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ABSTRACT

This thesis challenges some conventional understandings of strategic human capital in organizations and highlights the need for more nuanced and contextual perspectives in facilitating superior innovation performance. While much of previous research on strategic human capital examines how human capital diversity and mobility can be a critical source of a firm's competitive advantage primarily based on the resource-based view, our understanding of some of the essential micro-level individual constructs is still somewhat limited. Indeed, we still do not have a concrete answer to questions on whether and how teams or firms can achieve superior subsequent innovation performance from their human capital diversity and its integration or how human capital as a critical resource can be successfully redeployed.

Throughout my three dissertation papers, I examine the microfoundations of a firm's innovation performance concerning human capital diversity, mobility, and integration. By combining insights from strategic human capital, human management, and sociology studies, I focus on how knowledge diversity, individual experience, and integration of human capital diversity can better explain subsequent individual and collective level innovation performance. In my first paper, I examine how co-ethnic collaborations can have differential impacts on individuals depending on the proportion or relative status of the ethnicity and level of ethnic homophily across ethnic groups. I find that ethnic singulars, who can benefit from ethnic diversity and still avoid potential complications from collaborating with the same ethnic individuals within a team, can mainly be beneficial in increasing team innovation performance. My second paper investigates whether within-firm mobility can still provide a relatively more effective resource redeployment strategy over between-firm mobility when mobility requires the same geographic relocations of the mobile individuals. More specifically, I find that the relative benefits of within-firm geographic mobility are much more nuanced than previously claimed, and this resource redeployment strategy should consider who and when to relocate employees at the firm more carefully. Lastly, my third paper examines the contextual understanding of the relationship between the integration of diverse ethnic individuals within the organization and the firm's innovation performance. I find the importance of promoting ethnic integration that can represent the proportion of the population of ethnically diverse individuals to facilitate successful innovation performance.

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CHAPTER I. INTRODUCTION

Recognizing the significance of human capital within organizations, strategic management research has emphasized the potential benefits of human capital diversity in various contexts. Following the resource-based view, strategic human capital research has investigated how human capital diversity can be a crucial source of firm competitive advantages (Barney, 1991; Hatch & Dyer, 2004; Coff & Kryscynski, 2011). On the one hand, research in this stream examines how firms acquire a new set of knowledge and valuable assets through human capital. For instance, research on learning-by-hiring has documented evidence for effective and efficient mechanisms to incorporate valuable knowledge (e.g., Song, Almeida, & Wu, 2003, Slavova, Fosfuri, and De Castro, 2016) or disrupt obsolete firm routines (Jain, 2016). On the other hand, recent research has rejuvenated the scholarly debates on the benefits of ethnic diversity of human capital, emphasizing the role of diverse knowledge (e.g., Almeida, Phene, & Li, 2015; Choudhury & Kim, 2019). Studies in this stream emphasize the importance of ethnically diverse individuals as a source of distinctive knowledge for successful innovation performance in various organizational contexts.

Scholarly inquiry on the importance of human capital diversity is not limited to one research tradition. Somewhat more micro-level human resource studies similarly examine management practices that can better manage and utilize diverse resources at the firm (Gilbert, Stead, & Ivancevich, 1999; Ferdman, 2014; Ployhart, Nyberg, Reilly, & Maltarich, 2014; Shore, Cleveland, & Sanchez, 2018). In particular, research on human resource management emphasizes the critical roles of management practices related to hiring and developing valuable human capital resources (Wright & McMahan, 2011; Ployhart et al., 2014). Although studies in this research stream acknowledge the economic benefits facilitated by a group of diverse individuals who can provide various perspectives (Gilbert et al., 1999; Ferdman, 2014), we still

lack a concrete understanding of specific micro-level constructs related to human capital diversity that can better explain various firm's competitive advantages (Felin & Foss, 2005). More importantly, although there has been calls for the need to bridge human capital literature and the research on human resource management (e.g., Ployhart et al., 2014; Wright, Coff, & Moliterno, 2014), we still do not know how firms can facilitate superior innovation performance from integrating their human capital diversity, mobility, and integration.

