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Essays on the Formal and Informal Organization of Human Capital

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For Mom and Dad,

whose example, love, and encouragement made this dissertation possible.

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS iii

LIST OF TABLES v

LIST OF FIGURES vi

ABSTRACT vii

CHAPTER 1: INTRODUCTION 1

CHAPTER 2: WHAT MAKES KNOWLEDGE MOVE AROUND THE LAB? AUTONOMY AND INCENTIVES

- 2.1 Introduction 5
- 2.2 Organization, Knowledge, And Incentives In R&D 8
- 2.3 Organizing And Managing R&D At *Alpha Pharmaceuticals* 13
- 2.4 Modelling PRHC, Autonomy, and Knowledge Interactions 16
- 2.5 Data and Empirical Methods 20
- 2.6 Results 28
- 2.7 Discussion and Conclusion 40
- 2.8 References 44

CHAPTER 3: INSTRUMENTAL AND AFFECTIVE TIES WITHIN THE LAB: THE IMPACT OF INFORMAL CLIQUES ON INNOVATIVE PRODUCTIVITY

- 3.1 Introduction 49
- 3.2 Tie Content: Knowledge and Friendship Ties 52
- 3.3 Tie Structure: Embedded Triads (or Cliques) 56
- 3.4 Network Position: Brokering Cliques 62
- 3.5 Data and Empirical Methods 65
- 3.6 Results 72
- 3.7 Discussion and Conclusion 79
- 3.8 References 83

CHAPTER 4: WHEN HIRING, IS IT ABOUT HOW THE SHOE FITS?

- 4.1 Introduction 88
- 4.2 The Fit of Capitals 93
- 4.3 The Strategic Implications of Human Capital Fit and Social Capital Fit 98
- 4.4 The Overarching Framework: Strategizing by Hiring 105
- 4.5 Discussion and Conclusion 111
- 4.6 References 119

CHAPTER 5: CONCLUSIONS 129

LIST OF TABLES

Table 2.1 Summary Statistics for the Individual Level Sample 23

Table 2.2 Summary Statistics for the Dyad Level Sample 23

Table 2.3 Correlation Matrix for the Individual Level Sample 24

Table 2.4 Correlation Matrix for the Dyad Level Sample 24

Table 2.5 Tobit and OLS Estimations for Autonomy 30

Table 2.6 GLM Estimations Proportion of Non-related Knowledge Interactions (Full) 34

Table 2.7 GLM Estimations Proportion of Non-related Knowledge Interactions (Sci.) 35

Table 2.8 Logit Estimations Probability of a Non-related Knowledge Interaction (Full) 36

Table 2.9 Logit Estimations Probability of a Non-related Knowledge Interaction (Sci.) 38

Table 3.1 Descriptive Statistics and Correlations 72

Table 3.2 Negative Binomial Estimations of Patent Applications 74

Table 3.3 Different Model Specifications 77

LIST OF FIGURES

Figure 2.1 The Choice between Related and Unrelated Knowledge 8

Figure 2.2 The Relation between Autonomy and PRHC (Raw Data) 29

Figure 2.3 Marginal Effects of Autonomy (Full Sample) 37

Figure 2.4 Marginal Effects of PRHC (Full Sample) 37

Figure 2.5 Marginal Effects of Autonomy (Scientists) 39

Figure 2.6 Marginal Effects of PRHC (Scientists) 39

Figure 3.1 Instrumental-Based and Affect-Based Cliques 57

Figure 3.2 The Scientific Knowledge Network versus the Friendship Network 69

Figure 3.3 Dependent Variable Distribution Fit 72

Figure 3.4 Predictive Margins of Friendship Clique on Knowledge Clique 75

Figure 3.5 Average Marginal Effects of Friendship Clique on Knowledge Clique 75

Figure 4.1 Human Capital and Social Capital relative to the Firm 92

Figure 4.2 Human Capital Fit 96

Figure 4.3 Social Capital Fit 98

Figure 4.4 Strategies Based on Human Capital Fit and Social Capital Fit 106

ABSTRACT

This dissertation examines how organizations engaged in scientific and technological innovation can influence and benefit from the multiple informal interactions and relationships amongst their knowledge workers. Two studies include empirical analyses using unique data from the corporate R&D lab of a global pharmaceutical company and one study is conceptual. In the first study, I investigate how *autonomy* and *project-relevant human capital* (PRHC) influence the knowledge individuals acquire through their *informal interactions*: *project-related knowledge* and *project-unrelated knowledge*. I find non-linear relationships between autonomy, PRHC, and unrelated knowledge, suggesting that autonomy and PRHC affect the relative benefits workers derive from acquiring either type of knowledge through their interactions; thus influencing the informal organization of knowledge within the firm. After focusing on the influence of formal organizational aspects on informal relations, the second study considers the *network content, network structure,* and *network position* of individuals and their *innovative performance*. I examine how *instrumental* and *affective informal cliques* affect an individual's ability to generate innovative outcomes. I find that independently, both types of cliques are positive for innovation, but I also find that simultaneous involvement in both cliques is negatively related to innovation; suggesting the need to account for network content, structure, and position to better understand the relationship between networks and innovation. In the third study, I develop a conceptual framework that considers two key dimensions that can inform hiring decisions: *Human Capital Fit* and *Social Capital Fit*. I propose that organizations can pursue different goals by making strategic tradeoffs between these two dimensions. Through four hiring strategies, organizations can achieve knowledge specialization/diversification and/or social expansion/embeddedness, conditions that eventually impact innovation capabilities.

CHAPTER I

INTRODUCTION

Human capital is perhaps the most important determinant of firms' success. The study of human capital management, historically rooted in the tradition of economics, is typically an effort to understand why some individuals can create more value for the organization than others, considering human capital as an attribute of individual-level human assets (i.e. knowledge, skills, and abilities) that can be merely aggregated at different levels. Most recently, strategic human capital scholars are challenging the traditional focus on the value of a specific individual and the simple aggregation of individual assets as the assumption that human capital contributions are equal at all levels may be too simplistic and may incorrectly imply a compositional model of human capital value creation that ignores key processes though which value is created. This important concern calls for more attention on the relationships and interactions among individuals, as these intermediate actions can provide a better understanding of how managers can increase the effectiveness of human capital and generate greater benefits for the organization. The numerous relationships and interactions by which workers exchange diverse resources, and the value that emerges from them, is an informal organizational element that has been previously studied in conjunction with human capital and yet, the link between these two types of capital, particularly when considering them from the firm's strategic perspective, remains under theorized. More importantly, the implications for the effective management of these capitals have not been fully explored.

In this dissertation, I take the stance that a comprehensive understanding of human capital management needs to consider the equally relevant yet more complex collective and informal organizational elements that eventually play a crucial role in how organizations can create value from their workers. In general, I delve into this issue by taking two different perspectives: (1) I consider individual capital not in absolute terms but relative to a specific level of organization (project level and firm level) and examine the effect of formal managerial decisions at these specific levels of organization (delegation at project level and hiring at firm level) on individual informal actions (knowledge acquired through interactions) and potential organizational outcomes; and (2) I examine the effect of a specific informal network configuration (embedded triadic relationships) and its relational content (instrumental or affective) on individuals' innovative productivity (patenting).

Human capital and the diverse interactions created, sustained, and activated among individuals play a pivotal role in knowledge processes and innovation within firms, which are the two main drivers of competitive advantage in knowledge-intensive contexts. Thus, I am concerned about the innovative behaviors and outcomes of knowledge workers in knowledge-intensive industries. My theoretical foundations are human capital theory, organization theory, and network theory, and I specifically follow and contribute to two streams of research: strategic human capital management, and the interplay between formal and informal organization. First, motivating human capital in knowledge-intensive activities is a serious managerial challenge due to knowledge workers´ peculiar motives and the fuzzy link between rewards and actions/performance. Second, organizations are conformed by formal and informal elements that simultaneously exist and interact, and while the formal elements result from firm's motives the informal elements result from conscious agency by workers. I conducted two empirical studies using various sources of unique primary and secondary data from the corporate R&D center of a global pharmaceutical company headquartered in Europe (Chapter II and III), and I developed a theoretical framework from which I derive several propositions (Chapter IV).

In Chapter II, I investigate how the organization of innovation and the management of human capital influence workers' choices concerning the knowledge they acquire through their *interactions*. The assignment of people into projects determines the fit between an individual's human capital (knowledge, skills, and abilities) and a given project, i.e. *project-relevant human capital* (PRHC). Delegation decisions within the project set an individual's degree of *Autonomy*, i.e. freedom to decide on scheduling working time and selecting tasks, approaches, or problems. The analysis centers on the effect of autonomy and PRHC on workers´ choice between acquiring knowledge that concerns their formally assigned projects (this refers to *project-related knowledge*) implying that knowledge remains within project domains; or knowledge that concerns other projects within the lab (this refers to *project-unrelated knowledge*), implying that knowledge moves between project domains. While in this study I look into how formal organizational design and human capital management decisions affect informal actions, in the second study I focus on how informal structures influence individual performance. In Chapter III, I study how a specific network configuration (embedded triadic relationships) referred to as *informal cliques* and its relational content (affective or instrumental) affect individual's innovative performance. In particular, I distinguish between instrumental and affective (non-instrumental) cliques and posit that involvement in these informal groups has direct and interacting effects on individuals' innovative productivity. Chapter II and III provide insights regarding the formal and informal organization of human capital within the firm. In the final chapter, I take one step back and consider the origin of human capital management and the decision that "adjusts" the human capital composition of the firm: the *decision to hire* employees. In Chapter IV, I develop a conceptual framework based on the concepts of *Human Capital Fit* and *Social Capital Fit*, two key dimensions that can jointly inform hiring decisions. The idea behind these two constructs is that the degree of correspondence (matching) and/or mutual reinforcement (complementarity) between an individual's human/social capital and the organization's human/social capital structure can lead to four hiring strategies that can aid the firm to pursue different goals by balancing their needs for knowledge specialization/diversification and social expansion/embeddedness.

I intend to contribute to strategic human capital research, to the renewed interest in the interplay between formal and informal organization, and to network theory. First, by taking into consideration the importance of interactions among workers and how managers can influence and benefit from these interactions, I assertively bring an interpersonal dimension into the more traditional individually-oriented strategic human capital inquiry. Additionally, I complement this approach with a strategic perspective that considers human capital together with relationships and interactions, both relative to a specific level of the firm (project level and firm level). Second, by studying how organizational design choices and managerial decisions affect informal actions and structures, I advance our understanding of how the formal organization of activities influences the informal social structure of the firm. Third, consistent with recent studies, I challenge the belief that instrumental relational content and weak/sparse/bridging ties are the primarily drivers of individuals' ability to generate innovations, and provide evidence that can help us refine our current thinking about the relationship between relational content, network structure, network position and innovation. Lastly, the general framework and ideas developed in this dissertation have the potential to inform agency and tie formation, a core issue in network research with current and important implications for the design of organizational networks.

CHAPTER II

WHAT MAKES KNOWLEDGE MOVE AROUND THE LAB? AUTONOMY AND INCENTIVES

Abstract

The interactions among actors involved in research activities affect the knowledge dynamics within the firm and thus eventually determine innovation. These interactions are shaped by organizational design choices (firm level) and managerial choices (project level), but ultimately, they result from investments of time and effort by scientists and inventors, reflecting their distinct preferences. To investigate these processes, this study relies on a unique, project-level data set gathered from the corporate R&D lab of a global pharmaceutical company. I theoretically analyze and provide evidence of (nonlinear) relationships among the fit of knowledge workers with their formally assigned projects, the autonomy granted to these actors, and their interactions within the R&D lab. The theoretical and empirical investigation reveals nuanced links among the firm, project, and individual level of analysis, suggesting new implications for the organization of R&D and the management of human capital.

Keywords: R&D; autonomy; project; knowledge interactions; human capital.

2.1 INTRODUCTION

In knowledge-intensive contexts, employees contribute to firms' success by providing their own human capital and exchanging their knowledge and ideas with others, often through informal interactions (Ederer, 2013; Grigoriou & Rothaermel, 2014; Wright, Coff, & Moliterno, 2014). The way people mobilize their knowledge, whether within the same or across different domains, affects how knowledge flows throughout an organization. Knowledge mobilization is functional for specialization within domains, but knowledge exchanges tend to be more useful for knowledge diffusion across domains, in that they create opportunities for knowledge recombination (Fleming, 2001) and enhance the firm's ability to exploit varied information (Cohen & Levinthal, 1990; Grigoriou & Rothaermel, 2017). These processes in turn are critical for innovative performance and competitive advantage (Henderson & Cockburn, 1994, 1996), yet we have limited understanding of how and why they happen, as well as how firms can best exploit them. With this study, I propose that aspects related to organizational design and human capital management may have important influences on these processes.

For example, industrial R&D is formally organized around projects intended to solve specific problems (Brown & Eisenhardt, 1995), and scientists and inventors involved in these projects are expected to integrate their knowledge and expertise to tackle these problems. But beyond addressing the specific problem and generating knowledge idiosyncratic to the project (Henderson & Cockburn, 1994), their informal interactions also might support knowledge diffusion across knowledge boundaries. Thus, knowledge flow processes do not simply follow formal organizational boundaries, nor can they be planned and imposed by management; instead, they result from scientists' and inventors' investments of their time and effort (Gargiulo, Ertug, & Galunic, 2009; Perlow, 1999), driven by their personal motives (Ahuja, Soda, & Zaheer, 2012; Sauermann & Cohen, 2010). Therefore, beyond motivating performance, managers of these highly qualified knowledge workers, with their vast human capital, must also consider how these individual employees interact (Nyberg & Wright, 2015). This challenging endeavor for the internal organization of R&D (Arora, Belenzon, & Rios, 2014) and the strategic management of human capital (Nyberg, Moliterno, Hale, & Lepak, 2014) remains, theoretically and empirically, insufficiently explored.

In this study, I consider how interactions that trigger different patterns of knowledge flows within the firm relate to key aspects of organizational design and human capital management. I have assembled a unique, project-level data set from the corporate R&D lab of a global, science-based company, such that I can map the type of knowledge flowing through interactions among individual knowledge workers, identify key aspects of the formal organization of projects and the management of human capital, and establish robust empirical relationships. Furthermore, to delve into this empirical setting, I adopt a simple, formal model that sheds new light on the mechanisms that drive the patterns I observe in my empirical analysis.

I begin by paralleling the theoretical distinction between knowledge specialization within domains and knowledge diffusion between domains by mapping interactions among individual knowledge workers and classifying them as either related or unrelated to the scientific aspects of the R&D project to which they formally belong to. To explain individual choices to engage in each type of interaction, I also introduce two constructs: (1) the fit between projects in the R&D lab and the human capital of the scientists assigned by the firm to those projects, or project-relevant human capital (PRHC), and (2) the level of individual autonomy, implying a freedom to select tasks, timing, and methods, within those projects. The two constructs respectively reflect organizational design choices, in terms of setting the formal boundaries of projects, and managerial choices to delegate autonomy to employees assigned to these projects. In turn, I test for nonlinear relationships among autonomy, PRHC, and (un)related interactions. Theoretically, I develop a formal model that explains individual choices to engage in related or unrelated interactions, which reveals some nuanced relationships. Empirically, I estimate the proportion of (un)related interactions as a function of my measures of PRHC and autonomy. As a further step in my empirical investigation, I expand the analysis from the individual to the dyad level, by estimating the probability that two actors engage in an unrelated interaction. This investigation thereby complements and integrates existing streams of research that highlight individual motives and interactions in research contexts. I also contribute to the growing field of research dedicated to the interplay of formal and informal organization forms in firms (McEvily, Soda, & Tortoriello, 2014).

I elaborate the general framework in Section 2.2. Section 2.3 contains a description of my empirical setting, and in Section 2.4, I detail the formal model. Sections 2.5 and 2.6

describe the data and the empirical findings. I discuss my results and their implications in Section 2.7, before concluding in Section 8.

2.2 ORGANIZATION, KNOWLEDGE, AND INCENTIVES IN R&D

I define R&D projects as research efforts in which a group of scientists and inventors with diverse disciplinary expertise develop deeply embedded, tacit knowledge that is idiosyncratic to the project, such that each project establishes a specific knowledge domain (Henderson & Cockburn, 1994; Nonaka, 1994). Firms benefit from creating specialized knowledge domains, but innovation also requires knowledge diffusion across specialized knowledge domains (Cockburn & Henderson, 1998; Henderson & Cockburn, 1996). Embedded and tacit knowledge can flow through multiple interactions, but such interactions demand significant time and effort investments (Perlow, 1999; Reagans, Vir Singh, & Krishnan, 2015). Therefore, people purposively consider ways to make better use of interactions, according to the knowledge acquired through them. For example, they might prefer interactions that provide either knowledge related to the specific domain of an assigned project (*related interactions*) or knowledge related to the domains that mark the other projects carried out in the lab (*unrelated interactions*). Such choices steer how knowledge flows within the lab (see Figure 2.1).

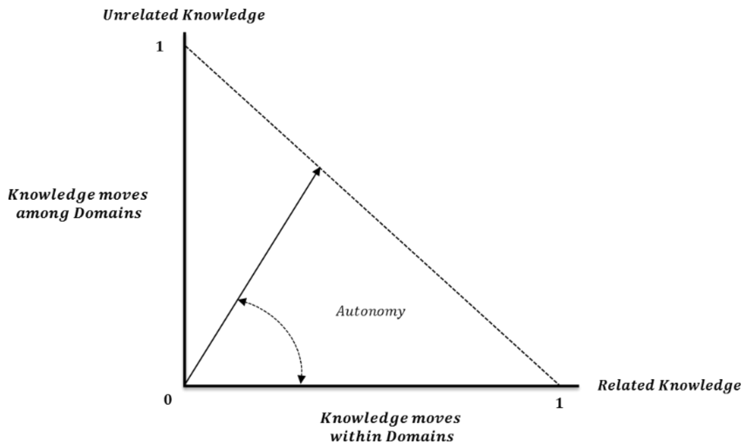

Figure 2.1 The Choice between Related and Unrelated Knowledge

Consider individual i assigned to project P_1, one of n projects undertaken by the firm. Each project is highly specialized and reflects the boundaries of a specific knowledge domain. Individual i engages in a knowledge interaction with individual j, and the knowledge that i exchanges with j might pertain to the knowledge domain of her own project P_1 (related interaction) or the knowledge domain of any of the other projects undertaken by the firm P_{n-1} (unrelated interaction). This choice to acquire related or unrelated knowledge might depend in turn on the formal organization of projects and the management of human capital in these projects. Specifically, I posit that two important factors shape the choice of acquiring related or unrelated knowledge through interactions: the assignment of knowledge workers to projects, which determines the fit between their human capital and their assigned projects, and the manager's decision to delegate within projects, which produces varying levels of individual autonomy.

2.2.1 Project-relevant Human Capital (PRHC)

Human capital consists of individual knowledge, skills, and expertise (Becker, 2002). Organizational scholars advance the idea of fit, particularly that defined by a demand–ability alignment, which suggests that an employee's knowledge is commensurate with the requirements of the specific task (Edwards, 1991). Linking fit to performance, strategy scholars further assert that human capital that is specific to the firm results in higher productivity (Campbell, Coff, & Kryscynski, 2012; Coff & Kryscynski, 2011). In general, fit can refer to correspondence (matching) or mutual reinforcement (moderation) between two factors (Venkatraman, 1989). For this study, I consider the fit between projects within the R&D lab and the human capital of scientists and inventors whom the firm assigns to these projects.

Imagine two projects organized within a firm: Project P_1 requires the combination of knowledge about organic chemistry and nanomaterials (i.e. $P_1's$ knowledge domain); P_2 involves a problem that demands knowledge about inorganic chemistry and nanomechanics (i.e. $P_2's$ knowledge domain). Individual i with knowledge about organic chemistry and nanomaterials represents human capital that fits project P_1 better than in P_2. When firms organize their projects, they generally define the formal boundaries and knowledge requirements, then assign members according to these definitions, which determines the level of fit between each employee's human capital and each project's knowledge requirements. Following this logic, I propose that *project-relevant human capital* (PRHC) refers to the extent to which individual knowledge matches the knowledge requirements of a focal project.

The better the fit between knowledge workers and projects, the more optimal the outcomes for the organization. Yet firms sometimes assign members to projects for which they have low PRHC. Considering the resource constraints, interdependencies among projects, individuals' capacity, and natural lags in updating human capital within firms, project organization cannot always be optimal, highlighting the need to understand how firms can best manage their human capital in such situations.

2.2.2 Autonomy

Autonomy is an essential work element in industrial R&D labs and it can be defined as "the freedom, once a problem has been set, to attack it by means determined by oneself, within given organizational resource constraints" (Bailyn, 1985, p. 7). More generally, autonomy can be understood as the manager conferring decision-making rights to the worker, i.e. "the rights to make decisions during the implementation of a project" (Gambardella, Panico, & Valentini, 2015: 37). Because autonomy is highly valued by R&D personnel, it even may be regarded as a reward in itself (Bailyn, 1991) and can function as an incentive to motivate people to engage in innovative activities (Coff, 1997; Gambardella, Panico, & Valentini, 2015). Autonomy can increase commitment and effort devoted to tasks (Gagné & Deci, 2005). It also has a productivity-enhancing role, if people who are knowledgeable about their tasks are allowed to make critical decisions (Grant, 1996; Jensen & Meckling, 1995). Yet in industrial R&D, decision-making rights initially reside with the manager, who dictates tasks, methods, and timing to subordinates or may choose to delegate these rights (Aghion, Dewatripont, & Stein, 2008). Thus, employee autonomy reflects a delegation decision by the manager representing the firm's interests.

Assume two knowledge workers assigned to a project P_1. Individual i has the right to decide whether to use the "exposure via intratracheal instillation" or "exposure via inhalation" method, as well as whether to experiment with both methods for a while; she even might take an alternative direction and come up with a brand new method, according to her own deadlines. In contrast, individual j has no right to choose and is required to use the "intratracheal instillation" method, with a two-week deadline to come up with a solution. In this simplified example, individual i has been granted more autonomy than individual j. Thus, I assess autonomy[1] as the decision-making rights that each individual knowledge worker has for a focal project, reflecting freedom to decide how to schedule work time and which tasks, approaches, or problems to pursue within the project, which eventually should affect the project's final outputs.

Having autonomy in a project gives employees the opportunity to mold it to their advantage and increases their motivation, yet it also creates the risk that they deviate from the assigned project. For example, scientists might devote time and effort to learning about

[1] Autonomy constitutes an essential job dimension that affects organizational outcomes (Hackman & Oldham, 1975); it has been linked to job performance (Langfred, 2005), motivation (Gagné & Bhave, 2011), intentions to share knowledge (Cabrera *et al.*, 2006), and social networks (Kilduff & Brass, 2010). Rather than a dimension of job design, we treat autonomy as a function of managerial choices at the project level.

scientific details unrelated to their projects or engage in informal collaborations unrelated to their projects (Criscuolo, Salter, & Ter Wal, 2014), which might not be optimal from the firm's perspective. Accordingly, individual autonomy must be limited according to the needs of the firm (Aghion *et al.*, 2008; Vallas & Kleinman, 2007), as well as with a consideration of the agency costs that result from a loss of control (Aghion & Tirole, 1997). That is, managers must note the motivational and efficiency-enhancing effects of autonomy, but also the inevitable loss of control over project activities, when deciding how much autonomy to delegate (Gambardella *et al.*, 2015). Through the strategic provision of autonomy, managers can provide incentives and influence knowledge workers' choices of activities within the lab.

2.2.3 Autonomy, Project-relevant Human Capital, and Knowledge Interactions

Scientists, researchers, and inventors make choices about how much of their time to allocate to different firm-related activities (e.g., creative vs. routine, Gambardella, Giarratana, & Panico, 2010; collaborative vs. solo, Bikard, Murray, & Gans, 2015; different types of collaboration, Libaers, 2012). Exchanging scientific knowledge through informal interactions is one important activity, to which organizational members allocate their limited time by choosing among diverse types of interaction.[2]

If these knowledge workers have high PRHC, they likely experience greater productivity gains in their projects, because they are knowledgeable about the problems they need to tackle. Lower levels of PRHC instead imply productivity losses, due to the important challenges that such projects pose. Therefore, I anticipate that PRHC affects people's knowledge interaction choices, though it is not clear how or why. Both high and low PRHC may lead to less related interactions: the former due to the lack of need for additional knowledge related to the focal project knowledge domain, and the latter due to the lack of

[2] Social network scholars provide extensive evidence of the personal benefits people can derive from establishing specific connections, supporting the idea of purposiveness (Burt 1982, 1992). A common instrumental action is the search for diverse information (Ahuja, 2000).

will to seek such knowledge. The parallel forms of these arguments apply to unrelated interactions (no need for related interactions may lead to more unrelated ones; no will for related interactions may lead to more unrelated interactions too). Considering the prominent value of autonomy in industrial R&D labs, I also predict that autonomy might be the determining factor for this choice. As a variable established by the manager, autonomy reflects the project level; PRHC, which has resulted from organizational design choices (composition of projects), refers to the firm level. As I show in Figure 2.1, autonomy, given PRHC, might shift employees' focus toward related or unrelated interactions.

These arguments imply an important link between a given level of PRHC and the manager's decision to delegate autonomy, which could help reveal the forces driving individual choices. To disentangle the mechanism driving these choices, I develop a simple agency model (see Section 2.4), grounded in the characteristics of my empirical context, as I briefly describe next.

2.3 ORGANIZING AND MANAGING R&D AT *ALPHA*

Alpha is a global pharmaceutical company headquartered in Italy, with a strong focus on in-house research and development (75% of its turnover is generated by its own R&D division). I studied one of the main functions within the corporate R&D center, in charge of chemistry, manufacturing, and controls (henceforth, the *unit*). At the time of our study, 12 projects were ongoing.

