An Integrative Model to Explain the Ability to Commercialize Innovations: Linking Networks, Absorptive Capacity, Ambidexterity and Environmental Factors

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Abstract

The ability to commercialize innovations is central to firm survival and success and, despite research on parts of the process, it remains somewhat obscure. We explore the literature to build an integrative model of the antecedents, mediators, and moderators of commercialization. We identify intra- and inter-organizational networks and the resources they embody as key drivers of the ability to commercialize. Absorptive capacity and ambidexterity act as mediators on that relationship. Further, environmental turbulence, munificence, and complexity moderate the relationship between networks and absorptive capacity and ambidexterity. We generate propositions on these relationships for empirical testing and further theoretical insight.

Keywords: Commercialization of Innovations, Ambidexterity, Absorptive Capacity, Networks

1. Introduction

It has been argued that successful commercialization of innovation is necessary in order for firms to be competitive (Nevens, Summe & Uttal, 1990). For example, Nokia and Sony-Ericsson, each successfully have introduced over seventy models of cellular phones in 2008, penetrating many available market niches with their portfolios. That pace of commercialization not only helps the innovators to be successful with introduced products but also raises barriers for existing and potential competitors. However, many new product launches are not successful—the list of failed commercializations includes everything from vitamin enriched sodas, smokeless cigarettes, to online bidding for groceries and gas, to failed automobile models. Scholars, not only have conjectured that successful commercialization of innovations is of strategic importance to firms (Nerkar & Shane, 2007), but also is necessary to advance the economy (Cohen & Levinthal, 1990; Eisenhardt &Martin, 2000; Zahra & Neilson, 2002; Sorensen & Stuart, 2000). The ability to commercialize can help firms improve market penetration and dominance in existing markets, or create new markets, which contributes to the attainment of sustained leadership and firm longevity, which, in turn, positively impacts the health of the economy within which the firm operates (Wallsten, 2000; Lerner 1999; Salamenkaita, & Salo, 2002). It therefore is no surprise that governments at nearly all levels attempt to mitigate market and other systemic failures to eliminate structural economic and industry-level rigidities. A better understanding of the successful commercialization of innovations is thus important at multiple levels.

There exists an emerging body of research that helps us understand which organizational characteristics correlate with a firm's ability to commercialize innovation. It has been suggested that the ability to commercialize innovations reflects a firm's capabilities (Damanpour 1991; Dourgerty & Hardy, 1996; McGrath et al., 1996; Pennings & Harianto, 1992, Teece, Pisano & Shuen, 1997), its human resource practices (Nerkar, McGrath & Macmillan, 1996; Scott & Bruce, 1994), the nature of the top management team (Bantel & Jackson, 1989; Howell & Higgins, 1990), and the external environment within which the firm operates (Abrahamson & RosenKopf, 1993; Keats & Hitt, 1988; Milliken, 1987; Wade, 1996). Much of the cited literature, however, has treated innovation and its commercialization as the same construct. In fact, commercialization in many cases was assumed. While we agree that innovation characteristics are a necessary component of future market success, innovation per se is not sufficient to ensure that success. Instead, innovations generally lead to market success through the process of commercialization (Drucker, 1985). While this growing body of work undoubtedly contributes to our understanding of successful commercialization, it remains that a dedicated model of the factors affecting commercialization is still essential.

Firms typically depend on products developed three to five years ago for large portions of their current sales. Correspondingly, they find themselves aiming three to five years in the future at a target that is both elusive and competitive in nature (Burgelman, Christensen & Wheelwright, 2006; Grove, 1996). Additionally, globalization of markets has put more pressure on firms to commercialize innovations in order to fend off global competition, to expand into global markets, or both (Hamel & Prahalad, 2002; Hamel & Getz, 2004; Collin & Porras, 1999; Huygens, Baden-Fuller, Van Den Bosh, Volberda, 2001; Huber, & Glick, 1993; March 1991). Thus, the need to bring innovations to market successfully is greater than ever. Again, Nokia responded to this environmental stimulus with the introduction of over eighty models of cellular phones and Sony responded with fifty models of portable audio players, with no apparent end to innovative products from either firm, and the same is true for rapidly growing companies like Samsung, and LG. In addition to these global stimuli, other environmental factors such as rapid technological development simultaneously enhances and exacerbates the need for successful commercialization of innovation. Advances in information technology, and greater ease of use of these technologies, have led to shorter cycle times in developing new technology applications. These changes have resulted in greater process improvements and more efficient generation of new products and product changes (Brynjolfsson & Mendelson, 1993; Gulati, Sawhney, & Paoni, 2002), which has further increased the speed with which firms and their competitors need to innovate and commercialize.

The rest of this paper is organized as follows. It begins with a discussion of the dependent variable—the ability to commercialize innovations. Then, we concentrate on a discussion of antecedents and mediators to commercialization, including, networks, ambidexterity, and absorptive capacity. In the subsequent section we discuss the factors that moderate the influence of networks and resources on ambidexterity and absorptive capacity. To ease assimilation of the discussion, we include a table of definitions of our constructs (Table 1) and our theoretical model (Figure 1). We conclude with a discussion of the contributions and limitations of this work, as well as suggestions for future research.

<Table 1 about here>

<Figure 1 about here>

2. Theoretical Model

2.1 Ability to Commercialize Innovation

According to Burgelman, Christensen, & Wheelwright (2006), the innovation process is defined as the combined activities leading to new, marketable products and services, or new product-delivery systems. As already noted, many scholars have combined innovation and commercialization within the same construct; for example, see Burgelman and colleagues (2006) who included the process of getting innovations to market within their definition of innovation. However, some have kept innovation and commercialization as separate and distinct constructs. Commercialization of innovation has been defined as the act or activities required for introducing an innovation to market (Kelm, Narayanan, & Pinches, 1995; Narayanan et al., 2000; Nambison & Sawhney, 2007; Andrew & Sirkin, 2003; Kwak, 2002; Nerkar & Shane, 2007). Nerkar & Shane (2007) measured commercialization of innovation as the early indication of commercialization, and operationalized it as the first sale of a given product or service. Moore (1991; 2000), on the other hand, posited that when an innovation is introduced in the market, only technology enthusiasts will adopt it, and such enthusiasts comprise less than three percent of the market. Moore (2000) thus argued that the larger mainstream market is comprised of pragmatists and conservatives, and so a successful commercialization is one that also captures this mainstream market. Fully capturing the mainstream market is difficult, and so we believe that the threshold for 'successful' commercialization of an innovation will lie somewhere between these two extremes—a single sale on the one hand and saturating the mainstream of a market on the other. We therefore define the ability to commercialize innovations as a firm's capacity to bring a product into a market and reach the mainstream of the market beyond the initial adopters. A minimum threshold for 'success' in commercialization thus is embedded in our definition.

