizen, Geurts, & Van Der Veen, 2009, p. 184). We put forth the notion that clusters are diverse ecosystems of complex combinations of specialized knowledge that DBFs seek to simultaneously acquire the resources that are necessary to create new therapies and develop an EO. A review of literature reveals two reasons that cluster DBFs are more likely to develop an EO than are their remotely located peers. First, these firms have access to knowledge. Marshall (1890) theorized that knowledge-based factors such as specialized labor, knowledge spillovers, and suppliers make clusters attractive. The concentration of knowledge provides firms with immediate access to the financial, human, institutional, and technological resources (Cooke, 2001). Since developing human health therapies is a multidisciplinary activity (DeCarolis & Deeds, 1999), the pooling of specialized knowledge in a cluster enables firms to effectively and efficiently conduct R&D activity. Second, clusters are hotbeds of entrepreneurial activities (Porter, 1998). Resources such as human capital and knowledge spillovers play a critical role in cluster-based entrepreneurship (Acs et al., 2009; Audretsch & Keilbach, 2007). Given that clusters contain diverse resources to support the development of an EO, we claim:

- Hypothesis 2: Cluster firms' composite EO scores will be higher than those of noncluster firms.

EO dimensions. Biotechnology firms located in clusters can secure various resources that can be leveraged to build an EO. From an innovative perspective, technically skilled employees flock to clusters to take advantage of career opportunities (Kukalis, 2010). In a fluid labor market, a firm benefits from the training and experience of another firm by hiring away some of the latter firm's workers (Chesbrough, 2006). These employees open their new firm up to new ideas and creativity (Østergaard, Timmermans, & Kristinsson, 2011). Learning through hiring is an important source of spillovers and positively influences innovation (Whittington, Owen-Smith, & Powell, 2009). Noncluster firms may not have access to superior technical labor in their physical location or may have to pay higher wages to lure talent to their location, both of which decrease their ability to innovate.

Several motives underlie cluster DBFs' proactiveness. First, the theory of knowledge spillover entrepreneurship suggests that knowledge-rich environments such as clusters promote entrepreneurial activity because of the abundance of exploitable opportunities (Audretsch & Keilbach, 2007). Owen-Smith and Powell (2004) contended that knowledge spills over via channels—social connections between employees, scientists, and faculty members. In these channels, "informal, spontaneous, and sometimes even accidental exchange of knowledge takes place as a result of social relations in the local or regional milieu" (Moodysson, 2008, p. 451).

In addition, face-to-face interaction promotes the efficient transfer of tacit knowledge. For example, co-location provides cluster DBFs with opportunities to gain access to novel technology and scientific breakthroughs by acquiring university inventions directly from faculty, thereby circumventing the university administrative processes (Markman, Phan, Balkin,

& Gianiodis, 2005). Third, cluster firms often partner with each other (Lechner & Dowling, 2003). These partnerships enable a DBF to build their networks and gain entrée to global pipelines—strategic partnerships with global reach (Bathelt, Malmberg, & Maskell, 2004).

An advantage of being located in a cluster is the reduction of the risks and uncertainties that emerge during the drug-development process. There is a high level of uncertainty associated with drug development. Cluster DBFs can reduce their uncertainties by observing actions of cluster firms (Bell, 2005). While cluster firms are located in areas rich with knowledge resources, noncluster firms have to develop unique strategies to secure some of the knowledge that is available to cluster firms (Fontes, 2005). Noncluster DBFs' isolated location may prevent them from securing the requisite resources required to build an EO. Thus:

- Hypothesis 2a: Cluster DBFs' innovativeness scores will be higher than those of noncluster DBFs.
- Hypothesis 2b: Cluster DBFs' proactiveness scores will be higher than those of noncluster DBFs.
- Hypothesis 2c: Noncluster DBFs' risk-taking scores will be higher than those of cluster DBFs.

Is EO a Function of Ownership?

Organizational structure is sometimes defined as the arrangement of workflow, communication, and authority relationships within an organization (Covin & Slevin, 1991, p. 17). It is widely accepted among scholars that a firm's ownership structure influences its R&D investment decisions. Ownership structure reflects a source of power that can be used to support or oppose managemen,t depending on how it is concentrated and used (Salancik & Pfeffer, 1980, p. 655). In this study, a firm's ownership structure reflects whether the firm is private or has publicly traded stock.

In the public arena, ownership structure is important because the owners (shareholders) hire executives as agents to operate the firm in their absence. As agents of the firm, managers may be inclined to make R&D investment decisions that support their personal well-being instead of maximizing shareholder value (Hoskisson, Hitt, & Hill, 1993). Although R&D investments play a critical role in a DBF's ability to develop new therapies, an EO, in the form of a configuration, also involves other entrepreneurial behaviors such as proactiveness that might be conducive to public firms.

There are conditions under which public firms might benefit by developing a consistent pattern of entrepreneurial behavior to promote goal attainment and meeting investors' expectations. First, managers of public DBFs have many voices they should pay attention to when creating R&D investment strategies (Hoskisson, Hitt, Johnson, & Grossman, 2002). A DBF's managers must make sufficient investments in R&D to provide the firm with the flexibility to identify and exploit opportunities (Cohen & Levinthal, 1990) as investors and the board of members change their preference for R&D investments. Second, executives of public firms must possess superior resource-picking skills (Barney, 1986) because they must convince a large number of investors that the firm is pursuing quality projects (Chemmanur & Fulghieri, 1999). Conversely, private firms do not endure the rigors of financial reporting, managing investors' expectations, and meeting listing requirements. Therefore, we propose:

- Hypothesis 3: Public DBFs' EO scores will be higher than those of private firms.

EO dimensions. Although public firms may have available adequate funds that can be used to explore new scientific frontiers, private firms are more likely than public firms to participate in scientific discovery activities. Shareholders of biotechnology firms seek significant returns for their risky investments. Public biotechnology firms are under immense pressure to generate profits; therefore, senior managers direct resources toward commercializing new products (Khilji, Mroczkowski, & Bernstein, 2006). Entebang, Harrison, and de Run's (2010) study of EO in public firms in Malaysia revealed that public firms do have a strong emphasis on R&D but most of their activities focus on exploitation and commercialization activities.

Conversely, private DBFs direct their energies to innovative activities in order to secure patents, which send signals to third parties about the appropriability of their R&D portfolio (Baum & Silverman, 2004). Since knowledge-based assets are more difficult to assess than are tangible ones (Higgins & Rodriguez, 2006), innovation, as evidenced by a firm's ability to create patents, plays a critical role in assisting outside parties to evaluate a private DBF's worth. We contend, creating new knowledge is important to private firms while generating value from existing inventions plays a critical role in public firms' innovation strategies.

From a proactive perspective, publicly traded DBFs focus their attentions on securing external investments and meeting shareholders' expectations (Chaganti & Damanpour, 1991). Enacting a proactive strategy focuses publicly traded DBFs' executives' attention toward exploiting existing assets today to generate profits in order to prevent the delisting of a DBF's stock due to insufficient capitalization (Golec & Vernon, 2007) or to avoid liquidation when commercialization projects fail (Pollack, 2009). Unlike their peers in public firms, executives in private DBFs are isolated from competitive market pressures and have more direct control and power over their firms. Executives in private DBFs can choose whether to explore new or exploit existing science and/or technology.

Managers within the organization place their reputations and financial futures at stake when investing in innovative activities that absorb significant resources and may not lead to any identifiable benefits. The possibility of failure may induce risk aversion because executives do not want to damage their reputation (Zahra, 1996) and they want to protect their job security by

avoiding investment in risky projects (Hoskisson et al., 1993; Hoskisson, Johnson, & Moesel, 1994). Executives of private firms do not encounter such pressures. These managers have a wide range of authority and control and might not be replaced even when their ventures fail (McEachern, 1975). Given this insight, we propose:

- Hypothesis 3a: Private DBFs' innovativeness scores will be higher than those of public firms.
- Hypothesis 3b: Publicly owned DBFs' proactiveness scores will be higher than those of private firms.
- Hypothesis 3c: Private DBFs' risk-taking scores will be higher than those of public firms.

METHODOLOGY

Sample

Data for this study were collected from U.S. biotechnology firms engaged in the development, production, and marketing of new biotechnology drug therapies (Pisano, 1990). The selection process began with 1,000 DBFs collected from HOOVERS and state biotechnology associations' member lists. Each DBF's North American Industry Classification Scheme (NAICS) codes were verified, using an A-to-Z database, to ensure that each DBF creates human health therapies, because of the arduous regulatory conditions monitoring the new-drug approval process, which can last nearly a decade (Rothaermel & Deeds, 2004). One hundred sixty-two DBFs were eliminated during the process of verification, resulting in a list of 838 potential respondents.