The unit engages in both basic and applied research, and it pursues drug substance development and formulation, along with device and analytical development. In its project-based organization, projects are highly specialized, such that "each project is a knowledge island by itself" (Head of R&D), supervised by a project manager who is accountable for the entire development process. Although the employees formally belong to departments, "projects take priority and direct the day-to-day work of employees," (Head of Department) such that organizing research projects begins with the assignment of scientists and inventors to projects as they are set to start (project composition). Projects primarily rely on the R&D personnel available in the lab.[3] In principle, these assignments account for the projects' priority and individual characteristics, though according to the head of R&D:

> Project managers bargain over personnel, and assignment to a project is a result of this bargaining process…they often have to work with the second-, third-, or fourth-best option of employee available for their projects. Project managers are well aware that they will not always get the right person for the job and it is part of managing the project to make the situation work anyway.

These frictions in the assignment process lead to variance in the fit between projects and available human capital, justifying our incorporation of PRHC into our formal model.

Moving beyond these formal design choices, *Alpha* manifests the strong belief that knowledge interactions provide a strong foundation for firm innovation (Fleming, Mingo, & Chen, 2007; Singh & Fleming, 2010). Managers also describe these knowledge interactions as a significant part of workers' daily activities and work time (Perlow, 1999). Following a meeting about data collection for example, the head of the function and a the heads of department expressed interest in "how many employees are engaged in frequent interactions for projects to which they are not formally assigned to, and how much time they might be investing in these exchanges!". They speculated that such activity may lead to cross-project knowledge spillovers, which is a primary concern ("We are not sure if knowledge is actually flowing across projects, which is something we want to encourage"). Consistent with prior

[3] The R&D staff of the company is quite stable (average tenure in our sample is 10.25 years, and 65% of employees have been with Alpha for at least 4 years); hiring new personnel represents a significant investment that takes a lot of time.

research, knowledge interactions appear motivated by learning, intellectual challenge, and stimulating future interactions.[4]

In terms of incentives, promotions and rewards are based on knowledge and expertise, and people advance in their careers according to their knowledge production and scientific standing (Cockburn, Henderson, & Stern, 1999).[5] Top management also encourages "risk-keen attitudes," and in their project execution assessments, they consider the "overall success" of the project, not "pieces of the process," implying a long-term orientation towards innovation (Ederer, 2013; Ederer & Manso, 2013). Beyond these formal and general rules, in several meeting and presentations managers and project managers explicitly noted the importance of autonomy within projects and the value that project managers can gain from it. Although there is no implicit or explicit policy, project managers are encouraged to leverage their granting of autonomy to fit the needs of each project. As stated in internal documents and expressed by the head of the function, project managers are advised to use "delegation of decisions (autonomy)" wisely in their projects to ensure that the project succeeds, reflecting the needs of the project and the competences of the project members. During our meetings, managers also identified the delegation of autonomy as a crucial concern for project managers, because of its effects on project development ("Sometimes project managers worry that an individual may get too relaxed if they do not tell them what to do and when to deliver, or they may take the project into a different path, but they still decide to give some workers more freedom than others, and most of the time it seems to work"). Thus, I also find justification for including autonomy at the project level as a key variable in the formal model.

[4] That is, 80% of our sample reported that they seek knowledge from colleagues mostly because they want to learn; 54% reported that they share knowledge with their colleagues mostly to stimulate future interactions; and 17% reported sharing knowledge because they value intellectual challenges.

[5] We collected and reviewed internal records and found that scientists, department heads, and unit heads actively engage in the production of scientific knowledge, by publishing in academic journals and attending scientific conferences.

The information about the organization and the management of R&D at *Aplha* led me to build a simple model that mirrors the empirical context under investigation. My main objective is to offer theoretical insights that I can use to interpret the patterns observed in the data.

2.4 MODELLING PRHC, AUTONOMY, AND KNOWLEDGE INTERACTIONS

The key ingredients in the model are the individual's PRHC and their level of autonomy in the project, which result from (exogenous) organizational design at the firm level and from (endogenous) managerial choices at the project level. The knowledge interactions, that are either related or unrelated to the focal project, are the result of the individuals' choice to allocate their available time.

Following the description of the unit at *Alpha*, I model a context whereby an individual (*he*) is formally assigned to a project and acts under the supervision of a project manager (*she*) representing the interests of the company. Mirroring the empirical setting, all variables in the analytical model refer to the project level. For each project-individual combination there is a corresponding level of PRHC denoted by $k>0$. Due to the frictions in the assignment process discussed above, I consider k as exogenous, i.e., it is fixed and beyond the project manager's control in the short-run. Let $\lambda \in [0,1]$ indicate the extent of the individual's autonomy in a given project; $\lambda =1$ corresponds to complete autonomy and $\lambda = 0$ to no autonomy. Conversely, I indicate with $1-\lambda$ the extent of control that the manager retains over the project. The project manager chooses the extent of the individual's autonomy reflecting his PRHC, but she cannot establish and command the individual's interactions. Thus, an individual decides how much to focus on the interactions that are related or unrelated to his project, which we model assuming that one unit of time is allocated between related (t) and unrelated (*1-t*) interactions.[6] Given my focus on R&D, where outputs are difficult to measure or verify with precision, at least in the short run, I exclude standard pay-for-performance mechanism to incentivize the individuals. Thus, the project manager can only maneuver autonomy in the assigned project to provide the incentives.

Project managers and individuals make choices (about autonomy and the use of time) that reflect utility considerations. Autonomy (λ) is the (contractible) variable that is endogenously determined and is set to incentivize the individual, who instead decides the (non-contractible) allocation of time. PRHC (k) is a key driver of the manager's choice to delegate autonomy, which in turn affects the individual's allocation of time (t). Following the approach by Gambardella, Panico, & Valentini (2015), a more autonomous individual gains greater benefits because he can steer the project in directions that fit more closely with his personal interests, at the cost of lower control for the project manager. An individual's overall benefits from related and unrelated interactions correspond to the function $u(\lambda, t; k)$, which is differentiable, increasing in λ and k, and single-peaked in t. To simplify the exposition and to work with a closed-form solution, I use the following functional form:

$$u(\lambda, t; k) = \sqrt{t\lambda k} + \sqrt{\gamma(1-t)}.$$

The parameter $\gamma > 0$ captures the benefits the individual gets from unrelated interactions. The manager's benefits stem instead only from the project's output, and are $f(1-\lambda, k)t$, where f is a differentiable function that is increasing in both arguments and exhibits complementarity between control ($1-\lambda$) and PRHC (k), with a decreasing marginal return from control and increasing marginal returns from PRHC. Note that a greater k

[6] In the empirical analysis we estimate the proportion of unrelated interactions, but because in our model time is normalized to one, the simple structure of the model parallels the empirical analysis. The same argument works for our analysis at the dyad-level, were we estimate the probability of an unrelated interaction.

generates more benefits for the manager and for the individual, while the choice of autonomy shifts the benefits from one party to the other.

Formally, the project manager aims to maximize her payoff choosing λ in anticipation of the individual's allocation of time. The manager maximizes the benefits from her project, and solves:

$$\max_{\lambda,t} f(1-\lambda,k)t,$$

s.t.:

$$\sqrt{t\lambda k}+\sqrt{\gamma(1-t)} \geq 0, \qquad \text{(PC)}$$

$$t=t^{*}=argmax\{\sqrt{t\lambda k}+\sqrt{\gamma(1-t)}\}. \qquad \text{(ICC)}$$

The two constraints are, respectively, the worker's participation constraint and the incentive compatibility constraint for the allocation of time. Thus, because it is not possible to directly enforce an allocation of time, the term t is chosen optimally by the worker (note that the participation constraint is always satisfied). The worker's allocation of time is guided by the relative benefits of each type of interaction, and by (ICC). The worker's choice is then

$$t(\lambda,k)=\frac{\lambda(k)k}{\lambda(k)k+\gamma} \in (0,1). \qquad \text{(A1)}$$

By substituting Equation (A1) into the manager's objective function, the problem reduces to

$$\max_{\lambda} f(1-\lambda,k)\frac{\lambda k}{\lambda k+\gamma}.$$

The optimal level of autonomy is implicitly determined by the FOC

$$-f_{1-\lambda}(1-\lambda,k)\frac{\lambda k}{\lambda k+\gamma}+f(1-\lambda,k)\frac{\gamma k}{(\lambda k+\gamma)^{2}}=0. \qquad \text{(A2)}$$

By rearranging terms, the solution to the manager's problem is

$$\lambda^{*}(k)\colon \frac{f_{1-\lambda}(1-\lambda,k)}{f(1-\lambda,k)}=\frac{\gamma}{\lambda(\lambda k+\gamma)}, \qquad \text{(A3)}$$

to which corresponds a time allocation

$$t^*(k) = \frac{\lambda^*(k)k}{\lambda^*(k)k+\gamma}. \quad \text{(A4)}$$

Equations (A3) and (A4) are the theoretical counterpart to the relationships that I estimate empirically, and they help to understand the nuanced relationship among the organization and management of research and the interactions among individuals. Thus, despite its simplicity, the model reveals the possibility of nonlinear relationships, that I resume in the following testable implications:

- *Autonomy and PRHC do not always covary, and the relationship between the two can be U-shaped*;
- *Unrelated interactions and PRHC do not always covary, and the relationship between the two can be ∩-shaped.*

Note first that the right-hand-side of Equation (A3) decreases with λ and *k*, and that the left-hand-side increases with λ. On the other hand, the effect of a change in *k* on the left-hand-side, $\frac{\partial}{\partial k}\left(\frac{f_{1-\lambda}(1-\lambda,k)}{f\,(1-\lambda,k)}\right) = \frac{f_{1-\lambda,k}f - f_{1-\lambda}f_k}{f^2}$, depends on the properties of the function *f* through the sign of the term $f_{1-\lambda,k}f - f_{1-\lambda}f_k$. As shown in Section 2.6.1, my empirical investigation suggests a worker's autonomy is greater for very low and very high levels of PRHC, and lower for intermediate values. The model explains that this is a possible pattern, that can arise in the presence of increasing returns from PRHC, i.e., when the function *f* is convex in *k*, with $f_k(\lambda,k) > 0, f_{kk}(\lambda,k) > 0$. For low levels of *k*, an increase in *k* has a small impact on the manager's benefits, i.e., f_k is very small, and if $f_{1-\lambda,k}f - f_{1-\lambda}f_k > 0$, then the left-hand side of Equation (A3) increases in *k*; therefore, by Equations (A3) and (A4), $\frac{d\lambda^*(k)}{dk} < 0$. For high values of *k*, meanwhile, $f_{1-\lambda,k}f - f_{1-\lambda}f_k$ becomes negative, which could imply that autonomy increases with *k*, $\frac{d\lambda^*(k)}{dk} > 0$. In such a case, $\lambda^*(k)$ can be U-shaped, reaching a minimum value for intermediate measures of PRHC. As for the allocation of time, it can be shown that Equation (A2) implies that $\frac{dt(k)}{dk} < 0$ for high values of k, and $\frac{dt(k)}{dk} > 0$ for low values of k, such that the relationship between PRHC and unrelated interactions, 1 - $t^*(k)$, can be ∩-shaped.

Intuitively, the possibility of nonlinear patterns originate from the balance between delegation of autonomy, to provide the incentives to the individuals, and the cost due to the managers' loss of control over the project; this cost-benefits analysis pushes $\lambda^*(k)$ in one direction or the other depending on the value of k, inducing in turn an individual to reallocate his time between related and unrelated interactions. In this respect, I note that the model clarifies how organizational design affects a manager's choice to fine-tune autonomy in relation to PRHC. A further interesting step would allow to close the loop and consider how the project managers' decisions to delegate are linked to the individuals' choices to engage in knowledge interactions, thus revealing the relationship between autonomy and the knowledge interactions corresponding to different levels of PRHC. Rather than building a fully-fledged model to investigate the formal conditions that could generate alternative patterns, I stress the practical importance to investigate them empirically by exploiting our dataset of *Alpha*.

2.5 DATA AND EMPIRICAL METHODS

2.5.1 Data Sources

I draw on detailed intrafirm data from primary and secondary sources, coupled with qualitative interviews and discussions with managers from the focal organization, similar to an "insider econometrics research design" (Obloj & Zenger, 2017). I study a single function within the corporate R&D lab of a global pharmaceutical company (see Section 2.3). The data include a structured vita for each employee; demographic information related to department affiliation, rank, tenure, age, and gender; and information gathered through an electronically delivered questionnaire, administered to the entire population of Alpha's employees.

5.2 Empirical Approach

With my empirical approach, I aim to examine how the choice of knowledge acquired through informal interactions depends on the formal organization and management of R&D projects. My main empirical objective is to link different levels of PRHC and autonomy to individual choices of related versus unrelated interactions. In accordance with the formal model presented in section 2.4, I predict that these relationships are driven by the (U-shaped) link between PHRC and autonomy. I begin the empirical analysis by exploring the raw data and testing this quadratic relationship, while controlling for alternative variables that could affect an individual's level of autonomy: tenure, rank, gender, and department affiliation. After addressing this testable implication derived from the model, I turn to the quadratic (∩-shaped) relationship between i's PRHC (k) and the proportion of unrelated interactions of i $(1-t)$. Furthermore, I test for the quadratic (U-shaped) relationship between i's autonomy (λ) and the proportion of unrelated interactions of i $(1-t)$. Each individual knowledge worker dedicates a given amount of work time to her informal interactions, so the proportion of unrelated interactions ([0,1]) mirrors the notion of time allocated to these interactions ([0,1]) in the formal model. I accordingly estimate variants of the following equation:

$$Proportion\,Unrelated_i = \alpha + \beta_1 AUT_i + \beta_2 AUT_i^2 + \beta_3 PSHC_i + \beta_4 PSHC_i^2 + \delta_1 x_i + \omega z_p + \varepsilon_i.$$

My dependent variable is fractional, so I follow an extant estimation strategy (Papke & Wooldridge, 2008) and estimate a generalized linear model with a logit link function and the Bernoulli family distribution, with robust standard errors (Baum, 2008). The term x_i corresponds to observable individual attributes, and z_p corresponds to project dummies that control for possible project effects.

My theory depends on both individual-level (autonomy and PSHC) and dyad-level (knowledge interactions) variables, so I complement the individual-level analysis with a dyadic analysis (Kleinbaum, 2012). I test the quadratic relationship between i's PRHC (k) and the probability of an unrelated interaction with individual j, as well as the quadratic relationship between i's autonomy (λ) and the probability of an unrelated interaction with individual j (the probability of an unrelated interaction also takes a value between [0,1]). Using a logit regression model with two-way clustered robust standard errors for both i and j, I estimate variants of the following equation:

$$P\left(Y_{nf(ij)}\right) = \Phi(\alpha + \beta_1 AUT_i + \beta_2 AUT_i^2 + \beta_3 PRHC_i + \beta_4 PRHC_i^2 + \delta_1 x_{ij} + \delta_2 x_i + \delta_3 x_j + \omega z_p + \varepsilon_i + \varepsilon_j),$$

where $Y_{nf(ij)}$ takes a value of 1 if the interaction between i and j is unrelated, and Φ is a logistic CDF. The term x_{ij} corresponds to attributes at the dyad level, and x_i and x_j indicate attributes at the individual level. Then z_p corresponds to project dummies to control for possible project effects, taking a value of 1 according to the project to which Y_{ij} is related.

2.5.2 Measures

For the empirical analysis, I created two datasets with measures at two different levels of analysis: dyad level and individual level. First, I mapped all knowledge interactions in the lab and constructed my main data set at the dyadic level. Each observation corresponds to a knowledge interaction reported by i with j related to project p. Second, from the dyad-level data set, I constructed a data set at the individual level, in which I aggregated knowledge interactions for each employee i, and each observation corresponds to the characteristics of employee i. I provide summary statistics in Tables 1 and 2, and correlations in Tables 3 and 4, for the dyad and individual level, respectively.

Table 2.1 Summary Statistics for the Individual Level Sample

Variable	Mean	Std. Dev	Min	Max
Proportion Unrelated Interactions	0.34	0.38	0.00	1.00
Autonomy	0.00	1.00	-2.30	1.59
Project-Relevant Human Capital	0.00	1.00	-2.15	1.59
Scientist	0.31	0.46	0.00	1.00
Tenure	0.00	1.00	-1.04	2.59
Head Of Unit	0.09	0.29	0.00	1.00
Head Of Department	0.04	0.20	0.00	1.00
Project Manager	0.04	0.20	0.00	1.00
Degree Centrality	0.00	1.00	-0.87	5.64
Betweenness Centrality	0.00	1.00	-0.56	5.85

Table 2.2 Summary Statistics for the Dyad Level Sample

Variable	Mean	Std. Dev	Min	Max
Unrelated Interaction	0.41	0.49	0.00	1.00
Project-Relevant Human Capital	4.96	1.35	2.33	7.00
Autonomy	5.07	1.32	1.67	7.00
Same Department	0.64	0.48	0.00	1.00
Same Gender	0.57	0.50	0.00	1.00
Same Project Memberships	0.00	1.00	-0.97	2.79
Number Of Projects I	0.00	1.00	-1.46	3.64
Tenure Absolute Difference	0.00	1.00	-1.23	3.59
Age Absolute Difference	0.00	1.00	-1.37	4.14
Both Scientists	0.18	0.38	0.00	1.00
Both Lab Technicians	0.12	0.33	0.00	1.00
Both Head Of Unit	0.02	0.13	0.00	1.00
Head Of Department J	0.06	0.24	0.00	1.00
Project Manager J	0.04	0.19	0.00	1.00
Knowledge Tie	0.25	0.44	0.00	1.00
Friendship Tie	0.22	0.41	0.00	1.00
E-I Index J	-0.21	0.53	-1.00	1.00
E-I Index J	-0.25	0.46	-1.00	1.00
Degree Centrality I	0.00	1.00	-0.67	5.84
Degree Centrality J	0.00	1.00	-0.69	3.92
Betweenness Centrality I	0.00	1.00	-0.98	5.13
Betweenness Centrality J	0.00	1.00	-1.05	5.82

Table 2.3 Correlation Matrix for the Individual Level Sample

		1	2	3	4	5	6	7	8	9	10	11	12
1	PROPORTION NON-TASK-RELATED INTERACTIONS	1.000											
2	PROJECT AUTONOMY	0.070	1.000										
3	PROJECT AUTONOMY SQUARED	0.153	-0.399	1.000									
4	PROJECT SPECIFIC HC	-0.018	0.435	-0.079	1.000								
5	PROJECT SPECIFIC HC SQUARED	-0.037	-0.033	0.092	-0.433	1.000							
6	SCIENTIST	-0.123	0.174	-0.063	0.100	0.092	1.000						
7	TENURE STD	0.038	-0.015	-0.111	0.111	-0.293	-0.201	1.000					
8	HEAD OF UNIT	0.206	0.150	0.113	0.310	0.022	-0.211	-0.100	1.000				
9	HEAD OF DEPARTMENT	0.204	0.099	-0.009	0.015	-0.112	-0.137	0.280	-0.066	1.000			
10	PROJECT MANAGER	-0.184	-0.063	0.086	0.098	-0.098	-0.137	0.075	-0.066	-0.043	1.000		
11	DEGREE CENTRALITY	-0.027	0.168	-0.048	0.181	0.007	0.299	-0.196	0.012	-0.104	-0.027	1.000	
12	BETWEENNESS CENTRALITY	0.116	0.961	-0.133	0.445	-0.010	0.165	-0.050	0.197	0.107	-0.035	0.164	1.000

Table 2.4 Correlation Matrix for the Dyad Level Sample

		1	2	3	4	5	6	7	8	9	10
1	NON-TASK-RELATED INTERACTION	1.000									
2	PROJECT SPECIFIC HC	0.073	1.000								
3	PROJECT SPECIFIC HC SQUARED	0.063	0.992	1.000							
4	PROJECT AUTONOMY	0.116	0.414	0.437	1.000						
5	PROJECT AUTONOMY SQUARED	0.135	0.436	0.460	0.989	1.000					
6	SAME DEPARTMENT	0.079	-0.008	-0.027	-0.116	-0.120	1.000				
7	SAME GENDER	0.086	-0.017	-0.009	-0.065	-0.058	0.033	1.000			
8	SAME PROJECT MEMBERSHIPS	-0.460	-0.058	-0.073	-0.107	-0.112	0.092	0.094	1.000		
9	NUMBER OF PROJECTS i	-0.402	-0.084	-0.101	-0.009	-0.015	0.099	-0.073	0.516	1.000	
10	TENURE ABSOLUTE DIFFERENCE	0.082	0.003	-0.014	0.034	0.025	0.028	0.086	0.000	-0.037	1.000
11	AGE ABSOLUTE DIFFERENCE	0.104	-0.007	-0.014	0.025	0.011	0.095	0.025	-0.119	-0.145	0.549
12	BOTH SCIENTISTS	-0.117	0.016	0.011	0.127	0.122	-0.101	-0.037	0.094	0.052	-0.092
13	BOTH LAB TECHNICIANS	0.043	-0.131	-0.131	-0.107	-0.119	0.013	-0.035	0.033	-0.095	0.047
14	BOTH HEAD OF UNIT	0.006	0.136	0.149	0.017	0.038	0.060	-0.000	-0.046	-0.066	-0.048
15	HEAD OF DEPARTMENT j	-0.001	0.015	0.018	-0.019	-0.022	-0.025	0.023	-0.131	-0.054	0.247
16	PROJECT MANAGER j	-0.025	-0.007	-0.011	-0.047	-0.046	-0.262	0.047	0.038	0.035	-0.014
17	KNOWLEDGE TIE	0.078	0.049	0.048	0.054	0.050	0.169	0.054	-0.022	-0.096	0.058
18	FRIENDSHIP TIE	-0.017	0.083	0.081	-0.023	-0.022	0.224	0.102	0.131	0.075	-0.132
19	E_I INDEX i	-0.094	-0.149	-0.136	0.104	0.129	-0.392	0.037	0.025	0.150	0.027
20	E_I INDEX j	0.011	-0.106	-0.105	-0.012	-0.009	-0.207	0.086	-0.010	0.031	0.017
21	BETWEENNESS CENTRALITY i	-0.136	-0.071	-0.062	0.121	0.119	-0.061	-0.112	0.024	-0.038	-0.077
22	BETWEENNESS CENTRALITY j	-0.073	0.055	0.061	0.030	0.033	-0.065	-0.168	0.041	0.032	-0.179
23	DEGREE CENTRALITY i	-0.057	0.053	0.062	0.106	0.093	-0.111	-0.023	-0.076	-0.231	-0.037
24	DEGREE CENTRALITY j	-0.022	0.018	0.021	0.012	0.015	-0.035	-0.001	-0.089	-0.033	-0.223

	11	12	13	14	15	16	17	18	19	20	21	22	23	24
11	1.000													
12	-0.103	1.000												
13	0.084	-0.175	1.000											
14	-0.109	-0.063	-0.050	1.000										
15	0.214	-0.117	-0.094	-0.034	1.000									
16	-0.064	-0.091	-0.073	-0.026	-0.049	1.000								
17	-0.009	0.092	0.047	0.120	0.160	-0.068	1.000							
18	-0.099	-0.065	0.071	0.067	-0.108	0.010	0.180	1.000						
19	-0.067	0.022	-0.079	-0.006	0.014	0.019	-0.130	-0.146	1.000					
20	-0.011	-0.073	-0.082	-0.001	0.190	0.160	-0.035	-0.146	0.211	1.000				
21	-0.061	0.182	-0.117	-0.001	0.021	-0.065	0.149	-0.018	0.112	-0.064	1.000			
22	-0.144	0.183	-0.152	-0.019	-0.103	-0.067	0.034	-0.050	-0.085	-0.023	0.032	1.000		
23	-0.041	0.207	-0.037	0.031	0.014	-0.085	0.298	0.021	0.063	-0.069	0.540	-0.008	1.000	
24	-0.139	0.083	-0.039	0.019	-0.184	-0.046	-0.102	-0.007	-0.048	-0.022	0.044	0.338	0.001	1.000

Knowledge Interaction: related vs unrelated. In the survey, each respondent was able to select the projects for which they were involved in knowledge interactions, and the respondent was asked the following question: *(1) Select the people with whom you most* ***frequently exchange knowledge*** *related to the* ***scientific aspects of the project***. With this information, I could identify a knowledge interaction reported by employee i with employee j related to project p_n, where $n = 1 - 12$. Using the archival data provided by the company, I classified each of these interactions as related or unrelated. If i reported frequent exchanges with j for project p_n, and p_n is not part of the set of projects in which i has formal assignment, this variable took a value of 1 (unrelated); and 0 otherwise (related).

Proportion of unrelated Knowledge Interactions. Once I mapped all knowledge interactions and classified them as related or unrelated, I grouped them at the individual level and obtained the composition of knowledge interactions for each worker i. I divided the number of unrelated interactions by the total number of interactions reported by each worker.

For the autonomy and PRHC variables, each of the questions required responses for three items using a Likert scale. A principal component factor analysis and a Cronbach's alpha test performed on the items for autonomy and PRHC revealed the unidimensionality and reliability of each scale: autonomy with a Cronbach's alpha=0.88 and principal component explaining 80.96% of the variance, and PRHC with a Cronbach's alpha=0.88 and principal component explaining 81.57% of the variance.

I asked workers: *For the following questions, please consider the* ***projects to which you are currently assigned****. Indicate to what extent you* ***agree*** *with each one of the statements (1. Strongly disagree - 7. Strongly agree)."*

Autonomy. To measure this construct, I used three items that followed the logic of autonomy originally developed by Hackman and Oldham (1975) and were also similar to those used in the PAT-VAL2[7] survey of inventors. I used the average value of the following three items: (1) 'I have considerable freedom in determining my tasks,' (2) 'I can decide how to allocate my work-time among different tasks,' and (3) 'I can freely decide how to do my tasks.'