Converting technical innovations to products and services entails the development of production and marketing capabilities, and assets such as manufacturing facilities and service and distribution networks (Ahuja, 2000; Mitchell, 1989; Teece, 1986). Thus, there are three aspects to commercialization that require acknowledgment—(a) recognize a market for an innovation, (b) develop and manufacture it into a product or service, and (c) sell and distribute the product or service through distribution channels. While, the last two can be outsourced (i.e, licensed or franchised), the first one cannot. Thus, while the ability to commercialize innovations depends on the firm's ability to produce and sell the product or services either by itself or by contracting out, the ability to commercialize innovations is inextricably embedded in an organization's ability to recognize current or emerging market opportunities.

2.2 Networks and Resources

The performance of firms in commercializing innovations can be explained by characteristics of the external network to which the firm belongs (Burkhardt, 1994; Burt, 1992; Dyer & Singh, 1998; Podolny & Stewart, 1995; Dourgerty & Hardy, 1996; McGrath et al., 1996; Pennings & Harianto, 1992; Teece, Pisano & Shuen, 1997). Gupta, Tesluk and Taylor (2007) specified the importance of networks within a multilevel approach for studying innovation. They argued (citing Scott and Bruce, 1994) that an organization's climate of innovation emerges from the shared perception of members of the organization on the degree to which organizational policies, resources, procedures and practices support and encourage innovation. Nohria (1992) and Nohria & Eccles (1992) have argued that the characteristics of an organization's network of social relations are relevant to a firm's ability to commercialize innovations.

Social, external and internal networks are considered as three different, albeit complementary, types of networks. They address different levels of analysis, use different theoretical constructs, and explain different outcomes of networks (Van Wijk, 2003). Social-networks thinking include organizations as social systems with a purpose, operating in a wider social structure. Organizations are differentiated by the network characteristics of the social relations they have with society and other organizations (Nohria, 1992). A social-network perspective provides an analytical tool to investigate structural, relational and positional embeddedness, tie strengths and trust (Nahapiet & Ghoshal, 1998). External-network research tends to focus on networks as a governance mode intermediating markets and hierarchies (joint ventures and strategic alliances), plus highlighting the competitive dimension of networks and associated performance issues (Dyer & Singh, 1998) along with the benefits of the networks such as interorganizational learning. Internal-network literature investigates intra-organizational structure and processes and management roles required for knowledge creation and sharing, maintaining flexibility, and enabling self-renewal (Volberda, 1998; Volberda & Lewin, 2003).

While there is a clear distinction between the focus of these networks, their outcomes can be overlapping. For instance, Volberda & Lewin (2003) argued that internal networks enable organizational self-renewal. Also, the distinction between social and external networks is not well defined. In fact Provan, Fish and Sydow (2007) mentioned that social networks often have been included within the construct of interorganizational or external networks, like the inclusion of social interaction as an attribute of interorganizational networks. Provan et al., (2007) mentioned that it is not entirely clear what organizational scholars are talking about when they use the term interorganizational networks. They noted that the term interorganizational network is used interchangeably with strategic alliances, coalitions, and cooperative arrangements, and has been tied to resource-dependence theory, transaction-cost economics, and interorganizational contracts. Despite these differences, Provan et al., (2007) argued that all definitions of interorganizational networks have common themes including social interaction, relationships, connectedness, collaboration, collective action, trust, and cooperation. Other common themes include business ecosystems (Moore, 1993) and clusters (Porter, 1998). Although great strides have been made in the study of interorganizational networks, a shared language with definitive meanings in the study of networks has not yet been developed (Provan et al., 2007). Consequently, the definition of what constitutes a network varies. On one hand it can be very generic, per Brass, Galaskiewicz, Geve, & Tsai (2004) who explained "a network as a set of nodes and the set of ties representing some relationship, or lack of relationship, between the nodes." On the other hand, it can be to very specific, per Barringer and Harrison (1990) who provided an overview of different types of interorganizational networks and then went into considerable detail explaining how each is different within the rubric of networks and as being constellations of organizations that come together through the establishment of social contracts or agreements.

According to Gulati and Gargiulo (1999: 1439), "Organizations enter alliances with each other to access critical resources, but they rely on information from the network of prior alliances to determine with whom to cooperate. These new alliances modify the existing network, prompting an endogenous dynamic between organizational action and network structure that drives the emergence of interorganizational networks." While networks are formed to access and share resources (Dyer and Singh, 1998; Gnyawali, He and Madhvan, 2006; Gulati, 1998; Gulati and Kletter, 2005; Gulati, Nohria and Zaheer, 2000; Klein, Rai and Straub, 2007; Pfeffer and Salancik, 1978), the networks themselves become valuable resources (Barney, 1991; Porter, 1998; Mata, Fuerst, and Barney, 1995; Melville, Kraemer, and Gurbaxani, 2004). Thus, we treat networks and the resources they embody as one construct.

Synthesizing the above, we define networks as the collective of structures, collaboration, and norms within and between organizations. From an external-network standpoint this includes social networks, business clusters, partnerships, business ecosystems, and relationships with innovation engines, such as universities. From the standpoint of intraorganizational or internal networks, it includes the individuals in the organizations and the context of the organizational structure and organizational policies and procedures. These networks become a valuable resource, enabling organizational flexibility and leading to self renewal.

2.2.1 Networks and Commercialization of Innovations

The structure, norms or collaboration of external networks often are explained by degree, centrality, multiplexity and broker relationships of networks (Borgatti and Everett, 2006; Freeman, 1977 & 1979; Provan et al., 2007; Wasserman and Faust, 1994). Degree centrality is based on the number of direct links maintained by an organization with other organizations in the network (Borgatti & Everett, 2006; Freeman, 1977 & 1979). If the network is directed (meaning that ties have direction), then two separate measures of degree centrality are considered: in-degree and out-degree. In-degree is a count of the number of ties directed to the node, while out-degree is the number of ties that the node directs to others. Calculation of in-degree and out-degree centrality also is possible and is based on the extent to which assets such as resources, information, and clients are coming into an organization from others in the network versus those being sent out to other organizations. But, according to Provan et al., (2007), the key question will be: does an organization occupy a central or a more peripheral position in the network, based on the number of network ties it maintains with other organizations.