Survey Administration

A survey was used (Table 1) to collect the firm-level data for all the variables assessed in this study (Lyon et al., 2000). Since executives, especially in small firms, are a key source of firm-level information (Li, 2001; Norburn, 1989), this survey was sent to each firm's most senior executive in charge of research and development (R&D). The respondents' titles included chief scientific officer, vice-president of research, and vice-president of scientific discovery. In smaller firms with simple structures, the president and CEO or vice-president of R&D received the questionnaire.

The average responding firm had 91 employees, was 9 years old, and had 1.32 projects in clinical trials. Further analysis of the respondents revealed that 36% had publicly issued stock, 74% were located in U.S. biotechnology clusters, 83% were founded by academic scientists, and 27% were university spin-offs. Regarding the respondents' titles, 12% were listed as president and CEO; 39% as vice president of R&D; 28% as chief scientific officer; and 21% as vice-president of scientific discovery.

Following survey methodology used in prior survey studies, Dillman's (1978) method of mail survey response and design was used to improve the response rate. Dillman's survey methodology involves sending out reminders in order to maximize survey returns. Three mailings, sent 6 weeks apart, were administered to collect questionnaire responses. The lag time between the mailings was necessary to collect responses and update the database with new firm information. In total, 990 surveys were mailed to eligible respondents. The distribution of the mailings is as follows: 680 usable surveys sent in the first mailing, 225 sent in the second mailing, and 85 sent in the final mailing. We received 204 responses but six were deleted due to missing data. The survey administration achieved a response rate of 19.8%.

Given that survey response rates have been decreasing over the past two decades (Baruch, 1999), many researchers analyze early and late responses to identify whether any significant differences exist between the respondents. The degree of nonresponse bias depends on two factors: the percentage of the sample that does not respond and the extent to which nonresponders differ systematically from the study population (Barclay, Todd,

TABLE 1
Survey questions

Age	(1) How old is your firm: _____(in years) and _____months
Ownership	(1) Is your firm's stock traded on public exchanges (NYSE, NASDAQ, etc.)?
Entrepreneurial Orientation	(1) Innovation #1: Top executives exhibit a strong emphasis on R&D
	(2) Innovation # 2: Top executives promote a diversified product pipeline
	(3) Innovation #3: Top executives favor dramatic change to pipeline
	(4) Risk Taking #1: Top executives favor high-risk projects
	(5) Risk Taking #2: Top executives favor bold acts to achieve firm goals
	(6) Risk Taking #3: Top executives adopt a wait-and-see attitude[a]
	(7) Proactiveness #1: Top executives initiate actions and competitors respond
	(8) Proactiveness #2: Top executives favor being the first business to introduce products, administrative techniques, and technologies
	(9) Proactiveness #3: Top executives favor a strong tendency to be ahead of others

[a]Reverse-coded question.

Finlay, Grande, & Wyatt, 2002). Analysis of variance (ANOVA) tests were used to determine whether there was any nonresponse bias influencing this study. The responding DBFs were divided into three groups: initial mailing, first reminder, and second reminder. The results revealed no significant differences among the three groups on organizational characteristics including age, size, and R&D spending and study variables such as EO and the three dimensions. The results of the *t* tests are consistent with Linder, Murphy, and Briers's (2001) response-rate meta-analysis which found that 86 of 114 (75.4%) of the studies they analyzed exhibited no differences between early and late respondents and between responders and nonresponders.

Measures

A pretest was conducted with respondents who were employed in a research-intensive industry to (a) determine scale validity and reliability, (b) identify areas of potential response bias, and (c) improve the administration of the survey. An electronic survey was used to administer the pretest to master's of business administration (MBA) alumni employed in the pharmaceutical industry. The pretest results and respondent feedback revealed no major issues with the questionnaire or survey scales. Measures in this study were ranked using a Likert scale that ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). Reliability was tested using Cronbach's alpha coefficient (α).

Entrepreneurial orientation reflects the extent to which "top managers are inclined to take business-related risks, to favor change and innovation in order to obtain a competitive advantage for their firm" (Covin & Slevin, 1989, p. 77). This variable represents the traditional conceptualization of EO as a gestalt or pattern of decision making (Covin & Slevin, 1989; Miller, 1983; Wiklund & Shepherd, 2005). In this variable, the dimensions are measured separately and the results of the individual assessments are combined to create a composite EO, which reflects a pattern of entrepreneurial decision making (Hughes & Morgan, 2007). EO is a nine-item scale that contains questions that asked respondents about their firm's product development, proclivity to take bold actions by supporting uncertain projects, and willingness to take aggressive actions to exploit opportunities. Firms with high scores tend to act entrepreneurially by fully exhibiting innovative, proactive, and risk-taking behaviors, while conservative firms with lower scores tend to wait to respond to competitors' actions, are averse to taking risks, and do not support creative problem solving. Cronbach's alpha (α) for the scale is .832.

Innovativeness (INV) reflects a firm's tendency to engage in new idea generation, experimentation, and R&D activities that result in new products and processes (Hughes & Morgan, 2007; Lumpkin & Dess, 1996; Wang, 2008). The three-item scale includes questions that asked respondents to reflect on their firm's new-product development and R&D portfolio. Cronbach's alpha (α) for the scale is .811.

Proactiveness (PA) highlights top managers' forward-looking perspective, a characteristic of a marketplace leader who has the foresight to act in anticipation of future demands and shape the environment (Lumpkin & Dess, 1996; Walter et al., 2006). The three-item scale includes questions that asked respondents to reflect on their firm's first-mover activities. Firms with a higher score are likely to be more proactive. Cronbach's alpha (α) for the scale is .752.

Risk-taking (RISK) emphasizes the degree to which managers are willing to make large and risky resource commitments (Hughes & Morgan, 2007). The three-item scale asked respondents to assess their firm's willingness to take risks. Cronbach's alpha (α) for the scale is .772.

Age refers to the number of years that have passed since the DBF was established (Wiklund, 1999). Age draws attention to a firm's ability to acquire resources, develop relationships, and establish legitimacy, which play a critical role in a collaborative drug-development process (Chesbrough, 2006). The current study uses 8 years of age because it is consistently used to assess "newness" in technology-based DBFs. To code this variable, DBFs were segmented into two groups: new DBFs aged 8 years or less and existing DBFs older than 8 years.

Cluster refers to the geographical location of the biotechnology firm (Casper, 2007). DBFs located in clusters or "hot spots" grow more rapidly than other industry participants do (DeCarolis & Deeds, 1999) because they have access to resources that pool around centers of economic activities (Boshuizen et al., 2009). To determine whether a DBF was located in a biotechnology cluster, we compared respondents' ZIP codes to the ZIP codes for the top biotechnology clusters listed in Ernst & Young's Annual Biotechnology Report (Ernst & Young, 2005). Since the 1990s Ernst & Young has published a comprehensive analysis of the international biotechnology industry, which contains detailed analysis of industry revenues, cluster characteristics such as firms, and competitive analysis. Biotechnology studies (Deeds, DeCarolis, & Coombs, 2000; Lee, Park, Yoon, & Park, 2010; Powell, Koput, & Smith-Doerr, 1996) have utilized information from Ernst & Young's biotechnology report.

The 2005 report identified 12 biotechnology clusters in the United States—California, Massachusetts, North Carolina, Maryland, New Jersey, New York, Pennsylvania, Georgia, Texas, Washington, Florida, and Connecticut. To determine a DBF's location, we acquired the ZIP codes for Ernst & Young's clusters from the U.S. Census Bureau Metropolitan Statistical Analysis for 2005 and compared them to the postmarks on the returned surveys. If a DBF's postmark was located in a biotechnology cluster the variable was coded as "1"; otherwise, it was coded as "0." In cluster studies, indicator variables that have been developed using ZIP codes have been used to characterize whether a firm belongs to a cluster (Bell; 2005; Kukalis, 2010).

Ownership reflects whether a DBF's stock is publicly traded on a stock exchange. Respondents were asked whether their DBF's stock was traded on a public stock exchange such as the NASDAQ, AMEX, or OTB. If a DBF's stock is publicly traded, the response was coded as "1"; otherwise, it was coded as "0."

RESULTS

Table 2 contains a list of the descriptives and frequencies for the responding firms and the variables used in this study.