Project-Specific Human Capital. To measure this construct, I used a question including items similar to those used in the PAT-VAL2 survey of inventors. I used the average value of the following three items: (1) 'There is a good match between my prior experience and the firm's capabilities to develop the projects to which I am assigned;' (2) 'My prior inventive experience was readily applicable to the projects in which I am assigned;' and (3) 'My technical expertise allowed me to easily perform in the projects in which I am assigned.' The first statement broadly captured the idea of complementarity between a worker's human capital and the capabilities of the firm in relation to specific projects. The two other statements captured a more specific view considering the applicability of prior inventive experience (understood as experience in non-routinized types of tasks) and technical expertise to their projects.

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[7] PAT-VAL2 is a survey of inventors from 20 European countries plus the U.S., Japan, and Israel listed in EPO patents with priority dates 2003-2005. This survey has been previously used by scholars (e.g. Giuri *et al.* 2007) .

2.5.2.1 Controls

At the individual level, I focused on controlling for individual aspects that could influence knowledge acquisition decisions, such as tenure, gender, department, and rank. I also included controls for project membership and informal accessibility to knowledge sources and their social tendencies (degree centrality and betweenness centrality in the organizational knowledge network).

At the dyadic level, I focused on controlling for alternative processes that could influence the type of knowledge they chose to acquire through their interactions, i.e. multiplexity, homophily, organizational foci, and informal structure position and disposition (Dahlander and McFarland 2013). Extant research has shown that friendship and advice ties are a relevant dimension of the informal organization (Gibbons 2004, Krackhardt1992). Thus, it is important to control for friendship and advice relationships as these may influence the knowledge search patterns of individuals. In this case, the sociometric survey included information about friendship and advice relationships, therefore we included dummy variables indicating whether i considered j to be a friend or a source of scientific knowledge. To account for employees' informal accessibility to knowledge sources and their social tendencies, I also created measurements for the number of knowledge advice connections that i and j had within the functional unit, as well as the degree to which these connections bridged different employees and crossed departmental boundaries (degree centrality and betweenness centrality in the organizational knowledge network as well as the E-I index relative to departments). I controlled for organizational foci, including dummies indicating if i and j belonged to the same department and the number of projects in which they shared formal membership. I also controlled for homophily by including variables indicating the absolute difference in tenure and age between i and j and dummies indicating if they had the same gender, if they were both scientists, or if they were both lab technicians. Even though the organization of projects was flat, we included controls for organizational rank and role: both head of unit, *j* Project manager, *j* head of department. Finally, to account for any unobservable heterogeneity across projects for which I was not able to obtain data (e.g. budget, equipment, collegiality, leadership style, etc.), I included project dummies indicating for which project the knowledge interaction occurred.

2.6 RESULTS

2.6.1 Individual Level

One testable prediction derived from the model is that the relationship between autonomy and PRHC could be U-shaped. From the raw data, I found indications that this relationship is U-shaped, but only for scientists (See Figure 2.2). Considering this, I perform all analysis for both the full population of R&D workers and for the sub-population of scientists, expecting that the model prediction will be stronger for scientists. I regressed the level of Autonomy on PRHC and a set of controls and, consistent with the raw data, I found evidence of a U-shaped relationship but only for scientists (see Table 2.5). As suggested by Haans *et al.* (2015), I used the Lind and Mehlum (2010) procedure to test the presence of a U-shaped relationship. This procedure tests whether the sign of the slope of the curve shifts according to the U-shaped relationship. For scientists, I could not reject the presence of a U-shape versus a monotone or an inverse U-shape at the 6% level of significance ($p < 0.06$, t-value = 1.59). The extreme point was 3.93 with a 95% Fieller interval of [-.16313548; 4.5074894].

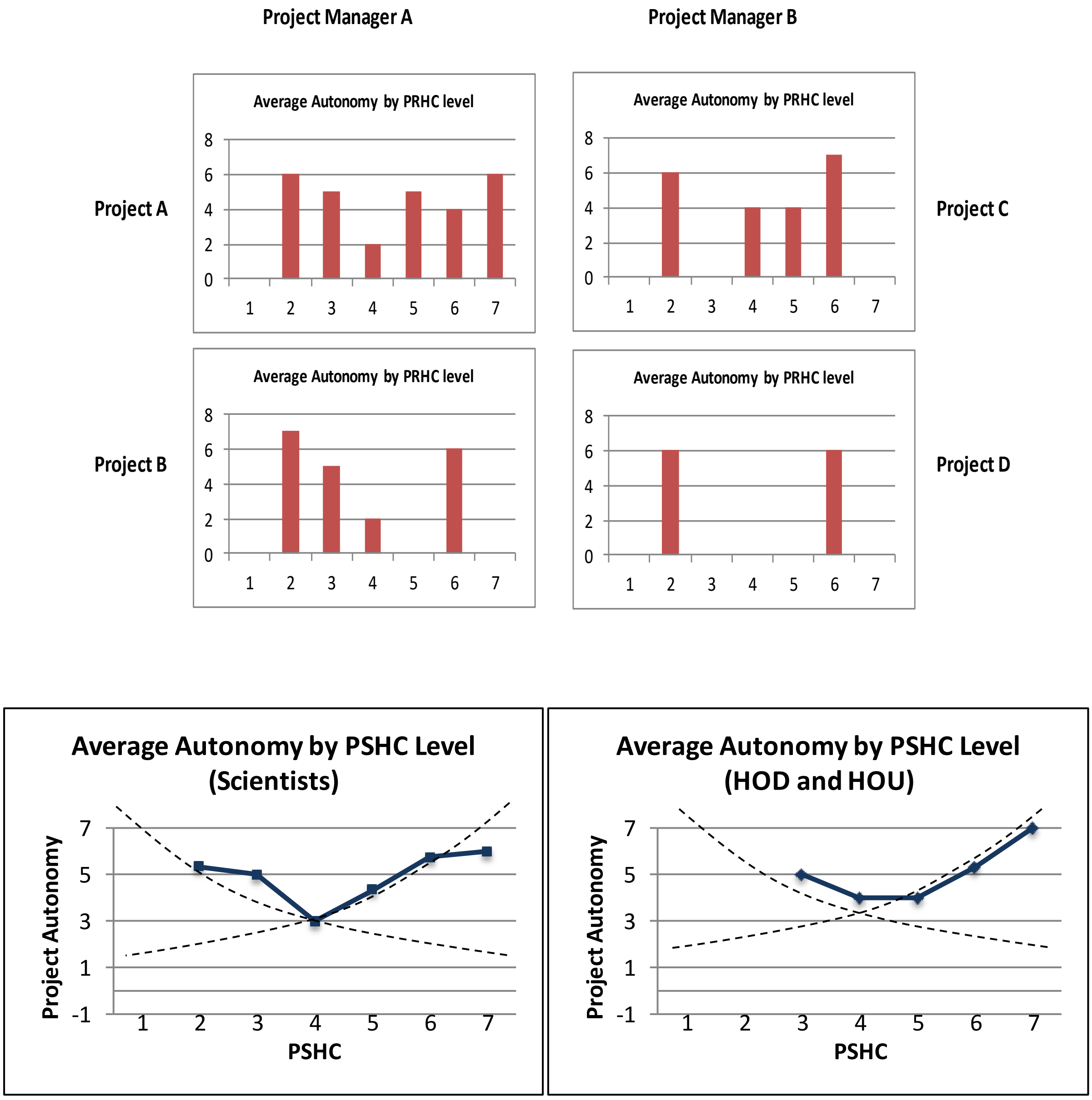

Figure 2.2 The Relation Between Autonomy And PRHC (Raw Data)

Table 2.5 Tobit and OLS Estimations for Autonomy

Dependent Variable: Autonomy	(Tobit) Full Sample	(Tobit) Scientists	(OLS) Full Sample	(OLS) Scientists
PROJECT RELEVANT HC	-0.7700	-2.311**	-0.770	-2.311*
	(0.736)	(0.989)	(0.789)	(1.162)
PROJECT RELEVANT HC SQUARED	0.139	0.294***	0.139*	0.294**
	(0.0771)	(0.107)	(0.0827)	(0.126)
TENURE	-0.0063	0.0022	-0.0063	0.0022
	(0.0128)	(0.0292)	(0.0137)	(0.0343)
FEMALE	0.0435	-0.2912	0.0435	-0.2912
	(0.2678)	(0.353)	(0.287)	(0.414)
CONSTANT	5.834***	9.684***	5.834***	9.684***
	(1.7970)	(2.423)	(1.927)	(2.845)
R^2	0.15	0.19	0.40	0.47
χ^2, F	15.27	26.27	8.17	2.37
Rank and Department Dummies	YES	YES	YES	YES
Observations	93	41	93	41

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The model also predicted that the relationship between PRHC and the time allocated to unrelated interactions could have an inverted U-shape and that the relationship between autonomy and the time allocated to unrelated interactions could be U-shaped. The results of the regressions are reported in Table 2.6. I regressed the fractional variable *proportion of unrelated interactions* on the set of controls in model 1, and I added the linear and quadratic measures of PRHC in models 2 and 3, respectively. We can observe an inverted U-shaped relationship. In models 4 and 5 I added the linear and quadratic measures of autonomy. We can observe a U-shaped relationship. In model 6 I included both autonomy and PRHC and the relationships held. I also tested the presence of U-shaped relationships. In the case of autonomy, I could not reject the presence of a U-shape versus a monotone or an inverse U-shape ($p < 0.014$, t-value = 2.23). In the case of PRHC, I could not reject the presence of an inverse U-shape versus a monotone or a U-shape ($p < 0.0103$, t-value = 2.35). The extreme point for autonomy was 4.13 with a 95% Fieller interval of [2.7810467; 5.121006]. The extreme point for PRHC was 4.37 with a 95% Fieller interval of [3.2131399; 5.0502027]. Both relationships were significant at the 1% level, and the extreme points and their confidence intervals fell within the value range of both independent variables.

As we can observe in our previous analyses, the predicted relationship between PRHC and autonomy was only significant for scientists. In Table 2.7 I show the regression results only for the subsample of scientists (unit heads and department heads are considered scientists within projects, as well). The effects are equally significant but larger in magnitude for both relationships.

2.6.2 Dyad Level

The results of our regressions are reported in Table 2.8 for the full sample. I regressed the binary variable for unrelated interaction on the set of controls in model 1, and I added the linear and quadratic measures of PRHC in models 2 and 3, respectively. We can observe a significant and positive coefficient for the linear term and a significant and negative coefficient for the quadratic term, suggesting the presence of an inverted U-shaped relationship. Similarly, I added the linear and quadratic measures of autonomy in models 4 and 5, respectively. We can observe a significant and negative coefficient for the linear term and a significant and positive coefficient for the quadratic term, suggesting the presence of a U-shaped relationship. In model 6 I included the linear and quadratic measures for both constructs and observe larger and more significant effects. The four measures were jointly significant ($\chi^2 = 1516.54$, $p < 0.000$). I found contrasting U-shaped relationships among autonomy, PRHC, and unrelated interaction.

I estimate the marginal effects of each construct to examine if the relationships were consistent with the expected shapes. Figure 2.3 and Figure 2.4 display the marginal effects of both constructs. We can observe the corresponding U-shaped relationships, with the average marginal effects shifting from negative to positive in the case of autonomy and from positive to negative in the case of PRHC. Nonetheless, for autonomy, the average marginal effects were only significant at very low levels. Considering this, I performed the same analyses in the subsample of interactions reported by scientists. These results are shown in Table 2.9. The four measures were jointly significant ($\chi^2 = 6052.29$, $p < 0.000$). Figure 2.4 and Figure 2.5 display the marginal effects of both constructs. We can observe the same U-shaped relationships, with the average marginal effects shifting from negative to positive in the case of autonomy and from positive to negative in the case of PRHC. For scientists, the negative effect of autonomy on unrelated interactions was significant, in line with the predictions of the agency model.

I also used the Lind and Mehlum (2010) procedure to test the presence of a U-shaped relationship. In the case of autonomy, I could not reject the presence of a U-shape versus a monotone or an inverse U-shape ($p < 0.001$, t-value = 3.03). In the case of PRHC, I could not reject the presence of an inverted U-shape versus a monotone or a U-shape ($p < 0.009$, t-value = 2.41). The extreme point for autonomy was 4.18 with a 95% Fieller interval of [3.5963153; 4.5382162]. The extreme point for PRHC was 4.65 with a 95% Fieller interval of [3.8571278; 5.4530446]. Both relationships were significant at the 1% level and the extreme points and their confidence intervals fell within the value range of both independent variables. These results strongly support the predictions for scientists' interactions choices.

2.6.3 Robustness Checks

I checked for the presence of a cubic effect, I examined the variance inflation factors (VIF), and I also replicated all of the analyses using different functional forms (the linear, probit, and logit models with clustered errors). The results did not qualitatively change. Similarly, I ran a selection model, predicting the likelihood of *i* reporting exchanges with *j* as a function of workers having roles related to coordination and analytics. The Inverse Mills Ratio was then introduced as an additional control variable. It did not change the significance of our results. I also followed the simulation-based approach developed by King *et al.* (2000) and used the CLARIFY module for Stata (Tomz *et al.* 2003) to perform an additional check of the U-shaped relationships and I observed the same expected U-shaped relationships. I also performed a Quadratic Assignment Procedure (QAP) analysis to determine if project networks (knowledge interactions aggregated per project) were highly correlated with one another, to rule out the possibility that workers from one specific project systematically interact with workers from another specific project, and I found low or non-significant correlations.

Table 2.6 GLM Estimations for the Proportion of Unrelated Knowledge Interactions (Full Sample)

Dependent Variable: Proportion of unrelated knowledge interactions	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
SCIENTIST	-0.237	0.154	0.259	0.160	0.0697	0.156
	(0.519)	(0.543)	(0.519)	(0.557)	(0.550)	(0.510)
TENURE	0.241	0.310	0.261	0.293	0.298	0.264
	(0.219)	(0.235)	(0.236)	(0.217)	(0.221)	(0.247)
HEAD OF UNIT	0.293	0.699	0.849	0.619	0.290	0.602
	(0.742)	(0.816)	(0.783)	(0.747)	(0.739)	(0.742)
HEAD OF DEPARTMENT	2.941***	29.16***	28.42***	29.44***	29.45***	28.88***
	(1.020)	(1.412)	(1.598)	(1.435)	(1.438)	(1.585)
PROJECT MANAGER	-12.80***	12.32***	12.60***	12.34***	12.39***	13.21***
	(1.472)	(1.595)	(1.737)	(1.557)	(1.573)	(1.759)
PROJECT RELEVANT HC		-0.0876	2.403**			2.898***
		(0.203)	(1.206)			(1.104)
PROJECT RELEVANT HC SQUARED			-0.266**			-0.331***
			(0.124)			(0.117)
AUTONOMY				-0.0579	-1.666**	-2.164**
				(0.173)	(0.831)	(0.928)
AUTONOMY SQUARED					0.189**	0.262**
					(0.0940)	(0.108)
CONSTANT	3.281***	3.340**	-1.940	3.223**	6.230***	1.100
	(1.018)	(1.334)	(2.963)	(1.310)	(1.980)	(3.061)
AIC/BIC	1.17/-301.26	1.21/-272.89	1.22/-269.88	1.21/-272.85	1.22/-269.54	1.24/-262.84
Log Pseudolikelihood	-32.15	-30.38	-29.62	-30.40	-29.79	-28.60
Project and Department Dummies	YES	YES	YES	YES	YES	YES
Network Structure Controls	YES	YES	YES	YES	YES	YES
Observations	98	93	93	93	93	93

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.7 GLM Estimations for the Proportion of Unrelated Knowledge Interactions (Scientists)

Dependent Variable: Proportion of unrelated knowledge interactions	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
PROJECT SPECIFIC HC		-0.00212	5.042**			4.991**
		(0.332)	(2.030)			(2.247)
PROJECT SPECIFIC HC SQUARED			-0.520***			-0.580**
			(0.201)			(0.234)
AUTONOMY				-0.00606	-4.606**	-6.305**
				(0.305)	(2.341)	(2.551)
AUTONOMY SQUARED					0.510**	0.755***
					(0.256)	(0.293)
CONSTANT	3.281***	3.340**	-1.940	3.223**	6.230***	1.100
	(1.018)	(1.334)	(2.963)	(1.310)	(1.980)	(3.061)
AIC/BIC	1.53/-75.85	1.63/-63.67	1.67/-58.64	1.63/-63.67	1.69/-57.58	1.71/-53.56
Log Pseudolikelihood	-13.97	-13.47	-12.27	-13.47	-12.60	-11.09
Project and Department Dummies	YES	YES	YES	YES	YES	YES
Network Structure Controls	YES	YES	YES	YES	YES	YES
Observations	43	41	41	41	41	41

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.8 Logit Estimations (with two-way error clustering) for the Probability of a Unrelated Knowledge Interaction (Full Sample)

Dependent Variable: Unrelated knowledge interaction	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
SAME DEPARTMENT	0.886**	0.911**	0.850**	0.949***	0.954***	0.852**
	(0.355)	(0.358)	(0.374)	(0.354)	(0.356)	(0.372)
SAME GENDER	0.563**	0.555**	0.662***	0.572**	0.567**	0.729***
	(0.222)	(0.219)	(0.215)	(0.224)	(0.238)	(0.242)
SAME PROJECT MEMBERSHIPS	-1.204***	-1.183***	-1.240***	-1.145***	-1.176***	-1.246***
	(0.266)	(0.265)	(0.271)	(0.256)	(0.242)	(0.253)
NUMBER OF PROJECTS i	-0.952***	-0.902***	-0.922***	-0.908***	-0.926**	-0.959***
	(0.348)	(0.341)	(0.336)	(0.335)	(0.370)	(0.342)
HEAD OF DEPARTMENT j	-1.438***	-1.375***	-1.347***	-1.285***	-1.307***	-1.159***
	(0.415)	(0.403)	(0.429)	(0.379)	(0.406)	(0.444)
PROJECT MANAGER j	0.111	0.193	0.142	0.263	0.262	0.221
	(0.429)	(0.452)	(0.494)	(0.457)	(0.469)	(0.502)
PROJECT SPECIFIC HC		0.0953	2.612**			3.599***
		(0.147)	(1.167)			(1.251)
PROJECT SPECIFIC HC SQUARED			-0.272**			-0.410***
			(0.124)			(0.137)
AUTONOMY				0.201	-2.060*	-2.359**
				(0.158)	(1.076)	(1.051)
AUTONOMY SQUARED					0.244**	0.301***
					(0.116)	(0.115)
CONSTANT	-2.137**	-2.602*	-8.314***	-3.206**	1.968	-5.622
	(1.070)	(1.355)	(2.836)	(1.471)	(2.596)	(4.208)
Pseudo R^2	0.3449	0.3341	0.3498	0.3393	0.3565	0.3855
χ^2	-1304.04	15.99	95.03	319.44	124.09	1516.54
Project Dummies	YES	YES	YES	YES	YES	YES
Network Controls	YES	YES	YES	YES	YES	YES
Observations	788	765	765	765	765	765

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

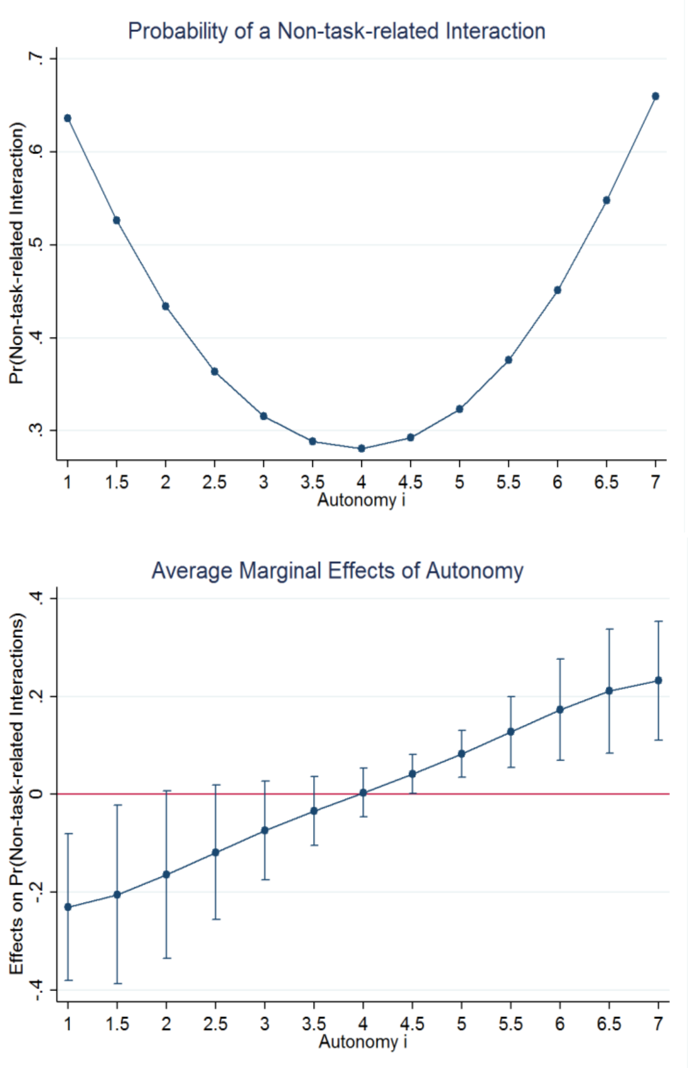

Figure 2.3 Marginal Effects of Autonomy (Full Sample)

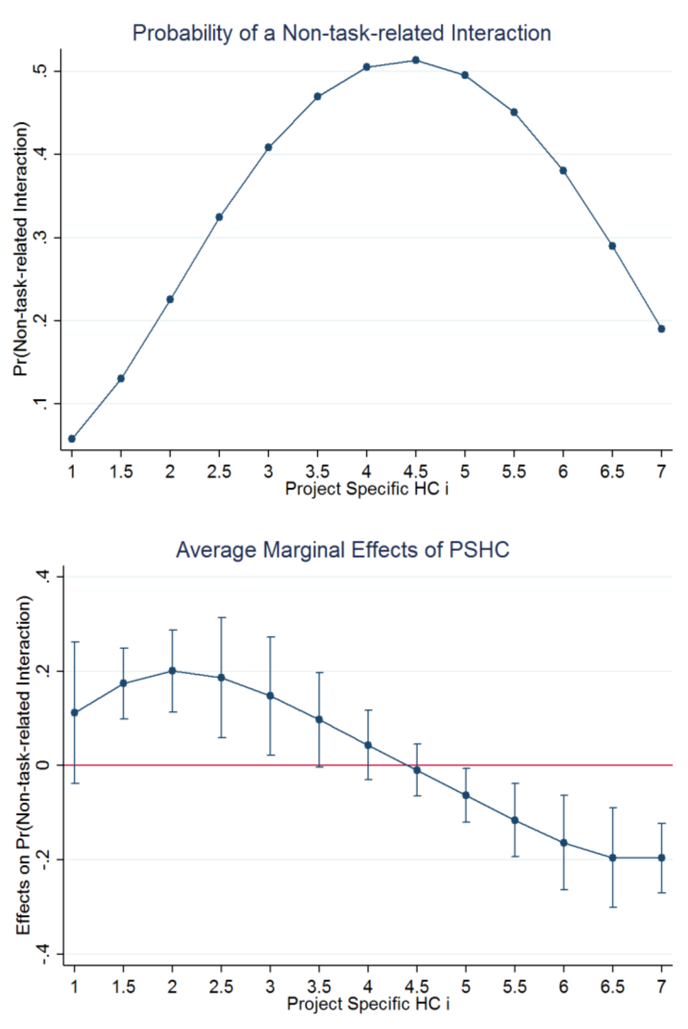

Figure 2.4 Marginal Effects of PRHC (Full Sample)

Table 2.9 Logit Estimations (with two-way error clustering) for the Probability of a Unrelated Knowledge Interaction (Scientists)

Dependent Variable: Unrelated knowledge interaction	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
SAME DEPARTMENT	1.241**	1.158**	1.193**	1.192**	1.228**	1.231*
	(0.508)	(0.487)	(0.555)	(0.502)	(0.535)	(0.632)
SAME GENDER	0.977***	0.923***	1.022***	0.943***	0.833***	1.031***
	(0.246)	(0.251)	(0.237)	(0.252)	(0.311)	(0.335)
SAME PROJECT MEMBERSHIPS	-1.305***	-1.315***	-1.434***	-1.255***	-1.416***	-1.563***
	(0.359)	(0.376)	(0.389)	(0.356)	(0.316)	(0.385)
NUMBER OF PROJECTS i	-1.317***	-1.289***	-1.241***	-1.356***	-1.857***	-2.116***
	(0.465)	(0.492)	(0.454)	(0.508)	(0.539)	(0.654)
HEAD OF DEPARTMENT j	-1.383*	-1.447*	-1.465**	-1.235*	-1.949**	-1.497***
	(0.764)	(0.754)	(0.684)	(0.724)	(0.767)	(0.543)
PROJECT MANAGER j	0.468	0.419	0.396	0.528	0.439	0.777
	(0.651)	(0.605)	(0.723)	(0.642)	(0.610)	(0.801)
PROJECT SPECIFIC HC		0.224	4.626**			6.630**
		(0.277)	(2.056)			(2.676)
PROJECT SPECIFIC HC SQUARED			-0.448**			-0.712**
			(0.206)			(0.285)
AUTONOMY				0.143	-5.268***	-5.931***
				(0.270)	(1.835)	(1.869)
AUTONOMY SQUARED					0.592***	0.709***
					(0.204)	(0.210)
CONSTANT	-3.012**	-4.037**	-14.64***	-3.753**	8.289*	-6.651
	(1.181)	(1.745)	(5.195)	(1.779)	(4.377)	(8.421)
Pseudo R^2	0.4159	0.4156	0.4433	0.4145	0.4778	0.5209
χ^2	155.35	260.29	604.81	359.39	132.21	6052.29
Project Dummies	YES	YES	YES	YES	YES	YES
Network Controls	YES	YES	YES	YES	YES	YES
Observations	423	417	417	417	417	417