Burt (1992) argued that network linkages enable and constrain the flexibility, effectiveness, and innovativeness of organizational members. Newell & Clark (1990) reported that British firms were less innovative than their U.S counterparts because they were less central in their interorganizational communication-networks. Further, Burns & Wholey (1993) found that hospitals that were centrally located in an interorganizational network were more likely to be early adopters of innovations than those outside the network. Centrality determines the relative importance of an entity or a node in a network. While some organizations will struggle to get to the central position in any network, others will quickly link themselves to the central node (Dyer and Singh, 1998; Gnyawali, He and Madhvan, 2006; Gulati, 1998; Gulati and Kletter, 2005; Gulati, Nohria and Zaheer, 2000; Klein, Rai and Straub, 2007). Reasons for this difference in behavior could be many, for example, it could be expensive for the entities to maintain and control such networks, or it may be that the central node is a venture capitalist to which other nodes simply want to connect for financing, consulting, or access to business incubators. Thus, these "external networks" can involve business ecosystems (Moore, 1993), and that includes joint ventures and strategic alliances with suppliers and customers. Being in a central position or having a direct link to the central node within an external network, firms are better able to access resources, such as research, finance, production facilities and, distribution channels that are required for commercialization of innovations (Ahuja, 2000; Dyer & Singh, 1998, Gnyawali, He, & Madhvan, 2006; Klein, Rai & Straub, 2007m Mitchel, 1989, Teece, 1986).

Closeness centrality addresses the question of whether or not an organization is in a structural position to spread resources such as information or knowledge that might reside in any organization in the network, even through indirect ties (Provan, et. al, 2007). Central organizations have short 'paths' (connections) to all other organizations in the network. Unlike degree centrality, indirect connections are viewed as valuable mechanisms for exchange of network-based resources in closeness centrality (Borgatti and Everett, 2006; Freeman, 1977 & 1979). Betweenness measures the influence a node has over the spread of information through the network (Newman, 2005). If an organization serves as a gatekeeper within the network, then it must maintain intermediary links between organizations that are not directly connected with one another. Such organizations have benefits in accessing information about resources such as innovations and fundamental research, funding opportunities, manufacturing partners, and distribution channels. Thus, in terms of resource access, these gatekeepers are potentially at a greater advantage for commercializing innovations.

Multiplexity deals with the strength of the relationship an organization maintains with network partners, and is based on the number of types of links (e.g., research ties, joint programs, referrals, and shared personnel) that connects them (Provan et al., 2007). Multiplexity also is referred to as heterogeneity of networks (Newman, 2001). Multiplex ties are thought to be an indicator of the strength and durability of an organization's links because they enable the connection between an organization and its linkage partner to be sustained, even if one type of link dissolves (Provan et al., 2007). As already noted, external networks also can include ties with universities, along with various types of research laboratories and institutes that conduct basic research and are regarded as engines of innovation because they create new knowledge and literally are in the business of innovation (Agarwal, 2006; Chataway & Wield, 2000; Colyvas et al., 2002; Numprasertchai & Igel, 2005; Henderson, Jaffee & Tratjenberg,1998). Though these innovation engines are not proximate in nature to commercial firms, they constitute a multiplex tie and can be treated under the same construct of external networks and resources.

Firms communicate with these innovation engines via formal and informal scientific meetings, licenses, joint ventures, research contracts, consulting, personal networks, research grants, recruitment of students, email, shared databases, workshops, communities of practice, and so on (e.g. Cohen et al., 1998; 2002; Powell, 1998; Oliver, 2004; Hoegl and Schulze, 2005; Rothaermel & Thursby, 2005; Salman & Saives, 2005). Such relationships help shorten the innovation cycle and promote faster commercialization. One example of such a tie would be the relationship that Nokia has with

academic and research institutes in Finland (Birkinshaw &Gibson, 2004). Through contracted, funded research, both the innovators and the commercializer benefit and the innovation/commercialization cycle appears to happen faster and more effectively (Birkinshaw & Gibson, 2004).

Broker relationships explain the extent to which an organization span gaps, or structural holes, in a network (Burt, 1992; Provan et al., 2007). Such organizations are considered to be brokers, often occupying positions of considerable influence (Provan et al., 2007) and includes organizations such as banks or other financial agencies like venture capitalists. Broker relationship help organizations to get necessary funds for commercialization of innovations.

According to Kirzner (1997), discovery of entrepreneurial opportunities is somewhat probabilistic in nature, as opposed to the result of a systematic search effort. Thus, diversity increases the probability of a successful search occurring. Also, because entrepreneurs seem best able to "discover" opportunities for commercialization that directly relate to their previous knowledge in the three dimensions of knowledge of markets, knowledge of how to serve those markets, and knowledge of specific customers' problems (Shane, 2000), a robust network is required to support information gathering, resource sharing, and idea generation. This knowledge is not equally distributed across all entrepreneurs and, therefore, is necessarily a function of their relationships with innovators, and funders (Anderson, 2008). Thus, recognition of an opportunity to commercialize an innovation is more likely to happen at the confluence of these entities, facilitated by the entrepreneurial entity and its corresponding network. Opportunities are believed to be not a matter of 'particular individuals' (the neoclassical interpretation of the entrepreneur), but rather a combination of individuals (Vintergaard, 2005). Therefore, having the right parties in a network is critical.

The above discussion mainly has concentrated on the effect of interorganizational networks on commercialization of innovation. Past research also has contributed to our understanding of effects of internal networks on a firm's ability to commercialize innovations. The antecedents that have been studied have included structural factors in organizations (Nerkar, McGrath & Macmillan, 1996; Scott & Bruce, 1994) and leadership (Bantel & Jackson, 1989; Ellis, 2003; Howell & Higgins, 1990).

For instance, Ellis (2003) noted that in response to technological innovation and extremely volatile environmental conditions, competitive organizations increasingly are becoming horizontal in their reporting structure and have reduced the levels of management between the CEO and the lowest levels by 25%. At the level of the individual, Nerkar et al., (1996) showed that three independent facets of job satisfaction—instrumental satisfaction with the way the task is progressing, social satisfaction with the way the team members interact with one another and the organization, and egocentric satisfaction with the individuals' perceived benefits to themselves—helps in commercialization of innovations. Scott and Bruce (1994) showed that leadership (leader-member exchange, leader-role expectation), individual problem-solving style (intuitive or systematic), and work-group relations influence the innovative climate of a firm, and Nevens et al., (1990) hypothesized that cross-functional skills are an antecedent to commercialization of technologies.