Throughout three dissertation papers, I investigate how individuals, teams, and firms can better integrate diverse knowledge with a more human-centric approach. In today's knowledge-based economy, the importance of diverse individuals in enhancing productivity and performance is rather challenging to underestimate (Kerr, Kerr, Ozden, & Parsons, 2016). However, we still observe various social contexts in which ethnically homogeneous teams, rather than diverse ones, achieve successful team collaborations, while various studies on human capital diversity have yielded instead 'diverse' implications (e.g., Horwitz & Horwitz, 2007). In my thesis, I argue that previous conflicting findings on the benefits of diversity can be reconciled once we consider potential threats of collaboration among the same ethnic individuals, potential difficulties from diversity itself, and successfully integrating diverse individuals. More specifically, by combining and building on insights from relevant fields on strategic human capital, human management, and, more generally, sociology studies on individuals, the chapters in this thesis investigate how diverse human capital within the firm can better explain the innovation performance of the firm. In so doing, my theoretical and empirical focus has emphasized knowledge diversity, experience, and human capital ethnic diversity.

In my first dissertation paper, I study how and why ethnic homophily among ethnic minorities can be counterproductive and consider why other co-ethnic team members influence ethnic minorities in collaborations. While the extant management literature on human capital

diversity has largely examined ethnic diversity and homophily separately due to different natures of the constructs (Joshi, Liao, & Roh, 2011; Lazarsfeld & Merton, 1954), the performance outcomes of ethnically diverse individuals are necessarily dependent on how individuals respond to other same and different ethnic individuals within a team. This is because ethnicity, an easily observable characteristic that triggers immediate responses (Blake & Mouton, 1961), can provide the basis of social categorizations and triggers for preference for collaborations (e.g., Ertug, Brennecke, Kovacs, & Zou, 2022). I investigate how teams can benefit from their ethnically diverse individuals by having more ethnic singulars, who I define as ethnically unique individuals in a team. The empirical analyses on inventor teams in the major US IT firms provide support for the hypotheses on the distinctive aspects and distinctive benefits of ethnic singulars.

My second dissertation paper investigates the relative benefits of within-firm mobility over between-firm mobility as a resource redeployment strategy with a consideration of the different implications of having the same geographic relocations of mobile individuals. Even though strategic human capital research suggests the comparative advantage of within-firm mobility over between-firm mobility due to its efficient knowledge transfer and superior performance (Bidwell, 2011; Karim & Williams, 2012; Choudhury, 2017), we still do not know whether these relative benefits still exist with geographic relocations, which may pose challenges to mobile individuals (e.g., Artuc, Docquier, Özden, & Parsons, 2015). Thus, by comparing the post-mobility innovation performance of individuals who experience within and between-firm mobility that requires the same geographic relocations, I examine the comparative advantages of within-firm geographic mobility as a resource redeployment strategy of human capital over between-firm mobility. Empirical analyses of individual-level patent data on inventor mobility and their performance within the major U.S. technology firms confirm that individuals who change their locations within their firms experience more

significant performance drops than those who change their locations and firms at the same time. In addition, sub-group analyses show differential implications of within-firm and between-firm mobility on mobile individuals. The results suggest more nuanced aspects of relative benefits of within-firm mobility with geographic relocations of the mobile individuals, and thus the importance of careful redeployment of human capital mobility.

In my last dissertation paper, I examine the implications of ethnic diversity and integration concurrently to investigate whether firms can increase innovation from ethnic diversity. As discussed earlier, ethnic diversity may lead to relative benefits and challenges in collaboration performance (e.g., Horwitz & Horwitz, 2007; AlShebli, Rahwan, & Woon, 2018; Ertug et al., 2022). While the first chapter of the thesis focuses on the potential conflicts of the same ethnic individuals within a team and thus implications of ethnic diversity within a team, this paper examines the conceptual boundary of ethnic diversity and explores why ethnic diversity cannot provide a complete picture without the discussion on the level of ethnic integration of ethnically diverse individuals at the firm level. For instance, even equally diverse firms may lead to heterogeneous performance due to different patterns of ethnic integration in their collaboration patterns. Thus, I examine how firm-level innovation performance depends on the level of ethnic (dis-)integration in collaborations and why ethnic diversity and integration may not automatically generate positive linear implications on a firm's innovation performance. The empirical analyses of the paper on patent data from all U.S. firms suggest the importance of having sufficient levels of ethnic integration in understanding the benefits of ethnic diversity and boundary conditions for when and how to facilitate superior firm-level innovation performance. The results also provide implications that go above and beyond the existing literature on ethnic diversity and integration by considering consecutive and overall collaboration patterns within a firm.