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

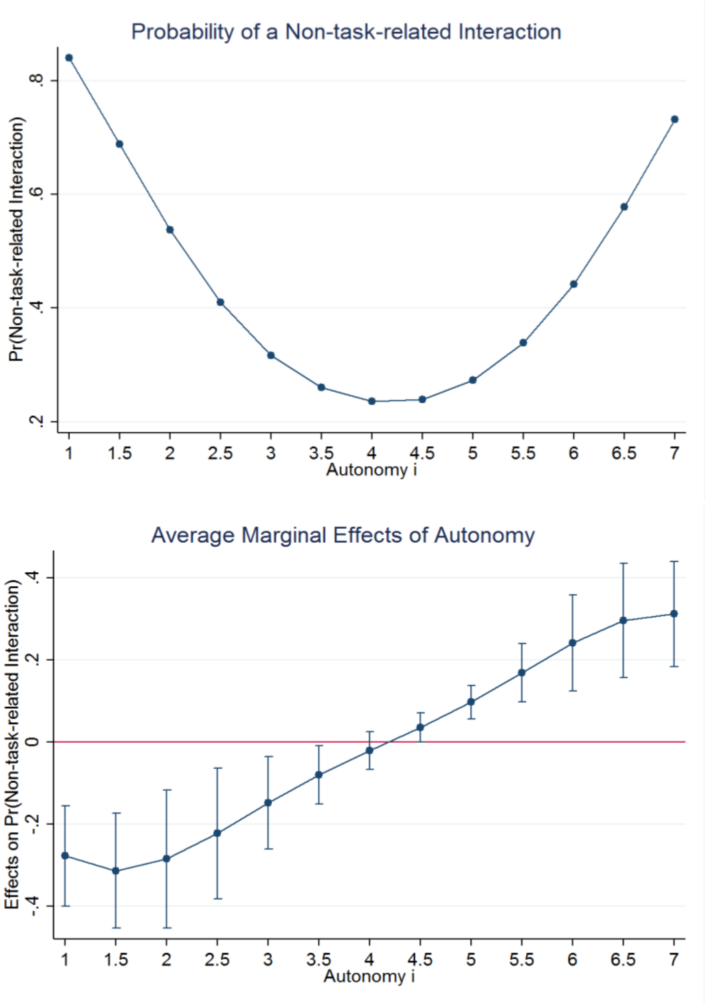

Figure 2.5 Marginal Effects of Autonomy (Scientists)

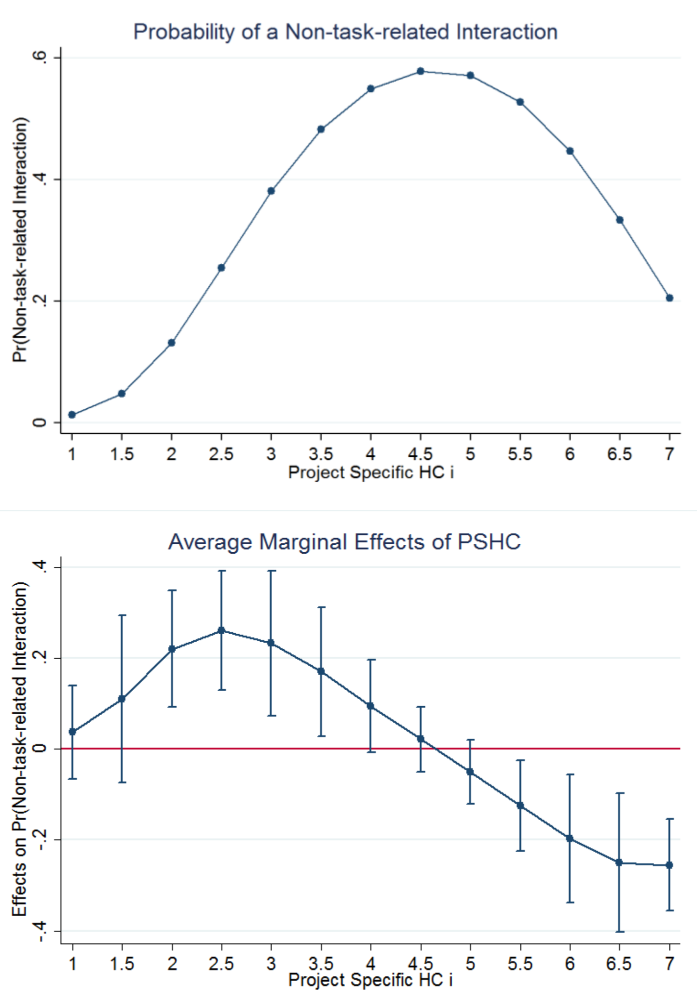

Figure 2.6 Marginal Effects of PRHC (Scientists)

Lastly, I also ran the same models including controls for number of patent applications and scientific publications for each worker prior to our study to control for the possibility that those who patent and publish more (a proxy for employee quality/innovativeness) enjoy better fit in their projects (higher PSHC) and the results did not qualitatively change.

2.7 DISCUSSION AND CONCLUSION

This study offers empirical evidence of the effects of organizational design and human capital management on scientists' and inventors' informal interactions. I complement the empirical analysis with a simple model, grounded in my empirical setting, to shed new light on the drivers of the observed empirical patterns. When autonomy and PRHC covary, we observe a negative relationship with unrelated interactions, such that a knowledge worker enjoys more benefits from the project and focuses most interactions on this project (more related interactions). In contrast, when autonomy and PRHC move in opposite directions, we observe a positive relationship with unrelated interactions, such that the worker trades off benefits, which tend to reduce the focus on projects (more unrelated interactions). Therefore, the manager's decision to delegate autonomy ultimately influences the worker's choice of which knowledge to acquire informally. These results highlight how project managers, facing conditions imposed by the organization, can manage human capital to benefit their projects and eventually affect knowledge processes within the firm.

The U-shaped relationship between autonomy and unrelated interactions indicates that scientists and inventors experience diminishing returns to autonomy in their assigned projects. High levels of autonomy lead to more unrelated interactions, which is an intuitive finding. For example, autonomous workers derive greater utility from searching for and applying new and creative ways to perform their tasks (Cabrera *et al.*, 2006), as can be achieved through unrelated interactions through which they access diverse knowledge that eventually they could apply to related tasks. Yet low levels of autonomy also lead to more unrelated interactions, which seems counterintuitive. This observed pattern is stronger for scientists, and it may reflect their peculiar motives as discussed in section 2.2, i.e. strong need for discovery (Stephan, 1996), such that they are driven by scientific curiosity, intellectual challenge, reputation, and visibility (Giuri *et al.*, 2007; Sauermann & Cohen, 2010). Thus, scientists experiencing "constrained" conditions (i.e., low level of autonomy) may be driven to fulfill their needs by accessing diverse knowledge content through unrelated interactions.

These findings also reveal notable ways that managers can enhance the value of human capital in innovative contexts, according to the influence of the organizational design and human capital management on employees' behavioral responses. Unrelated interactions resulting from high autonomy likely benefit both the employee and the manager, because the employee is free to apply any unrelated knowledge obtained to project-related tasks, with potential cross-project spillover effects. In a corporate R&D lab, successful projects require members who are knowledgeable about other projects within the lab, because then the researchers are familiar with solutions to similar problems and can take advantage of knowledge spillovers (Rizova, 2006). People also are better able to generate inventions when they gather knowledge from different domains (Hargadon & Sutton, 1997). Unrelated interactions that result from low autonomy instead may be more beneficial for the worker than for the firm, because the lack of freedom to apply unrelated knowledge means that any unrelated interaction in which the employee engages must generate private benefits—personally enriching but distracting from the related project—which may harm project performance. In one prior study, the organizational processes of two life sciences firms were hampered by too much collaboration, when people spent a disproportionate amount of time engaging in interactions with others who had no actual stake in the problems they were assigned to solve (Cross, Thomas, & Light, 2009). Furthermore, just gathering more knowledge often fails to result in better organizational outcomes (Pfeffer & Sutton, 1999); knowledge gathering even can hinder project performance (Haas & Hansen, 2005). Conditions that limit unrelated interactions also may result in “knowledge lock-in” or tunnel vision, which ultimately hampers innovative performance. For example, knowledge workers tend to search locally, because their high involvement with their projects leads them to systematically overvalue other project members’ knowledge and undervalue knowledge held by outsiders (Hayes & Clark, 1985; Katz & Allen, 1982).

This study also has some limitations. First, knowledge workers’ decision to engage in related or unrelated interactions may reflect individual, unobservable factors, for which we cannot fully account in this analysis. This endogeneity might be particularly problematic in settings where workers’ motives are not well understood, tasks are predictable, and performance is fully observable. Nonetheless, considering extant literature on scientists’ motives and the nature of R&D activities, plus my understanding of the empirical setting, the formal model complements the empirical analysis by proposing a causal interpretation for my results. Second, with my relatively small sample, the robustness checks I can perform at the individual level are limited. However, the individual-level analyses mirror the robust dyad-level analyses, which offers some confidence for my empirical results. Third, my measures of PRHC and autonomy refer to the individual level, not the individual-project level, which may raise some measurement error concerns. I performed an additional analysis using a subsample of employees who participated in only one or two projects (thus minimizing measurement error), and the results remained qualitatively unchanged.

Finally, this study offers notable insights for the organization of R&D projects and the management of human capital in science- and technology-based contexts. First, managerial decisions are formal governance instruments within the firm, and knowledge interactions constitute informal organizational elements. Accordingly, my results advance understanding of how the formal organization of activities influences the informal structure of the firm (McEvily *et al.*, 2014). Second, whereas most literature focuses on either the individual value of human capital or else the value of the structures emerging from individual interactions, I provide evidence of an intermediate step, namely, a person's decision to pursue certain types of interactions. Third, my findings and framework have potential to advance organizational network theory. In particular, I believe these ideas can inform investigations of tie content and tie formation, which are core issues for network research (Ahuja *et al.*, 2012; Phelps, Heidl, & Wadhwa, 2012). Most tie formation research focuses on organizational foci, homophily, preferential attachment, transitivity, or multiplexity (Dahlander & McFarland, 2013), or else personality traits and perceptions (Oh & Kilduff, 2008; Sasovova, Mehra, Borgatti, & Schippers, 2010). But such studies are limited in terms of providing concrete managerial guidance for how to influence knowledge interactions within the firm.

In conclusion, autonomy within innovation projects provides a strategic lever to influence knowledge interactions. Delegation decisions ultimately can affect the informal organization of knowledge within the firm. The balance across related and unrelated interactions in turn can determine innovative outcomes, due to the potential for knowledge recombination and spillover effects resulting from workers' incentives to interact and exchange knowledge, information, and ideas from diverse knowledge domains. A focus on individual characteristics offers a static view of how organizations can leverage their human capital. By bringing attention to the management of interpersonal interactions, and the related influence on the emergence of different knowledge flow patterns and network structures.

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CHAPTER III

INSTRUMENTAL AND AFFECTIVE TIES WITHIN THE LAB: THE IMPACT OF INFORMAL CLIQUES ON INNOVATIVE PRODUCTIVITY

Abstract

Innovation entails a collaborative process that is influenced by the network of relationships in which individuals are embedded, yet these relationships convey diverse relational content. We distinguish between instrumental and affective (non-instrumental) embedded relationships or cliques and posit that these "informal groups" have an impact on individuals' innovative performance. Using original data from the corporate R&D lab of a global science-based company, we provide evidence that instrumental/knowledge-exchange cliques and non-instrumental/friendship cliques are positively associated with individuals' innovative performance. However, we also observe that innovative performance is hindered when individuals simultaneously belong to both instrumental and non-instrumental cliques. Our findings highlight the importance of jointly considering network content, structure, and position to better understand the complex relationship between networks and innovation.

Key words: innovative productivity; affective ties; instrumental ties; cliques; individual level

3.1 INTRODUCTION

Knowledge workers are fundamental for firm performance due to their capacity to generate ideas, integrate knowledge, and ultimately develop innovations (Argote *et al.,* 2003; Perry-Smith, 2006; Sosa, 2011). Their ability to contribute to the generation of innovations is due to their individual human capital (Castanias and Helfat, 2001; Coff and Kryscynski, 2011), but it is also driven by the network of relationships and informal interactions through which they exchange knowledge and information (Paruchuri and Awate, 2016; Tortoriello, 2015; Grigoriou and Rothaermel, 2014; Singh and Fleming 2010; Kleinbaum and Tushman, 2007; Reagans and McEvily 2003). One of the primary mechanisms through which informal networks are thought to contribute to individuals' ability to generate innovations is by providing access to relevant knowledge and information (Burt, 1982, 1992). As knowledge is unevenly distributed in organizations, developing network relationships whereby knowledge is accessed and mobilized becomes a key enabler for individuals' innovativeness. Consistent with this tenet, network scholars interested in innovation have focused on the advantage of having access to diverse sources of knowledge that certain network structures and network positions provide through instrumental/knowledge-exchange ties. Yet, limiting the analysis to instrumental (i.e. knowledge-sharing) ties might end up providing only a partial view of the mechanisms through which social relationships affect innovativeness (Casciaro and Sousa, 2008). As innovative activities are characterized by a high degree of uncertainty and risk, non-instrumental (e.g. affective) ties providing social support, help and assistance could also play an important role in favoring the process leading up to the development of innovations (Perry-Smith and Mannucci, 2017; Sosa, 2011).

In this study, I aim to refine our understanding of the relationship between networks and innovation by investigating the effect that the relational content of network ties has on individuals' innovative performance and, furthermore, how this effect is contingent on individuals' network structure and network position. First, I suggest that the exclusive reliance on instrumental (e.g. knowledge-exchange) ties as the only driver of the process leading to the generation of innovations might be overlooking meaningful complementary explanations to this process that can be found in the existence of affective-based or non-instrumental types of relationships (e.g. friendship ties). As it has been previously suggested, for instance, the affective content of ties can influence the way individuals seek, access, and mobilize resources impacting creativity, motivation, collaboration, and ultimately innovation (Casciaro and Lobo, 2008; Sosa, 2011). Second, I focus on embedded triadic relationships, as recently argued by Perry-Smith and Mannucci (2017), "the process of converting the idea into a tangible outcome" is more likely to benefit from embedded rather than from sparse relationships. Given the need for long-term and reciprocal commitment among the parties involved in an innovation effort, the constant support, mutual trust, and willingness to help that characterize embedded relationships become critical factors increasing the likelihood of success for a given collaboration endeavor (Kilduff and Brass, 2010; Uzzi, 1996; Obstfeld, 2005). Finally, considering the instrumental or affective nature of embedded relationships could provide new insights into the process through which access to knowledge, information or other resources favors individuals' innovative performance. These arguments suggest that jointly considering the relational content and the structure of informal relationships, as well as the position of individuals' within these networks deserves further attention to explain the success or failure of innovation initiatives.

Within this framework, I explore how embedded relationships conveying instrumental and non-instrumental relational content, affect individuals' innovative performance. I center my analysis on a specific network configuration that constitutes the most elemental level of embeddedness and that is likely to be associated with the successful implementation of a new idea into an actual innovation (Perry-Smith and Mannucci, 2017; Tortoriello and Krackhardt, 2010): embedded triadic relationships. There is a long research tradition on this type of embedded relationships (Krackhardt, 1998, 1999; Krackhardt and Kilduff, 2002; Tortoriello and Krackhardt, 2010; Tasselli and Kilduff, 2017), suggesting that these structural arrangements are distinct and qualitatively different from simple dyadic relationships given that the presence of a common third-party tie transforms isolated dyads into "three-person informal groups" (i.e. *cliques*). Embedded triads are usually characterized by strong, stable, and durable relationships among the involved parties, and they represent the building blocks of more complex social structures (Krackhardt, 1999). Sharing a third-party tie increases "the potential for longer-term generativity and coordination" (Obstfeld, 2005: p. 121), and helps promoting the stability of ties through psychological (Heider, 1964) or social mechanisms

(Krackhardt and Handcock, 2007). The strength, stability, and durability of embedded triads should therefore favor individuals' ability to generate innovations.

In what follows I seek to develop this line of reasoning by theorizing and providing empirical evidence for the importance of embedded relationships considered in the context of instrumental *and* non-instrumental ties as important drivers of individuals' innovative performance. More specifically, in the context of the R&D function of a large European pharmaceutical company, I study embedded triadic relationships of instrumental (i.e. knowledge-exchange) and non-instrumental (i.e. friendship) ties among 127 researchers (scientists and technical staff) as determinants of their ability to generate innovations. My results show that having embedded relationships matters for innovative performance. In particular, I observe that in addition to instrumental embedded relationships, also affective embedded relationships are positively related to individuals' innovative performance. Interestingly, however, combining embedded instrumental with embedded affective ties rather than increasing the positive performance effects, reduces innovative performance. Implications for network theories of innovation and for practice are discussed.

3.2 TIE CONTENT: KNOWLEDGE AND FRIENDSHIP TIES

A focus on the structural patterns of relationships has mostly treated different kinds of relationships as more or less equivalent, largely neglecting the relational content of these ties, and often aggregating different types of ties together (e.g. Obstfeld, 2005; Burt 1992, 2000; Zaheer & Soda, 2009). But in reality, even in professional contexts, "people exchange emotional and material aid, information and companionship" when interacting with one another (Plickert *et al.*, 2007: 406); indeed, social networks scholars have acknowledged that different kinds of relationships, whether instrumental or affective, have different effects on individual behavior (e.g. Battilana and Casciaro, 2013; Casciaro and Lobo, 2008; Coleman *et* *al.* 1966). Informal ties within organizations can vary depending on the tie being principally a conduit of task-related resources (instrumental tie) or a conduit of organizational identity and sense of belonging (affect-based tie) (Podolny and Baron 1997). While some informal ties are valued for the resources that flow through them (e.g. knowledge); some other ties are sources of identity and social support and are often "valued for their own sake" (e.g. friendship) (Ibarra and Smith-Loving, 1997). This suggests that similar structural patterns may result in different outcomes, or similar structural patters may trigger different mechanisms when the content of the relationship is considered (Kilduff and Brass, 2010; Balkundi and Harrison, 2006). In this chapter, I argue that the relational content of social ties has an impact on individuals' innovative productivity, and that this impact is better understood if these types of ties are studied relative to each other: instrumental (knowledge-exchange) versus non-instrumental (friendship) ties.

Instrumental ties facilitate gathering information, knowledge, advice, and resources necessary to accomplish a task (Umphress *et al.* 2003). Non-instrumental or affect-based ties provide social support, sense of identity and personal belonging, and serve to transmit normative expectations (Coleman 1988, 1990). Instrumental ties, and particularly knowledge-exchange ties, have been extensively studied by network scholars and their relevance for innovation is generally accepted (Phelps, *et al.*, 2012). Through knowledge-exchange ties individuals can access, transfer, absorb, and apply/recombine knowledge, and these actions are fundamental for innovation (Fleming, 2001; Fleming *et al.*, 2007; McFadyen *et al.* 2008; Singh and Fleming, 2010; Reagans and McEvily, 2003). The relevance of non-instrumental/affect-based ties for innovation on the other hand has seldom been studied and it is therefore less well understood. Yet, as innovation entails a long-term process that is characterized by high degree of uncertainty and risk, understanding the role of socially supportive forces and the influence of interpersonal affect on the way people seek out and access resources is relevant for collaboration and innovation (Casciaro and Lobo, 2008; Perry-Smith and Mannucci, 2017; Sosa, 2011).

Early research proposed to distinguish ties in terms of their strength. Granovetter (1973) in particular originally conceived tie strength as "the (probably linear) combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie" (p. 1371). Later he asserted that in general, "strong ties have greater motivation to be of assistance and are typically more easily available" (Granovetter, 1982; p. 113). Subsequent research on tie strength has focused primarily on the frequency of interactions leaving relatively unexplored the more affect-driven components of tie strength. The emotional intensity, intimacy, and reciprocal aspects of a strong tie imply a close resemblance to a friendship type of relationship (Krackhardt, 1998). Friends, relative to acquaintances, are more likely to be truly interested in helping other friends: "Notwithstanding ambiguity, people agree on the fact that a friend gives support, can be trusted, shows respect and real interest, is verbally open, and is a comrade" (Stokman 2004: p. 19). Friendship relationships, in fact, imply the existence of affect-based trust among parties (McAllister, 1995) or the belief that parties are benevolent towards one another and therefore no advantage will be sought once a party reveals vulnerabilities (Levine and Cross, 2004), for instance by asking for sensitive information or showing lack of knowledge or inexperience. Similarly, friendship relationships are charged with strong positive affect (Krackhardt, 1998), which in turns can influence individuals' motivation and willingness to put forward greater effort on personal initiatives (Sosa, 2011).

Battilana and Casciaro (2013) have recently shown that strong ties can lead to garnering support for new ideas by means of emotional bonds between individuals, an important finding as it is the implementation of ideas, and not just recombination, that leads to the realization of innovation (Obstfeld, 2005; Sosa, 2011). Similarly, the trust engendered by friendship ties can lead to the exchange of sensitive/strategic information between parties (Krackhardt, 1992; Westphal *et al.*, 2006); and, the qualities of strong ties may be a necessary condition for the effective transfer of complex and tacit knowledge (Hansen, 1999; Levin and Cross, 2004). Thus, friendship ties can also serve as means by which individuals can access strategic/sensitive information, exchange complex and tacit knowledge, and further develop their ideas with the support of friends. Moreover, friendship ties are also charged with strong positive affect and positive affect has been found to stimulate creativity and innovation (Amabile *et al.* 2005; Amabile *et al.*, 1996; Amabile, 1988). Positive affect can lead to an increased perception of idea-stimulating information, can facilitate the storage and access of relevant information, can favor the combination of this information in novel and creative ways, and can also increase the willingness to continue exploring unusual and complex ideas (see Hayton and Cholakova (2011) for a systematic review of the role of affect and entrepreneurial activity). The positive affect and high levels of intrinsic motivation that is fostered in an affect-based relationship is a combination that is conducive to generative creativity and to the pursuit of actions to innovate (Sosa, 2011).

Research in social psychology has asserted that "the social environment [in which an individual is embedded] can influence the level and the frequency of creative behavior…which is the starting point for innovation" (Amabile *et al.* 1996: p. 1155). As scientists, inventors, and researchers are agents embedded in a social world, relationships and colleagues are a key aspect of this social world as they ultimately affect their ingenuity (Carmeli *et al.*, 2015). The reactions of peers to one's ideas is one of the most emotionally powerful event within organizations (Stone and Neale, 1942; Weiss and Cropanzano, 1996), and "when reactions to ideas are encouraging, a virtuous cycle may be established, in which cognitive variation and creativity are subsequently increased" (Amabile *et al.*, 2005: p. 394). Classical work on the psychology of invention have underscored the importance of social interactions in science (Feist and Gorman, 1998). For example, Simonton (1988) found that inventors evaluate their inventions before exposing them to the broad community, activity that is likely to involve close colleagues. Similarly, inventors must "learn the rules and content of the domain" and "the preferences of the field" to invent (Csikszentmihalyi, 1996: 47), and must answer questions like, "Whose perceptions should be used to evaluate quality? What criteria are used? How is it decided how to weigh the various criteria? Are these criteria and evaluations fair or biased against particular individuals or groups of individuals?" (Feist and Gorman, 1998); strategic information that can be accurately obtained from close colleagues. These crucial susceptible actions (expose and develop ideas) and need for information (that can be sensitive/strategic) suggest the necessity of an essential level of interpersonal trust between those involved, the type of trust engendered in strong relationships (McAllister, 1995; Perry-Smith and Mannucci, 2017).

3.3 TIE STRUCTURE: EMBEDDED TRIADS (OR CLIQUES)

This cursory review of prior research suggests that probably, in addition to instrumental (knowledge-exchange) ties, also non-instrumental/affect-based (friendship) ties could play an important role for the generation of innovations. But beyond the characteristics of the ties, also their structural configuration is likely to matter in order to explain variation in individuals' innovative capabilities. In particular, recent studies are starting to challenge the belief that sporadic ties to unconnected individuals are better catalysts for innovation than other types of ties (e.g. Sosa, 2011; Tortoriello and Krackhardt, 2010). These studies are bringing more attention to the fact that creative ideas need a significant amount of "social traction" and support to evolve into actual innovations (e.g. Fleming *et al.*, 2007; Perry-Smith and Munnucci, 2017; Obstfeld, 2005). In particular, considering that the process leading to the generation of innovations is lengthy and difficult; strong, stable, and durable relationships, relative to sporadic connections, are more likely to provide the type of support, mutual trust, and willingness to help which are necessary for achieving a successful outcome for any given collaboration (Kilduff and Brass, 2010; Uzzi, 1996). Thus, we pose that to better understand the association between different types of relationships and individuals' innovative productivity, it is more informative to focus on strong, stable and durable relationships among individuals rather than sporadic ties. Network researchers maintain that embedded triads, i.e. dyadic relations with a shared third party, relative to dyadic relations in general, are stronger and more stable over time (Krackhardt, 1998). Therefore, our study focuses on the relationship between instrumental vs non-instrumental embedded triads or "triadic cliques" and individuals' ability to generate innovations (see Figure 3.1).

