



## ההשפעה של מעברי ידע על למידה ושינוי ארגוני

דניאל צבר

### Knowledge Stocks and Flows and Firm Technological Learning and Change

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#### תקציר

המחקר הבא מתמקד ביישום ובפיתוח של תיאוריות ארגוניות, הבוחנות את הגורמים ללמידה ולשינוי טכנולוגי. שתי שאלות עיקריות מנחות את המחקר שלי: (1) כיצד מעבר ידע באמצעות גיוס הון אנושי ושיתופי פעולה בין ארגונים, משפיע על למידה ושינוי המרקם הטכנולוגי של החברה? (2) כיצד המבנה החברתי וההון הטכנולוגי של החברה, משפיעים על יכולתה למנף ידע קיים וחדש כדי לקדם חדשנות ושינוי טכנולוגי? מסיכום המחקרים שלי עד היום, עולה כי שינוי ולמידה ארגוניים תלויים לא רק באיכות ובמקור הידע שעובר, אלא גם במאפיינים החברתיים והפלטפורמה הטכנולוגית הקיימת של החברה. בנוסף, מחקר יי מלמדים שהלימה גבוהה בין מקור הידע למבנה החברתי-טכנולוגי, מאפשרת לארגונים לצבור יתרון דינמי במירוץ לייצור חדשנות טכנולוגית.

#### Introduction

My research focuses on creating and testing organizational and strategic theories related to the micro-mechanisms that facilitate learning and technological change. It is guided by two inter-related research questions: 1) How does flow of knowledge across firm boundaries through various sources affect learning and change? 2) How do social and technological contexts within a firm affect the firm's ability to leverage its existing and new inflowing knowledge? Accordingly, the first branch of my research examines various sources of knowledge flow across firm boundaries: individual scientists, R&D alliances and the geographic locations. The second branch of research highlights the importance of social context in enabling full utilization of a firm's stocks and flows of human, social and intellectual capital.

Cumulatively, my research to date demonstrates that while the source and characteristics of knowledge inflows and outflows affect a company's opportunities for learning and development of new technology, our understanding of these relationships is

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incomplete without considering the firm's social context and technological characteristics. Additionally, in contrast to the existing theoretical effort to identify forces that encourage organizations to favor *incremental* changes through exploiting existing knowledge, my work opens up new avenues of understanding the mechanisms that facilitate *significant* technological transformations in organizations. I highlight the micro-mechanisms associated with human capital as a key driver of these transformations. This research provides the foundation for future integration of literatures on learning, knowledge-based view and resource dependence theory to address the intriguing question about: how do a firm's human, technological and social capitals interact to facilitate/hinder the development/transformation of the firm's technological capabilities?

#### **D) Knowledge flows across firm boundaries**

***Recruitment and technological repositioning.*** In the first article from my dissertation I examine how and under what conditions the recruitment of seasoned scientists enables the hiring firm to transform its portfolio of technological capabilities. Counter to prior work arguing the learning and change following mobility can occur when there is a great degree of knowledge overlap between hired scientists and the hiring firm, I argue and demonstrate that the recruitment of technologically distant scientists can increase a firm's potential to explore new opportunities. Furthermore, drawing on the literature on power and learning, I show that while recruitment of technologically distant scientists increases the likelihood that the hiring firm will reposition its technology significantly, the presence of prolific incumbent inventors reduces this effect. I explain this finding by arguing that because these incumbent inventors tend to control the firm's research agenda and its resources, they limit the ability of new hires to lead a new research agenda. Separately, the likelihood that a newly hired scientist creates a new research program increases when the firm has moderate levels of technological breadth but declines at very high or low levels. Companies with a narrow knowledge base have a limited understanding of new and unrelated sources of knowledge, so they may be less receptive to such proposals. In contrast, firms with a very broad knowledge base may experience knowledge overload when presented with access to new and different knowledge sources. Therefore, I conclude that to realize the full potential of its new hires, a firm's recruitment strategy must be aligned with its social and technological structure. This conclusion supports a major theme in strategy literature, namely, that strategy and structure interrelate. A firm's strategy helps determine which knowledge areas might be valuable if accessed through hiring. Conversely, existing

structures and processes constrain the knowledge that can be assimilated and applied and hence which strategies are feasible. Thus, to realize their potential, firms must align their organizational strategy with their social and technological structures. By focusing on the role of the social and technological context, this study contributes to our knowledge about how employees, at the technical level, promote or inhibit changes in the organization's capabilities (Tzabbar, 2009).

