

Essays on Dynamic Capabilities: The Role of Intellectual
Human Capital on Firm Innovation

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Abstract:

Following the dynamic capabilities perspective, I suggest that antecedents to innovation can be found at the individual, firm, and network level. Accordingly, I advance a set of hypotheses to simultaneously assess the direct effects of antecedents at the individual, firm, and network level on innovation output. I then investigate whether a firm's antecedents to innovation lie across different levels. I juxtapose the hypothesis that the individual, firm, and network-level antecedents to innovation are substitutes versus the proposition that these innovation mechanisms are complements. I test my multi-level theoretical model using an unusually comprehensive and detailed panel dataset that documents the innovation attempts of global pharmaceutical companies within biotechnology over a 22-year time period (1980-2001). I find evidence that the antecedents to innovation lie across different levels of analysis and can have compensating or reinforcing effects on firm-level innovative output.

Dissertation Summary:

The recent extension of the resource-based view into dynamic markets provides a new perspective for analyzing how firms develop new capabilities to cope with shifting markets (Teece, Pisano, & Sheun, 1997). This research reveals that a firm's ability to 'integrate, build, and reconfigure internal and external competencies to address rapidly changing environments' lies at the center of its ability to learn and innovate and thus realize potential competitive advantages (Teece et al., 1997: 516). Thus, these 'dynamic capabilities' facilitate not only the ability of an organization to recognize a potential technological paradigm shift but also to adapt to it through innovation (Cohen & Levinthal, 1990; Hill & Rothaermel, 2003; Teece et al., 1997). An important issue that has preoccupied researchers and practitioners is where the locus of such knowledge, or 'Shumpeterian' capital, resides. The purpose of this dissertation is to shed light on this issue, by investigating the nature of the mechanisms firms employ to develop dynamic capabilities.

The key aspect of this construct is that it extends the resource-based view ("RBV") of the firm beyond consideration of simple resource existence, to the more complex issues associated with resource emergence. Thus, while the RBV focuses on how organizations select between appropriate resources, dynamic capabilities emphasizes resource development and renewal. While this difference presents organizational researchers with unique opportunities to better understand resource emergence, it also presents significant theoretical and methodological challenges that have resulted in many questioning the efficacy of the construct. Although the construct of dynamic capabilities has its origins in the RBV, its focus on emergence requires that researchers move beyond the simple selection models associated with the RBV.

Research that utilizes this 'RBV lens', by investigating an organization's choice between appropriate dynamic capabilities, is inevitably plagued by endogeneity.

In this dissertation I suggest that while consideration of selection is important, of import is not the choice between capabilities, but rather the choice between the different mechanisms that organizations employ to develop and change these capabilities. This distinction is important because it allows for the analysis of the emergent properties of dynamic capabilities. By considering the relationship between these choices I hope to both refine as well as extend our understanding of the construct of dynamic capabilities.

Research investigating this issue has revealed that the relevant knowledge for innovation can be located either be developed internally or accessed from external network connections. The choice between internal and external technological sourcing is particularly relevant when the firm is attempting to adapt to a new technological paradigm, because of the significant investment required to develop or acquire knowledge that is new to the firm. Specifically, firms wishing to innovate in a new technological paradigm use their *internal* human capital asset base to develop key firm-level researching capabilities and thereby increase the efficiency of its *external* networking efforts. This five-chapter dissertation contributes to our understanding of the antecedents to dynamic capability formation by exploring this interaction between the internal and external mechanisms firms employ to develop these capabilities. Each of the chapters highlights the importance of not only considering the heterogeneity of a firm's intellectual capital but also the interaction between this resource and the other mechanisms firm's can utilize, including spending on research and development, undertaking acquisitions, and forming strategic alliances.

A major contribution of my dissertation is that it illustrates the need to incorporate the individual level of analysis when investigating the antecedents of dynamic capabilities. This need is best revealed by shifting the focus of analysis temporarily

away from the concrete investigation of firm activity to the abstract analysis of how the dynamic capabilities construct is positioned within the literature. As mentioned above, to date the construct of dynamic capabilities has been conceptualized as an extension of the resource-based view of the firm (RBV) (Eisenhardt & Martin, 2000; Teece et al., 1997). Central to RBV is the notion that resources are heterogeneously distributed among organizations (Barney, 1991). Additionally, researchers have theorized that the possession of certain valuable, rare, inimitable, and non-substitutable resources can allow a firm to achieve a competitive advantage. The theoretical focus of RBV researchers, therefore, has traditionally been at the resource level (Barney, 2001; Teece et al., 1997). In contrast, conceptual research on dynamic capabilities has primarily focused at the process or routine level of analysis. Of concern is that these firm processes and routines are themselves a collective action, representing combinations of firm resources (Nelson & Winter, 1982).