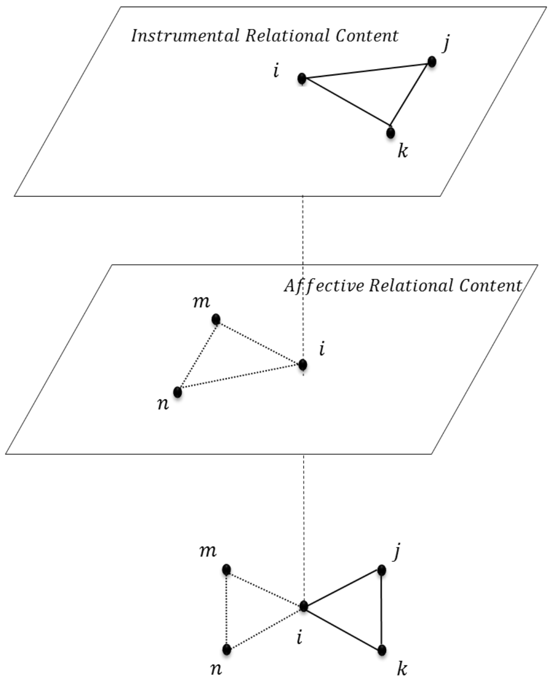


Figure 3.1 Instrumental-Based and Affect-Based Cliques

3.3.1 Cliques and Individual Innovative Productivity

Enduring patterns of relationships are the footholds of complex social structures, which once revealed, can provide explanations of outcomes at different levels (Kilduff and Brass, 2010: p.325). Perry-Smith and Mannucci (2017) argue that both tie strength and micro-structural characteristics are relevant for creativity and innovation. In their theoretical framework, they highlight the need for social support and the development of a shared vision and understanding as critical aspects at different phases of the innovation process. In particular, they argue that structural closure or embeddedness is a network characteristic that facilitates individual idea production. The idea of embeddedness or embedded ties is reminiscent of Simmelian relationships, which are considered the building blocks of more complex social structures (Krackhardt, 1999). A Simmelian relationship exists when the parties involved in a dyad are reciprocally connected to one another and each one is reciprocally connected to a common third party, i.e. dyads embedded in triads or triadic cliques (Krackhardt, 1999). There are three main conditions that make a Simmelian relationship different from other types of relationships. First, reciprocity is a necessary condition for social equilibrium and cohesion to exist (Simmel, 1950). Second, when two individuals are directly connected, the shared third party reinforces that tie by acting as an neutral arbitrator (Krackhardt, 1998). And third, shared third parties also reduce the psychological imbalance that arises from experiencing disconnected others (Heider, 1964). Thus, by making an analogy from cell biology, I argue that Simmelian relationships represent the nucleus of an individual's network. Just like the nucleus is the kernel of the cell, Simmelian ties represent the core component of an individuals' network and therefore, they exercise a great deal of influence over an individual's actions.

Simmelian relationships can be empirically captured by identifying *cliques* of three or more people each one of whom is directly and reciprocally connected to all the other members of the clique (Krackhardt, 1999). In this study, I refer to cliques as informal groups of three people[8] who are reciprocally connected to one another, i.e. each individual has a Simmelian tie with one another and therefore they are embedded in a triadic clique (Tortoriello and Krackhardt, 2010). Cliques have important characteristics. Being embedded in a clique mitigates the pursuit of individuals' self-interests because it reduces the bargaining power of single individuals, and facilitates cooperation and conflict resolution (Krackhardt, 1999). The actions of individuals involved in cliques are reminiscent of cooperative strategies found in game theory, where a third party brings "loss of control and certain vulnerability to the subsequent collusion of alters, but along with the potential for longer-term generativity and coordination." (Obstfeld, 2005: p.121). Cliques are characterized by higher levels of trust and higher effort towards transferring information and solving problems when compared to "arm's-length" relationships (Kilduff and Brass, 2010; Uzzi, 1996). Cliques can provide a social micro-structure that enhances an individual's performance: "A cohesive network conveys a clear normative order within which the individual can optimize performance, whereas a diverse, disconnected network exposes the individual to conflicting preferences and allegiances within which it is much harder to optimize" (Podolny and Baron, 1997: p. 676). Finally, shared third parties aid the focal actor by enabling a better interpretation of information, resulting in richer, deeper, and higher quality exchanges (Gavetti and Warglien, 2015; Ter Wal *et al.*, 2016). These ideas are in line with Coleman's (1988) classical

[8] I consider cliques of three people as the qualitative difference of a relationship is most significant from the dyad to the triad, i.e. cliques of more than three people only have marginal effects on clique dynamics. As Simmel (1950) argued: "Dyads thus have very specific features. This is shown not only by the fact that the addition of a third person completely changes them, but also, and even more so, by the common observation that the further expansion to four or more by no means correspondingly modifies the group any further" (p. 138).

proposition that social structures facilitate certain actions for those involved in such social structures: “a group within which there is extensive trustworthiness and extensive trust is able to accomplish much more than a comparable group without that trustworthiness and trust” (p. S101).

In a knowledge-exchange clique, individuals are willing to share more knowledge and to share higher quality knowledge, that is more unique, more relevant, and richer/deeper knowledge. Within the knowledge-exchange clique, individuals are inclined to share knowledge more openly even when this might dilute the informational advantages that someone has. Individuals within a knowledge-exchange clique may feel more secure and more willing to ask for knowledge to others and to concede deference to their colleagues for the solution of critical problems, even when this may amount to conferring them power and status by acknowledging their ability to deal with a specific problem or issue. Similarly, in a friendship clique, individuals find themselves in a trustworthy environment where they can expose their ideas and obtain sensitive/strategic information knowing that other clique members will be genuinely interested in aiding them to further develop these ideas. A friendship clique also extrinsically fosters dyadic social support therefore strengthening a collaborative environment around the dyad. A friendship clique is a source of stable and enduring “doses” of positive affect influencing individual’s generative capabilities and sustaining the willingness to continue developing ideas until they realize into actual innovations.

To summarize, structurally speaking, cliques create a micro-context in which the interests and actions of clique members are pre-aligned providing optimal conditions to efficiently mobilize those interests and actions. In R&D settings like the one I am studying, shared third parties can promote the development of a common language and shared understandings that can facilitate coordinated actions necessary to innovate (Carlile, 2004; Obstfeld 2005). Any informational advantage from a given tie can be hindered by those involved acting opportunistically against one another, condition that is ameliorated by the presence of a common third party (Tortoriello and Krackhardt, 2010). Shared third parties can increase the willingness to devote time and effort for knowledge-based collaboration, for the development and implementation of innovation, and for the learning of tacit and complex knowledge (Kilduff and Brass, 2010; Obstfeld, 2005; Reagans and McEvily, 2003; Tortoriello and Krackhardt, 2010). Moreover, the need for long-term and reciprocal commitment among the parties involved in an innovation effort suggests that cliques could explain the final outcomes of the innovation process (e.g. patent applications). Hence, we contend that cliques serve as facilitators of the process leading to the generation of innovation.

The arguments thus far presented indicate that cliques, whether instrumental or affect-based, offer a safe and valuable ground in which researchers and inventors can learn, discuss, test and further develop their ideas because all parties involved are willing to work towards a common goal and make use of their own effort and resources to support each other's ideas. More formally, I hypothesize that:

> ***Hypothesis 1a****: Involvement in a knowledge-exchange clique is positively related to individual's innovative productivity.*
>
> ***Hypothesis 1b****: Involvement in a friendship clique is positively related to individual's innovative productivity.*

3.4 NETWORK POSITION: BROKERING CLIQUES

Considering the positive effects that knowledge-exchange and friendship cliques can have on individual's innovative productivity, it is intuitive to expect them to be complementary, amplifying the positive performance effects observed when considered independently. While an individual could obtain relevant, unique, and high-quality knowledge from her knowledge-exchange clique; she could also simultaneously obtain, from her friendship clique, the social support and positive affect necessary to push her ideas further until they become tangible innovation outputs. Nonetheless, instrumental-based relationships may have very distinct logics compared to affect-based relationships. As I have discussed so far, instrumental relationships are valued by the expectation of gains while affect-based relationships are valued for their own sake. While the former implies a "means to an end" logic, the latter implies a "benevolence" logic. Relatedly, it is possible that the trust engendered in each type of clique rests on different foundations. McAllister (1995) differentiated between cognitive-based trust and affect-based trust. The former is the result of rationality and the latter is the result of emotional bonds. Correspondingly, and closer to my theorizing, Levine and Cross (2003) differentiated between benevolence-based trust – being vulnerable to the benevolence of others; and competence-based trust – believing in the usefulness of other's competencies/knowledge. While trust as a general concept comprises different levels of these dimensions, it is most likely that the trust engendered in instrumental cliques has more of a cognitive/competence nature and the trust engendered in affect-based cliques has more of an affect/benevolence nature. While both types of trust can become complementary when shared by the same individuals, this dualism between instrumental and affective logics resulting from the relational content of these ties can generate conflicting pressures over those individuals who belong to cliques composed by different individuals. Individuals occupying these positions between cliques consisting of unshared third-parties (an "inter-clique position") may be subject to perceptions of potential "trust breach" from either clique, which can eventually hinder their ability to benefit from either clique.

Similarly, the high relational strength that characterizes a clique suggests that each clique demands substantial investments in terms of time and effort from each clique member. Consider an individual i who is in a knowledge clique with j and k and in a friendship clique with m and n (see Figure 3.1). Assume that m and n are investing significant time and effort in encouraging and morally supporting i to develop a very complex idea to be implemented in the lab. Also, j and k are investing significant amounts of time and effort in providing high quality and unique scientific knowledge to i for the development of her idea. At some point in between, both n and j find themselves needing support from i, they are both likely to feel entitled to obtain this support, n because of the emotional bond shared with i, and j because of the rational expectations shared with i; yet i must decide to whom she will focus on as she is constrained by her own time and effort space. Dealing with such competing demands puts a strain on i which is now dealing with different types of expectations from the members of the two cliques to which she simultaneously belongs. Furthermore, when these demands are of a very different nature they may exacerbate the strain on i as it would be more difficult to decide how to prioritize among them to attempt to evenly comply with both constituencies. While this could be dismissed as an oversimplified fictional example far from what happens in reality, there is actually concrete empirical evidence that individuals in organizations experience time and effort constraints when dealing with informal connections, and that similar mechanisms might be operating in professional contexts when certain network structures emerge. For example, Reagans *et al.* (2015) studied knowledge workers in an IT services firm and found evidence that unshared third-parties hinder knowledge transfer.

They argue that unshared third parties create conflicting demands (time and effort) on the focal actor that end up stifling the knowledge transfer process. While in their study they did not observe the performance implications of this proposition, and they only limited the analysis to instrumental relationships, their findings clearly hint at the fact that there might be potentially negative effects on individuals' ability to mobilize knowledge when they occupy what is colloquially referred to as a "bowtie network position".

The arguments thus far presented suggest that while cliques, whether instrumental or affect-based, offer a trusty and valuable ground in which researchers and inventors can learn, discuss, test and further develop their ideas; occupying a position between two different cliques, i.e., a bowtie network position, could be so problematic and demanding that an individual occupying such a position could end up being worse off than if she simply lived in a single clique, especially when these cliques are built under very different logics. These arguments resonate with classical work in network theory, where scholars have argued about the negative effects that individuals who are involved in separate cliques may experience as they must satisfy the norms and logics of different/non-overlapping social circles, referring to this phenomenon as "the ties that torture" (Krackhardt's, 1999). An individual who shares membership in different cliques is subject to the vigilance of co-clique members who can "punish" any violation of the norms and values held within the clique by being part of a different clique (Krackhardt, 1998, 1999). Unshared third-parties expose the individual to "conflicting preferences and allegiances within which it is much harder to optimize" (Podolny and Baron, 1997: p. 676). Simultaneous affiliation to different cliques drives ego to "keep a low profile in either group, or try to segregate in time or space his affiliation with the groups" – ego is therefore "rip-sawed by conflicting pressures" (Burt, 2015: pp.151). In essence, the stability and durability that characterizes cliques is hindered by the "brokerage" position between cliques, because this position jeopardizes the engendered trust and expectations of either clique. I extend and contribute to this stream of research by qualifying and distinguishing ties in terms of their instrumental or affective nature which identify different motives and logics behind their formation and existence. In particular, what I conclude is that while belonging to cliques of one kind (either friendship or advice) is positively associated with individuals' innovative performance, being simultaneously associated with both types of cliques is negatively associated with individuals' innovative performance. More formally, I hypothesize that:

> ***Hypothesis 2****: Simultaneous involvement in a knowledge-exchange and a friendship clique is negatively related to individual's innovative productivity.*

3.4 DATA AND EMPIRICAL METHODS

3.4.1 Research site and data sources

The research site used to test my theory is the corporate R&D center of a global pharmaceutical company. The company has a strong focus on in-house research and development (75% of its turnover is generated by its own R&D division) and it is one of the top patent filing companies in Europe, constantly increasing investments in R&D and expanding its range of products. This study is focused on the functional unit in charge of chemistry, manufacturing, and control (CMC). This functional unit oversees drug substance development, and formulation, device, and analytical development. At the time of data collection, it employed 128 individuals, consisting of 37 scientists, 48 laboratory technical staff, 10 heads of unit, 6 heads of department, 5 technical leaders, and 22 analytics and administrative staff (including the head of the function). Interviews were held with several employees and a network survey was conducted within the lab. Archival data was also provided by the company. During these interviews, managers expressed that "workers' interactions are a significant part of their daily activities and working time, in particular due to the complexity that this type of knowledge entails". There is also a strong belief that workers' interactions are a major source of innovation for the company as workers can "take advantage of each other's diverse expertise and experience" and can "rely on each other's support and encouragement". Similarly, workers in this setting reported that when they engage in interactions they are mostly motivated by learning, intellectual challenge, and stimulating future interactions: 80% of the sample reported that they seek knowledge from colleagues mostly because they want to learn and 54% of the sample reported that they share knowledge with their colleagues mostly because they want to stimulate future knowledge interactions and 17% because they like to have intellectual challenges. This goes in line with the fact that promotions and rewards are based on knowledge and expertise and people advance in their career based on their knowledge production and scientific standing (Cockburn *et al.* 1999). There is also strong patenting activity, with 79 patent applications filed during the period of our study (just from the CMC).

3.4.2 Survey

The network questionnaire was developed after field interviews with the Head of the function, Heads of Department, and Human Resources representatives. The questionnaire was pre-tested with a pilot study involving a limited number of the management team to create network questions as specific as possible that elicited long-term patterns of interaction rather than one-time events (Freeman *et al.*, 1987). The questionnaire was electronically delivered to the entire population of CMC employees. The network measurements were based on workers' individual outgoing choices, which have the advantage to be largely under the control of the focal actor. These measures are very reliable when researchers follow appropriate procedures to help individuals to recall their social structure (Borgatti and Cross, 2003). As soon as the respondents started typing the first letters of their contacts' name or surname, the on-line survey tool suggested names of CMC employees matching with the letters inserted, thus easing the "alters" selection task. Hence, we both avoided typos and, at the same time, potential intricacies arising from a roster with hundreds of names. Completed questionnaires were returned by 109 employees yielding a high response rate (85%). I assessed the risk of non-response bias by conducting a wave analysis comparing the demographic variables for early (1^{st} week) versus late (3^{rd} week) respondents (Rogelberg and Stanton, 2007). The assumption is that the group of late respondents will be more similar to the non-responding group than to the group of early respondents. An analysis of variance (ANOVA) of the difference in means for the two groups for the demographic variables showed that the hypotheses of differences in means could all be rejected (F-values < 2).

3.4.3 Archival Data

I complemented the survey data with archival data provided by the company. These data included a structured *vitae* for each employee (which included patent applications and grants as well as scientific publications) and employees' demographic information related to department affiliation, rank, tenure, age, and gender.

3.4.4 Dependent Variable

Using information (provided by the company) – which was then corroborated and updated by reviewing the patent applications filed in the United States Patent and Trademark Office (USPTO) and the European Patent Office (EPO) using the Google Patent search engine, I tracked down the patent applications filed by respondents during an 18 months period: 6 months before and 12 months after the collection of network data (Tortoriello and

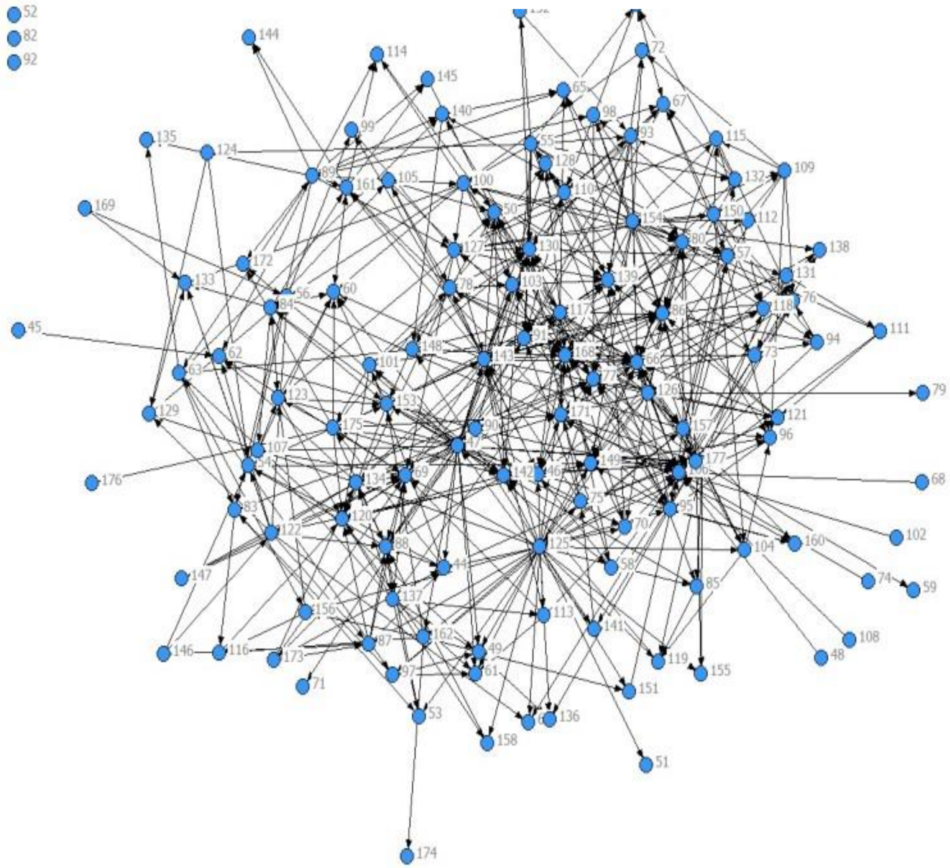
Krackhardt, 2010). The number of patent applications generated by respondents during this period represents this study's dependent variable.

3.4.5 Independent Variables

The network data was generated by asking respondents two network questions, one related to instrumental ties (scientific knowledge acquisition) and one related to affective ties (friendship), specifically: (1) "Please select the people from whom you receive and to whom you provide **science related** knowledge" and; (2) "Please select the people who you consider **good friends**". Using this information, I mapped all scientific knowledge and friendship ties in the laboratory. In Figure 3.2 I show both networks.

From the network graphs shown in Figure 3.2 it is easy to see how there are important differences in the morphology of the two networks. Particularly, while both networks are equally dense (0.036) and have the same average degree centrality (4.6), they are quite different in terms tie distribution and therefore we identify relationships that are substantively distinct. This can be seen for instance in terms of the degree of network centralization (knowledge network = 0.24 vs. friendship network = 0.12), reciprocity of the relationships (knowledge network = 0.14 vs. friendship network = 0.44), and closure (knowledge network = 0.27 vs. friendship network = 0.34). These measures indicate that: (1) the knowledge network is more centralized around particular individuals than the friendship network, which indicates individuals tend to attach to "more knowledgeable" researchers showcasing the instrumentality behind this type of relationships, whereas friendship relationships are more diffuse and spread out among individuals; (2) friendship relationships, as intuition would suggest, are substantially more reciprocated than knowledge relationships, which indicates an important difference in terms of the logic behind the establishment of each type of

Scientific Knowledge Network



Friendship Network

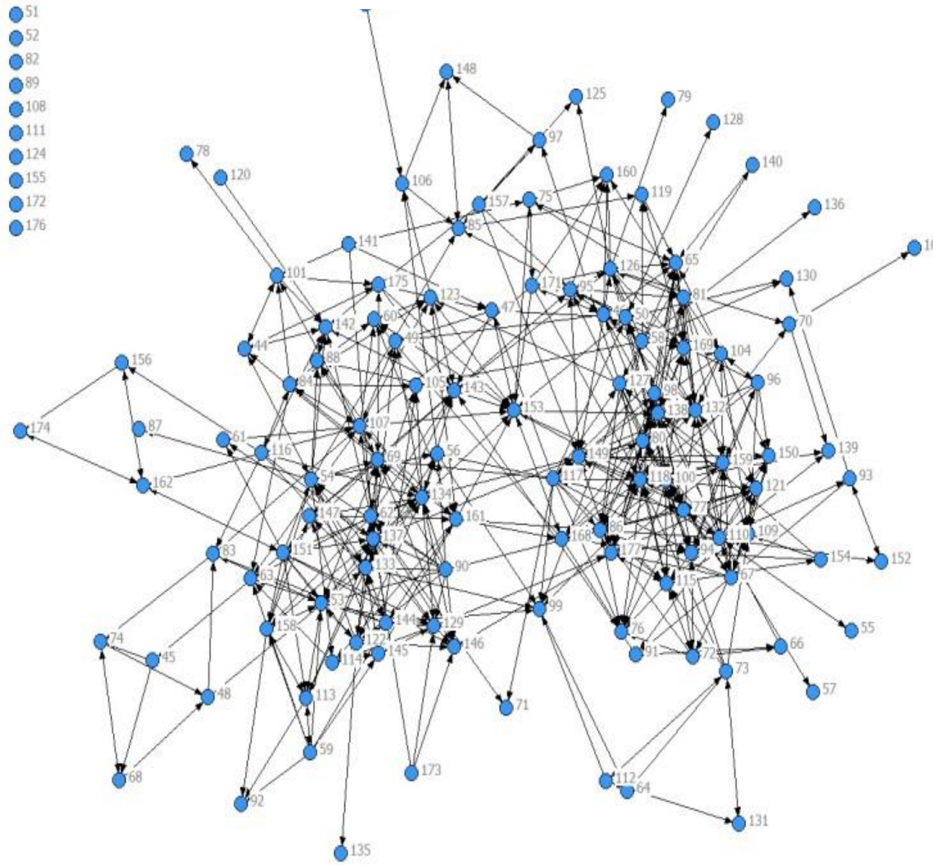


Figure 3.2 The Scientific Knowledge Network versus the Friendship Network

relationship, friendship ties tend to be reciprocated because people value the relationship in and of itself while knowledge ties tend to be non-reciprocated because there is no point for more knowledgeable people to seek out for advice less knowledge ones; finally, (3) the friendship network has higher closure than the knowledge network, which indicates that on average individuals are better connected through friends than through knowledge contacts.

The raw data from these assessments can be represented as a friendship tie f_{ij} or a scientific knowledge tie k_{ij}, where i represents the sender of the tie and j represents the receiver of the tie. Then, an identifier for friendship or scientific knowledge tie (a friendship dummy and a knowledge dummy) was created. I used Krackhardt's (1998) formulation to identify Simmelian ties (i.e. ties embedded in triadic cliques) from our set of raw ties. A tie from i to j is Simmelian if and only if both i and j share a tie with k (i.e. i, j, and k form a triadic clique). For each friendship tie f_{ij} in our sample we checked if $f_{ij} = f_{ji} = f_{ik} = f_{ki} = f_{jk} = f_{kj} = 1$, and then a Simmelian friendship dummy identifies f_{ij} as a Simmelian tie. Similarly, for each scientific knowledge tie k_{ij} in our sample we checked if $k_{ij} = k_{ji} = k_{ik} = k_{ki} = k_{jk} = k_{kj} = 1$, and then a Simmelian knowledge dummy identifies k_{ij} as a Simmelian tie. Any tie not satisfying these conditions was considered a non-Simmelian tie.

I then constructed a dataset at the individual level where we aggregated friendship and scientific knowledge ties for each worker i, and each observation corresponds to ego characteristics. There is a dummy variable indicating whether worker i is involved in a Friendship Clique and a dummy variable indicating whether worker i is involved in a Knowledge Clique. When worker i is involved in both a Friendship and a Knowledge Clique, I created a dummy variable that is equal to 1 when both the Knowledge Clique and Friendship Clique dummies are equal to 1 (the interaction term).

3.4.6 Control Variables

I control for several elements that might provide alternative explanations for the hypothesized relationships between Knowledge cliques, Friendship cliques, and individual innovativeness. For instance, I use dummy variables to identify Technical Leaders, Heads of Departments, and Heads of Unit to control for the possibility that, because of their formal roles, they might be involved in more patent filings than their colleagues. I also use dummy variables to identify Scientists and Technical staff to control for the possibility that because the nature of their tasks, they might be more or less involved in patent filings. I also control for gender in order to account for differences in patenting propensities between men and women (Whittington and Smith-Doerr, 2008). I also control for the level of education (i.e. having a PhD degree) as individuals with a doctorate degree can be expected to be especially skilled in generating innovations (Gruber *et al.* 2013). I also control for the number of contacts in individuals' friendship and knowledge networks as a greater number of connections can provide more opportunities and resources. Given that scientists and researchers can develop human capital that is either oriented towards commercialization (invention-oriented) or towards scientific knowledge (research-oriented), this would influence their innovative productivity in terms of patenting (Toole and Czarnitzki, 2009); therefore, I control for the number of patents filed by each respondent in up to 10 years before our study period (i.e. number of patent applications filed 10 years before the time window used to determine our dependent variable), and I also control for the number of papers published in academic journals in the 10 years before our study period. Finally, I also include controls for tenure within the company to account for any possible advantage in patent filing resulting from firm-specific human capital.

3.5 RESULTS

Descriptive statistics and correlation coefficients are reported in Table 3.1. Overdispersion in the dependent variable suggested the use of a Negative Binomial model with robust standard errors. I corroborated the distribution fit of the dependent variable with a Negative Binomial and a Poisson distribution and, the Negative Binomial best suited my dependent variable (see figure 3.3). Results from the analysis are presented in Table 3.2.