In differentiating between high- and low-performance firms, in terms of commercializing of innovations, Nevens et al., (1990) posited that, in high-performance companies, top management maintains a visible presence to reinforce commercialization. They found that even in extremely decentralized and divisionlized firms, like Hewlett Packard and 3M, top management will involve themselves in details seen as crucial to the commercialization process. Further, the authors posited that in high-performance firms top-management teams act as tie breakers in disputes at the project level by giving precedence to commercialization of related activities over others, by ensuring a deadline is met, by clearing calendars of key employees of other work, speeding decision making, and making sure that the right people come together. Bantel and Jackson (1989), in their assessment of the effect top-management teams have on innovations in banking found that more innovative banks were managed by more educated teams that are diverse in their functional areas of expertise. These relationships remain significant when organizational size, team size, and location are controlled for. In assessing the effect of top management on technological innovations, Howell & Higgins (1990) investigated the personality characteristics, leadership behaviors, and influence tactics of champions of technological innovations. They found that Champions exhibited higher risk-taking and innovativeness, initiated more influence attempts, and used a greater variety of influence tactics than non-champions.

Synthesizing the above, we posit that networks, be they within firms, between firms, or between firms and innovation engines not only will help in opportunity recognition but also in the remainder of the commercialization process. Networks thus help in moving innovations to markets, networks with financial agencies help raise funds for manufacturing, through networks firms can know if manufacturing can be outsourced to another entity or not, and they help in identifying the distribution channels for selling the products. This leads us to propose:

Proposition 1: Centrality, multiplexity, and broker relationships of external networks, and supportive structural and leadership factors of internal networks positively affect a firm's ability to commercialize innovations.

2.3 Ambidexterity: Balancing Exploration and Exploitation

In order for an organization to succeed over the long term, it needs to master both adaptability and alignment, a dual mode that is termed as ambidexterity (Birkinshaw & Gibson, 2004; Gibson & Birkinshaw, 2004; Raisch & Birkinshaw, 2008). As an example, Birkinshaw and Gibson (2004) noted that while Nokia launched a vast array of new mobile-technology product offerings, they also continued to make pricing and other product decisions in order to continue to be the dominant handset provider. Focusing too much on alignment makes an organization lose long-term vision, while emphasizing adaptability over alignment means building tomorrow's business at the cost of today's (Birkinshaw & Gibson, 2004). Similarly, Duncan (1976) reasoned that in order to innovate successfully, organizations must balance two stages of innovation namely, initiation and implementation, and he referred to this balance as ambidexterity. During the initiation phase, an organization needs low formalization, with less centralization, whereas during implementation the organization needs more formalization, with lower complexity and higher centralization.

Similar to Birkinshaw and Gibson's (2004) idea of alignment and adaptability, and Duncan's (1976) idea of blending initiation with implementation, is March's (1991: p.71) concept of exploration and exploitation:

"Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution. Adaptive systems that engage in exploration to the exclusion of exploitation are likely to find that they suffer the costs of experimentation without gaining many of its benefits. They exhibit too many undeveloped new ideas and too little distinctive competence. Conversely, systems that engage in exploitation to the exclusion of exploration are likely to find themselves trapped in suboptimal stable equilibrium. As a result, maintaining an appropriate balance between exploration and exploitation is a primary factor in system survival and prosperity." Seen from the sense of Birkinshaw and Gibson (2004), March's conceptualization of exploration would be Nokia's experiment with newer technology and exploitation would be their continuing investment and commitment in their existing product lines.

Exploration, thus encompasses knowledge creation and analysis of emerging and future opportunities, while exploitation is defined as making use of existing knowledge to leverage current opportunities (March, 1991; Wielemaker, 2003; Sidhu, Commandeur, & Volberda. 2007; Zack, 1999; Zack, 2003). Past research has positively linked a balance between exploration and exploitation with organizational self-renewal through constant innovations in volatile business environments (Lewin & Volberda, 1999; Levinthal & March, 1993; Levinthal, 1997; March, 1991; Nahapiet & Ghosal, 1998; Volberda 1998; Volberda & Lewin, 2003; Huber & Glick, 1993; Hamel & Getz, 2004). In addition, a number of studies collectively have posited that a balance between exploration and exploitation leads not only to organizational renewal but that this, in turn, helps firms to be more innovative and, as a result, such firms are more long-lived (Lewin & Volberda, 1999; Levinthal & March, 1993; Levinthal, 1997; Levinthal & March, 1991; Volberda 1998; Volberda & Lewin, 2003; Dess & Beard, 1984; Hamel & Prahalad, 2002; Hamel & Getz, 2004). While some scholars defined the dual mode of operation of blending adaptability and alignment, exploration and exploitation, efficiency and flexibility as ambidexterity (Birkinshaw & Gibson, 2004; Gibson & Birkinshaw, 2004; Raisch & Birkinshaw, 2008), others (e.g., Simsek, 2009) have mentioned that such a dual model itself leads to ambidexterity. Combining the work of March (1991), Birkinshaw & Gibson (2004), Gibson & Birkinshaw (2004), and Raisch & Birkinshaw (2008), we define ambidexterity as the property of an organization to balance the two activities of exploration and exploitation.

From a thorough review of literature on ambidexterity Simsek, Heavey, Veiga and Souder (2009) and Simsek (2009) concluded that there are four ways to achieve a balance between exploration and exploitation, namely, harmonic, cyclical, partitional, and reciprocal. Harmonic balance is achieved through concurrently pursuing exploitation and exploration (Simsek et al., 2009), but attaining a balance means competition for scarce resources, which can lead to conflicts and inconsistencies. Organizational practice and routines that alleviate these problems are necessary for achieving a viable harmonic balance.

Cyclical ambidexterity is long periods of exploitation (or relative stability) interspersed by sporadic episodes of exploration (or change). Simsek et al., (2009), related it to Gersick's (1991) punctuated equilibrium. Antecedents to cyclical ambidexterity are found in human resource practices that emphasize innovation, teamwork, and flexibility (Simsek et al., 2009). Also, Simsek et al., (2009) traced partitional ambidexterity back to Duncan's (1976) work, where he emphasized the role of dual structure of initiation and implementation. Organizational theorist like Tushman and O'Reilly (1996), and O'Reilly and Tushman (2004) envisioned partitional ambidexterity as an interdependent, simultaneous phenomenon. From a structural perspective, partitional ambidexterity is achieved by creating separate units or divisions for exploitation and exploration (Duncan; 1976; Tushman and O'Reilly, 1996), with each unit embodying distinct strategic and operating logics, cultures, and incentive systems. As explained by O'Reilly & Tushman (2004), the ability simultaneously to pursue both exploitation and exploration results from "hosting multiple contradictory structures, processes, and cultures within the same firm" (2004: 24). While tightly coupled and integrated at the business unit level, these logics must remain loosely coupled across business units (Benner and Tushman, 2003).