***Learning by hiring or hiring to avoid learning?*** In a second study, my co-authors and I challenge the "learning by hiring" literature by showing that what has previously been imputed as representing an organization's learning from recruited inventors is in fact due to the recruited inventors' citing their own pre-recruitment work. Building on the social network literature, we demonstrate that, to integrate and utilize a hired inventor's knowledge, incumbent inventors must be willing and able to share knowledge to promote mutual understanding. Specifically, we demonstrate two results. First, a hired employee does not offer a window onto all technological knowledge of her prior employer; rather, the hiring firm cites those former employer patents in which she was directly involved far more than patents in which she was not involved. Put differently, what might appear to be organizational learning by hiring may actually reflect hiring in lieu of learning. Second, mere access to new knowledge through hiring is insufficient for organizational learning; internalizing a new hire's knowledge also requires a high degree of collaboration among a firm's inventors. Together, these results cast new light on prior literature about accessing new information through personnel turnover. Whereas most of this literature views hiring as a mechanism of learning at the organizational level, our results indicate that such learning is limited in scope, occurs through newly-hired inventors' references to their own prior knowledge, and depends heavily on the degree of collaboration among the hiring firm's inventors. We conclude that unless an organization creates the social structures that facilitate the exchange of knowledge within and throughout the organization, such collaborations will not occur (Tzabbar, Silverman & Aharonson, 2015).

***Temporal effect of recruitment & R&D alliances.*** In three separate studies. In the first, my co-authors and I further examined recruitment in light of its effects on the utilization of the existing stock of a company's human capital. We found that that while the effect of scientist's recruitment and R&D alliances decay overtime. By implications we demonstrate that for firms to benefit from their existing human capital – that is, for a firm's incumbent inventors to remain productive, they need to continuously infuse new knowledge into the

company by hiring experienced talent. However, high degrees of human capital and social capital reduce the speed of new assets erosion. We conclude that the understanding of the impact of recruitment and alliance on innovative success is incomplete unless jointly considered with the level of existing stock of human capital and social capital (Al-Laham, Tzabbar & Amburgey, 2011).

In a follow-up study my co-authors and I consider the rate at which a firm can integrate externally acquired knowledge – a capability that is key to firms' sustainable competitive advantage. We study two contingency factors: the attributes of knowledge sources, including their familiarity and type, and firm-specific capabilities to absorb external knowledge, as reflected in prior experience forming R&D alliances and recruiting scientists from other firms. In comparing the moderating effect of firms' general and specific experience with recruitment and alliances we seek to resolve theoretical inconsistencies in the literature of absorptive capacity. Counter to prior research we found that the rate of knowledge integration is higher when scientists with distal knowledge are recruited than when an alliance is formed with a familiar partner. We attribute these findings to the fact that alliance and recruitment involve different underlying knowledge building processes. We further showed show that the rate depends not only on the type of knowledge accessed and the knowledge source but also the level of prior experience (i.e., knowledge stocks). Experience with successful prior R&D alliances increases the rate of knowledge integration, though general experience with recruitment has no such benefits for the rate of knowledge integration after the recruitment of a distal scientist. Our additional analysis reveals that a more specific type of prior experience, namely, with recruiting distal scientists, increases the rate of knowledge integration as we predicted. In other words, firms with greater general experience can leverage new sources of information better and more quickly than firms with specific experience. We concluded that development of general experience with recruitment and R&D alliances is more critical than specific experience in enhancing the speed of knowledge integration from various sources (Tzabbar, Aharonson & Amburgey, 2013).