Table 3.1 Descriptive Statistics and Correlations

		Mean	Stdv	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Patent Applications	0.62	1.96													
2	Knowledge Clique	0.14	0.35	0.091												
3	Friendship Clique	0.41	0.49	0.081	0.169											
4	Pre Patent Applications	2.70	8.65	0.447*	-0.049	-0.062										
5	Pre Publications	1.23	3.21	0.078	0.132	0.178*	0.100									
6	Female	0.65	0.48	-0.278*	-0.079	0.009	-0.123	0.008								
7	Scientist	0.29	0.46	0.098	0.337*	-0.001	-0.058	0.228*	-0.108							
8	Technician	0.38	0.49	-0.244*	-0.128	0.148	-0.210*	-0.188*	-0.038	-0.494*						
9	Head of Department	0.05	0.21	0.024	-0.090	-0.033	0.452*	0.122	-0.069	-0.141	-0.172					
10	Head of Unit	0.08	0.27	0.176*	0.050	-0.004	0.092	0.006	-0.091	-0.186*	-0.225*	-0.065				
11	Technical Leader	0.04	0.19	0.390*	-0.082	0.162	0.308*	0.099	-0.020	-0.129	-0.156	-0.045	-0.059			
12	Has a PhD	0.05	0.23	-0.023	0.100	0.151	-0.076	0.552*	0.105	0.150	-0.044	-0.053	-0.07	-0.048		
13	Centrality Knowledge N.	4.56	5.71	-0.024	0.502*	0.089	-0.038	0.248*	0.015	0.252*	-0.119	-0.015	0.007	-0.048	0.097	
14	Centrality Friendship N.	4.60	4.58	0.125	0.296*	0.571*	-0.033	0.184*	-0.071	0.226*	-0.081	-0.159	0.108	0.000	0.172	0.308*

* Significant at $p < 0.05$.

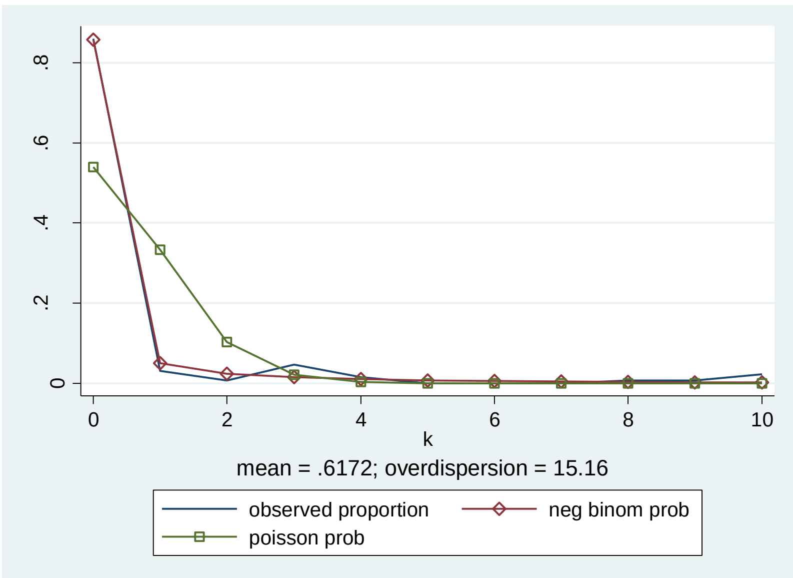


Figure 3.3 Dependent Variable Distribution Fit

In model 1 I regress the count of patent applications on our set of control variables. In models 2 and 3 I include the terms for Knowledge Clique and Friendship Clique respectively. In model 4 I include both terms and in model 5 I include the interaction term. From the full model, we can observe, as expected, that female workers and technicians are negatively related to patent applications ($p<0.01$ significance level), while having roles as Head of Unit, Head of Department, or Technical Leader are positively related to patent applications ($p<0.01$ significance level). The variables of interest, Knowledge Clique and Friendship Clique are both positively related to the generation of patent applications ($p = 0.003$ and $p = 0.008$ significance levels respectively). The substitution effect between Knowledge and Friendship Cliques on patent application generation is tested through an interaction term that takes the value of one when a worker is involved in both types of cliques. The coefficient of the interaction term is negative and significant ($p = 0.025$). These results suggest that the qualitative differences of either affective or instrumental clique relationships are relevant for individuals' ability to generate innovations. Yet, they also suggest there is a substitution effect between the affective and instrumental content of these relationships.

I plot the predicted effects in Figure 4. The likelihood of generating patent applications is positively correlated with either Knowledge or Friendship Cliques, yet this positive correlation is diminished for individuals who are involved in both types of cliques concurrently compared to individuals who only have either of the two. In Figure 5, I further qualify my findings by showing the average marginal effects of the interaction term. For those who patent, the average marginal effect of a Friendship Clique is 4.7 ($p<0.000$) more patent applications, nonetheless, if they also belong to a Knowledge Clique then they file 2.19 ($p<0.03$) less patent applications.

Table 3.2 Negative Binomial Estimations of Patent Applications

Dependent Variable: Number of Patent Applications	(1) Controls	(2) K Clique	(3) F Clique	(4) K/F Cliques	(5) KxF Cliques
Controls					
Pre Patent Applications	0.104***	0.125***	0.126***	0.152***	0.160***
	(0.0321)	(0.0397)	(0.0339)	(0.0445)	(0.0409)
Pre Publications	-0.0129	0.0173	-0.0448	-0.0196	-0.191
	(0.100)	(0.116)	(0.0936)	(0.107)	(0.120)
Female	-1.846***	-1.483***	-2.270***	-1.922***	-2.485***
	(0.571)	(0.565)	(0.595)	(0.567)	(0.793)
Scientist	15.04***	16.20***	15.84***	15.21***	16.55***
	(0.612)	(0.679)	(0.519)	(0.591)	(1.009)
Technician	-14.34***	-13.92***	-14.88***	-14.97***	-14.50***
	(0.577)	(0.580)	(0.644)	(0.641)	(0.819)
Head of Department	10.82***	11.14***	10.97***	9.208***	11.24***
	(1.550)	(1.758)	(1.604)	(2.016)	(2.059)
Head of Unit	14.99***	16.60***	15.77***	15.54***	16.52***
	(0.721)	(0.764)	(0.695)	(0.741)	(0.937)
Technical Leader	15.40***	16.47***	15.41***	14.59***	15.36***
	(1.018)	(1.027)	(1.083)	(1.141)	(1.317)
Has a PhD	0.169	-0.168	-0.264	-0.582	0.751
	(1.274)	(1.366)	(1.120)	(1.222)	(1.112)
Tenure	0.000284	0.000902	-0.00143	-0.000949	-0.00350
	(0.00536)	(0.00528)	(0.00460)	(0.00454)	(0.00436)
Centrality Knowledge Network	-0.128	-0.200**	-0.143*	-0.225**	-0.0999
	(0.0865)	(0.0941)	(0.0780)	(0.0978)	(0.0941)
Centrality Friendship Network	0.0718	0.0506	0.00497	-0.0241	-0.0644
	(0.0537)	(0.0617)	(0.0442)	(0.0490)	(0.0524)
Explanatory Variables					
Knowledge Clique		1.414**		1.396*	2.099***
		(0.710)		(0.814)	(0.714)
Friendship Clique			1.333**	1.380*	2.978***
			(0.674)	(0.722)	(1.117)
Knowledge Clique x Friendship Clique					-3.346**
					(1.493)
Constant Terms	-14.69***	-16.27***	-15.26***	-14.96***	-16.31***
	(1.103)	(1.051)	(0.948)	(0.924)	(1.051)
Log Pseudolikelihood	-67.3483	-65.8177	-65.7909	-64.2521	-62.0391
χ^2	9253.76	9135.51	11202.03	11433.14	7238.28
Pseudo R^2	0.2985	0.3145	0.3147	0.3308	0.3538
Number of Observations	127	127	127	127	127

Robust standard errors in parentheses
*** *p<0.01*, ** *p<0.05*, * *p<0.1*

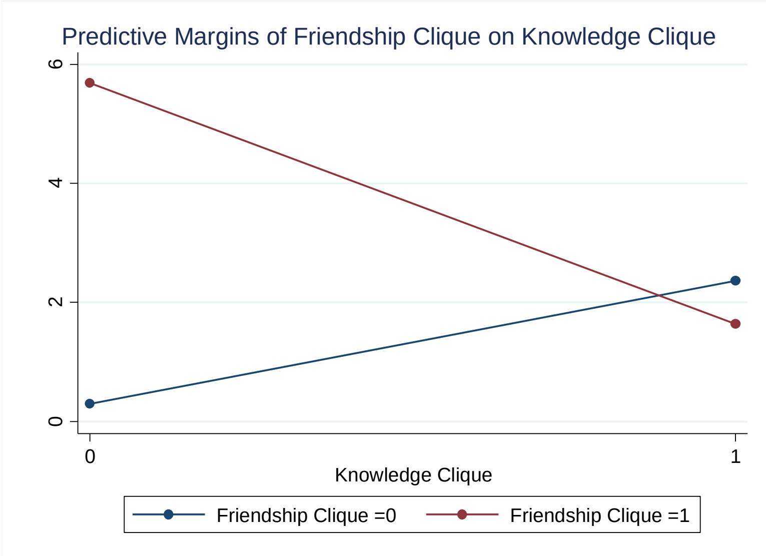


Figure 3.4 Predictive Margins of Friendship Clique on Knowledge Clique

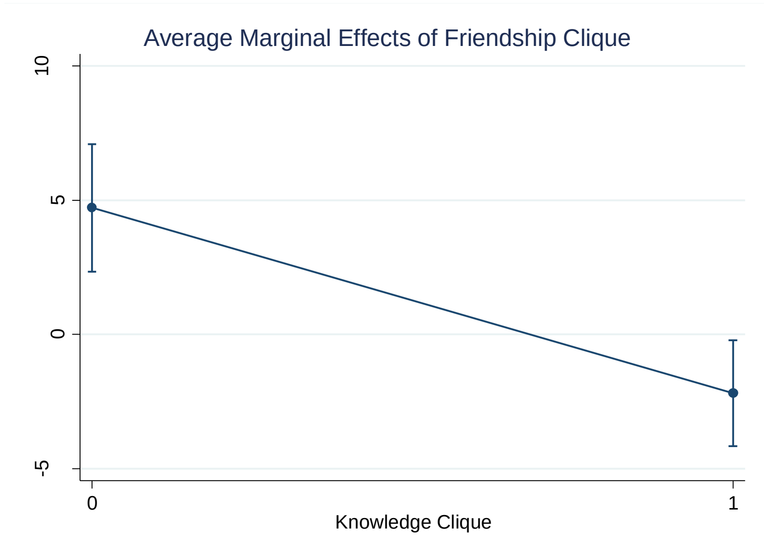


Figure 3.5 Average Marginal Effects of Friendship Clique on Knowledge Clique

Put differently being in a Friendship Clique but not in a Knowledge Clique is significantly above the 0 (no effect) line, while being in a Friendship Clique and in a Knowledge Clique at the same time is significantly below the 0 line.

3.5.1 Robustness tests

I perform a series of extra analyses to assess the robustness of my main results and present the results of these analyses in Table 3.3.

First, access to diverse information and a variety of different perspectives has been proved to be relevant for innovative performance. Research on brokerage has shown that the presence of structural holes (ego is connected to two alters that are disconnected themselves) provides advantages from access to diverse knowledge and information leading to the generation of new ideas (Burt, 2004). In model 6 I include a control for structural holes[9] in the knowledge and the friendship network and, although these variables are statistically significant, we observe no changes in the magnitude or significance of our findings.

Second, a possible concern regards the fact that some individuals may have a higher propensity to be involved in cliques compared to others and therefore the potentially endogenous nature of being located in a clique could bias our results. To account for this, I follow Terza's (1998) two-stage method of moments for count data models with endogenous binary explanatory variables. This is a control function approach similar in nature to a Heckman two-stage model (a comparable approach was followed by Kleinbaum (2012) and Tortoriello (2015)). When dealing with non-linear estimators, the control function is preferred to using instrumental variables as the latter has been found to be ineffective for this type of estimators (Davidson and Mackinnon, 1993). I identified a variable that was significantly associated with the likelihood of been part of a Knowledge or Friendship Clique but that was not likely to be associated with the ability to generate innovations. Empirical analyses indicated that the number of colleagues within an age range of 5 years relative to the age of a focal individual (e.g. for a given individual i who is 35 years old we counted the number of colleagues within the lab that were between 32.5 – 37.5 years old at the time of the survey) affected the likelihood of being involved in a clique ($p < 0.003$ for Knowledge Clique and $p<0.05$ for Friendship Clique) while being unrelated to that individual's ability to

[9] To control for structural holes we used the measurement of constraint proposed by Burt (1992).

generate patent applications. Indeed, people might be more inclined to form ties, and particularly cohesive/embedded ties, with colleagues in their age cohort rather than with individuals who belong to different age cohorts (Reagans, 2005). However, it is unreasonable to expect that being in the same age cohort should predict professional success in terms of number of patent applications filed. Hence, using a probit regression, I predicted the likelihood of each worker i involvement in a Knowledge or Friendship Clique as a function of worker i's "5 years range age cohort size" and a set of controls. The predicted probabilities of Knowledge or Friendship Clique from the probit regression was transformed into a propensity correction term that was introduced as an additional control variable in model 3. Including this correction term in my regressions yields results that are substantively similar to those presented in Table 3.2 thus still supporting the hypothesized relationships.

Finally, I evaluated the potential of multicollinearity and outliers' issues. While I do not observe particularly high correlations between our variables there might still be some concerns regarding multicollinearity. I also examined the variance inflation factors (VIF) in our models and I did not find evidence of multicollinearity (mean VIF = 1.76; largest VIF = 2.55). I also replicated the analyses excluding the three employees who filed the highest number of patent applications (10) during the 18 months period and the results remained qualitatively the same.

Table 3.3 Different Model Specifications

Dependent Variable: Number of Patent Applications	(6) SH Control	(7) † TSM
Controls		
Pre Patent Applications	0.188*** (0.0437)	0.221*** (0.0460)
Pre Publications	-0.275** (0.120)	-0.171* (0.0915)

Female	-2.716**	-3.180***
	(1.223)	(0.946)
Scientist	17.01***	9.673***
	(0.783)	(2.800)
Technician	-6.861***	-12.96***
	(1.113)	(2.600)
Head of Department	12.00***	14.62***
	(1.543)	(2.069)
Head of Unit	17.10***	8.853***
	(0.809)	(2.871)
Technical Leader	15.31***	16.48***
	(1.078)	(1.328)
Has a PhD	1.190	0.733
	(0.995)	(0.866)
Tenure	-0.00210	-5.59e-06
	(0.00408)	(0.00410)
Centrality Knowledge Network	-0.00377	
	(0.0623)	
Centrality Friendship Network	-0.187***	
	(0.0525)	
Added Controls		
Constraint Knowledge	4.722***	6.187***
	(1.595)	(1.517)
Constraint Friendship	-7.227***	-6.536***
	(1.986)	(1.840)
Propensity Knowledge Clique		-0.964**
		(0.376)
Propensity Friendship Clique		1.130**
		(0.523)
Explanatory Variables		
Knowledge Clique	1.855***	1.504*
	(0.665)	(0.860)
Friendship Clique	2.815**	3.705***
	(1.414)	(1.401)
Knowledge Clique x Friendship Clique	-3.328**	-4.473***
	(1.576)	(1.536)
Constant Terms	-15.53***	-10.01***
	(1.030)	(3.341)
Pseudo R^2	0.4560	0.4374
Number of Observations	127	127

Robust standard errors in parentheses
*** *p<0.01, ** p<0.05, * p<0.1*

† For Terza's (1998) two-stage method of moments estimation I had to exclude the controls for degree centrality as the model did not converge when having both degree and constraint together with the correction terms from the first stage. I did the estimation including only controls for degree centrality (without constraint) and the coefficients remained significant. I also estimated including controls for density instead of degree centrality and constraint and the coefficients remained significant.

3.6 DISCUSSION AND CONCLUSION

Individuals contribute to innovation not only through their human capital, but also by exchanging knowledge, information, and ideas through the numerous relationships and interactions in which they engage with one another, affecting knowledge processes within the firm (Ederer, 2013; Grigoriou and Rothaermel, 2014; Reagans and McEvily, 2003; Singh and Fleming, 2010; Tsai, 2007). Moreover, beyond knowledge-exchange, ties can also convey affective content, which can in turn influence the way individuals seek, access, and mobilize resources impacting creativity, motivation, collaboration, and ultimately innovation (Casciaro and Lobo, 2008; Sosa, 2011). This is particularly relevant because the strategic management of human capital within firms must be concerned not only with motivating workers to perform, but also with ensuring that workers' informal interactions can generate benefits for the firm (Nyberg and Wright, 2015).

I argue that both instrumental and non-instrumental relationships are meaningful for individual innovative productivity within firms. In particular, I focus on the role of embedded triadic relationships as the process of converting an idea into a tangible innovation outcome is more likely to benefit from embedded rather than from sparse relationships. I identify instrumental (knowledge exchange) and non-instrumental (friendship) embedded triads or "triadic cliques" among R&D workers and found compelling evidence that these types of relationships are positively associated with individuals' innovative productivity. Furthermore, I found that while these knowledge-exchange and friendship relationships are independently related to an individual's ability to generate innovations, they also introduce competing rather than complementary logics, creating a substitutive effect that offsets the gains from involvement in either type of clique. As such this study contributes to research on intraorganizational networks and innovation within firms by bringing attention to the equally relevant role of non-instrumental ties vis-à-vis instrumental ties on individuals' innovative productivity and furthermore, by simultaneously considering relational content, network structure, and network position. While being part of either a knowledge-exchange or a friendship triadic clique is significantly associated with a higher number of patent applications, simultaneous participation in both types of triadic relationships is significantly associated with less patent applications. These findings support the claim that embedded triadic relationships, given that they are usually characterized by strong, stable, and durable relationships among the involved parties, provide the social traction and support necessary to turn ideas into innovation outcomes (e.g. Fleming *et al.*, 2007; Perry-Smith and Munnucci, 2017; Obstfeld, 2005). Correspondingly, these findings also support the claim that those who straddle different cliques, given that each clique imposes conflicting logics – "means to an end" logic vis-à-vis "benevolence" logic –, are subject to competing pressures from either clique resulting in these individuals experiencing a negative impact in their performance (Krackhardt, 1998, 1999). Thus, I conclude that Affective ties matter for innovation just as much as instrumental ties do and yet, it is not possible for an individual to optimize on both. In the context of informal cliques, if an individual try to combine them hoping to get a boost on performance, she would instead risk getting the opposite result.

There are also important practical implications associated with these findings. A manager interested in promoting the innovativeness of her organization should acknowledge the existence of different logics through which collaborations can result in innovative outcomes. Favoring knowledge sharing among individuals obviously matters, but also favoring an open, friendly environment could become an important asset to leverage. Most important though, individuals should be encouraged not to mix different types of interactions as they form social and professional relationships at work. The logics, expectations, and nature of instrumental relationships are substantively different from those of affective relationships and trying to manage both at once could be hard to do in a professional setting and have a negative impact on the ability to generate innovations.

The findings presented here, while contributing to research on intraorganizational networks and innovation, have also important limitations that need to be acknowledged. Mainly, the cross-sectional nature of the study raises concerns of endogeneity. For instance, it is possible that some workers may enjoy more or better opportunities to form triadic cliques (e.g. workers who are more productive may be more visible or may "attract" each other into this type of relationships). In the analysis, I took several steps to minimize this concern. First, I control for several individual-level characteristics related to individuals' experience, ability, and knowledge such as network size, level of education, and job type and rank. Additionally, I control for prior patenting and publishing experience as a proxy for their ability to patent and for their access to external knowledge. Second, the observed results remained robust to the introduction of estimates predicting the likelihood of being part of a clique as a function of an exogenous variable such as the size of the "5 years range age cohort". While these robustness checks are encouraging, lacking access to longitudinal data, the risk of endogeneity cannot be ruled out definitively. Notwithstanding the limitations of the data collected and used in this study, there are important features in this study that hold the potential for stimulating theoretical and empirical development in the study of intra-organizational networks and innovation. For instance, future research can explore whether individuals occupying positions between two cliques are beneficial for the firm despite experiencing negative effects at the individual level. In this study, we observed that the innovative productivity of those in between cliques suffers. However, these individuals do engage in intensive interactions between different cohesive groups. This overlapping position between cohesive groups may serve as a conduit of high quality resources flowing for other group members to the expense of the "inter-clique broker", and it can ultimately generate benefits for the organization at large. A further possibility to extend these findings could be to assess the impact of clique characteristics on individual innovativeness. For instance, the human capital heterogeneity or perceived similarity within and between cliques could provide further insights into the precise mechanisms driving our observed relationships and may also shed light into boundary conditions. While within clique heterogeneity may be beneficial for the clique, between clique heterogeneity may be detrimental for the inter-clique broker.

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CHAPTER IV

WHEN HIRING, IS IT ABOUT HOW THE SHOE FITS?

Abstract

I explore how hiring decision-making can be enhanced by jointly considering two significant dimensions of employee-employer matching: Human Capital Fit and Social Capital Fit. I define *Human Capital Fit* as the extent to which an individual's human capital matches with an organization's human capital structure, and *Social Capital Fit* as the extent to which an individual's social capital matches with an organization's social capital structure. I argue that different combinations of fit imply different alternatives that would either maintain or modify the scope and depth of organizational resources, eventually impacting organizational processes and outcomes. Thus, I build a conceptual framework that allows me to identify four different hiring strategies and theorize why organizations would pursue them. By taking a strategic perspective that considers both individual and relational assets relative to the organization I extend prior theory on employee mobility and on the effects of new hires in organizations.

Key words: hiring decisions; human capital; social capital; fit

4.1 INTRODUCTION

The characteristics of new hires can be complementary to the characteristics of organizations but, how is this complementarity between organizational and new hires characteristics achieved? And therefore, what motivates the decision to hire specific types of workers into organizations? (Mawdsley & Somaya, 2016). Most research on workers' mobility has placed attention to the generation of value through the addition of new hires' knowledge into the organization's pool of resources, particularly looking at "star" workers and their performance differences in the new organization (Lacetera, Cockburn, & Henderson, 2004). More recently, scholars have started to study the value that new hires can generate through their impact on other workers and the benefits emerging from their relationships (localized learning/learning-by-hiring/knowledge transfers) (Palomeras & Melero, 2010; Parrotta & Pozzoli, 2012). Nonetheless, while there are germane studies about organizations benefiting from new hires, and even when scholars have gone great lengths to empirically deal with the fact that worker mobility is hard to track and that it is a phenomenon endogenous to the hiring organization and to the new hire, the underlying mechanism(s) driving new hires' performance changes and their effects in the hiring organization are still not well understood (Slavova, Fosfuri, & De Castro, 2015). This argument goes back to the basic questions posed at the beginning, questions that suggest a great need to better understand organizational composition and employee-employer matching (Hoisl, 2007). Thus, the aim of this paper is to develop a conceptual framework that considers both the human capital and social capital of an individual (new hire) relative to the human capital and social capital of a hiring organization.

I refer to human capital as an individual's stock of knowledge and expertise (Becker, 2002); and to social capital as an individual's stock of relationships, assuming there are resources embedded within the individual's network of relationships (Nahapiet & Ghoshal, 2011). With this framework, I aim to shed light into how different interactions between social capital and human capital can lead to different value creation opportunities for organizations. While considering human capital simultaneously with social capital is not new, taking a strategic perspective that jointly considers these dimensions relative to the organization can be more informative that simply looking at individuals' characteristics (Nyberg & Wright, 2015). In general, organizations strive for renewal to gain or maintain their competitive advantage and survive and/or thrive , and for this reason, organizations must constantly make choices between allocating resources (e.g. people) to pursue either uncertain alternatives with distant and risky returns or refine existing alternatives with proximate and predictable returns (Levinthal & March, 1981; March, 1991). But, when deciding about allocating resources, it is not only a choice in the scope of alternatives that organizations need to make, but it is also a choice in the depth of alternatives that eventually affects organizational capabilities and performance (Katila & Ahuja, 2002). Under this logic, the human capital and social capital of a new hire represent potential resources by which an organization can gain, renew or maintain its competitive advantage, and both dimensions present alternatives in terms of the scope and depth of organizational resources. For instance, whether the organization decides to expand its social capital structure by hiring someone with different connections from the organization's current members or perhaps consolidate its knowledge domains by hiring someone with the same human capital profile of the organization's current members, is a complex decision that must take into account the goal that the organization wants to pursue with this new hire while assuming the level of risk that each condition entails.

Strategy scholars have extensively studied the value of human capital relative to the firm, concluding that firm-specific human capital creates productivity gains and competitive advantage (Campbell, Coff, & Kryscynski, 2012; Coff & Kryscynski, 2011; Coff & Raffiee, 2015). However, this stream of literature has focused mostly on the individual incentives for specific-human capital investments and how firms can deter mobility. On the other hand, research on labor mobility suggests that when workers move between firms they improve the "quality of worker-employer match" and therefore, a better match should increase worker's performance (Liu, 1986; Topel & Ward, 1992). But perhaps the most important ingredient behind the idea of aiming for higher "quality of worker-employer matching", is which characteristics or elements organizations should consider when evaluating worker-employer matching, and also how to approach this matching. Human capital matching has been previously addressed by scholars (Brousseau, 1983; Carpenter, Sanders, & Gregersen, 2001); nonetheless, social capital has been seldom analyzed considering this approach. Most research on social capital and mobility has looked into the individual benefiting from having ties with the hiring organization (N Lin & Dumin, 1986; Nan Lin, Ensel, & Vaughn, 1981;

Wegener, 1991) or on organizations benefiting from the individual's previous ties (Corredoira & Rosenkopf, 2009; Somaya, Williamson, & Lorinkova, 2008). Some recent studies hint at the role of new hire's ties in driving learning-by-hiring effects (Slavova *et al.*, 2015). Relatedly, Zucker & Darby (1997) acknowledged that an organization's resource base is the result of the collective actions of individuals within them, and these individuals are both a source of knowledge and means by which this knowledge is transferred within and between organizations, indicating the strategic significance of social processes and structures for knowledge-intensive organizations. Therefore, the potential source of value creation that Individual social capital, together with human capital, represent equally significant points of reference when making hiring decisions. As recently recognized by Nyberg & Wright (2015: p.289): "the need to spend more time focusing on the social capital element and its connections with [human capital] HC and [human capital resources] HCR is a pressing issue for management and strategy scholars".