Reciprocal interdependence is where the outputs of exploitation from unit A become the inputs for exploration by unit B and the outputs of unit B cycle back to become the inputs of unit A (Simsek et al. 2009), this being the classic situation in strategic alliances. Lavie and Rosenkopf (2006: 814) observed that firms "appear to balance their tendencies to

explore and exploit with respect to the nature of their alliances or choice of partners over time and across domains." Their findings highlight the significance of alliances and interorganizational networks as mechanisms for combining exploitation and exploration across time and units. In this vein, knowledge integration among alliance partners may be especially relevant to the pursuit of this form of ambidexterity (Simsek et al. 2009). We thus see that, irrespective of the type of balance, ambidexterity is enabled by networks (Birkinshaw and Gibson, 2004; Gibson and Birkinshaw, 2004; Raisch and Birkinshaw, 2008). But, collaboration within, between, and among organizations affects the ability to strike a balance between exploration and exploitation.

Simsek (2009) noted that centrality and multiplexity (cited as diversity) of networks affect ambidexterity. Centrally positioned organizations, because of their more numerous direct and indirect connections to others, have more relationships to draw upon in obtaining resources and so are less dependent on any single organization for exploration (Scott, 1991). In addition, the access facilitated by centrality means a higher likelihood of exposure to the various disparate social circles within the network and to more clusters, or pockets, of highly connected organizations (e.g. Powell et al., 1996; Simsek 2009). As a consequence, exploitation also is enabled because central organizations become better informed about what is going on in the network.

Network diversity improves the likelihood of achieving ambidexterity. Firstly, it provides the organization with the benefit of heterogeneity in its problem-solving arsenal (Simsek, 2009). An organization that has a homogenous network has little opportunity to consider multiple perspectives because most network members see the world similarly. By contrast, diverse ties imply organizations may differ in their modes of reasoning, problem formulation and solution. Exposure to these different approaches adds to the repertoire of ideas that the organization can bring to bear on exploitation and exploration, yielding deeper and more comprehensive analysis of design problems, and novel framing of opportunities (Baum et al., 2000; Beckman & Haunschild, 2002; Simsek, 2009). Secondly, diverse network ties are valuable for ambidexterity because they can help the organization overcome the familiarity trap; that is, a tendency to favor the familiar over the unfamiliar (Ahuja & Lampert, 2001; Simsek, 2009). Thirdly, diverse ties can promote ambidexterity by helping organizations overcome the convenience trap, a tendency to search for solutions that are in the neighborhood of existing solutions rather than search for completely new solutions (Ahuja & Lampert, 2001; Simsek, 2009). Lastly, diverse ties also enable the organization to access a wider circle of information about potential markets, new business opportunities, innovations, sources of capital, and potential customers. Thus, an organization with heterogeneous partners is likely not only to have access to more complementary resources but also to know more about how to productively put these resources into use (Burt, 1992; Simsek, 2009). For example, through its strong relation with universities in Finland, Nokia is able to experiment with a vast array of new mobile-technology inventions (such as the Nokia Symbian operating system) relatively inexpensively, while continuing to invest in being the dominant handset franchise, thereby enabling their ambidexterity (Birkinshaw and Gibson, 2004).

The ability of ambidextrous firms to come up with radical new products without hampering activities in existing markets, make them long-lived (Tushman & O'Reilly, 1996, 2002; O'Reilly & Tushman, 2004). The works of Collin and Poras (1999), Huygens et al.(2001), Porter (1998), and Van Wijk (2003) suggest that long lived-firms have structural and cultural similarities, and from the standpoint of intraorganizational networks, Tushman and O'Reilly (1996) identified a decentralized structure, a common culture and vision, and supportive leaders and flexible managers as key sources of ambidexterity. Thus, factors within firms that affect ambidexterity include decentralization, a tolerant management style, and sensitivity towards the emerging trends in the environment. Similarly, co-evolutionary theory (Van den Bosch et al. 1999; Flieret al., 2003; Volberda & Lewin, 2003) speaks to the interdependence of organizations and their environments. Combining work on corporate longevity and co-evolutionary theory, Volberda & Lewin (2003) proposed three key principles of self renewal within organizations: (a) self renewing organizations focus on managing requisite variety by regulating internal rates of change equal to or exceeding external rates of environmental change triggered by customer orientation, technology innovation, industry competition, and product obsolescence; (b) self-renewing organizations optimize self-reorganization; and (c) self-renewing organizations synchronize concurrent exploitation and exploration. Therefore, the management of internal and external networks can enable a firm continuously to renew and fit within a changing business environment.

Synthesizing the above, we propose:

> *Proposition 2A: An organization's ability to create and manage inter- and intra-organizational networks positively affects its ability to balance exploration and exploitation.*

Technologically oriented organizations that engage in successive or cyclic rounds of exploitation and exploration are best equipped to pursue product innovations (Tushman and O'Reilly, 1996; Simsek et al, 2009; Simsek, 2009). By engaging in intensive periods of exploration, firms discover new technologies that not only spur the proliferation of new

products, but also can become established as the dominant design in the industry (Henderson & Clark, 1990). Then, by subsequently shifting to exploitation, they can improve the performance of product innovations through process innovation (Simsek et al, 2009). Partitional-ambidextrous firms have been observed to be successful in launching breakthrough products and services and in ensuring the continued high performance of existing products (O' Reilly & Tushman, 2004).

Tushman and O'Reilly (1996) argued that large corporations, such as Johnson & Johnson, and Asea Brown Boveri (ABB), have been able to compete in mature market segments through incremental innovation, and in emerging market segments through discontinuous innovation. They reconcile conflicting demands from their task environment and synchronize and balance concurrent exploration of new opportunities and exploitation of existing ones (Duncan, 1976; Gibson & Birkinshaw, 2004; Birkinshaw and Gibson, 2004; O'Reilly & Tushman, 2004; Tushuman & O'Reilly, 1996). In this way, ambidextrous organizations can renew themselves through the creation of breakthrough products, services and processes without destroying or hampering traditional businesses (Gibson & Birkinshaw, 2004; Volberda & Lewin, 2003; Tushman & O'Reilly, 1996).