Lastly, examining the effect of recruitment in the context of new ventures life cycle, Barak Aharonson and I show that the effect of recruitment on a firm's likelihood of creating successful innovation declines as time elapses since recruitment and that the duration of the effect decreases at a faster rate for firms in their early stages than for those in their adolescent years. We also establish that companies endowed with higher levels of intellectual capital experience an increase in the duration of the effect of recruitment on innovative success, but

this effect is stronger for early stage ventures with high levels of intellectual capital. The results provide stepping-stones for future theoretical and empirical work pertaining to recruitment and a firm's innovative success (Tzabbar & Aharonson, 2016; forthcoming).

***Inventor turnover and technological exploration and exploitation.*** In my most recent work in this sphere, Rebecca Kehoe and I have shifted our attention to outward mobility, examining the dual effects of the departure of star scientists from a company. Whereas the growing body of research on employees' turnover has focused on the rate and degree of turnover, suggesting that such changes deplete the organization's social and intellectual capital, we maintain that a more nuanced view is warranted, one that examines who leaves the company. We find that while the departure of a star inventor disrupts existing innovative routines and reduces the exploitation of his or her unique knowledge, this "shock" creates opportunities for the firm to search beyond its existing knowledge boundaries, thereby increasing its exploration. However, the departing star's degree of engagement in a firm's innovative effort strengthens the negative effect and weakens the positive effect of the star's leaving on exploitation and exploration in the firm, respectively. On the other hand, a departing star's centrality in the social network within the firm strengthens the negative effect of the star's exit on exploitation but increases the positive effect of his or her leaving on exploration, thereby fostering opportunities for technological renewal. Therefore, we conclude that the prognosis for firms losing star inventors may not always be dire. Our examination also adds to the thin literature on star inventors, which usually focuses on the star's direct and indirect impact on a firm's productivity (Tzabbar & Kehoe, 2014).

***Geographic dispersion as a source of knowledge flow.*** I examine geographic dispersion as another conduit through which a firm can tap into external sources of information. While extent research commonly underscores the challenges and poor social dynamics associated with geographically dispersed activities, Alex Vestal, my former PhD student, and I extent this research and examine such teams effect of novel innovation. The access to the diverse information that teams gain through the geographic dispersion of their members is argued to increase the likelihood that they will produce more novel innovations. Although valuable, such dispersion also increases communication and coordination costs, making it difficult to utilize this information in developing new knowledge. To resolve this theoretical dilemma, we investigate the conditions that alter the effect of team members' geographic dispersion on innovative novelty. We show that as the geographic dispersion of team member's increases, the propensity to generate novel innovation is curvilinear:

increases and then decreases. We also establish that the effect of geographic dispersion on the novelty of a team's innovation depends on the team's social environment. The greater the relational strength among research and development team members, the stronger the initial positive effect of their geographic dispersion, and the weaker the negative effect at higher levels of dispersion. Furthermore, the greater the status asymmetry in a team, the weaker the initial positive effect of geographic dispersion, and the stronger the negative effect at high levels of dispersion. These results offer insights into how aligning an R&D team's geographic composition with its social attributes enhances its members' ability to leverage their diverse knowledge to generate novel innovations (Tzabbar & Vestal, 2015).