My focus on the interactive relationship between human capital and social capital resonates with two other questions posed by Mawdsley & Somaya (2016): "is it true that higher levels of both human capital and relational capital are optimum for firms because both are presumed to have a positive impact on firm performance?" and "what are the organizational trade-offs of hiring talent with moderate levels of human and relational capital as opposed to having, say, a superior level of human capital and a lower level of relational capital?". These questions, together with the argument that human capital and social capital can be considered to be broadly complementary but with the caveat that their level of complementarity may depend on the organization's own resources; pose the basis of the framework presented in this paper. First, I propose the concepts of *Human Capital Fit*, or the extent to which an individual's human capital matches with a focal organization's human capital structure, and *Social Capital Fit*, or the extent to which an individual's social capital matches with a focal organization's social capital structure. Second, fit indicates the degree of correspondence between an organization's capitals and an individual's capitals and therefore, depending on the level of fit between a new hire and the hiring organization in these two dimensions, the latter can either deepen (broaden) its current social structure and/or deepen (broaden) its current knowledge structure. And third, value creation then results from trade-offs between coordination (alignment of actions) and cooperation (alignment of goals) gains/costs arising from broadening/deepening the organization's social and knowledge structures, which would eventually affect individual and organizational outcomes (see Figure 4.1).

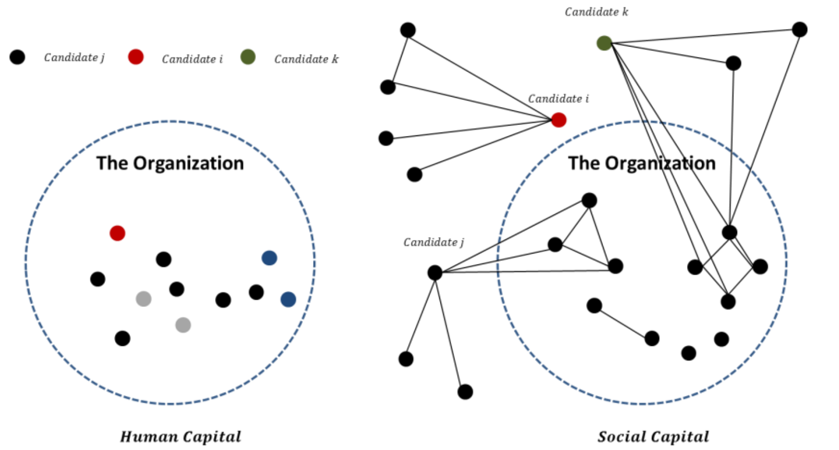

Figure 4.1 Individual's Human Capital and Social Capital relative to the Organization

4.2 THE FIT OF CAPITALS

The idea of fit, popularized by Contingency Theory, is a well-established paradigm in social science and has been studied at multiple levels of conceptualization (such as individual, team, and organization)[10]. Broadly, fit can refer to the level of correspondence (matching) and/or

[10] See Kristof-Brown and Guay (2011) for the most recent review of the literature on person-environment fit.

mutual reinforcement (moderation) between two factors (Venkatraman, 1989). The main idea behind this matching/reinforcement is that an individual has a set of assets that "fit better" in some organization than others, i.e. the value placed on the assets an individual possesses differs across organizations (Lazear, 2009). Drawing on this fundamental intuition I propose two conceptualizations of fit that are relevant when confronting the decision to hire knowledge workers: *Human Capital Fit* and *Social Capital Fit* between a candidate and the hiring firm. The main underlying assumption is that when an individual joins an organization, she brings-in not just her knowledge and expertise, but also her web of social relationships in which resources are embedded. At the same time, the organization offers a context with both intellectual and social resources that a newly hired worker can exploit. How much these two sets of capital "fit" with each other provides a useful framework for an organization's hiring strategy.

4.2.1 Human Capital Fit

Human capital positively impacts employee performance, and it is a critical factor in organizational performance and success. Workers are characterized by their individual human capital, or their specific knowledge, skills, and abilities, and they create some value for the organization (Campbell *et al.*, 2012; Wright, Coff, & Moliterno, 2014) because "Individual skills and abilities are key contributors to the entire bundle of firm resources that enable some firms to generate rents" (Castanias & Helfat, 2001: p. 661). However, while human capital can be considered as the microfoundation of competitive advantage for firms, it has mostly remained conceptualized as an attribute of individual-level human assets. Nyberg, Moliterno, Hale, & Lepak (2014) conducted a systematic review of the human capital literature and acknowledged the multilevel nature of human capital, suggesting the need for differentiation between the individual and the unit level, and hence pointing out to the construct of Human

Capital Resources (HCR) proposed by Ployhart & Moliterno (2011: p.127), as "a unit-level resource that is created from the emergence of individuals' knowledge, skills, abilities, and other characteristics". This suggests that firms must consider individual human capital as a latent resource, one which can create value for the firm depending not only on the individual level of knowledge and expertise, but also on the current structure of knowledge and expertise composed by all individuals within the organization.

Consequently, I propose the concept of *Human Capital Fit* as the extent to which an individual's human capital matches with a focal organization's human capital structure. More precisely, this notion of fit relates to the overlap between an individual's knowledge and expertise and the human capital structure of the organization. To better understand this concept, I further elaborate using formal reasoning and notation. Assume there is an organization consisting of a set of agents $N = \{1, \dots, n\}$, $n > 2$. An agent i is of a type $\theta_i \in [\underline{\theta_i}, \overline{\theta_i}]$, interpreted as the human capital profile of the agent. The organization has then a human capital structure given by $\boldsymbol{\theta} = (\theta_1, \dots, \theta_n)$. Assume that $\boldsymbol{\theta}$ is generated by a function $F(\boldsymbol{\theta})$, where $\overline{\boldsymbol{\theta}}$ represents the average human capital profile of the organization (i.e. the prototypical member), and $\sigma^{\boldsymbol{\theta}}$ represents the level of human capital diversity in the organization. Any given agent i of human capital profile θ_i considering joining the organization is ε_i distant from $\overline{\boldsymbol{\theta}}$, where $\varepsilon_i = |\ \theta_i - \overline{\boldsymbol{\theta}}\ |$, therefore ε_i can be interpreted as the level of fit between agent i and the organization's human capital structure (the prototypical member is a unidimensional representation of this structure). If $\varepsilon_i \to 0$ it means that agent i has a higher fit with the organization, i.e. i's human capital profile completely overlaps with the organizations prototypical member, $\theta_i = \overline{\boldsymbol{\theta}}$. As $\varepsilon_i \to \infty$ then agent i has the lowest fit with the organization, i.e. i's human capital profile completely differs from the organization's prototypical member, $\theta_i \neq \overline{\boldsymbol{\theta}}$. For instance, in figure 4.2, we can consider each dot representing an individual and the color of the dot indicating that individual's human capital profile. There are three individuals considering joining the organization, each one with different human capital profiles θ_i, θ_j, θ_k. From the composition of human capital of the organization, we can see that the prototypical member will have a human capital profile that is closer to the color black. In this case, agent j is the one who has the highest human capital fit and agent k is the one who has the lowest human capital fit.

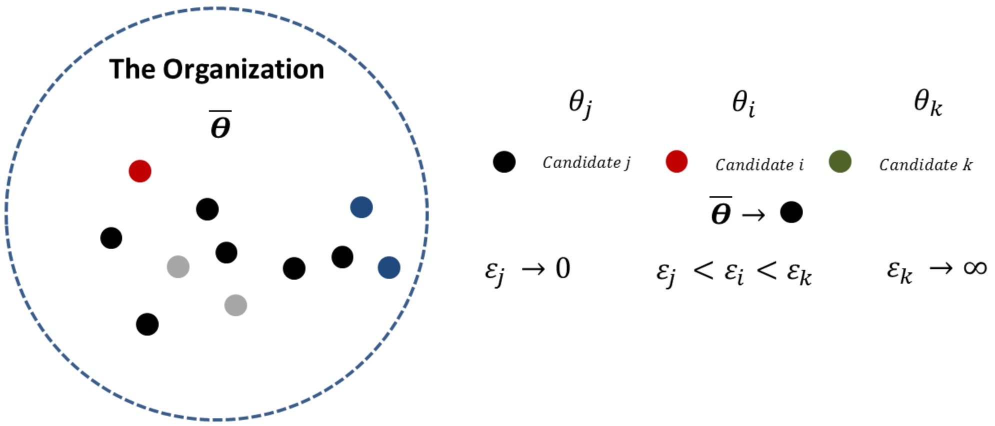

Figure 4.2 Human Capital Fit

4.2.2 Social Capital Fit

Social capital theory proposes that the collection of relationships held between different actors contains valuable resources that provide those actors with "the collectivity-owned capital, a 'credential' which entitles them to credit, in the various senses of the word" (Bourdieu, 1986: p. 249). Social Capital theory rejects the extreme individualistic premises of individual rationality and conceives social capital as a resource for rational action (Coleman, 1988). Although social capital can take many forms, each one of these forms is characterized by two common elements: (1) some aspect of the social structure, and (2) the facilitation of individual action within that structure (Coleman, 1990). This premise allows the concept of social capital to be tightly related to network theory. Network theory provides a concrete approach to assess the elusive concept of social capital, as social networks can be easily conceived as representations of the social structure in which individuals and their actions are embedded, and network analysis can be used to assess how value can be created at different levels (Burt, 2000). While the value of social capital may depend on the level of analysis and on contingent factors of the specific context under study, to this date, there is enough evidence to assert that independent from which approach is taken, there is significant value in the web of relationships in which actors are embedded. Considering the dynamic conversation on social capital, a fair definition of this concept is provided by Nahapiet & Ghoshal (2011: p. 243), where they define social capital "as the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit". I follow this conceptualization for the development of my arguments regarding social capital, and in particular, I focus on the crucial multilevel aspect of it and the acknowledgement of latent resources. Social capital then can be regarded both at the individual level and at the organization level, where the latter can be a function of the former, considering that organization-level network properties arise from individual-level network structures and interactions (Moliterno & Mahony, 2011). Thus, an organization's social capital can be conceptualized as the collection of the individual social capitals of its members, coming whether from the internal linkages between them as from the external linkages they hold with others (connecting the organization with other organization).

Consequently, I propose the concept of *Social Capital Fit* as the extent to which an individual's social capital matches with a focal organization's social capital structure. This notion of fit relates to the overlap between an individual's network structure and the organization's social capital structure (i.e. the network of relationships of its members). To better understand this concept, I also elaborate using formal reasoning and notation. Assume the same organization defined in the previous section. An agent i is of a type $\vartheta_i = [l_{i,1} \quad l_{i,j} \quad l_{i,n}]$ where $l_{i,j} \in [0,1]$ and $l_{i,j} = 1$ means agent i has a tie with agent j, interpreted as the social capital profile of the agent. The organization has then a social capital structure given by $\boldsymbol{\vartheta} = (\vartheta_1, \ldots, \vartheta_i \ldots, \vartheta_n) = \begin{bmatrix} l_{1,1} & \cdots & l_{1,n} \\ \cdots & l_{i,j} & \cdots \\ l_{n,1} & \cdots & l_{n,n} \end{bmatrix}$. Any given agent i of social capital profile ϑ_i considering joining the organization is ϵ_i distant from all agents in the organization $(-i)$, therefore ϵ_i can be interpreted as the level of fit between agent i and the organization's social capital structure. As social capital here is represented by vectors, I consider $\epsilon_i = \frac{1}{n} \sum_{j \in N} \sqrt{\sum_{k=1}[(l_{i,k} - l_{j,k})^2 + (l_{k,i} - l_{k,j})^2]}$ $i \neq k,\ j \neq k,$ which corresponds to the average Euclidean distance[11] between ϑ_i and ϑ_{-i}. If $\epsilon_i = 0$ it means that agent i is structurally equivalent to all other agents in the organization and has the highest fit with the organization, i.e. i's ties (social capital profile) completely overlap with $-i'$s ties (organization members' social capital profiles). As $\epsilon_i \to \infty$ then agent i has the lowest fit with the organization i.e. i's ties completely differs from $-i'$s ties. For instance, in figure 4.3, we can consider each dot representing an individual and the ties to which that dot is connected to other dots indicating that individual's social capital profile. The same three individuals considering joining the organization have different social capital profiles ϑ_i, ϑ_j, ϑ_k. From the social capital structure of the organization (the ties of those individuals who currently belong to the organization), we can see that in this case, agent k is the one who has the highest social capital fit and agent i is the one who has the lowest social capital fit. Agent i has no

[11] See Wasserman and Faust (1994) for a definition of structural equivalence and the different mathematical approaches to measure it in social network analysis. Here I focus on the Euclidean distance as straight forward approach to compare vectors.

overlapping connections with the connections of any member of the organization, while agent's k connections completely overlap with the connections of one organization member (she is structurally equivalent to that member).

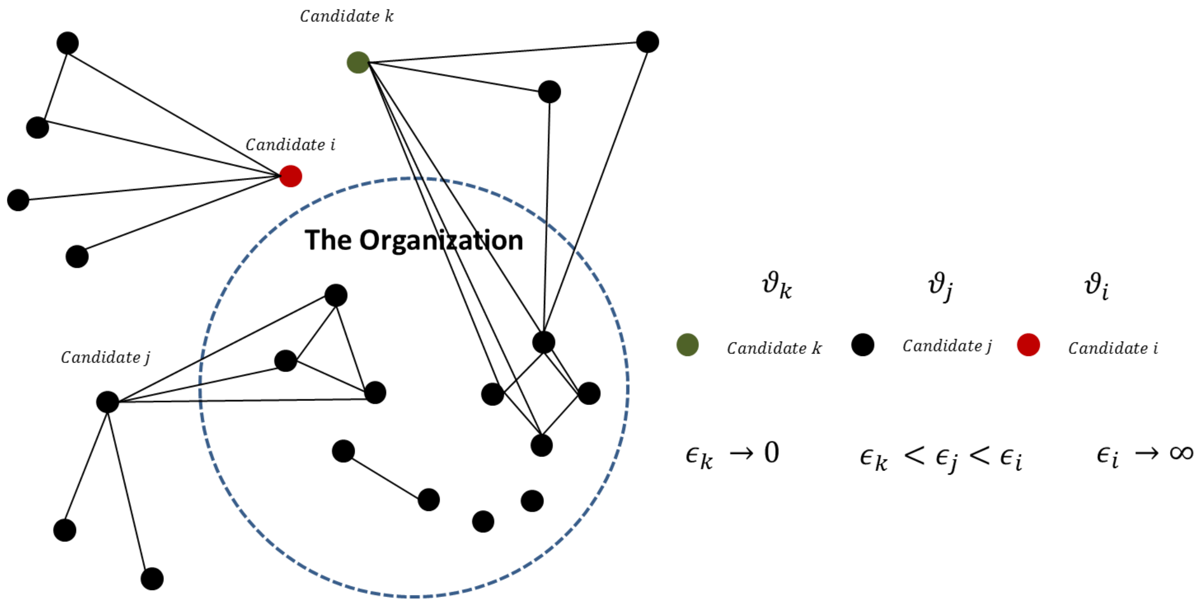

Figure 4.3 Social Capital Fit

4.3 THE STRATEGIC IMPLICATIONS OF HUMAN CAPITAL FIT AND SOCIAL CAPITAL FIT

The knowledge structure of an organization can be conceived as the "set of elements or individual pieces of knowledge representing the content of what the organization knows" (Yayavaram & Ahuja, 2008:p.333). This structure has been traditionally conceived and operationalized by patents and scientific publications (Fleming, 2001; Katila & Ahuja, 2002), yet knowledge is fundamentally embodied and created by individuals (Nonaka, 1994; Nonaka, von Krogh, & Voelpel, 2006) and individuals "draw on other's knowledge and experience in addition to their own" (Fleming, 2001:p.120). Then, patent portfolios and scientific articles are an objective, established, and convenient representation of an organization's knowledge structure; but what they actually represent is a signal (or an embodiment) of the real knowledge structure of an organization, one which is essentially composed by the collective human capital of its employees. Organizations bring in individuals to use and integrate their diverse knowledge towards finding solutions to specific problems, therefore creating diverse "fields for interaction" that result in specific knowledge domains (Nonaka, 1994).

Thus, a high human capital fit condition implies that the knowledge and expertise of the individual that is brought into the organization is very similar to some of the elements already contained in one or several domains of the organization's knowledge structure, meaning that these knowledge domains become "deeper", i.e. the organization becomes more specialized. Consider figure 4.2, each color can represent a different knowledge domain, and the number of dots can represent how deep that knowledge domain is. For example, an organization that hires an organic chemist for an R&D lab that already has four organic chemists increases the depth of the organic chemistry knowledge domain. Conversely, hiring scientists who work in research areas which are not covered by the current R&D lab employees would increase the knowledge breadth of the organization's knowledge structure, e.g. adding a biologist in the R&D lab when there are no other biologists implies adding a new knowledge domain to the organization's knowledge structure. Thus, human capital fit contributes to a change in the knowledge structure of an organization, by either increasing its knowledge depth (homogeneity and specialization of knowledge) in case of high fit, or its knowledge breadth (heterogeneity and diversification of knowledge) in case of low fit.

Furthermore, to fully exploit the potential of human capital, the knowledge and expertise held by individuals needs to be "collaborated" across people. Collaboration involves both coordination and cooperation. Coordination can be understood as the "deliberate and orderly alignment or adjustment of partners' actions to achieve jointly determined goals" (Gulati, Wohlgezogen, & Zhelyazkov, 2012: p. 537). Coordination is in essence related to the alignment of actions across self-interested agents that need to combine and integrate their resources. Coordination problems may arise due to cultural differences, cognitive limitations, bounded rationality, and/or failure to recognize interdependencies. Classical work in organizational design proposed the information processing model and focused on the coordination issues that arise in organizations due to information processing requirements (Galbraith, 1974). Formal models[12] in economics have emphasized information exchange and communication between actors and its coordination effects. For example, building on Arrow's (1974) arguments about specialized codes in organizations, Cremer, Garicano, & Prat (2007) proposed the idea of organizational language, analyzing the trade-off between specialization and coordination. In their model, they show how communication costs and potential synergies across homogenous groups create incentives to either develop a common language or develop translators across groups, suggesting the important implications that knowledge overlap among members can have on organizational performance. Management scholars have also found that similarity in expertise allows efficient communication increasing knowledge sharing motivations (Black, Carlile, & Repenning, 2016) and that knowledge depth increases the efficacy of knowledge transfers (Salomon & Martin, 2008). Thus, a high human capital fit guarantees smooth communication making it easier to coordinate actions within the organization. Conversely, a low human capital fit creates communication problems that may frustrate coordination.

Considering the previous arguments I propose two lemmas:

[12] See also Marschak and Reichelstein (1998).

Lemma 1*: A higher human capital fit deepens the organization's knowledge structure (reinforces its current knowledge domains).*

Lemma 2*: A higher human capital fit enhances the organization's collaboration processes (improves informational efficiency).*

The benefits that a new hire can generate for the focal organization in terms of human capital fit depend on how these "knowledge deepening" and "better collaboration" can play a role in organizational outcomes. By using these two lemmas and by making a simple thought experiment using the previous formal reasoning and notation of human capital fit, I derive one proposition. Assume that if agent i (the new hire) joins the organization she can create value for the organization, but this value creation is dependent on both her human capital profile and the organization's human capital structure. In this sense, also assume that value is created by agent i either producing innovative outcomes x^I (outcomes that are very different from what the organization has produced before) with probability P or producing traditional outcomes x^T (outcomes that are very similar from what the organization has produced before) with probability $1-P$. P depends on agent $i's$ human capital fit ε_i, and also depends on the human capital diversity $\sigma^{\boldsymbol{\theta}}$ she would encounter in the focal organization, but in this case I consider this parameter as given, therefore $P(\varepsilon_i, \sigma^{\boldsymbol{\theta}})$. I also assume this is a differentiable function that can be concave in both arguments, implying that there is a possible optimal level of diversity in the organization and an optimal level of fit for a given agent to produce an innovative outcome. Agent i incurs in some costs when producing either x^I or x^T, and these costs are a function of the level of production and the level of fit of agent i, $C_i(x_c^T(\varepsilon_i),\ x_c^I(\varepsilon_i))$ which is increasing in $x_c^T(\varepsilon_i)$ and $x_c^I(\varepsilon_i)$. When $\varepsilon_i = 0$ then $x_c^T(\varepsilon_i) \rightarrow 0$ but $x_c^I(\varepsilon_i) \rightarrow \infty$, meaning that an agent with a perfect fit incurs minimal costs in producing traditional outcomes, but very large costs in producing an innovative outcome. Following the logic behind Lemma one and Lemma two, it is expected that $\frac{\partial^2 c_i}{\partial x^T \varepsilon_i} > \frac{\partial^2 c_i}{\partial x^I \varepsilon_i} > 0$, which implies the cost for the agent increases as fit decreases (ε_i becomes larger) and that as fit decreases the cost of producing a traditional outcome increases faster, i.e. a lower fit increases costs for the agent and it is even more costly for a lower fit agent to produce a traditional outcome. Notice the tension here: a lower fit is more likely to produce an innovative outcome but it also incurs higher costs, a higher fit is more likely to produce a traditional outcome and incurs lower costs. Therefore, considering agent i is rational and that the organization does not have any particular incentive scheme in place to influence agent i's behavior, I derive the following proposition:

> ***Proposition 1****: higher human capital fit decreases the organization's scope of productivity (increases the similarity of organizational outcomes).*

A similar thought experiment can be made for social capital fit. The social capital fit of a potential hire shapes the social structure of an organization. Regarding the interplay between social structure and actions, there are two overarching mechanisms that have been proposed to be the source of social capital: brokerage and closure (Ahuja, Soda, & Zaheer, 2012; R. Burt, 2000; Gargiulo & Benassi, 2000). As argued above, social capital for the organization consists of the web of internal relations as well as the web of external relations, both representing different opportunities and constraints for the focal organization derived from either brokerage or closure. Therefore, a high social capital fit condition, independent from the organization currently gaining /suffering from either brokerage or closure, implies that the "new" connections that are brought into the organization are very similar to the connections already possessed by the organization, meaning that the social structure of the organization is maintained and strengthen, i.e. the organization becomes more embedded. Moreover, as argued above, collaboration involves both cooperation and coordination. Cooperation can be described as the "joint pursuit of agreed-on goal(s) in a manner corresponding to a shared understanding about contributions and payoffs" (Gulati, Wohlgezogen, & Zhelyazkov, 2012: p.533). Cooperation is in essence related to the alignment of objectives of several self-interested agents that need to provide resources towards a mutually beneficial joint effort. As already discussed above, Coleman's conception of social capital was about the development of norms and trust among actors and how actions where facilitated under these conditions, i.e. cooperation (Coleman, 1988). A high social capital fit enhances organizational cohesion, which contributes to goal alignment due to increased trustfulness, social pressures, and/or potential reputational damages (Gulati & Gargiulo, 1999); therefore contributing to cooperation. For example, hiring an individual who has ties with five out of ten members of the organization enhances the internal social structure of the organization; furthermore, if this individual also has ties with other external individual who have ties with organizational members it maintains the organization's social ties within the broader social context. Conversely, hiring someone who has no ties with current employees or with other external individual who have ties with current employees would broaden the organization's social structure. For instance, some very simplified example would be an R&D lab hiring a scientist with no previous connections to current R&D Employees yet strong connections to an elite R&D Lab with which the focal organization have no previous links, meaning that this new employee would be adding valuable connections to the focal organization although there are no overlapping connections that could enhance the current social structure.

Considering the previous arguments I propose two lemmas:

Lemma 3: *A higher social capital fit deepens the organization's social structure (reinforces its current social relationships).*

Lemma 4: *A higher social capital fit enhances the organization's collaboration processes (improves trust, adoption of norms, and awareness).*

The benefits that a hiring candidate can generate for the focal organization in terms of social capital fit depend on how "social deepening" and "better collaboration" can play a role in organizational outcomes. By following a similar logic as the one I used for human capital fit, I derive one proposition for social capital fit. In the case of social capital fit it can be expected that instead of focusing on coordination issues, here the main issue relates to cooperation (one can think about this as "informal incentives" that influence individual behavior). While in the case of social capital, fit can also increase the probability of producing a traditional outcome given the pressure i can experience to comply, it can be also the case that fit could aid i in gaining support for non-traditional ideas that could lead to an innovative outcome. Certainly, social capital fit can influence the probability of an innovative outcome as well, nonetheless, since I expect social capital fit to be more related to getting support within the organization (as social capital facilitates individual action), I focus more on this dimension. When $\epsilon_i = 0$ then $\infty > x_c^I(\epsilon_i) > x_c^T(\epsilon_i) > 0$. Thus, the tension in this case arises from a lower fit experiencing higher costs due to "unwillingly" cooperation from other agents, whilst a higher fit experiencing lower costs due to "willingly" cooperation from other agents; still higher for innovative outcomes relative to traditional outcomes. Therefore, considering agent i is rational and the organization does not have any particular incentive scheme in place to influence agent i' behavior, I derive the following proposition:

***Proposition 2**: higher social capital fit increases the organization's productivity (increases the rate of organizational outcomes).*

In sum, the fit of capitals is neither good nor bad, and its strategic implications depend on the potential outcomes sought by the organization and the costs for the new hire in the context of the hiring organization. For instance, from the organization's perspective, Burt (1993: p.65) argued that "at minimum, the dense network is inefficient in the sense that it returns less diverse information for the same cost as the sparse network. A solution is to put more time and energy into adding non-redundant contacts to the dense network. But time and energy are limited, which means that inefficiency translates into opportunity costs". And in the case of human capital, (Cremer, Garicano, & Prat, 2007: p.376) argued that "firms cannot capture the synergy and leave everything else the same. Capturing it requires some coordination and communication between services, which requires in turn that they speak a common language. Since a common language cannot be well-suited to the needs of diverse specialized individual services, the scope of the firm is limited". Thus, each fit dimension poses trade-offs for the individual and for the organization. Complementarity is then achieved only in view of the specific goal/task for which the organization would like to bring and combine the assets of the new hire with the current organizational resources (Giuseppe Soda & Furlotti, 2017). Then, different plausible configurations of fit arise, each one posing different potential outcomes and risks. I elaborate on these issues in the next section.