Hypotheses Testing

The current study seeks to compare EO scores between two groups of DBFs in various contexts; independent *t* tests were used for hypothesis testing. The independent *t* test is used to determine whether two sample means are sufficiently different so as to be unlikely to have been drawn from the same population (Shaughnessy & Zechmesiter, 1997, p. 393). Hashai and Almor (2004) used *t* tests to compare the degree of internationalization between subsidiaries of marketing-based firms and firms engaged in R&D or production. The results from the independent *t* tests are summarized in Table 3.

Group 1 hypotheses: age. Hypothesis 1 states that existing DBFs' EO scores will be higher than scores of new DBFs. The data do not support Hypothesis 1. There was no significant difference in the scores for existing and new DBFs, $t(198) = .333$, $p =$ n.s. Regarding the EO dimensions, the results were mixed. Hypothesis 1a indicates that existing DBFs' innovativeness scores will be greater than those of new DBFs. Although the mean innovativeness scores for existing firms are higher than new firms' scores, the differences were not significant, and the data do not support this hypothesis, $t(198) = .727$, $p =$ n.s. The findings for the final two hypotheses are favorable. Hypothesis 1b suggests that existing DBFs are more proactive than are their younger counterparts. The results support this assertion, $t(198) = 1.71$, $p < .05$. Conceivably, existing DBFs have products in the development stage and they use their networks for commercialization purposes. Finally, Hypothesis 1c indicates

TABLE 2
Descriptives and frequencies

	Mean	*SD*	Range	Yes	No
Age	8.98	5.67	2–27 years		
R&D Spending	3.47	0.84	$85,000–$450 million		
Size	3.33	0.68	2–440 employees		
EO	3.36	0.68	1–5		
INV	3.47	0.84	1–5		
PA	3.39	0.79	1–5		
RISK	3.19	0.92	1–5		
Ownership: Public				65 (32.8%)	133 (67.3%)
Cluster				145 (73.2%)	53 (26.8%)

TABLE 3
t-Tests analysis: Composite EO and individual dimensions by age, location, and ownership

	EO	INV	PA	RISK
Model 1: Existing vs. new firms				
Existing Firms (96 months -above)	3.35 (0.65)	3.52 (0.80)	3.48 (0.73)	3.09 (0.93)
New Firms (0-95 months)	3.31 (0.72)	3.43 (0.88)	3.24 (0.84)	3.28 (0.91)
t-Value	0.333	0.727	1.71**	–1.39*
Model 2: Cluster vs. noncluster firms				
Cluster Firms	3.34 (0.72)	3.53 (0.87)	3.31 (0.80)	3.17 (0.97)
Non-Cluster Firms	3.31 (0.59)	3.31 (0.71)	3.35 (0.79)	3.28 (0.77)
t-Value	0.214	1.65**	−0.256	−0.778
Model 3: Public vs. private				
Public	3.40 (0.63)	3.48 (0.78)	3.44 (0.72)	3.23 (0.90)
Private	3.30 (0.71)	3.47 (0.87)	3.27 (0.82)	3.16 (0.92)
t-Value	1.77**	0.062	1.40*	0.476

Note. Mean/(standard deviation), $N = 198$; significance: $^{*}p < .10$; $^{**}p < .05$.

that new DBFs will have higher risk-taking scores than existing DBFs. We find a significant difference in the scores for existing and new DBFs, $t(198) = -1.39$, $p < .10$. New DBFs may be willing to take risks because they have a lesser stake in maintaining the status quo (Schumpeter, 1934).

Group 2 hypotheses: clusters. The second group of hypotheses addresses differences in EO and the dimensions between DBFs located in biotechnology clusters and those DBFs located outside of clusters. Model 2 contains the *t*-test findings. There was no significant difference in the EO scores for cluster and noncluster DBFs, $t(198) = .214$, $p > .10$. With respect to innovativeness (Hypothesis 2a), we find that cluster DBFs will possess higher innovative scores than noncluster DBFs, $t(198) = 1.65$, $p < .05$. This positive difference supports existing studies that identify clusters as hotbeds of innovative activity (Porter, 1998). Hypothesis 2b proposes that cluster DBFs are more proactive than are their noncluster peers. The results do not support this hypothesis, $t(198) = -.256$, $p =$ n.s. Similarly, Hypothesis 2c, which suggests that noncluster DBFs should be willing to take more risks than cluster DBFs do, was not supported, $t(198) = -.778$, $p =$ n.s.

Group 3 hypotheses: ownership. The last group of hypotheses claims EO differences exist between public and private DBFs. Model 3 lists the *t*-test results. Hypothesis 3 indicates that public DBFs' EO scores will be higher than the EO scores of private DBFs. The data support this hypothesis. The analysis uncovered a significant difference in the EO scores of public and private DBFs, $t(198) = 1.77$, $p < .05$. Hypothesis 3a indicates that public DBFs possess lower innovativeness scores than private DBFs do. There was no significant difference in the innovativeness scores of public and private DBFs, $t(198) = .062$, $p =$ n.s. Hypothesis 3b indicates that public DBFs possess higher proactiveness scores than private DBFs do. There was a significant difference in the proactiveness scores of public and private DBFs, $t(198) = 1.77$, $p < .05$. Finally, Hypothesis 3c suggests that private DBFs will be willing to take more risks than public DBFs do. The results do not support this assertion.

Reflecting on our results, we conducted post hoc analyses on the age categorization because it was the only context in which DBFs were classified using subjective measures. Determining a DBF's location and ownership structure does not require as much interpretation as defining new firms. In the current study, we adopted Eisenhardt and Schoonhoven's (1990) new firm classification of 8 years. In management studies, new firms have also been classified as those firms younger than 3 years (Klapper, Laeven, & Rajan, 2006) and 5 years (Qian & Li, 2003; Wiklund & Shepherd, 2003). We also include 10 years as a classification for new firms because it may take 10–15 years, given the regulatory regime, for a DBF to realize a return on its research and development efforts (DeCarolis & Deeds, 1999); until then, the firm may have limited revenues.

The results of these analyses are listed in Table 4 and depicted in Figure 1. There were two significant observations. First, the findings show that a DBF's EO is stable across age groups: new firms less than 36 months ($M = 3.33$), new firms less than 60 months ($M = 3.31$), new firms less than 96 months ($M = 3.31$), and new firms less than 120 months ($M = 3.35$). Second, all three categories indicate that existing firms have higher mean innovativeness scores than do new firms. As previously argued, this is one characteristic that makes the biotechnology industry different from other industries. Schumpeter (1934) argued that new firms

TABLE 4
t-Tests: Additional analysis by age: New firms younger than 3, 5, 8, and 10 years

	EO	INV	PA	RISK
Model 1: 3 years and below				
Existing DBFs (36 months and above)	3.43 (0.64)	3.51 (0.79)	3.36 (0.75)	3.15 (0.89)
New DBFs (0–35 months)	3.33 (0.67)	3.22 (1.02)	3.12 (0.95)	3.42 (1.03)
t-Value	0.801	1.76**	1.35	–1.53*
Model 2: 5 years and below				
Existing DBFs (60 months and above)	3.43 (0.62)	3.46 (0.80)	3.34 (0.76)	3.11 (0.92)
New DBFs (0–59 months)	3.31 (0.66)	3.46 (0.93)	3.29 (0.84)	3.37 (0.89)
t-Value	1.14	0.020	0.378	–1.85**
Model 3: 8 years and below				
Existing DBFs (96 months and above)	3.35 (0.65)	3.52 (0.80)	3.48 (0.73)	3.09 (0.93)
New DBFs (0–95 months)	3.31 (0.72)	3.43 (0.88)	3.24 (0.84)	3.28 (0.89)
t-Value	0.333	0.727	1.71**	–1.39**
Model 4: 10 years and below				
Existing DBFs (120 months and above)	3.34 (0.69)	3.52 (0.81)	3.35 (0.76)	3.12 (0.88)
New DBFs (0–119 months)	3.35 (0.63)	3.43 (0.85)	3.31 (0.80)	3.23 (0.93)
t-Value	−0.077	0.687	0.322	−0.835

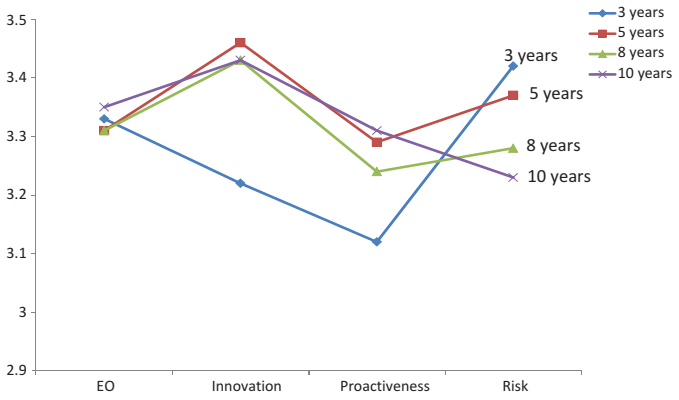

FIG. 1. Comparison of EO score: new DBFs under 3, 5, 8, and 10 years.

revolutionize the market with their new ways of doing things. In the biotechnology industry, new firms enter the market with new inventions, which are sold to existing firms or leveraged to secure development capital from existing firms. This innovation aligns more with Schumpeter's (1950) later work. He amended his original perspective on entrepreneurship and suggested that existing firms have the capital and resources to invest and out-innovate new firms when bringing new products to market. If innovation consists of invention plus commercialization, then existing firms might have the resources to out-innovate their younger counterparts. The next section elaborates on these findings and discusses their implications.