Although the conversations in this dissertation have been largely pivoted on implications on innovation performance, I believe the core research questions in my thesis may also apply to other dimensions of diversity construct, which is now gaining much more interest in various traditions and practitioners alike (e.g., Plummer, 2003). Indeed, effectively managing ethnically diverse team members may be one of the most important and valuable questions in today's specialized knowledge economy (Jones, 2009; Kerr et al., 2016). In connecting my dissertation chapters to a broader literature on strategy and entrepreneurship, I hope to advance scholarly understanding on how our technology and innovation can benefit from human capital diversity, mobility, and integration through my three papers in this thesis and my future work.

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CHAPTER II. THE PURSUIT OF UNIQUENESS: THE IMPACT OF ETHNIC SINGULARS ON TEAM INNOVATION

Abstract

While recent innovation research has increasingly focused on the implications of ethnic diversity, the extant research is relatively silent on how ethnically diverse individuals are influenced by and respond to the same ethnic collaborators in their teams. However, as ethnically diverse teams essentially necessitate collaborations with the same and/or different ethnic individuals, understanding how the team members' ethnic composition conditions the benefit of ethnic diversity is crucial. By focusing on ethnic singulars, defined as ethnically unique individuals within a team, I investigate when ethnically diverse collaboration teams can benefit from their ethnic diversity while avoiding potential challenges. The empirical analyses on inventor teams in the major US IT firms provide support for the hypotheses on the distinctive aspects and distinctive benefits of ethnic singulars.

Keywords:

Human capital; Innovation; Ethnic diversity; Complementarity; Integration; Collaboration

2.1. INTRODUCTION

Although recent innovation research emphasizes how ethnic diversity can distinctively be beneficial in improving innovation performance (Almeida, Phene, & Li, 2015; Choudhury & Kim, 2019; Richard, Murthi, & Ismail, 2007) by focusing on the critical roles played by highly skilled ethnically diverse teams in shaping a knowledge-based economy (Kearney, Gebert, & Voelpel, 2009; Kerr, Ozden, & Parsons, 2016), we still observe various social and corporate contexts in which ethnically homogeneous teams are more prevalent and thus do not have a concrete understanding of the benefits of ethnic diversity. However, in ethnically diverse teams, it is often the case that these individuals collaborate with individuals who have the same and different ethnic backgrounds simultaneously. Even though the extant research has examined the implications of having faultlines or polarization (Lau & Murninghan, 1998; Mäs, Flache, Takács, & Jehn, 2013; Montalvo & Reynal-Querol, 2005), not much attention has been given to potential complications that arise from teams that have multiple same ethnic team members and how they collaborate within and across their ethnic boundaries.

The extant management literature on human capital diversity has largely examined ethnic diversity and homophily separately, while ethnic diversity as a structural characteristic of any group with members of diverse ethnicities (e.g., Joshi, Liao, & Roh, 2011; Shemla, Meyer, Greer, & Jehn, 2016), ethnic homophily as a behavioral attitude with which individuals prefer to collaborate with the same ethnic individuals (Lazarsfeld & Merton, 1954). Yet, as ethnicity is an easily observable demographic characteristic that can evoke immediate responses among individuals (Blake & Mouton, 1961), it provides the basis of social categorizations and triggers for preference for collaborations (e.g., Ertug, Brennecke, Kovacs, & Zou, 2022). As such, translating human capital ethnic diversity into superior innovation performance is necessarily dependent on how individuals respond to situations in which they need to collaborate with the same and different ethnic individuals within a team. Thus, in this study, I investigate why the

benefits of ethnic diversity can be conditioned by the same ethnic team members and examine conditions under which individuals can avoid potential challenges of collaboration among individuals with diverse ethnicities.