4.4 THE OVERARCHING FRAMEWORK: STRATEGIZING BY HIRING

As I have argued in the previous sections, there are costs and benefits associated to both human capital fit and social capital fit. Continuing with the formal logic of human capital fit and social capital fit that I have developed so far and taking into account the two derived propositions, by considering both dimensions of fit I can make the following simple thought experiment: Now the probability of producing an innovative outcome depends on both levels of fit, $P(\varepsilon_i, \epsilon_i)$ and it is reasonable to expect that P increases in both ε_i and ϵ_i, but that $\frac{\partial P^2}{\partial \varepsilon_i \epsilon_i} < 0$. This implies that ϵ_i and ε_i are substitutes for innovative outcomes. The costs also depend on both levels of fit, $C_i(x_c^T(\varepsilon_i, \epsilon_i), x_c^I(\varepsilon_i, \epsilon_i))$ and $\frac{\partial C_i}{\partial \varepsilon_i \epsilon_i} > 0$. This implies that a "double misfit" condition, low human capital fit and low social capital fit, is very costly for the agent. Notice a new tension here: a lower fit in human capital is compensated by a higher fit in social capital to produce an innovative outcome and vice versa, and also a higher fit in one dimension can compensate for the higher costs associated to a lower fit in the other dimension. Similarly, a low fit in both dimensions incurs the highest costs.

By combining the two dimensions and their levels we arrive to four possible hiring strategies that organizations can pursue (see figure 4.4):

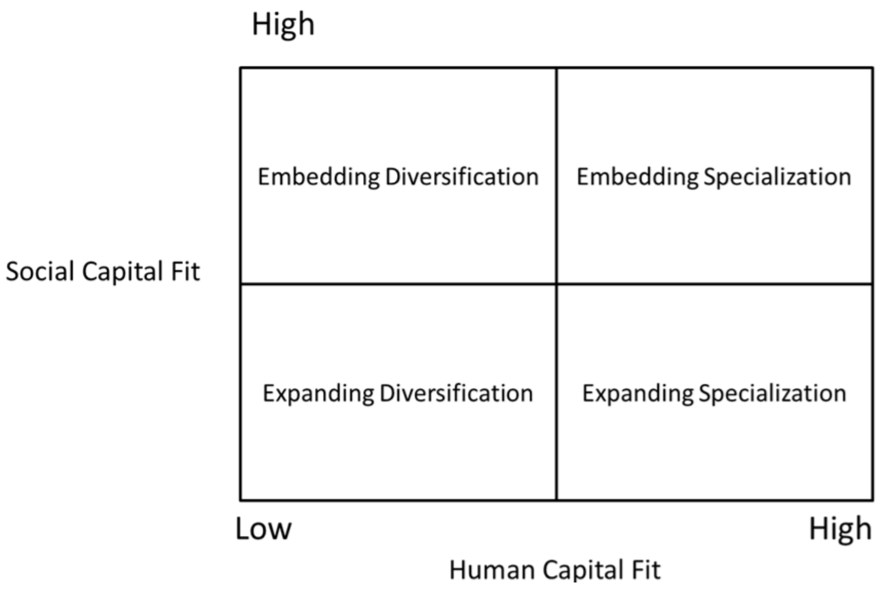

Figure 4.4. Strategies based on human capital fit and social capital fit

EMBEDDING SPECIALIZATION (high social capital fit and high human capital fit): hiring strategy aimed to maintain and strengthen the organization's social structure and to deepen the organization's knowledge structure.

EMBEDDING DIVERSIFICATION (high social capital fit and low human capital fit): hiring strategy aimed to maintain and strengthen the organization's social structure and to broaden the organization's knowledge structure.

BROADENING SPECIALIZATION (low social capital fit and high human capital fit): hiring strategy aimed to broaden the organization's social structure and to deepen the organization's knowledge structure.

BROADENING DIVERSIFICATION (low social capital fit and low human capital fit): hiring strategy aimed to broaden the organization's social structure and to broaden the organization's knowledge structure.

Which strategy to choose?

From an evolutionary perspective, strategic choices are fundamentally driven by environmental pressures and the interaction between adaptation and selection processes. Thus, organizations could take two strategies to handle the environment, they could become either specialists or generalists, the latter requiring the maintenance of excess capacity (surplus and variety of resources, e.g. knowledge and expertise) allowing organizations flexibility when facing a variable environment; while the former enjoys more efficiency given lower requirements of excess capacity and higher focus, nonetheless facing less flexibility (Carroll, 1985; J. Freeman & Hannan, 1983; Hannan & Freeman, 1977). From a Strategic management perspective the choice of diversification vis-à-vis specialization happens "when the firm expands to make and sell products or a product line having no market interaction (technically, having zero cross price-elasticity) with each of the firm's other products" (Rumelt, 1982: p.363). Strategy explanations for the rationale behind diversification rest on the interaction between economies of scope and economies of scale. Firms achieve some form of complementary configuration that economizes on transaction costs (Williamson, 1999), and "firms efficiently allocate resources internally, in particular, where the production of two or more products depends upon the same proprietary knowhow base and recurrent exchange is called for, and when a specialized indivisible asset is a common input into the production of two or more products" (Teece, 1980: 240-41). While organizational sociology considers the degree of specialization as a strategy used to cope with the environment, strategic management focuses more on the efficient use of resources given the firm's cost structure and capabilities. In general, both perspectives consider diversification as a strategy that implies the acquisition or development of different types of resources that can be efficiently deployed to produce different types of outcomes, dependent on the firm's internal and external context (e.g. proprietary resources versus market conditions). Irrespective of which diversity level in knowledge the organization currently possesses, human capital fit will sustain it, meaning that a high human capital fit specializes the organization vis-à-vis a low human capital fit that diversifies the organization, in terms of the internal knowledge structure. Then, from *proposition 1*, higher human capital fit will decrease the organization's scope of productivity, increasing the similarity of organizational outcomes, whilst a lower human capital fit will expand the organization's scope of productivity, decreasing the similarity of organizational outcomes.

On the other hand, organizational sociologists argue that social capital emerges from the obligations, expectations, and social norms that facilitate rational action and that arise due to the existence of trustworthiness and effective monitoring in the social system – e.g. the degree of closure of a social networks (Coleman, 1988). For example, dense networks positively affect the motivation to invest effort in transferring knowledge (Gargiulo, Ertug, & Galunic, 2009; Reagans & McEvily, 2003; Reagans, Zuckerman, & McEvily, 2004), or they can promote the adoption of novel ideas through enhanced information flows and cooperation (Fleming, Mingo, & Chen, 2007; Obstfeld, 2005). Conversely, building upon the propositions about the strength of weak ties (Granovetter, 1985), points of control and betweenness centrality (Freeman, 1977), and the distribution of power in exchange relationships (Cook, Emerson, Gillmore, & Yamagishi, 1983), structural holes theory holds that social capital is generated by the positions actors occupy in a network structure. A strategic position that allows a focal actor exposure or control advantages regarding resource flows between other actors provides the focal actor with an "asset in its own right" – brokerage in the social network (R. Burt, 1997: 340). Structural holes affect information redundancy (Burt, 1992), innovative outputs (Ahuja, 2000), and the ability to adapt to changes in the environment (Gargiulo & Benassi, 2000). Some researchers have also looked into the contingent effects of social structure, considering aspects as culture (Xiao & Tsui, 2007) or time (G. Soda, Usai, & Zaheer, 2004). Similarly, the hierarchical social position of an actor (i.e. its status) emerges from that actor's pattern of affiliations (Bonacich, 1987; Podolny, 1993). Irrespective of which social structure the organization currently possesses, social capital fit will sustain it, meaning that a high social capital fit embeds the organization in its current social structure vis-à-vis a low social capital fit that broadens the organization's social structure. Then, from *proposition 2*, higher social capital fit will increase the organization's productivity, increasing the rate of organizational outcomes, whilst lower social capital fit will decrease the organization's productivity, decreasing the rate of organizational outcomes.

Thus, what is a good combination of fits? I have argued that for the organization, complementarity between the fit of capitals is a function dependent on the organization's own internal resources, the competitive environment the organization faces, and its own strategic vision; therefore, fully addressing this question requires extensive theoretical reasoning, which goes beyond the scope of this paper. Moreover, while it can be argued that some of the proposed combinations are empirically unobserved, I take a more generative approach and focus on the plausibility of combinations rather than starting from an empirically driven *ex-post* approach, as this can provide a "theoretically informed, logically sound exploration of the plausibility of unobserved configurations… because their existence and outcomes are justifiable from a theoretical and logical standpoint" (Soda and Furnari, 2012). In the next section, I elaborate on how to approach these questions and provide some further guidance.

4.5 DISCUSSION: IMPLICATIONS OF THE FOUR HIRING STRATEGIES

The ability to adapt to dynamic knowledge environments is critical for sustained organizational survival (Eisenhardt & Martin, n.d.; Teece, Pisano, & Shuen, 1997). Organizations must constantly make choices between allocating resources to pursue uncertain alternatives with distant and risky returns or refine existing alternatives with proximate and predictable returns (Levinthal & March, 1981; March, 1991). In dynamic environments, the creation of new alternatives is perhaps as essential to survival as is the effective selection of alternatives (Hannan & Freeman, 1977). But, it is not only a choice in the scope of alternatives but also a choice in the depth of alternatives that affects an organization's capability to create and recombine knowledge and ideas (Katila & Ahuja, 2002). The ability to value, acquire, assimilate, transform and exploit knowledge creates competitive advantage for organizations (Zahra & George, 2002); however, this ability relies on the breadth and depth of knowledge exposure and on social integration mechanisms (Cardinal, 2001;

Spender, 1996). Organizations can therefore attain competitive advantage by choosing among the proposed four hiring strategies as they are likely to affect organizational capabilities, strategic flexibility, and therefore performance (Barney, 1991). The choice among these four strategies however, relies on weighing their associated risks and time frames against their potential benefits. Here I focus on two types of risks I consider to be relevant in knowledge-intensive contexts: employee turnover and Knowledge replication. I also consider integration concerns and time frames for each one of the strategies.

4.5.1 Employee turnover

Personnel turnover is a way to produce and sustain variability in the organization, increasing experimentation and therefore improving collective knowledge (March, 1991). Organizations can strategically manage their knowledge breadth and knowledge depth needs by means of their human capital, i.e. their employees' knowledge and expertise (Glassa & Saggib, 1998; Mowery & Oxley, 1995; Veugelers, 1997). Voluntary turnover diminishes organizational human capital and eliminates the organization's return on investment on the departing employee, therefore decreasing organizational productivity (Dess & Shaw, 2001). Hiring knowledge workers is usually a very taxing and very costly process and, when these individuals leave the organization, they take with them most of the value they have created during their tenure. Some of the main antecedents to voluntary turnover are organizational commitment, job satisfaction, fulfilment of individual's expectations, and organizational culture (Arnold & Feldman, 1982; Cotton & Tuttle, 1986). These antecedents can be readily associated with my proposed hiring strategies. For example, an organization with a strong focus in the same knowledge domain of a new hire is more likely to provide a fitting organizational culture and to ensure a greater alignment of the new hire's expectations. Similarly, social relations are more likely to provide emotional attachment and job satisfaction, and, they also provide a priori information that may result in better employee-employer matches as expectations may turn to be more accurate once the new hire joins the organization. For instance, social capital may be related to collegiality, which has been found to be significantly and positively related to altruism, courtesy, conscientiousness, sportsmanship, and civic virtue (Podsakoff, MacKenzie, Paine, & Bachrach, 2000), an important organizational feature that can enhance potential collaboration and productivity in an innovative setting. Following these arguments, one can expect an embedding specialization hiring strategy to pose a low level of risk regarding individual turnover. Conversely, a broadening diversification hiring strategy would pose a high risk of turnover. In the former, the new hire is easily assimilated by the organization and its integration is effortless as neither the new hire nor the organization's members face important issues in terms of coordination and cooperation, increasing collaboration opportunities for the new hire. In the latter, assimilation is challenging as coordination and cooperation is difficult leading to limited collaboration opportunities.

Embedding diversification and broadening specialization present intermediate levels of risk of turnover as they counterbalance coordination issues with cooperation advantages and vice versa. Informal networks in the workplace influence career advancement and work satisfaction (Baron & Pfeffer, 1994; Gartrell, 1987) and therefore, hiring someone with diverse knowledge from that of the organization but with social ties with organization members may lead to extra efforts through cooperation that can overcome coordination issues. Conversely, having expertise in the same knowledge domains in which the organization has a strong tradition can lead to social identification[13] with the organization

[13] A case can also be made considering homophily. Assuming that the recruiting organization members have limited knowledge about the new hire, and the new hire has limited knowledge about the recruiting organization members, they resort to salient sociodemographic cues (initially, they based their assessment on

(Ashforth & Mael, 1989) and therefore, hiring someone with similar knowledge from that of the organization but with no social ties with organization members may lead to extra efforts through coordination that can overcome cooperation issues. When pursuing these two hiring strategies, organizations can leverage on either social ties or knowledge similarity to address integration issues and manage turnover risk.

4.5.2 Knowledge Replication

Ideas that fall outside an organization's knowledge domains are usually unnoticed as it is difficult for the focal organization to recognize and comprehend them(Leonard-Barton, 1995; Rosenkopf & Nerkar, 2001). Correspondingly, specialized organizations may fall into the familiarity, maturity, and propinquity competence traps (Ahuja & Morris Lampert, 2001). The familiarity trap refers to excessive focus on existing knowledge; the maturity trap refers to the need of reliable and predictable outcomes; and the propinquity trap refers to the tendency to remain around closely related knowledge domains. The main risk associated with these traps is the replication of the same ideas, given the organizational failure to spot, pursue, and develop emerging radical ideas, as these ideas rely on deviations from prevailing knowledge (Benner & Tushman, 2002; Levinthal & March, 1993). Nonetheless, using similar knowledge elements repeatedly can reduce errors and false starts, can make knowledge search more predictable, and can lead to a better ability to recombine familiar knowledge elements: "Exploitation is important, not just for fine-tuning and economizing the efficiency of an existing technology, but also for creating new knowledge" (Katila & Ahuja, 2002: 1191). Also, when a new knowledge domain is introduced in an organization it can enrich the knowledge base and improve recombination possibilities; but, it can also increase integration

what Lazarsfeld & Merton (1954) would refer to as status homophily, and eventually they will move into value homophily) to assess similarity among each other.

costs and decrease reliability (Katila & Ahuja, 2002). Following this reasoning, I also argued that similarity in knowledge leads to diminishing coordination challenges, and consequently, organizations that develop effective coordination become more reliable and are expected to fare better than loosely-coupled organizations, although they might reduce their chance of gaining competitive primacy by coming up with innovative or disruptive offerings (March, 1991).

The logic of similarity in knowledge domains can also be equated to similarity in social relations. Dense connectedness limits knowledge scope and deviant behavior (Uzzi, 1997) and dense networks are inefficient as they return less diverse information (Burt, 1997). On the contrary, non-redundant contacts provide access to new sources of knowledge or other resources (Burt, 1992). The main risk associated with dense connectedness, or embeddedness under my framework, is therefore the replication of the same ideas. Nonetheless, as argued in the preceding sections, social connectedness is useful for knowledge combination and knowledge creation (McFadyen & Cannella, 2004); for gaining legitimacy and adoption of ideas (Subramaniam & Youndt, 2005); and for developing trust and cooperation (Paul S. Adler & Kwon, 2000). Network cohesion or network density increases the rate and extent to which ideas, information and knowledge transfer and diffuse at the individual level (Argote, Mcevily, & Reagans, 2003; Fleming *et al.*, 2007; Singh, 2005) and at the unit level (Reagans & Zuckerman, 2001); individuals gain cooperation from unit members to implement their idea when there is network cohesion (Obstfeld, 2005); and tie strength also enhances knowledge transfer and cooperation (Levin & Cross, 2004; Uzzi & Lancaster, 2003). I have also argued that similarity in social relations leads to diminishing cooperation challenges, and consequently, organizations that develop effective cooperation ensure goal alignment among its members (Gulati & Gargiulo, 1999) and are expected to fare better than uncooperative organizations. Thus, embedding specialization poses a high risk of replication yet low integration concerns. On the other hand, broadening diversification poses a low risk of replication yet high integration concerns.

4.5.3 Time horizon

"What is good in the long run is not always good in the short run…The search for new ideas, markets, or relations has less certain outcomes, longer time horizons, and more diffuse effects than does further development of existing ones" (March, 1991: 73). Considering the effortless integration possibilities of the embedding specialization strategy, it is a strategy than can be pursued within a short time frame. Results from engaging in embedding specialization are predictable and more likely to be observed shortly. On the contrary, considering the challenging integration possibilities of the broadening diversification strategy, a long time frame seems more adequate as outcomes are more uncertain and may take longer to be observed. Embedding diversification and broadening specialization would fall in intermediate time frames.

4.5.4 Other factors

In this brief discussion I have contemplated some of the main implications organizations may experience when pursuing each one of the hiring strategies proposed by my theoretical framework. Still, it is important to highlight that the influence of other factors may also be interesting and relevant to investigate. Both the internal and the external organizational contexts have influence over an organization's behavior and performance, and it is then imperative to understand how both contexts present distinct challenges and opportunities that can be tackled with both social and human capital features. As expressed in Adler & Kwon (2002: 21)'s review on social capital, "the behavior of a collective actor such as a firm is influenced both by its external linkages to other firms and institutions and by the fabric of its internal linkages: its capacity for effective action is typically a function of both". The Internal organizational context can include formal facets of an organization (such as formal membership and authority) and informal aspects as well (such as norms, knowledge exchange, and collaboration), and many outcomes that are related to human capital depend on the relational networks between employees (Hollenbeck & Jamieson, 2015). Concerning the external context, classical work on strategic management argued about the competitive advantage provided by the position a firm holds within an industry versus its competitors (Bain, 1956; Ghemawat, 1986; Rumelt, 1984); and classical work on social theory argued about the embeddedness of economic behavior and market structures, where the structure of social relationships among actors affects economic transactions (Granovetter, 1985) – for example, on open source software development projects technical success (Grewal, Lilien, & Mallapragada, 2006); on interfirm alliances novelty creation (Gilsing, Nooteboom, Vanhaverbeke, & Duysters, 2008); on joint venture dissolution (Polidoro, Ahuja, and Mitchell, 2011); on influence and learning through board interlocks (Beckman & Haunschild, 2002; Haunschild, 1993; Haunschild & Beckman, 1998); on innovation output at the firm level (Ahuja, 2000); and on innovation output at the business unit level (Tsai & Ghoshal, 1998); or rewards resulting from status in the social structure (Bonacich, 1987; Castellucci & Ertug, 2010; Podolny, 1993; Stuart, Hoang, & Hybels, 1999; Washington & Zajac, 2005). This suggests a broad array of specific factors that may have an influence on the adequacy of each of the four hiring strategies and therefore the managerial choice to pursue each one of them.

4.5.5 Conclusion and future venues

Hiring knowledge workers is a core strategic process that affects every aspect of an organizations life, in particular, the efficient and effective production and diffusion of ideas and intellectual products, making these individuals an essential asset thru which organization enact their strategies. In this paper, I have brought the social capital dimension into the more traditional strategic human capital inquiry, challenging the prevailing focus on individual human capital considerations when making hiring decisions. While there is extensive evidence of the value that social capital represents for individuals and organizations, the potential value that organizations can capture from new hires' social capital has been seldom studied. I believe the proposed framework provides a stepping stone that can motivate further scholarly inquiry regarding complementarities between human and social capital.

The need for change is another important aspect for which my theorizing can provide insights. As organizations strive for organizational renewal to gain or maintain competitive advantage they confront a growing burden of knowledge, situation that may pose important challenges for revitalization. Organizational renewal can be achieved by either internal revitalization or external network location enhancement, conditions that can be addressed thru our proposed model by choosing the respective strategy according to the specific state of nature faced by the organization. For instance, it has been shown that when specialized clusters are connected they enable the specialized knowledge within them to circulate, "inspiring innovation" (Uzzi & Spiro, 2005). By pursuing expanding strategies, organizations can create links between specialized clusters within and outside their organizational boundaries or, thru diversifying strategies, create new specialized clusters across well connected individuals.

I also believe that the proposed model provides a germane framework to delve into multi-level analyses and to investigate network dynamics and individual agency (Moliterno

& Mahony, 2011). For example, as the dynamic environment of knowledge-intensive industry is rapidly changing the role of individuals, where a ubiquitous shift towards teamwork accompanied by decreasing innovative output by individuals is obviously apparent, it would be interesting to study how the proposed hiring strategies trigger distinct purposive actions from new hires, at different points in their careers (e.g. young scientists versus star scientists). From a network perspective, agency refers to "the focal actor's motivation and ability to shape relations and create a beneficial link or dissolve an unprofitable one, or to shape and advantageous structure" (Ahuja, Soda, & Zaheer, 2012: 437). Agency then could be manifested by the fact that employees disregard the potential provided by internal structures and will seek links outside the focal organization, links which may be characterized as having a higher degree of uncertainty and risk, and with the potential of being less efficient relative to local links, yet, may result in higher personal prestige gains. Forming these links also implies high motivation and ability from the focal actor. As I have argued in the preceding sections, it has been found that actors are willing to provide effort in exchange of status, meaning that higher-status actors can secure greater effort in the exchange relationship with lower-status actors (Castellucci & Ertug, 2010).

Finally, organization and strategic human capital scholars can investigate about optimal distribution levels of human and social capital, and at which levels it would be more effective to pursue each one of our proposed strategies. Organizational behavior scholars can investigate integration issues arising from hiring different combinations of human and social capital fits, considering interesting variables such as membership, identity, attachment, commitment, and organizational citizenship behavior. And network scholars can explore and propose different operationalization forms of our proposed fit constructs, allowing for thought-provoking empirical studies that can inform academics and practitioners alike.

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CHAPTER V

CONCLUSIONS

In this dissertation, I have attempted to bring into focus the notion that organizations can purposely benefit from workers' interactions and relationships. In contrast to extant research in strategy and organization, which either tends to focus on the individual level value of human capital or on the effects of instrumental networks on performance, I examine the linkages between human capital management and the multiple interactions in which individuals engage with one another exchanging diverse resources, and shed light into how firms can purposively benefit from this. The formal organization of human capital within the firm results from managerial decisions that follow the motives of the firm, while the informal organization of human capital within the firm results from the private motives of individuals. Therefore, the main contribution of this dissertation is twofold. First, it shows that considering the characteristics of individuals relative to a specific context and how individuals interact with one another exchanging diverse resources provides a valuable perspective that can advance our understanding of how to use managerial decisions to strategically manage both human and relational capital. Second, it shows that affective relational content for innovation is just as important as instrumental relational content for innovation and yet, it might not be possible to simultaneously optimize on both. Consequently, the empirical analyses conducted in this dissertation result in two main findings: (a) formal managerial decisions affect informal interactions, and (b) the relational content of informal interactions is relevant for innovative performance. Jointly, the theoretical developments and the empirical findings of this dissertation result in the following three main propositions:

(1) *Delegation decisions in innovation projects can influence the informal organization of knowledge within the firm by creating incentives that drive workers´ choices regarding the knowledge they acquire through their interactions*. Human capital that is relevant to a give task increases workers' efficiency as workers are more knowledgeable about the problems they need to solve and find value in engaging in related interactions. Then, autonomy can be used strategically to complement higher levels of relevant human capital or compensate lower levels of relevant human capital, affecting the relative benefits workers derive from acquired knowledge that is more related or more unrelated to their tasks. This distinction is relevant for the organization of innovative activities as it can reveal two critical underlying forces that impact innovation: knowledge specialization within domains vis-à-vis knowledge diffusion between domains. Furthermore, given that managerial decisions can influence the way in which people interact suggest a potential channel by which firms can think about designing network structures.

(2) *The relational content and the embeddedness of relationships have direct and interactive effects over individuals' innovative performance*. Individuals involved in instrumental/knowledge embedded triads (knowledge-exchange cliques) are more likely to generate innovations, but also individuals involved in non-instrumental/friendship embedded triads (friendship cliques) are more likely to generate innovations. Nonetheless, individuals simultaneously involved in both instrumental and non-instrumental cliques are less likely to generate innovations. This suggests that the relational content of embedded relationships can introduce competing rather than complementary logics that end up stifling instead of enhancing individuals' ability to generate innovations. It is problematic to attempt to optimize

on both. Thus, firms interested in promoting innovation should acknowledge the existence of different logics through which collaborations can result in innovative outcomes. Encouraging an open, friendly environment matters as much as favoring knowledge sharing among individuals for innovation, but more importantly is to be aware that individuals should not be encouraged to mix different types of interactions as they can bring substantively different logics and expectations and trying to manage both at once could be hard to do in a professional setting, eventually hindering one's ability to generate innovations.

(3) *Assessing an individual's human capital and social capital relative to the firm presents alternatives for the firm in terms of adjusting the scope and depth its knowledge and social structures. Through these alternatives an organization can renew or maintain its competitive advantage.* When hiring, organizations can assess the level of fit between a new hire´s human Capital/social capital and the hiring organization´s human Capital/ social capital structures (Human Capital Fit and Social Capital Fit respectively). Value creation then results from tradeoffs between coordination (alignment of actions) and cooperation (alignment of goals) gains/costs arising from either deepening (broadening) the organization's current social structure and/or deepening (broadening) the organization's current knowledge structure, which would eventually impact individual and organizational outcomes. Thus, firms can expect complementarity between the fit of these capitals depending on the organization's own internal resources, the competitive environment the organization faces, and its own strategic vision.