We already have mentioned that ambidextrous firms are better able to attain organizational longevity, and that such long-lived organizations compete in mature market segments through incremental innovations (Abernathy & Utterback, 1978; Christensen, 1992a and 1992b) and in emerging market segments through radical innovations (Burgelman, Christensen, & Wheelwright, 2006; Abernathy & Utterback, 1978; Burgelman & Grove, 1996; Burgelman, 2002; Galunic & Eisenhardt, 1996; Christensen, 1992a; Henderson & Clark, 1990). For instance, the ability of Hewlett Packard to balance its mainstream computing and printing market with emerging IT service markets led to leading products in computers, printers and IT services, like HP open view. Thus, being ambidextrous leads a firm to combine current opportunities with future vision, which, per our definition of ability to commercialize innovations, includes being able to recognize current and emerging markets. Further, we have argued that the ability to balance exploration and exploitation leads to an organization's being cognizant of existing and emerging markets, and capitalize on both types of market opportunities. Therefore:

> *Proposition 2B: The better the balance between a firm's exploitation and exploration, the more successful it will be at commercialization of innovations.*

2.4 Absorptive Capacity

According to Cohen and Levinthal (1990) and Jansen et al. (2005), absorptive capacity is the limit to the quantity and rate at which a firm can absorb scientific or technological information. Conceptually, absorptive capacity is similar to information-processing capacity but at the firm level rather than at the individual level. Absorptive capacity underlies a firm's knowledge capabilities by which the firm acquires, assimilates, transforms, and exploits knowledge resources to produce dynamic capabilities such as innovativeness (Zahra and George 2002). Networks affect absorptive capacity. Not only are they important for increasing a firm's knowledge base and for creating new knowledge, which can be observed in the form of new patents (which are embodiments of knowledge), new categories of products and services (which come from understanding the competition and market needs) and, in extreme cases, the creation of new industries (Jansen et al., 2005), they also play an important role in building a firm's absorptive capacity by providing skills and processing abilities that can support the acquisition, assimilation, transformation, and exploitation of knowledge for innovation (Alavi & Leidner 2001; Holsapple & Joshi, 2000; Holsapple and Joshi, 2002; Dehning et al. 2003; Jansen et al., 2005; Lane & Lubatkin, 1998; Zahra & George, 2002). The primary antecedents to absorptive capacity, according to Cohen & Levinthal (1990), are the structure of communication between the organization and entities in its external environment (termed outward absorptive capacity), the structure of communication between subunits in the organization (termed cross-functional absorptive capacity), and the structure of communication within subunits in the organization (termed inward absorptive capacity). The latter is self evident insofar as good communication within units will permit more and quicker absorption of knowledge than will poor communication, but outward and functional absorptive capacity need some illustration and explanation.

Some examples of outward absorptive capacity are the strategic partnership between Intel and Microsoft (Grove, 1996), the business ecosystem that Walmart created with its suppliers (Moore, 1993; Burgelman et al., 2006), and the relationship that Nokia has with academic and research institutions. In each case the experiences or knowledge of one firm or entity increases the limit of absorption of the other entity over the network. A classic example of cross functional absorptive capacity is the tight linkages between design and manufacturing subunits that enabled Japanese firms to move products rapidly from design through production, marketing, sales, and into the market (Cohen and Levinthal, 1990). The concept was explained in more detail by Clark & Fujimoto (1987) who argued that overlapping product-development cycles facilitated collaboration and coordination across subunits within a firm. Cross-functional

interfaces, organizational networks, and socialization were shown to be important for the development of absorptive capacity (Jansen et al. ,2005) and, an organic structure has been deemed as being desirable for promoting absorptive capacity because it better enables people to solve unstructured problems quickly and well (Cohen & Levinthal, 1990; Chen, 2004; Jansen et al., 2005). Thus, structure and collaboration within intraorganizational networks, can affect its absorptive capacity.

Further, the relationships between firms, and between firms and innovation engines affect a firm's absorptive capacity (Cohen and Levinthal, 1990; Cohen et al. 1998, 2002). Cohen et al. (1998; 2002) noted that publications, public meetings and conferences, informal and personal exchanges of information, and consulting contracts appear to be the four primary channels for knowledge exchange between firms and innovation engines. The relative importance of the channels also may vary across industries. Cohen and Levinthal (1990), and Cohen et al., (2002) found that some channels are more important than others for exchange of knowledge. Similarly, Powell (1998), Oliver (2004), Salman and Saives (2005), and Lin et al.,(2006) also noted idiosyncrasies in channel use. From these works, it appears that networks between academia and industry can benefit participating firms in that there is a useful flow of knowledge either in the sharing of research findings, or through the guidance of the scientist (e.g., if the scientist were to serve as an advisor or board member for the participating firm) or in some case through transfer of intellectual property. Thus, as Cohen and Levinthal (1990) concluded, these types of networks between firms and innovation engines expand an organization's absorptive capacity. From the discussions above we posit that firms with networks with other firms and with innovations engines will have greater absorptive capacity than those without. We therefore posit:

> *Proposition 3A: Absorptive capacity is positively related to a firm's internal and external networks—as the number of networks, and the quality of linkages (number, type, tightness) increase, so too does absorptive capacity.*

Cohen & Levinthal (1990) argued that absorptive capacity allows firms to predict more accurately the commercial potential of technological advances. In other words, a higher absorptive capacity can promote innovation within a firm as well as its ability to comprehend the commercial potential of innovations. Both inward and outward absorptive capacity can increase the ability to commercialize innovations. For instance, as Clark and Fujimoto (1987) found, the overlapping interfaces between design, manufacturing, sales and marketing in Japanese firms led to increased absorptive capacity leading to movement of the product from design, to market. Similarly, outward absorptive capacity, derived from networks between firms and innovation engines, increases the ability to commercialize innovations, as innovators can view their innovations as finished products and firms can sense the business value of fundamental research. Nokia has done exactly that with its networks with academia (Birkinshaw and Gibson, 2004).

Again, in our definition of ability to commercialize innovations, we included an organization's ability to recognize current and emerging markets as a fundamental component. From the above, it is apparent that absorptive capacity underpins that ability. Therefore:

> *Proposition 3B: Higher absorptive capacity increases a firm's ability to commercialize innovations.*

2.5 Moderating Factors

2.5.1 Intensity of Environmental Turbulence

Goldsmith and Mechling (2008) identified four stages of environmental change: stable, evolutionary, revolutionary and turbulent. In a stable environment the need to develop new innovations is low, while during turbulent times, the need to innovate and commercialize is extremely high (Goldsmith and Mechling, 2008), and its resource allocation and mobilization also will be different in stable and turbulent environments (Eisenhardt & Martin, 2000; Teece et al., 1997, Volberda, 1996; Wade & Hulland, 2004).