## **II) Context facilitating the utilization of the stock and flow of human capital**

*Star inventors, power asymmetries and firm innovation.* A major theme in my research is the role that star inventors, as inherently powerful organizational actors, play in facilitating learning and the performance outcomes of their colleagues (Tzabbar, 2009; Tzabbar & Vestal, 2015). More recently, Rebecca Kehoe and I have investigated the effect of a star inventor on a company's innovative performance by asking: Do star inventors enhance or constrain the innovative performance of an organization? Drawing from resource dependence theory (power imbalance and mutual dependence), we establish that while stars have a positive effect on the firm's innovative productivity, both directly and indirectly. However, their presence constrains the emergence of other innovative leaders in an organization. As such our results highlight the duality of the effects that star employees have on their firm's performance. Furthermore, our arguments and findings further demonstrate that the differential effects that stars have on their firms' research environments—based on their collaborative strength with colleagues and the breadth of stars' expertise—are important determinants of the effects stars have on their firms' innovative outcomes. As expected, relative to stars who collaborate rarely or not at all, the presence of stars with high collaborative strength improves both the productivity and innovative leadership opportunities of other scientists in a firm. Furthermore, our results indicate that a firm's innovative productivity and innovative leadership increase with greater breadth in a star's expertise (although the positive effect of expertise breadth on productivity diminishes at very high levels of breadth in expertise). Moreover, we show that both innovative productivity and innovative leadership are highest in firms employing a star who has broad expertise and high collaborative strength. The results thus reinforce an important theme in the strategic human capital literature—namely, that the value of human capital is not absolute, but rather

depends on how it is leveraged in a firm. This study underscores that the effects of star scientists vary based on their internal position in a firm's workflow and on the social interdependencies associated with them. By integrating human capital theory with the resource dependence literature, we offer insights for cross-disciplinary assessments of the role that high-status individuals play in the development of a firm's human capital and sustained competitive advantage. (Kehoe & Tzabbar, 2015).

***Complementarity and supplementarity of human capital.*** Building on research dealing with knowledge stocks and flows, my co-authors and I introduce the notion of knowledge complementarities between three knowledge stocks and consider the joint effect of these knowledge stocks on innovative success to address their dynamic relationships. We maintain that the impact of one knowledge stock may depend on not just the level of that stock but also the level of other stocks; their combination can explain performance differences between firms. We further argue that the value of one knowledge stock increases or decreases in combination with other knowledge stocks. To test our arguments, we examine the extent to which other stocks of knowledge complement or supplement a firm's human capital, as reflected by number of prolific inventors. We show that, in the context of innovative productivity, human capital can substitute for both intellectual and collaborative capital, whereas intellectual capital complements and enhances collaborative capital. We conclude that a firm can be viewed as consisting of a nexus of resources and capabilities in which the configuration of human capital along with other knowledge stocks can explain why some firms benefit more from their human capital than others. Viewing knowledge complementarities through such a lens gives rise to systems effects and explains when the whole is bigger (or smaller) than the sum of its parts. (Tzabbar, Aharonson, Amburgey & Al-Laham, 2008).

***CEO power, Star scientists and firm innovative direction.*** In a new stream of research I investigate the dynamics associated with multiple star employees. Following March's (1991) seminal work, Srikanth Paruchuri and I examine the interplay between key personnel such as CEOs making explicit and implicit choices, respectively, and a firm's exploration. We advance the notion that the aptitude of each of these players for exploring new technological domains is critical and, thus, should be examined jointly in exploring the internal factors facilitating exploration. We hypothesize and document that the number of prolific inventors in a firm is negatively associated with the firm's technological exploration. We also demonstrate that this relationship is weaker when an outsider succeeds as CEO than

when an insider becomes CEO. Examining the joint effect of both key players—prolific inventors and their CEOs—is important given the interdependent nature of their relationship in the process of innovation (Tzabbar & Paruchuri, Under review).

***Executive power, VC funding and innovative novelty.*** I have also extended the above research by examining various sources of a CEO's power. In a study of how the dynamic between venture capital and CEOs shapes entrepreneurial firms' innovative novelty, Dennis Park and I find that structurally powerful CEOs intensify the positive effect of VC funding on innovation novelty in the early stages of a venture. Moreover, such CEOs attenuate the negative effect of VC funding on innovation novelty in the late stages of the venture. In contrast, CEOs whose power derives from their innovation-related expertise typically seek a more balanced approach to innovation. Such CEOs attenuate both the positive effect of VC funding on innovation novelty in the early stages of a venture and the negative effect of VC funding on innovation novelty in the late stages of the venture. This study sheds new light on the VC-CEO relationship and provides insights into how the incentives and abilities of mutually dependent actors in new ventures affect the innovation outcomes of these ventures (Tzabbar & Park, Forthcoming).