DISCUSSION

Results Summary

We contend that biotechnology is a unique context with its strict regulatory regime, resource- and time-intensive new-product development process, and high level of interorganizational collaborations among nonprofit, government, and industry actors. In this context, we explored under what conditions DBFs exhibit an EO. To answer this research question, we put forth and assessed nine hypotheses to determine whether one or both conceptualizations of EO,as a gestalt or as individual behaviors, would be significant across internal and external situations such as age, location, and ownership structure. We hypothesized that older, cluster-located, and publicly traded DBFs would have higher EO scores than would new, remotely located, and private DBFs (Hypotheses 1–3). The results show that there was a positive and mean significant difference only in the mean EO scores between public and private DBFs, with public firms having the higher score. Public firms have access to capital markets to fund innovative activities. They might also have more collaboration opportunities than do their private DBFs because public firms must adhere to rigorous financial reporting requirements, which may reduce potential partners' uncertainty about their R&D assets and business practices. Interestingly, research has found that public DBFs are engaging in a higher level of risk taking. Thesmar and Thoenig (2004) contended that there are more institutional, private, and cross-border investors in the market. Thus, publicly traded firms seek to secure investors by adopting riskier strategies that will produce greater expected profits. Developing systematic processes that promote entrepreneurial behaviors might enable public DBFs to adapt to and contend with regulatory, competitive, and ownership pressures.

Regarding the multidimensional assessments, our findings show that new firms are more risk taking than were their older peers. Schumpeter (1934) argued that the rules of the game are created and promulgated by existing firms to support their ways of doing things and their ability to generate profits. To play the game, new DBFs have to take risks to establish their legitimacy and secure the resources they need to operate (Hannan & Freeman, 1987; Stinchcombe, 1965). Older DBFs search for opportunities to exploit their existing assets by participating in development opportunities with pharmaceutical firms (Rothaermel & Deeds, 2004), sponsoring faculty research to move their projects to the next stage of development (Lee, 2000), or actively seeking to be acquired by pharmaceutical firms that are seeking to restock their pipelines and because of the lack of interest in biotechnology initial public offerings (IPOs) (Behnke & Hultenschmidt, 2007; Frantz, 2006).

When testing the multidimensional location hypotheses, our findings support the assertion that cluster DBFs are more innovative than remotely located DBFs. Porter (1998) argued that close geographical location spurs innovation. Our assessment of the individual dimensions in the ownership structure revealed that public firms had higher proactive scores than did their nonassertive peers. By adopting a proactive disposition, public DBFs engage in activities such as scanning to search for opportunities to support innovation as well as to appease current shareholders. These findings contribute to the literature in the following ways.

Contributions

First, the study expands EO research, which so far has been primarily focused on assessing the entrepreneurial process in the manufacturing industry (Covin, Green, & Slevin, 2006), across a broad spectrum of mature industries (Tang et al., 2010), or within the high-technology sector that includes computers as well as biotechnology and pharmaceutical firms (Bierly, Damanpour, & Santoro, 2009). By doing so, we gain an understanding of the entrepreneurial process but may overlook contextual variations. For example, the results of Hypothesis 1a revealed (1) no statistical differences in the innovativeness scores of new and existing DBFs and (2) that existing DBFs' innovativeness scores were higher than those of new DBFs. This finding contradicts a basic entrepreneurial premise: that new firms are more entrepreneurial than existing firms (Glaeser & Kerr, 2009). However, Tripsas's (1997) exploration of the typesetting industry indicated that incumbents that possess

complementary capabilities can survive and exploit the creative destruction process ignited by other firms.

Our focus on the biotechnology industry seeks to expand our understanding of EO beyond mature industries. For example, Rauch, Wiklund, Lumpkin, and Frese (2009) conducted a meta-analysis of 51 EO studies in which there were several mixed high-technology studies but none solely focused on science-based businesses. In the last decade, EO studies have begun to explore knowledge-based phenomena such as learning (Wang, 2008), innovation sourcing (Pérez-Luño, Wiklund, & Cabrera, 2010), experimental and acquisitive learning (Zhao, Li, Lee, & Chen, 2011), and knowledge creation (Li, Huang, & Tsai, 2009). Since biotechnology is a knowledge-intensive Lindustry where by firms operate in a technologically complex and dynamic environment (Colwell and DeCarolis, 2010), our study supports the expanding investigation of the interplay between EO and knowledge.

Second, the findings presented in this article draw attention to the proactive EO dimension. Our analysis revealed that the proactive dimension was significant in two out of the three conditions: age and ownership structure. Given the resource-intensive nature of developing new drugs, adopting a proactive disposition can improve managers' ability to process information (Tang et al., 2010) when scanning the environment to search for new opportunities (Davis et al., 2011). Biotechnology scholars have explored new opportunities in terms of exploration and exploitation alliances (Al-Laham, Amburgey, & Bates, 2008; Rothaermel & Deeds, 2004), learning and alliance races (Baum, Calabrese, & Silverman, 2000; Silverman & Baum, 2002), and alliance and learning networks (Gay & Dousset, 2005; Powell, Koput, & Smith-Doerr, 1996). The act of creating new knowledge, although it is important, is not sufficient to transform an invention into an innovation that has the power to destroy existing technologies and firms and create new industries. An invention must be followed by entrepreneurial action before it has significant economic terms (Utterback, 1971, p. 77). The entrepreneurial action to which Utterback (1971) referred is the recognition and exploitation of opportunities. These findings refocus our attention on the significant role that proactiveness plays in the entrepreneurial process (Shane & Venkataraman, 2000).

Third, our findings contribute to the rich literature on biotechnology agglomerations by confirming the differential between innovation among cluster and noncluster firms. Innovation is a knowledge-centric, social process, and clusters are wellsprings of human capital in the form of specialized workers and university-trained graduate students (Kukalis, 2010) who support the process. The congregation of specialized talent fosters an environment where purposeful and accidental encounters provide the medium through which knowledge is created as it is being converted between tacit and explicit categories (Nonaka & Toyama, 2005). Research has identified how information dissemination and different modes of communication contribute to cluster innovation (Moodysson, 2008). The human capital, potential for structured and informal interactions, and opportunities for face-to-face knowledge transfer support cluster innovation. The significant difference between the innovativeness of cluster and noncluster DBFs makes a case for gaining further insight about why DBFs would choose to be remotely located when cluster knowledge externalities support innovativeness. Our understanding of noncluster DBFs is driven by their role as the "comparison other" in most cluster studies. To date, there have been a few empirical attempts (Fontes, 2005) solely focused on identifying remote characteristics.

In summary, our findings contribute to existing studies by supporting existing literature on cluster innovation and the importance of proactiveness to EO as well as highlighting the conditions within the biotechnology industry where the entrepreneurial process may differ from existing research. In the following sections, we discuss the implications of our findings.

Theoretical Implications

In this study, we seek to advance knowledge about the importance of time when studying EO. Wiklund and Shepherd (2003, 2005) have argued that EO is a dynamic capability that may change over time. In their studies, Wiklund and Shepherd measured EO twice with a lag time of several years between each measurement to assess how EO changes. Our post hoc analysis found that DBFs' EOs differ for new firms that are defined as being less than 3, 5, and 10 years old. Figure 1 depicts EO changes that occur as older firms are classified as new firms. Interestingly, the mean EO scores for all three EO firms are similar. The figure suggests that when firms classified as new are less than 5 years old, these DBFs have the highest innovativeness. Firms tend to issue IPOs when they are between 5 and 7 years of age (Loughran & Ritter, 2001). New firms less than 5 years old may be preparing to issue an IPO or to enhance their reputation as viable collaboration partners.