According to Ghemawat and Costa (1993), firms faced with more stable environments tend to emphasize static efficiency at the expense of dynamic efficiency, and the process is reversed when firms find themselves in unstable environments. In other words, a firm tends to be inward looking during stable times and outward looking during disruptions. Cohen & Levinthal (1990) argued that in an uncertain environment, absorptive capacity permits the firm to predict more accurately the mature and commercial potential of technological advances. In highly dynamic environments, there is rapid and discontinuous change in demand, competitors, technology, or regulations. As a result, information often is inaccurate, unavailable, or obsolete (Eisenhardt and Bourgeois, 1988; Simsek, 2009). Dynamic environments thus demand that the organization develop adaptive responses quickly and expand the scope of information acquisition and gathering (Sidhu et al., 2004; Simsek, 2009). In so doing, dynamism imposes a challenge to the organization by demanding flexibility and agile actions ranging from information scanning, selection, and processing to interpretation (Miller and Friesen, 1983; Simsek, 2009).

We also must realize that for centrally positioned organizations, a turbulent environment puts strains on an organization's information-processing capability (Simsek, 2009). Absorptive capacity is information processing capacity at the firm level (Cohen and Levinthal, 1990). Such information overload may impede organizations from realizing potential values of certain innovations, and cripple their ability correctly to assess the diverse information and knowledge benefits that come from networks (Simsek, 2009). Thus, while environmental turbulence gives an impetus to increase absorptive capacity, it will, in reality, inhibit it. Therefore:

> *Proposition 4A. Environmental turbulence negatively moderates the relationship between networks and absorptive capacity.*

During stable times, a firm exploits existing markets and the impetus for exploring new possibilities is low, while in times of environmental disruptions the need to explore emerging markets without hurting existing markets is higher (Leornard-Barton, 1992; Levinthal & March, 1993; Melville et al. 2004). As noted earlier, successful long-lived firms tend to be ambidextrous, but their need to be ambidextrous is higher in the face of environmental turbulence. Simsek (2009), however, posited that during turbulent or dynamic environmental conditions, over-reliance on inter-organizational networks may prevent centrally positioned organizations from responding in a timely manner while, at the same time, coordination, information processing, and collaboration become more expensive and difficult to manage in a dynamic environment because of rapidly unfolding conditions and contingencies. In addition, Simsek (2009) argued that the positive effects of network diversity or multiplexity on ambidexterity may be dampened by environmental turbulence. We argued earlier that for organizations to be able to improve their ambidexterity from diverse network ties, they first must sufficiently access, process, and utilize the diverse information and knowledge benefits that these ties provide. But, dynamism will force the organization to develop solutions by taking actions quickly without utilizing the integrative benefits of the network ties. In addition to reducing the benefits, environmental dynamism also can increase costs associated with diverse array of ties because of changes in network memberships and relationships. The cost with some structural elements of interorganizational networks, such as centrality and multiplicity, may outweigh the benefits of ambidexterity. Since we have already stated that structural elements of networks affect ambidexterity, we propose that:

> *Proposition 4B. Environmental turbulence negatively moderates the relationship between networks and ambidexterity.*

2.5.2 Environmental Munificence

An environment is said to be munificent to the extent that it supports a firm's continued and sustained growth (Dess & Beard, 1984). Environments that are mature and shrinking are characterized by low munificence, while an industry that is growing is said to have relatively high munificence (Keats and Hitt, 1988).

A mature environment is characterized by regularity and predictability of market changes (Duncan, 1972; Dess & Beard, 1984; Keats and Hitt, 1988), where more information is available concerning partners, competitors, and their potential actions, and where firms are better able to assess and predict effects of actions (Milliken, 1987). Therefore, firms in mature environments tend to focus on increasing efficiency rather than creating new knowledge and launching new products, which are both time-consuming and resource-consuming. Firms that explore newer opportunities in a mature environment may not do any better than those that do not. Thus, the need to be ambidextrous is lower in a mature environment than in growth environment. For low environmental-munificence, firms will tend toward more exploitation rather than exploration, whereas firms faced with high environmental-munificence will have a need to take advantage of the opportunities around them because, if they do not, their competitors will. Firms in a munificent environment therefore will tend to have a better balance of exploration and exploitation. We propose:

> *Proposition 5. Environmental munificence positively moderates the relationship between networks and ambidexterity.*

2.5.3 Environmental Complexity

Dess and Beard (1984), defined complexity as the heterogeneity and concentration of environmental elements. A highly complex environment is characterized by the level of heterogeneity of firms within the industry, a high number of suppliers and customers, and a wide range of products being offered (Wade & Hulland, 2004). Simsek (2009) noted that an organization's environment is more complex to the extent that the organization needs to consider heterogeneous actors and a range of activities, linkages, and interactions outside its boundaries in strategic decision-making.

Environmental complexity exerts its primary influence on organizational structure (Keats and Hitt, 1988). MacCrimmon and Taylor (1976) and Bobbitt and Ford (1980) suggested that organizational decision-makers deal with environmental complexity by structural divisionalization. Divisionalization allows development of specialized knowledge to deal with

specific environmental elements and creates decentralized decision-making authority to take needed actions (Keats and Hitt, 1988), and such development of specialized knowledge, through creation and assimilation, were, according to Lane and Lubatkin (1998), indicators of absorptive capacity. Thus, we can deduce that environmental complexity provides the impetus to align resources and networks to develop absorptive capacity. This leads us to posit:

Proposition 6A: Environmental complexity positively moderates the relationship between networks and absorptive capacity.

Complex environments do not diminish an organization's ability to take action, but it makes it difficult to identify what is most appropriate (Boisot and Child, 1999). Considering the demands of a complex environment in understanding the critical drivers of success, network centrality and diversity (multiplexity or heterogeneity) will lead to greater ambidexterity in a complex environment than in a simple environment (Boisot and Child, 1999; Simsek, 2009). Particularly, while a complex environment demands greater levels of ambidexterity, centrality and diversity enhance the organization's ability to develop ambidextrous responses to maintain an appropriate level of fit with the environment as well as strategic flexibility such that complexity does not mitigate its ability to develop appropriate actions (Boisot and Child, 1999; Simsek, 2009). In other words complex environments demand a wider array of knowledge and perspectives for developing and evaluating solutions to complex and multifaceted problems. Thus, complexity is likely to increase the beneficial influences of network centrality and diversity on ambidexterity. Indeed, research by Powell et al. (1996) shows that in industries that are complex and expanding, with sources of expertise that are widely dispersed, network ties tend to become salient predictors of the organization's innovation performance. Similarly, through central and diverse network connections, the organization is better positioned for developing the increased number of responses that are needed to attain ambidexterity in a complex environment (Simsek, 2009). Therefore:

Proposition 6B: Environmental complexity positively moderates the relationship between networks and ambidexterity.

While turbulence and complexity both moderate the relationship between networks and ambidexterity, the direction of the relationship is different. The reason, as posited by Simsek (2009), is that whereas dynamism results in an inability to predict and foresee, complexity is, instead, associated with difficulty in monitoring.