***Founding team human capital and Founder-CEO duality.*** In a study examining the effect of the founding team's human capital on a firm's innovation, Jaclyn Margolis, a former PhD student, and I establish that contrary to common wisdom, the positive effect of this asset is stronger in the growth stage than the early stages of a startup. We also show that these relationships are moderated by the CEO's power, as reflected by founder-CEO duality, which increases the positive effect of the founding team's human capital in the early stage. However, at a later stage, founder-CEO duality reduces the impact of the founding team's human capital. Therefore, to fully appreciate the effect of human capital on a venture's success in innovation, we must consider both the firm's stage of life and its decision-making structure (Tzabbar & Margolis, Under review).

### ***Summary of Research and Future Plans***

My research highlights that while access to external sources of information through recruitment, R&D alliances and geographic location, power asymmetries and social networks are critical mechanisms that affect the ability, motivation and opportunities for knowledge sharing and learning within and between organizations. Moving forward, I plan to continue to focus on the intersection of strategic human capital, technology innovation

and entrepreneurship at various levels of analysis. In addition to continued large-sample statistical research, I am currently involved in more fieldwork focusing on the mechanisms that underlie knowledge flows within and across individuals, teams and organizations.

### References

- Al-Laham, A., Tzabbar, D., & Amburgey, T. L. 2011. The dynamics of knowledge stocks and knowledge flows: Examining the consequences of knowledge exploration and exploitation in biotechnology. *Industrial & Corporate Change*, 20(2): 555-583.
- Kehoe, R. & Tzabbar, D. 2015. Lighting the way or stealing the shine? An examination of the duality in star scientists effects on firm innovative performance. *Strategic Management Journal*, 36:709-727.
- Park, H. D., & Tzabbar, D. How venture capitalists influence innovation novelty at different venture stages. *Organization Science* (3rd revision).
- Paruchuri, S., & Tzabbar, D. Prolific inventors, CEO succession and firms' technological exploration. *Strategic Management Journal* (Under review).
- Tzabbar, D. 2009. When does scientist mobility affect technological repositioning? *Academy of Management Journal*, 52(5): 873-896.
- Tzabbar, D., Aharonson, B. S., When does scientist recruitment effect innovative success: Adding a temporal dimension to the study of employee mobility. *Journal of Management Studies*, (Under review).
- Tzabbar, D., Aharonson, B. S., Amburgey, T. L., & Al-Laham, A. 2008. When is the whole bigger than the sum of its parts? The effects of bundled knowledge stocks on innovative success. *Strategic Organization*, 6(4): 375–406.
- Tzabbar, D., Aharonson, S. B., & Amburgey, T. L. 2013. When does tapping external sources of knowledge result in knowledge integration? *Research Policy*, 42(2): 481-494.
- Tzabbar, D., & Kehoe, R. 2014. Can opportunity emerge from disarray? An examination of exploration and exploitation following star scientist turnover. *Journal of Management*, 40(2): 449-482.

Tzabbar, D. & Margolis, J. Beyond startup stage: The moderating effects of a new venture's life-stage and founder-CEO duality on its founding team's human capital and technological impact. *Organization Science*. (2nd revision).

Tzabbar, D., Silverman, B., & Aharonson, B. S. 2015. Learning by hiring or hiring to avoid learning. *Journal of Managerial Psychology*, 30(15):550-564.

Tzabbar, D. & Vestal, A. 2015. Bridging the social chasm in geographically distributed R&D teams: The moderating effects of relational strength and status asymmetry on the novelty of team innovation. *Organization Science*, 26(3): 811-829.