When DBFs are classified as new up to 8 years old, the findings show that these firms have low innovativeness. Since it takes an average of 6 years for a firm to transition through drug discovery and preclinical trials to begin clinical trials (PhRMA, 2013), DBFs less than 8 years old probably have a project in clinical trials. Interestingly, DBFs that are classified as new and are less than 10 years old have the highest proactiveness score. These firms might have an approved product or a product that is in the final stages of clinical trials. The commercialization process overlaps with the patent protection window. At the end of clinical trials, a DBF might have less than 10 years to recoup its R&D costs and accumulate financial resources to fund another new-product commercialization. Proactive activities such as international alliances (Bathelt, Malmberg, & Maskell, 2004) or small firm acquisitions (Higgins & Rodriguez, 2006) will enable these DBFs to continue to leverage their approved product and acquire new science and capabilities. Our study points to the possibility that key organizational events could change managerial attentions and their entrepreneurial disposition.

Second, when assessing EO in small and medium-sized firms, it may be difficult to untangle managerial beliefs or wishes from actual firm-level behaviors. EO emerges from the strategic choice perspective that explains how managers make decisions that enable their organizations to adapt to their environment in order to gain an advantage. Many DBFs are independently owned (Zahra, 1996) firms that have fewer than 100 employees (U.S. Department of Commerce, 2003). In small and medium-sized firms, top management teams play significant roles in determining the firm's strategies and operating procedures (Lubatkin et al., 2006), which provides them with unique insight regarding their firm's entrepreneurial processes. When assessing EO, Wiklund and Shepherd (2003) used only SMEs in their sample because top management is not separated from the firm's behaviors. This premise also pertains to entrepreneur-led firms where the behaviors of the firm and those of the entrepreneur are likely to be the same (Poon, Ainuddin, & Junit, 2006).

EO scholars have acknowledged the extent to which managers influence a firm's EO. Covin, Green, and Slevin (2006) described EO as a strategic construct whose conceptual domain includes certain firm-level outcomes and managerial-related preferences, beliefs, and behaviors as expressed among a firm's top-level managers (p. 57). Simsek, Heavey, and Veiga (2010) proposed that EO represents CEOs' decision-making styles because these executives have significant influence in determining the firm's goals and objectives. According to Krauss and peers (2005), "While not emphasized explicitly, the measure is in fact a psychological assessment of individual EO" (p. 316). Similarly, Miller (1983) claimed, "In small centralized firms, entrepreneurship is predominantly influenced by the leader: his personality, his power, and his information" (p. 773). In small and medium enterprises (SMEs) like those in the biotechnology industry, top executives have the insight to assess a firm's EO because of their wide range of responsibilities; however, it may be prudent to proceed with caution when interpreting EO results because of the possibility of managerial and executive biases when reporting about their firm's EO.

Limitations and Future Direction

We would like to highlight some limitations of our study that draw attention to areas of future research. First, a firm's entrepreneurial orientation emerges over time (Lee et al., 2001). Wiklund (1999) and Wiklund and Shepherd (2003, 2005) used a longitudinal approach to assess entrepreneurial orientation. Thus, measuring EO across years would lead to a more robust understanding of whether a firm enhances its development of processes and systems that facilitate EO than measuring it at a single point in time. In the future, research may seek to assess DBFs' EO over time; however, because this assessment may be compromised by the high rate of failure among biotechnology firms, a future study might focus on publicly traded firms to minimize the mortality risk.

Second, data in this study were obtained from single informants. Although entrepreneurial studies often rely on single respondents (Chandler & Hanks, 1994), this reliance may inflate assessments. Lyon, Lumpkin, and Dess (2000) proposed that one disadvantage in measuring EO using self-reports is the possibility of managerial bias. It is not controversial to presume that managers of these firms would believe their firms to have a strategic posture that is closer to the entrepreneurial end of the spectrum than to the conservative end. SME studies were more often likely to use surveys to collect data than general studies because secondary and archival data are usually not widely available to small, privately owned firms (Bartholomew & Smith, 2006). Future studies might use triangulation—the combination of methodologies when studying the same phenomenon (Denzin, 1978)—to increase the robustness of the research by offering new insights and addressing problem areas. Using surveys and public information on firm-level behaviors such as patent counts to assess innovativeness (DeCarolis, 2003) will help researchers identify the extent to which differences exist in the objective and subjective data.

Third, this study did not assess how a firm's growth plans influence EO. Since EO emerges over time, firms that seek to be acquired may not be concerned with developing EO but may focus on maintaining a high level of innovativeness to send a signal of high quality to potential acquisition partners. Understanding how growth motivations influence this study would offer insight into firms' desire to develop and maintain an EO. Future research might seek to assess whether a founder's growth or exit plans such as acquisition or IPO influence a firm's development and utilization of an entrepreneurial strategic posture.

Practical Implication and Conclusion

A DBF's managers might need to be cautious when attempting to use strategies, processes, and routines from other industries. It may be helpful for managers to assess their firms' resources and capabilities and to understand industry dynamics and scientific and technological complexities before adopting new approaches or dispositions.

In conclusion, given the nature of drug development, there may be differences in the range of entrepreneurial dispositions that are available to a firm that can create a new product and sell it within several months or years versus those the range available to those firms that must wait nearly a decade to reap the benefits of their R&D investments.

REFERENCES

Acs, Z. J., Braunerhjelm, P., Audretsch, D. B., & Carlsson, B. (2009). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, *32*(1), 15–30.

Al-Laham, A., Amburgey, T. L., & Bates, K. (2008). The dynamics of research alliances: Examining the effect of alliance experience and partner characteristics on the speed of alliance entry in the biotech industry. *British Journal of Management*, *19*(4), 343–364.

Alvarez, S. A., & Barney, J. B. (2001). How entrepreneurial firms can benefit from alliances with large partners. *Academy of Management Executive*, *15*(1), 139–148.

Audretsch, D. B., & Feldman, M. (2003). Small-firms strategic research partnerships: The case of biotechnology. *Technology Analysis & Strategic Management*, *15*(2), 273–288.

Audretsch, D. B., & Keilbach, M. (2007). The theory of knowledge spillover entrepreneurship. *Journal of Management Studies*, *44*(7), 1242–1254.

Barclay, S., Todd, C., Finlay, I., Grande, G., & Wyatt, P. (2002). Not another questionnaire! Maximizing the response rate, predicting non-response and assessing non-response bias in postal questionnaire studies of GPs. *Family Practice*, *19*(1), 105–111.

Barney, J. B. (1986). Strategic factor markets: Expectations, luck, and business strategy. *Management Science*, *32*(10), 1231–1241.

Barringer, B. R., & Bluedorn, A. C. (1999). The relationship between corporate entrepreneurship and strategic management. *Strategic Management Journal*, *20*(5), 421–444.

Bartholomew, S., & Smith, A. D. (2006). Improving survey response rates for chief executive officers in small firms: The importance of social networks. *Entrepreneurship Theory and Practice*, *30*(1), 83–96.

Baruch, Y. (1999). Response rate in academic studies: A comparative analysis. *Human Relations*, *54*(4), 421–438.

Bathelt, H., Malmberg, A., & Maskell, P. (2004). Clusters and knowledge: Local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography*, 28(1),31–56.

Baum, J. A., Calabrese, T., & Silverman, B. S. (2000). Don't go it alone: Alliance network composition and startups' performance in Canadian biotechnology. *Strategic Management Journal*, *21*(3), 267–294.

Baum, J. A., & Silverman, B. S. (2004). Picking winners or building them? Alliance, intellectual, and human capital as selection criteria in venture financing and performance of biotechnology startups. *Journal of Business Venturing*, 19(3),411–436.

Behnke, N., & Hultenschmidt, N. (2007). New path to profits in biotech: Take the acquisition exit. *Journal of Commercial Biotechnology*, *13*(2), 78–85.

Bell, G. (2005). Cluster, networks, and firm innovativeness. *Strategic Management Journal*, *26*(3), 287–295.

Bettis, R. A., Bradley, S. P., & Hamel, G. H. (1992). Outsourcing and industrial decline. *The Executive*, *6*(1), 7–22.

Bierly, P. E., Damanpour, F., & Santoro, M. D. (2009). The application of external knowledge: Organizational conditions for exploration and exploitation. *Journal of Management Studies*, *46*(3), 481–509.