To specify a theory solely at the collective or group level, as it is been presented in the conceptual work on dynamic capabilities to date, researchers have implicitly assumed that the individual members of the group are sufficiently similar with respect to the construct in question. Such uni-level analysis makes two key assumptions: (1) that significant variance exists at the focal level of analysis, while other levels of analysis are assumed to be homogeneous, and (2) that the focal level of analysis is more or less independent from other levels of analysis (Felin & Foss, 2005; Felin & Hesterly, 2007). As such, heterogeneity among individual group members is not taken into consideration, because a single value or characteristic is considered sufficient to describe the group (Klein, Dansereau, & Hall, 1994). By investigating routines such as R&D, alliance formation, or search processes *solely* at the process or collective level of analysis, dynamic capabilities researchers are inherently making the assumption that the resources that comprise these processes must be more or less homogeneous (Felin &

Foss, 2005). This assumption, however, contradicts the central premise of the resource-based view that valuable and rare resources are distributed heterogeneously across firms. Further, individual employees are often the very resources that contribute to a firm's competitive advantage (Coff, 1997; Tushman & Katz, 1980; Zucker, Darby, & Armstrong, 2002a).

Thus, it is problematic to ignore the specific role individuals play because firm innovative performance is at least partially a function of the value of its human capital (Hitt, Bierman, Shimizu, & Kochhar, 2001). My dissertation builds on the framework of Crossan, Lane, and White (1999) which describes the process through which organizations process knowledge and thus, learn. The authors suggest that individuals serve not only to facilitate the creation of tacit knowledge, but also aid in the process of intuiting the links between the sources of such knowledge. The creation and ownership of such tacit knowledge is especially crucial in high-velocity environments (Eisenhardt & Martin, 2000).

The premise that individuals are critical to the formation of dynamic capabilities has not gone unchallenged, however. For example, Levitt and March (1988: 320) claim that key routines are "independent of the individual actors who execute them." Similarly, Cohen and Levinthal (1990) claim that an organization's ability to acquire, assimilate, and apply external knowledge develops cumulatively, and thus tends to be path dependent. These abilities, referred to as a firm's absorptive capacity, tend to build on a firm's prior investments in its members' individual absorptive capacities (Lane, Koka, & Pathak, 2006). Therefore, while dynamic capabilities may not be vested in a single individual, a key component of their effectiveness, absorptive capacity, does depend upon the actions of individuals. Adding complexity to the issue, prior research has demonstrated that not all individuals are equally important in a firm's innovation efforts (Lacetera, Cockburn, and Henderson, 2004; Rothaermel and Hess, 2007; Zucker,

Darby, and Torero, 2002b). Explicating this heterogeneity is critical to the understanding of the roles individuals play in facilitating organizational innovation. Specifically, different individuals facilitate specific organizational capacities associated with the innovation process. Following Crossan et al. (1999), I suggest that these capacities are related to the organization's ability to intuit and interpret new knowledge, and in turn, allow organizations to identify and exploit new opportunities within their respective environments.

SUMMARY OF THE INDIVIDUAL CHAPTERS

This dissertation attempts to contribute to our understanding of the antecedents to dynamic capability formation by exploring the interaction between the internal and external mechanisms firms employ to develop these capabilities. Each of the three chapters highlights the importance of not only considering the heterogeneity of a firm's intellectual capital but also the interaction between this resource and the other mechanisms firms can utilize; including spending on research and development, undertaking acquisitions, and forming strategic alliances.

Chapter 1 of the dissertation serves to introduce and synthesize the major themes and contributions of my dissertation. In Chapter 2, I develop a multi-level framework of dynamic capabilities formation. By analyzing the role individuals play in a firm's ongoing innovation efforts, I illustrate not only the process through which dynamic capabilities are formed but also how they relate to a firm's strategy-making process. In particular, I suggest that there are three stages in the process of dynamic capabilities formation, through which the firm identifies, acquires, codifies, and eventually commercializes new knowledge. My analysis highlights the role key employees play in moderating the effectiveness of the developed capabilities and the role average employees play in mediating their existence.