More specifically, I examine whether individuals of ethnic singulars, who I define as ethnically unique individuals in an inventor team, can better enable the benefits of ethnic diversity. As I argue, these ethnic singulars are particularly effective in enabling the benefits of human capital in ethnic diversity while avoiding complicated social contexts from having the same ethnic team members. By augmenting innovation research on human capital and knowledge flows (Agrawal, Kapur, & McHale, 2008; Breschi & Lissoni, 2009) and recent development in sociology research on homophily (Ertug et al., 2022), I examine some of the distinctive characteristics of ethnic singulars in their collaborations with ethnically diverse team members. In particular, I consider how team performance changes with the increase of ethnic singulars compared to ethnic non-singulars. Furthermore, as it is crucial to disentangle the positive implications of having ethnic singulars from the mere increase of team members with complementary skills (Agrawal et al., 2008; Lazear, 2009), I also investigate how the potential benefits of ethnic singulars differ from the positive impact of having more team members, especially compared to ethnic non-singulars. Lastly, I propose several boundary conditions of the benefits of ethnic singulars by investigating how the legitimacy of ethnic singulars in terms of tenures and commonalities can condition the potential implications of having ethnic singulars in achieving more successful collaboration performance.

I test these propositions in the context of innovative collaborations among 222 international companies in the information and technology industry that are headquartered in the United States. This research setting is particularly suitable for a study on ethnic diversity and singulars as these firms can achieve and maintain their comparative advantages based on intensive research-oriented activities that have been suggested to have a high involvement of

individuals with various ethnic backgrounds (Jones, 2009; Kerr et al., 2016; Mathieu, Gallagher, Domingo, & Klock, 2019). The results of the study provide evidence of the critical roles played by ethnic singulars by explicating the comparative benefits of ethnic singulars over individuals who are not singulars and thus have co-ethnic team members. That is, the beneficial outcomes of having ethnic diversity may primarily arise from the fact that ethnic singulars can avoid knowledge redundancy while promoting team member cognitive diversity among team members. In contrast, individuals who have co-ethnic team members within the team may have difficulties in achieving these positive benefits due to challenges within and across ethnic boundaries. By examining previously less studied facets of ethnic diversity related to within team same ethnic individuals and the value of ethnic singulars, this study aims to provide potential explanations for the conflicting findings in the management literature on the paradoxical implications of ethnic homophily and ethnic diversity.

2.2. THEORY DEVELOPMENT

2.2.1 Literature review: Ethnic diversity and innovation performance

Orchestrating collaborations among specialized individuals with diverse backgrounds is getting increasingly critical in various organizational contexts with the specialization of knowledge (Jones, 2009; Mathieu et al., 2019). Previous management studies have examined the benefits of team member diversity on innovation performance in relation to the improved information processing capability (McGrath, 1964; Hong, Morris, Chiu, & Benet-Martinez, 2000), creative and innovative perspectives (Cox & Blake, 1991; Miller, Burke, & Glick, 1998), or effective communication (Bell et al., 2011). While diversity and skill-set complementarity of members can generally improve the quality of knowledge sharing and innovation creation (Agrawal et al., 2008), the ethnic diversity of a team can provide a particularly critical mechanism in improving innovation performance (e.g., Earley & Mosakowski, 2000; Alesina

& La Ferrara, 2004; AlShebli, Rahwan, & Woon, 2018). Relatedly, recent innovation studies started to emphasize the benefits of ethnic diversity as a source of different knowledge sets in the context of innovative collaborations (e.g., Almeida et al., 2015; Choudhury & Kim, 2019; Richard et al., 2007). In short, various studies find that ethnically diverse individuals can improve innovation performance by enabling diverse perspectives and knowledge sets, both of which are critical in achieving creative and innovative collaborations.