Boshuizen, J., Geurts, P., & Van Der Veen, A. (2009). Regional social networks as conduits for knowledge spillovers: Explaining performance of high-tech firms. *Tijdschrift voor Econimishce en Sociale Geografie*, *100*(2), 183–197.

Brown, T. E., & Davidsson, P. (1998, May). Entrepreneurial orientation versus entrepreneurial management: Relating Miller/Covin & Slevin's conceptualization to Stevenson's. *Entrepreneurship Research Conference* (pp. 21–23). Gent, Belgium.

Burns, T., & Stalker, G. M. (1961). *The management of innovation*. London, England: Tavistock.

Burrill, G. S., & Lee, K. B. (1992). *Biotech 93: Accelerating commercialization: An industry annual report*. New York, NY: Ernst & Young.

Casper, S. (2007). How do technology clusters emerge and become sustainable? Social network formation and inter-firm mobility within the San Diego biotechnology cluster. *Research Policy*, *36*(4), 438–455.

Chaganti, R., & Damanpour, F. (1991). Institutional ownership, capital structure, and firm performance. *Strategic Management Journal*, *12*(7), 479–491.

Chandler, G. & Hanks, S. H. (1994). Market attractiveness, resource-based capabilities: Venture strategies and venture performance. *Journal of Business Venturing*, *9*(4), 331–349.

Chemmanur, T. J., & Fulghieri, P. (1999). A theory of the going public decision. *Review of Financial Studies*, *12*(2), 249–279.

Chesbrough, H. (2006). *Open innovation*. Boston, MA: Harvard Business School Press.

Chiesa, V., & Chiaroni, D. (2005). *Industrial clusters in biotechnology, driving forces, development processes and management practices*. London, England: Imperial College Press.

Clausen, T., & Korneliussen, T. (2012). The relationship between entrepreneurial orientation and speed to the market: The case of incubator firms in Norway. *Technovation*, *32*(9–10), 560–567.

Cohen, W., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, *35*(1), 128–152.

Colwell, K., & D. M. DeCarolis (2010). Business–university alliances and innovation in new and adolescent technology ventures. In D. B. Audretsch, G. B. Dagnino, and R. Faraci (Eds.), *New frontiers in entrepreneurship: Recognizing, seizing, and executing opportunities* (pp. 175–194). New York, NY: Springer-Verlag.

Cooke, P. (2001). Regional innovation systems, clusters, and the knowledge economy. *Industrial and Corporate Change*, *10*(4), 945–974.

Covin, J. G., Green, K. M., & Slevin, D. P. (2006). Strategic process effects on the entrepreneurial orientation–sales growth rate relationship. *Entrepreneurship Theory and Practice*, *30*(1), 57–81.

Covin, J. G., & Slevin, D. P. (1989). Small firms in hostile and benign environments. *Strategic Management Journal*, *10*(1), 75–87.

Covin, J. G., & Slevin, D. P. (1991). A conceptual model of entrepreneurship as firm behavior. *Entrepreneurship Theory and Practice*, *16*(1), 17–25.

Covin, J. G., Slevin, D. S., & Heeley, M. B. (2000). Pioneers and followers: Competitive tactics, environment, and firm growth. *Journal of Business Venturing*, *15*(2), 175–210.

Covin, J. G., & Wales, W. J. (2011). The measurement of entrepreneurial orientation. *Entrepreneurship Theory and Practice*, *36*(4), 677–702.

Davis, J. A., Marino, L. D., Aaron, J. R., & Tolbert, C. L. (2011). An examination of entrepreneurial orientation, environmental scanning, and market strategies of nonprofit and for-profit nursing home administrators. *Nonprofit and Voluntary Sector Quarterly*, *40*(1), 197–211.

DeCarolis, D. M. (2003). Competencies and imitability in the pharmaceutical industry: An analysis of their relationship with firm performance. *Journal of Management*, *29*(1), 27–50.

DeCarolis, D. M., & Deeds, D. L. (1999). The impact of stocks and flows of organizational knowledge on firm performance: An empirical investigation of the biotechnology industry. *Strategic Management Journal*, *20*(10), 953–968.

DeClercq, D., Dimov, D., & Thongpapanl, N. T. (2010). The moderating impact of internal social exchange processes on the entrepreneurial orientation–performance relationship. *Journal of Business Venturing*, *25*(1), 87–103.

Deeds, D. L., DeCarolis, D., & Coombs, J. (2000). Dynamic capabilities and new product development in high technology ventures: An empirical analysis of new biotechnology firms. *Journal of Business Venturing*, *15*(3), 21–229.

Denzin, N. K. (1978). *The research act: A theoretical introduction to sociological methods*. New York, NY: McGraw-Hill.

Dess, G. G., Lumpkin, G. T., & Covin, J. G. (1997). Entrepreneurial strategy making and firm performance: Tests of contingency and configuration models. *Strategic Management Journal*, *18*(9), 677–695.

Dillman, D. A. (1978). *Mail and telephone surveys: The total design method*. New York, NY: John Wiley & Sons.

Dutton, J. E., & Jackson, S. E. (1987). Categorizing strategic issues: Links to organizational action. *Academy of Management Review*, *12*(1), 76–90.

Drucker, P. F. (2002). The discipline of innovation. *Harvard Business Review*, *80*(8), 95–91.

Eisenhardt, K. M., & Schoonhoven, C. B. (1990). Organizational growth: Linking founding team, strategy, environment, and growth among U.S. semiconductor ventures. *Administrative Science Quarterly*, *35*(3), 504–529.

Entebang, H., Harrison, R. T., & de Run, C. E. (2010). Entrepreneurial orientation of public enterprises in Malaysia. *Business Strategy Series*, *11*(2), 75–77.

Ernst & Young (2005). *Competitive growth and growing competition*. Retrieved from http://www.ey.com/alumni/whitepapers

Evans, G. H. (1949). The entrepreneur and economic theory: A historical and analytical approach. *The American Economic Review*, *39*(3), 336–348.

Fontes, M. (2005). Distant networking: The knowledge acquisition strategies of "out-cluster" biotechnology firms. *European Planning Studies*, *13*(6), 899–920.

Frantz, G. (2006, December). Pipeline problems are increasing the urge to merge. *Nature*, *5*, 977–979.

Gaglio, C. (1997). Opportunity identification: Review, critique and suggested research direction. In J. Katz & R. Brockhaus (Eds.), *Advances in entrepreneurship, firm emergence and growth* (pp. 139–202). Greenwich, CT: JAI Press.

Gassman, O., Reepmeyer, G., & Zedwitz, M. V. (2004). *Leading pharmaceutical innovation: Trends and drivers for growth in the pharmaceutical industry*. New York, NY: Springer-Verlag.

Gay, B., & Dousset, B. (2005). Innovation and network structural dynamics: Study of the alliance network of a major sector of the biotechnology industry. *Research Policy*, *34*(10), 1457–1475.

George, G., Zahra, S., & Wood, D. R. (2002). The effects of business-university alliances on innovative output and financial performance: A study of publicly traded biotechnology companies. *Journal of Business Venturing*, *17*(6), 577–609.

Glaeser, E. L., & Kerr, W. R. (2009). Local industrial conditions and entrepreneurship: How much of the spatial distribution can we explain? *Journal of Economics & Management Strategy*, *18*(3), 623–663.

Golec, J. H., & Vernon, J. A. (2007). Financial risk in the biotechnology industry (Paper No. w13604). Washington, DC: National Bureau of Economic Research.

Hannan, M. T., & Freeman, J. (1987). The ecology of organizational founding: American labor unions, 1836–1985. *American Journal of Sociology*, *92*(4), 910–943.

Hashai, N., & Almor, T. A. (2004). Gradually internationalizing "born global" firms: An oxymoron. *International Business Review*, *13*(4), 465–483.

Herper, M. (2012). The truly staggering cost of inventing new drugs. *Forbes Online*. Retrieved from http://www.forbes.com/sites/matthewherper/2012/02/10/the-truly-staggering-cost-of-inventing-new-drugs/

Higgins, M. J., & Rodriguez, D. (2006). The outsourcing of R&D through acquisition in the pharmaceutical industry. *Journal of Financial Economics*, *80*(2), 351–383.

Holcomb, T. R., Holmes R. M., & Connelly, B. L. (2009). Making the most of what you have: Managerial ability as a source of value creation. *Strategic Management Journal*, *30*(5), 457–485.