3. Conclusions and Implications

We began by asking a very practical question as to why some organizations are better at commercializing innovations than are others. Our investigation of the literature has helped identify the antecedents, mediators, and moderators to the commercialization of innovation and, from this, we have created an integrative model. In addition to elucidating commercialization of innovations, this work also contributes to our thinking on the various facets of networks, absorptive capacity, and ambidexterity.

While commercialization of innovations essentially is bringing innovations to market, the task differs greatly when a firm tries to compete in an existing market versus create a new one, or when the innovation is incremental versus radical. This led us to underscore the importance of ambidexterity. Realizing the market potential of an innovation is fundamental to commercialization of innovations, and such, it is contingent a firm's absorptive capacity. Further, the antecedents to both ambidexterity and absorptive capacity can be found in networks within a firm, between firms, and between firms and innovation engines. These networks directly affect a firm's ability to commercialize innovations, not only by helping in recognizing market opportunities for innovations, but also by helping in accessing resources required for manufacturing and distribution. In addition, the relationships that networks have with absorptive capacity and ambidexterity are moderated by environmental turbulence, munificence and complexity.

Our model suggests that for a firm to remain competitive it must do a number of things well. First, creation of an environment that fosters knowledge sharing and diffusion of knowledge through deployment of a number of internal mechanisms is crucial. Second, alliances with external partners are needed to access and direct resources towards commercialization of innovations. Both these activities lead to an ability to increase absorptive capacity, and the ability to explore new areas and exploit current opportunities. Third, alliances can include innovation engines such universities and research organizations, and leveraging these relationships can increase absorptive capacity. Lastly, an understanding of nature of the environment within which the firm operates and how that affect the ability to commercialize innovations also is crucial for success.

Before these or any other lessons can be acted up on with confidence, much research remains to be done. Each of the propositions offered in this paper opens doors for empirical research and further theoretical understanding. Surveys or secondary data sets can be used to conduct positivist research in order to test the propositions, while detailed case studies of firms in specific industries under given circumstances may aid in attaining an interpretivist understanding of commercialization of innovation that is deeper, richer, and more detailed.

All work has limitations. In this work we treated ambidexterity and absorptive capacity as two distinctive constructs with no overlap. There could be a cause and effect relationships between the two constructs, but for theoretical simplicity we are treated them as distinct. Also, this paper does not distinguish between the consequences of inter-organizational networks, intra-organizational networks, or networks between firms and innovation engines. Again, to keep the model manageable, we have treated networks as one entity. Future research should be geared towards − (a) showing how each type of network contributes towards commercialization of innovations, ambidexterity and absorptive capacity, (b) how each type of network relates to the others, and (c) how absorptive capacity and ambidexterity relate to each other.

We have posed a timely research question, and provided a theoretical model to address the question. While the thinking in this work is of relevance to practice, our intent has been to generate a model that acts as a catalyst for scholars to extend existing research on the commercialization process and, thus, create an even deeper understanding of this crucial business activity.

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Table 1. Definitions of the Constructs

Construct name	Type	Definition
Ability to Commercialize Innovations	Dependent Variable	A firm's capacity to bring a product or service into a market and reach the mainstream of the market beyond the initial adopters. There are three aspects to our definition (a) recognize a market for an innovation, (b) develop the products and (c) sell/distribute the product. While the last two can be outsourced, the first one cannot.
Networks and Resources	Independent Variable	The collective of structures, collaboration, and norms within and between organizations, and between organizations and innovation engines.
Ambidexterity	Mediator	The property of an organization to balance activities of exploration and exploitation.
Absorptive Capacity	Mediator	The limit to the rate at which a firm can absorb scientific or technological information and/or a limit to the quantity of such information that can be absorbed.
Environmental Turbulence	Moderator	The level of uncertainty and unpredictability in the firm's environment
Environmental Munificence	Moderator	The extent to which a firms' environment supports continued and sustained growth.
Environmental Complexity	Moderator	The extent to which a firm's environment has a wide range of firms in its industry, high number of suppliers and customers, and/or a high range of products of services.

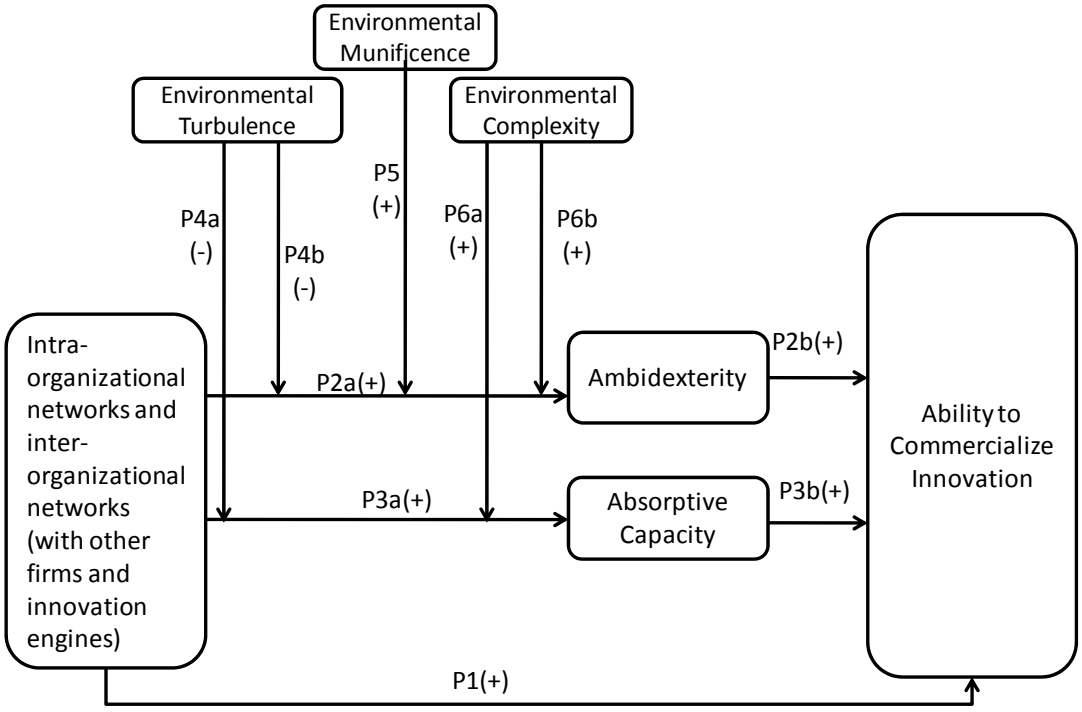

Figure1. An Integrative Model for Commercialization of innovation