Yet, there exists another stream of research that suggests potential difficulties of team member ethnic diversity due to the beneficial implications of having team members who are ethnically homogeneous. Indeed, ethnic homophily, a phenomenon that has been widely documented in various contexts (Lazarsfeld & Merton, 1954; Byrne, 1971; DiMaggio & Garip, 2012), is widely considered a powerful predictor and determinant of successful social networks in numerous organizational settings (e.g., McPherson, Smith-Lovin, & Cook, 2001; Tsui, Egan, & O'Reilly, 1992) and experimental designs (e.g., Leszczensky & Pink, 2015). This is because while individuals are more likely to be attracted by similar individuals (Similarity-attraction paradigm: Byrne, Clore, & Worchel, 1966), diverse backgrounds of individuals may provide sources of different identities (Social identity theory: Tajfel & Turner, 1986; Griffith & Neale, 2001). Thus, individuals may find it challenging to collaborate with team members who have different backgrounds.

While much of the previous discourse on ethnic diversity has indeed examined the relative benefits of ethnic diversity or homophily, scholars have been less keen on the potential influences of having the same ethnic team members in the collaboration performance. Yet, because observable demographic characteristics such as ethnicity can necessarily and immediately trigger in-group or out-group categorizations (Blake & Mouton, 1961; Bell et al., 2011), the ethnic diversity of a team necessarily activates how individuals respond to other team members depending on their ethnicities. As such, to understand how ethnic diversity can

improve or impede collaboration performance, it is necessary to consider how individuals are affected by the same and different ethnic individuals within the team and thus examine ethnic diversity and ethnic homophily concurrently.

2.2.2 The (in)conspicuous challenges of having co-ethnic team members

Translating ethnic diversity into a firm's valuable asset is moderated by the extent to which individuals can efficiently and effectively communicate and collaborate (Smith, Carroll, & Ashford, 1995; Van Knippenberg & Mell, 2016). For instance, when individuals collaborate with others with fairly distinctive cultural backgrounds, these individuals may find it difficult to form a trust or even communicate with others due to linguistic and cultural differences (De Jong, Dirks, & Gillespie, 2016; Tenzer, Terjesen, & Harzing, 2017). In contrast, as individuals of the same ethnic background often share history, languages, and customs (Fearon, 2003), same ethnic individuals can benefit from ethnic homophily such as more efficient collaborations (Ertug et al., 2022). However, while previous studies have suggested potential challenges of having the same ethnic individuals within a team due to faultlines (Lau & Murnighan, 1998) or polarization among team members (Mäs et al., 2013; Montalvo & Reynal-Querol, 2005), there exist several reasons why working with the same ethnic individuals may have more nuanced implications on collaboration.

One such characteristic hinges on the over-embeddedness by becoming relatively more reliant upon the same ethnic collaborators (Uzzi, 1996; Burt et al., 2013). When individuals of the same ethnicity excessively rely upon and get embedded within their ethnic boundaries, the collective team innovation performance will be negatively affected. Indeed, recent management scholars suggest that over-reliance on ethnic communities may provide one crucial explanation for the negative impacts of having ethnic diversity as individuals overly rely on their same ethnic team members, even downplaying knowledge from different ethnic backgrounds (e.g., Almeida et al., 2015). As one of the major benefits of ethnic diversity is

related to having less redundant and more diverse knowledge, if certain individuals in a team do not integrate into the team but prefer to communicate only with their co-ethnic team members, the entire team not only suffers from faultlines that hamper the collective identity (Smith et al., 1995; Lau & Murnighan, 1998) but also fails to achieve effective collaboration among individuals with diverse backgrounds.

Relatedly, the same ethnic team members become more salient referents in a team with various ethnic group members (Nickerson & Zenger, 2008). Thus, by observing how other same ethnic team members behave within the team, individuals may calibrate or compromise on their level of effort. This is because individuals are inclined to behave in certain ways in order not to be rejected by their own ethnic communities. While team collaborations among ethnically diverse individuals may be affected by various factors, if individuals do not exert their maximal effort level, the overall team performance will not be improved.