Hoskisson, R. E., Hitt, M. A., & Hill, C. W. (1993). Managerial incentives and investment in R&D in large multiproduct firms. *Organization Science*, *4*(2), 325–341.

Hoskisson, R. E., Hitt, M. A., Johnson, R. A., & Grossman, W. (2002). Conflicting voices: The effects of institutional ownership heterogeneity and internal governance on corporate innovation strategies. *Academy of Management Journal*, *45*(4), 697–716.

Hoskisson, R. E., Johnson, R. A., & Moesel, D. D. (1994). Corporate divestiture intensity in restructuring firms: Effects of governance, strategy, and performance. *Academy of Management Journal*, *37*(5), 1207–1251.

Hsu, D. H., Roberts, E. B., & Eesley, C. E. (2007). Entrepreneurs from technology-based universities: Evidence from MIT. *Research Policy*, *36*(5), 768–788.

Hughes, M., & Morgan, R. E. (2007). Deconstructing the relationship between entrepreneurial orientation and business performance at the embryonic stage of firm growth. *Industrial Marketing and Management*, *36*(5), 651–661.

Hung, K. P., & Chiang, Y. H. (2010). Open innovation proclivity, entrepreneurial orientation, and perceived firm performance. *International Journal of Technology Management*, *52*(3), 257–274.

Jensen, R., & Thursby, M. (2001). Proofs and prototypes for sale: The licensing of university inventions. *American Economic Review*, *91*(1), 240–259.

Kaplan, S., Murray, F., & Henderson, R. (2003). Discontinuities and senior management: Assessing the role of recognition in pharmaceutical firm response to biotechnology. *Industrial and Corporate Change*, *12*(2), 203–233.

Khilji, S. E., Mroczkowski, T., & Bernstein, B. (2006). From invention to innovation: Toward developing an integrated innovation model for biotech firms. *Journal of Product Innovation Management*, *23*(6), 528–540.

Kirzner, I. M. (1979). *Perception, opportunity, and profit: Studies in the theory of entrepreneurship*. Chicago, IL: University of Chicago Press.

Klapper, L., Laeven, L., and Rajan, R. (2006). Entry regulation as a barrier to entrepreneurship. *Journal of Finance Economics*, *82*(3), 591–629.

Kollmann, T., & Stöckmann, C. (2012). Filling the entrepreneurial orientation–performance gap: The mediating effects of exploratory and exploitative innovations. *Entrepreneurship Theory and Practice*. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1540-6520.2012.00530.x

Krauss, S. I., Frese, M., Friedrich, C., & Unger, J. M. (2005). Entrepreneurial orientation: A psychological model of success among southern African small business owners. *European Journal of Work and Organizational Psychology*, *143*), 315–344.

Kreiser, P., Marino, L., & Weaver, K. (2002). Assessing the psychometric properties of the entrepreneurial orientation scale: A multi-country analysis. *Entrepreneurship Theory and Practice*, *26*(4), 71–94.

Kukalis, S. (2010). Agglomeration economies and firm performance: The case of industry clusters. *Journal of Management*, *26*(2), 453–481.

Lechner, C., Dowling, M., (2003). Firm networks: External relationships as sources for the growth and competitiveness of entrepreneurial firms. *Entrepreneurship and Regional Development*, *15*(1), 1–26.

Lee, Y. S. (2000). The sustainability of university–industry research collaboration: An empirical assessment. *Journal of Technology Transfer*, *25*(2), 111–133.

Lee, C., Lee, K., & Pennings, J. (2001). Internal capabilities, external networks, and performance: A study on technology-based ventures. *Strategic Management Journal*, *22*(6–7), 615–640.

Lee, S., Park, G., Yoon, B., & Park, J. (2010). Open innovation in SMEs—An intermediated network model. *Research Policy*, *39*(2), 290–300.

Lerner, J., & Merges, R. P. (1998). The control of technology alliances: An empirical analysis of the biotechnology industry. *Journal of Industrial Economics*, *46* (2), 125–156.

Li, H. (2001). How does new venture strategy matter in the environment–performance relationship? *Journal of High Technology Management Research*, *12*(2), 183–204.

Li, Y., Liu, Y., Yi, D., & Li, M. (2008). Entrepreneurial orientation, strategic flexibilities and indigenous firm innovation in transitional China. *International Journal of Technology Management*, *41*(1), 223–246.

Li, Y. H., Huang, J. W., & Tsai, M. T. (2009). Entrepreneurial orientation and firm performance: The role of knowledge creation process. *Industrial Marketing Management*, *38*(4), 440–449.

Lieberman, M. B., & Montgomery, D. B. (1988). First-mover advantages. *Strategic Management Journal*, *9*(S1), 41–58.

Linder, J. R., Murphy, T. H., & Briers, G. E. (2001). Handling nonresponse in social science research. *Journal of Agricultural Education*, *42*(4), 43–53.

Loughran, T., & Ritter, J. R. (2001). *Why has IPO underpricing increased over time?* (Working paper). Gainesville, FL: University of Florida.

Lubatkin, M. H., Simsek, Z., Ling, Y., & Veiga, J. F. (2006). Ambidexterity and performance in small-to medium-sized firms: The pivotal role of top management team behavioral integration. *Journal of Management*, *32*(5), 646–672.

Lumpkin, G. T., Brigham, K. H., & Moss, T. W. (2010). Long-term orientation: Implications for the entrepreneurial orientation and performance of family businesses. *Entrepreneurship and Regional Development*, *22*(3–4), 241–264.

Lumpkin, G. T., & Dess, G. G. (1996). Clarifying the entrepreneurial orientation construct and linking it to performance. *Academy of Management Review*, *21*(1), 135–172.

Lumpkin, G. T., & Dess, G. G. (2001). Linking two dimensions of entrepreneurial orientation to the firm performance: The moderating role of environment and industry life cycle. *Journal of Business Venturing*, *16*(5), 429–451.

Lyon, D. W., Lumpkin, G. T., & Dess, G. (2000). Enhancing entrepreneurial orientation research: Operationalizing and measuring a key strategic decision making process. *Journal of Management*, *26*(5), 1055–1085.

Madhok, R., & Osegowitsch, T. (2000). The international biotechnology industry: A dynamic capabilities perspective. *Journal of International Business Studies*, *31*(2), 325–335.

Malecki, E. (1997). *Technology and economic development: The dynamics of local, regional, and national change*. Urbana, IL: University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship.

Markman, G. D., Phan, P. H., Balkin, D. B., & Gianiodis, P. T. (2005). Entrepreneurship and university based technology transfer. *Journal of Business Venturing*, *20*(2), 241–263.

Marino, L., Strandholm, K., Steensma, H. K., & Weaver, K. M. (2002). The moderating effect of national culture on the relationship between entrepreneurial orientation and strategic alliance portfolio extensiveness. *Entrepreneurship Theory and Practice*, *26*(4), 145–160.

Marshall, A. (1890). *Principles of economics*. London, England: Macmillan.

McClelland, D. (1961). *The achieving society*. Princeton, NJ: D. Van Nostrand.

McEachern, W. A. (1975). *Managerial control and performance*. Lexington, MA: Lexington Books.

Miles, R., & Snow, C. (1978). *Organization strategy, structure, and process*. New York, NY: McGraw-Hill.

Miller, D. (1983). The correlates of entrepreneurship in three types of firms. *Management Science*, *29*(7), 770–791.

Mintzberg, H. (1973). Strategy making in three modes. *California Management Review*, *16*(2), 44–53.

Momma, S., & Sharp, M. (1999). Developments in new biotechnology firms in Germany. *Technovation*, *19*(5), 267–282.

Moodysson, J. (2008). Principles and practices of knowledge creation: On the organization "buzz" and pipelines" in life science communities. *Economic Geography*, *84*(4), 449–469.

Naldi, L., Nordqvist, M., Sjöberg, K., & Wiklund, J. (2007). Entrepreneurial orientation, risk taking, and performance in family firms. *Family Business Review*, *20*(1), 33–47.

Niosi, J (2003). Alliances are not enough: Explaining rapid growth in biotechnology firms. *Research Policy*, *32*(5), 737–750.

Nonaka, I., & Toyama, R. (2005). The theory of the knowledge-creating firm: Subjectivity, objectivity and synthesis. *Industrial and Corporate Change*, *14*(3), 419–436.

Norburn, D. (1989). The chief executive: A breed apart. *Strategic Management Journal*, *10*(1), 1–15.

Oliver, A. L. (2004). Biotechnology entrepreneurial scientists and their collaborations. *Research Policy*, *33*(4), 583–597.