In Chapter 3 of my dissertation I turn to empirically examine, more generally, the importance of not only considering the heterogeneity of the intellectual human capital, developed in chapter 2, but also the other mechanisms firms employ to access and assimilate knowledge that resides outside of the firm. Following the dynamic capabilities perspective, I suggest that antecedents to innovation can be found at the individual, firm, and network level. Accordingly, I advance a set of hypotheses to assess the effect of individual, firm, and network-level antecedents on innovation output. I then investigate whether a firm's antecedents to innovation lie across different levels. To accomplish this, I propose two competing hypotheses. I juxtapose the propositions that the individual, firm, and network-level antecedents to innovation are substitutes versus complements.

The fourth chapter of my dissertation examines several of the interesting findings of Chapter 3 in more detail, through the lens of a specific dynamic capability, ambidexterity. To this end, I develop and empirically test a contingency framework of ambidexterity across exploration and exploitation activities. While an exploration-exploitation lens has been applied to strategic alliances based on their strategic motivation, I propose that it can also be applied to a firm's intellectual human capital based on a bifurcation of "star" versus "staff scientists." Following a dynamic capabilities perspective, I suggest that antecedents to building these capabilities *within* the same activity (either indented for exploration or exploitation) compensate for one another, and thus are *substitutes*. Conversely, I hypothesize that different dynamic capability antecedents *across* exploration or exploitation activities positively reinforcing one another, and thus are *complements*. To empirically investigate the relationship between different antecedents to dynamic capabilities, I focus on the pharmaceutical firms' adaptation to biotechnology over a 30-year time period, 1974-2003. In general, I find support for the notion that building capabilities within the same activity compensate for one another, while ambidexterity across exploration and exploitation enhances a firm's

innovative performance. Finally, my dissertation concludes with Chapter 5, which again summarizes the major themes and contributions of my dissertation. In addition, I offer some limitations of the current study as well as areas of interest for future consideration.

The data utilized in the dissertation is an unusually comprehensive and detailed panel dataset that documents the innovation attempts of global pharmaceutical companies within the new biotechnology paradigm over a 23-year time period. In general, my extensive data collection process has produced fine-grained, longitudinal data on over 3,100 alliances, 3,500 new drug introductions, 36,000 biotechnology patents that have been cited 80,000 times, 147,000 non-biotechnology patents, 171,000 publishing scientists, 672,000 journal publications, and 9.9 million journal citations. I utilize the data to investigate the following model:

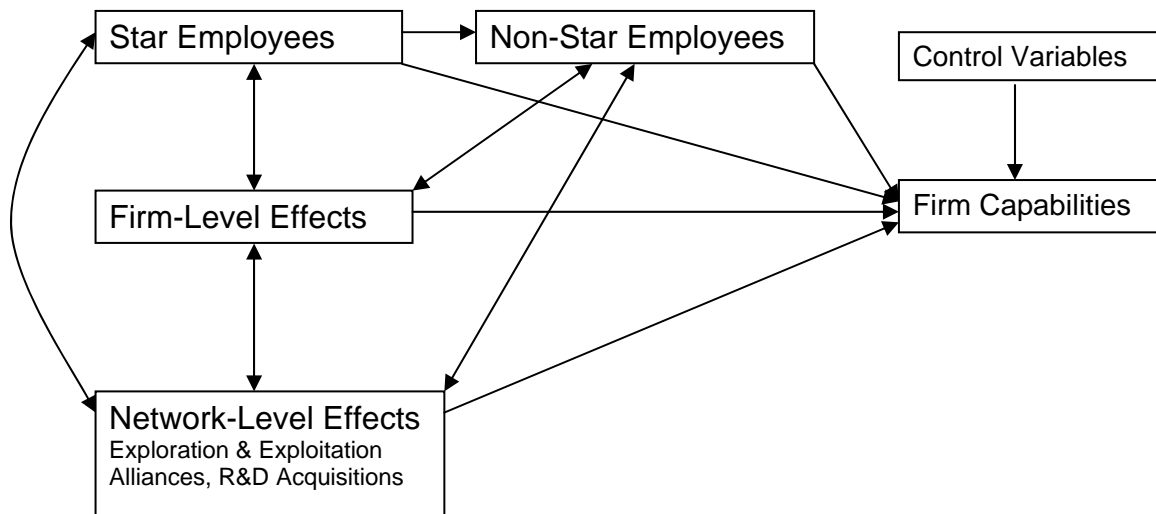


Figure 1.1: Model

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