Lastly, same ethnic individuals within a team may have strong social norms that dictate these individuals, for instance, to communicate with other same ethnic individuals within their own languages. Broadly speaking, social norms are a set of typical behaviors that a specific group of people believes to be the behaviors of others, and studies suggest that having social norms can provide more effective, adaptive, and sometimes socially accepted behaviors among the involved individuals (Cialdini et al., 1991). In other words, certain ethnic communities have strong social norms that force their members to follow a set of certain rules when engaging with the same ethnic individuals (DiMaggio & Powell, 1983). Yet, when certain team members in an ethnically diverse team prioritize their own ethnic social norms, for instance, by using their own languages when communicating with other individuals of the same ethnicities, the collective team identity and its performance will suffer. Besides, using one's own language may not only exacerbates polarization (Mäs et al., 2013; Montalvo & Reynal-Querol, 2005) but also triggers negative perceptions toward people of ethnic minorities (e.g., Maznevski,

1994). As such, following ethnic social norms within a team with different ethnic individuals will lower the team's collective identities and thus have negative impacts on collaboration performance. In sum, whereas ethnic diversity of a team may positively affect the level of team collaboration, having more than one same ethnic individual within a team can cause potential challenges in efficient collaborations and, therefore, may reduce team collaboration performance. Hence,

> ***Hypothesis 1.*** *An increase in the number of same ethnic individuals of an ethnic minority within the team decreases team innovation performance.*

2.2.3 The benefits of being unique: Ethnic singulars

While previous scholars have emphasized why numerically rare individuals of a certain identity, for instance, in terms of ethnicity, may find it challenging to gain legitimacy within the team (Tokenism: Kanter, 1977), close examinations of individual motivation and knowledge diversity may reveal previously less examined but rather crucial and potentially beneficial aspects of ethnic singulars. Figure 2.1 shows conceptual illustrations of inventor team ethnic compositions. While different shapes represent different ethnic group members, the highlighted square shapes stand for individuals of the ethnic majority. Here, ethnic singulars of ethnic minority individuals are represented as shaded shapes.

[Insert Figure 2.1 about here]

First, ethnic singulars are (ethnically) unique within the team and thus benefit from this very situation, especially when they seek to establish favorable reputations among team members. Research in psychology suggests that people constantly encounter a tension between the need for belongingness and the need to be unique. In other words, people tend to decide their social identities by seeking similarity with and acceptance by specific groups and wish to maintain a distinctive and unique sense of themselves (Optimal distinctiveness theory: Brewer, 1991). Thus, while individuals may generally be ethnically homophilous (Ertug et al., 2022),

these individuals also want to be different from others, without which they perceive themselves to be too similar or identical to other members (Fromkin & Snyder, 1980). Even if the relative strengths of the need for belongingness and the need to be unique may be heterogeneous across individuals (Pickett, Bonner, & Coleman, 2002) or contexts (Correll & Park, 2005), unlike individuals who have the same ethnic team members and therefore need to balance these conflicting forces, ethnic singulars, who are already ethnically unique within the team, can better focus on their need for belongingness within the team.

Relatedly, ethnic singulars are highly motivated to have a strong desire to be successful and responsible for their work roles due to high visibility and more scrutiny, partially due to their unique ethnicity (Kanter, 1977). This situation provides strong incentives to establish their reputations and motivations to be responsible and successful within the team. With these incentives, ethnic singulars can further improve the levels of pride and confidence in their ethnic identity (Amabile & Kramer, 2011), which may also increase team performance. In addition, as ethnic singulars are endowed with unique ethnic knowledge that resides in their ethnic boundary (Almeida et al., 2015), these ethnic singulars can further facilitate successful innovation performance. Whereas too much pressure from high visibility and scrutiny would result in a suboptimal level of performance, a certain level of pressure upon ethnic singulars from being ethnically unique within the team would provide incentives for them to advance their collaboration performance.