Østergaard, C. R., Timmermans, B., & Kristinsson, K. (2011). Does a different view create something new? The effect of employee diversity on innovation. *Research Policy*, *40*(3), 500–509.

Owen-Smith, J., & Powell, W. W. (2004). Knowledge networks as channels and conduits: The effect of spillovers in the Boston Biotechnology Community. *Organization Science*, 15(1),5–21.

Pérez-Luño, A., Wiklund, J., & Cabrera, R. V. (2010). The dual nature of innovative activity: How entrepreneurial orientation influences innovation generation and adoption. *Journal of Business Venturing*, *26*(5), 555–571.

Pharmaceutical Research and Manufacturers of America. (2013). *The research and development process*. Retrieved from http://www.phrma.org/research-development-process

Pisano, G. (1990). The R&D boundaries of the firm: An empirical analysis. *Administrative Science Quarterly*, *35*(1), 153–176.

Pisano, G. P. (2006). Can science be a business? Lessons from biotech. *Harvard Business Review*, *84*(1), 114–125.

Pollack, A. (2009, March 28). Biotech firm to liquidate under investor's pressure. *The New York Times*. Retrieved from http://www.nytimes.com on March 30, 2009.

Poon, J. M., Ainuddin, R.A., & Junit, SH. (2006). Effects of self-concept traits on entrepreneurial orientation on firm performance. *International Small Business Journal*, 24(1),61–82.

Porter, M. E. (1998). Clusters and the new economics of competition. *Harvard Business Review*, *76*(*4*), 77–90.

Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly*, *41*(1), 116–145.

Prevezer, M. (1997). The dynamics of industrial clustering in biotechnology. *Small Business Economics*, *9*(3), 255–271.

Qian, G., & Li, L. (2003). Profitability of small- and medium-sized enterprises in high-tech industries: The case of the biotechnology industry. *Strategic Management Journal*, *24*(9), 881–887.

Ramachandran, K., & Ramnarayan, S. (1993). Entrepreneurial orientation and networking: Some Indian evidence. *Journal of Business Venturing*, *86*, 513–524.

Rauch, A., Wiklund, J., Lumpkin, G. T., & Frese, M. (2009). Entrepreneurial orientation and business performance: An assessment of past research and suggestions for the future. *Entrepreneurship Theory and Practice*, *33*(3), 761–787.

Renko, M., Carsrud, A., & Brännback, M. (2009). The effect of a market orientation, entrepreneurial orientation, and technological capability on innovativeness: A study of young biotechnology ventures in the United States and in Scandinavia. *Journal of Small Business Management*, *47*(3), 331–369.

Richard, O. C., Wu, R. P., & Chadwick, K. (2009). The impact of entrepreneurial orientation on firm performance: The role of CEO position tenure and industry tenure. *The International Journal of Human Resource Management*, *20*(5), 1078–1095.

Rothaermel, F. T., & Deeds, D. L. (2004). Exploration and exploitation alliances in biotechnology: A system of new product development. *Strategic Management Journal*, *25*(3), 201–221.

Rothaermel, F. T., & Deeds, D. L. (2006). Alliance type, alliance experience, and alliance management capability in high-technology ventures. *Journal of Business Venturing*, *21*(4), 429–460.

Salancik, G. R., & Pfeffer, J. (1980). Effects of ownership and performance on executive tenure in U.S. corporations. *Academy of Management Journal*, *23*(4), 653–664.

Scarmoutzos, L. M. (2006). The Economic Promise of Biotechnology. *BioExecutive International*, *2*(7), 12–13

Schumpeter, J. (1950). *Essays*. Ed. R. V. Clemence. Cambridge, MA: Addison-Wesley.

Schumpeter, J. A. (1934). *The theory of economic development*. Oxford, UK: Oxford University Press.

Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. *Academy of Management Review*, *25*(1), 217–226.

Shaughnessy, J. J., & Zechmesiter, E. B. (1997). *Research methods in psychology* (4th ed.). New York, NY: McGraw-Hill.

Shefer, D., & Frenkel, A. (2005). R&D, firm size and innovation: An empirical analysis. *Technovation*, *25*(1), 25–32.

Silverman, B. S., & Baum, J. A. (2002). Alliance-based competitive dynamics. *Academy of Management Journal*, *45*(4), 791–806.

Simsek, Z., Heavey, C., & Veiga, J. J. F. (2010). The impact of CEO core self-evaluation on the firm's entrepreneurial orientation. *Strategic Management Journal*, *31*(1), 110–119.

Stinchcombe, A. S. (1965). Social structure and organizations. In J. G. March (Ed.), *Handbook of organizations* (pp. 153–193). Chicago, IL: Rand McNally.

Stram, W., & Elfring, T. (2008). Entrepreneurial orientation and new venture performance: The moderating role of intra- and extraindustry social capital. *Academy of Management Journal*, *51*(1), 97–111.

Stuart, T. E., Hoang, H., & Hybels, R. C. (1999). Interorganizational endorsements and the performance of entrepreneurial ventures. *Administrative Science Quarterly*, *44*(2), 315–349.

Stuart, T. E., Ozdemir, S. Z., & Ding, W. W. (2007).Vertical alliance networks: The case of university-biotechnology-pharmaceutical alliance changes. *Research Policy*, *36*(4), 477–498.

Tang, Z., Kreiser, P. M., Marino, L., & Weaver, K. M. (2010). Exploring proactiveness as a moderator in the process of perceiving industrial munificence: A field study of SMEs in four countries. *Journal of Small Business Management*, *48*(2), 97–115.

Thesmar, D., & Thoenig, M. (2004). *Financial market development and the rise in firm level uncertainty*. Paris, France: Centre for Economic Policy Research.

Tripsas, M. (1997). Unraveling the process of creative destruction: Complementary assets and incumbent survival in the typesetter industry. *Strategic Management Journal*, *18*(Summer Special Issue), 119–142.

U.S. Department of Commerce. (2003). *A survey of the use of biotechnology in US industry*. Washington, DC: U.S. Department of Commerce Administration Bureau of Industry Security.

Utterback, J. M. (1971). The process of technological innovation within the firm. *Academy of Management Journal*, *14*(1), 75–88.

Wales, W. J., Monsen, E., & McKelvie, A. (2011). The organizational pervasiveness of entrepreneurial orientation. *Entrepreneurship: Theory & Practice*, *35*(5), 895–923.

Walter, A., Auer, M., & Ritter, T. (2006). The impact of network capabilities and entrepreneurial orientation on university spin-off performance. *Journal of Business Venturing*, *26*(4), 541–567.

Wang, C. L. (2008). Entrepreneurial orientation, learning orientation, and firm performance. *Entrepreneurship, Theory, and Practice, Firm Performance*, *32*(4), 635–657.

Wiklund, J. (1999). The sustainability of the entrepreneurial orientation-performance relationship. *Entrepreneurship Theory and Practice*, *24*(1), 37–48.

Wiklund, J., & Shepherd, D. (2003). Knowledge-based resources, entrepreneurial orientation, and the performance of small and medium-sized businesses. *Strategic Management Journal*, *24*(13), 1307–1314.

Wiklund, J., & Shepherd, D. (2005). Entrepreneurial orientation and small business performance: A configurational approach. *Journal of Business Venturing*, *20*(1), 71–91.

Wiseman, R. M., & Catanach, A. H. (1997). A longitudinal disaggregation of operational risk under changing regulatory conditions: Evidence from the savings and loan industry. *Academy of Management Journal*, *40*(4), 799–830.

Whittington, K. B., Owen-Smith, J., & Powell, W. W. (2009). Networks, propinquity, and innovation in knowledge-intensive industries. *Administrative Science Quarterly*, *54*(1), 90–122.

Zahra, S. A. (1996). Governance, ownership, and corporate entrepreneurship: The moderating impact of industry technological opportunities. *Academy of Management Journal*, *39*(6), 1713–1735.

Zhao, Y., Li, Y., Lee, S. H., & Chen, L. B. (2011). Entrepreneurial orientation, organizational learning, and performance: Evidence from China. *Entrepreneurship, Theory, & Practice*, *35*(2), 293–317.

Zucker, L. G., & Darby, M. R. (1996). Star scientists and institutional transformation: Patterns of invention and innovation in the formation of the biotechnology industry. *Proceedings of the National Academy of Sciences, USA*, *93*(23), 12709–12716.

Zucker, L. G., & Darby, M. (1997). Individual action and the demand for institution. *American Behavioral Scientist*, *40*(4), 502–513.

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