Furthermore, ethnic singulars cannot be polarized and are thus more likely to be flexible (Mäs et al., 2013; Montalvo & Reynal-Querol, 2005). It is important to note that these positive implications of ethnic singulars are not solely attributed to their status of being new to the teams (e.g., Soda, Mannucci, & Burt, 2021). Rather, the benefits of ethnic singulars come from their less bounded mentalities socially and cognitively when compared to individuals with other same ethnic team members. On the one hand, as discussed earlier, individuals may face a

certain social bound in their collaborations precisely because of their same ethnic team members. This social confinement may rise two-fold: within and across the ethnic boundary. Although successful collaboration may not be entirely determined by the ethnicities of participants, individuals who have the same ethnic team members are more prone to take into about the social norms within their ethnic boundary. In addition, as ethnicity can provide a cue for categorization within the team (Blake & Mouton, 1961; Lau & Murnighan, 1998; Bell et al., 2011), same ethnic individuals may also be considered relatively more similar by other team members. In contrast, ethnic singulars do not have any other individuals who have the same ethnicities and therefore can avoid difficult, socially complicated situations in which they should pay more care due to their co-ethnic collaborators. Besides, ethnic singulars are less likely to suffer from being culturally and historically redundant as they are unique within the team. Thus, ethnic singulars can maintain the benefits of being ethnically distinctive so that they can draw rather distinctive knowledge from their own ethnic community (Almeida et al., 2015) while reducing redundant information or knowledge, at least based on their ethnic backgrounds.

On the other hand, ethnic singulars are less likely to suffer from their cognitive lock-in, which refers to a state in which not enough openness or flexibility is exhibited among team members and thus may harm their innovation performance (Crescenzi, Nathan, & Rodriguez-Pose, 2016). Due to their lack of concerns related to (ethnic) in-group and out-group differences within the team, ethnic singulars are more willing to collaborate with various other individuals with more open-minded approaches. In the management literature, the critical roles played by boundary spanning roles in achieving improving performance in various levels and organizational contexts are fairly well evidenced (e.g., Tushman & Scanlan, 1981; Rosenkopf & Nerkar, 2001). As ethnic singulars, by definition, cannot be confined to their ethnic and social boundary within a team, it is more probable for these individuals to suffer less from

cognitive lock-ins and to engage with various other team members. In addition, it is difficult to expect ethnic singulars to downplay other team members based on their ethnicities, as the primary purpose of the collaboration within a firm should achieve successful outcomes. As ethnic singulars can incorporate cognitively diverse ideas in their innovation activities by maintaining a more flexible collaboration attitude towards other individuals within the team, teams with ethnic singulars are more likely to outperform. In sum, by providing effective mechanisms to avoid potentially unfavorable results of being embedded in their ethnic societies (Uzzi, 1996, Burt et al., 2013; Almeida et al., 2015) while utilizing the benefits of being ethnically diverse, teams can increase their innovation performance when they have more ethnic singulars. Accordingly,

> ***Hypothesis 2a.*** *An increase in the number of individuals of an ethnic minority increases team innovation performance when these inventors are* ***ethnic singulars****.*

Whereas a team can increase its collaboration performance by having more ethnic singulars, the proposed relationships may be spurious if the positive implications of having ethnic singulars are attributable solely to the increased number of team members, that is, a bigger team size. However, a team can benefit from its various team members only if these individuals can provide sufficiently unique and complementary skills (Agrawal et al., 2008; Lazear, 2009). In other words, when an additional team member is less likely to provide distinctive knowledge to the team's knowledge set, then there may not exist a positive impact of adding the new member. For instance, while ethnic singulars can provide sufficiently distinctive knowledge and perspectives based on their ethnic backgrounds (Parrotta, Pozzoli & Sala, 2016), ethnic individuals who are not singulars may experience limitations in drawing knowledge from their ethnic backgrounds as it may raise polarization issues (Mäs et al., 2013; Montalvo & Reynal-Querol, 2005) while same ethnic individuals may also have conflicting heterogeneous knowledge from their same ethnic backgrounds (Leszczensky & Pink, 2019).

Furthermore, given that inventor ethnicities cannot be artificially manipulated and there exist limited ethnic groups in general, having more team members of ethnic minorities may also imply less possibility of having ethnic singulars within the team. In sum, the positive implications of having ethnic singulars within the team would be even more pronounced as the team becomes bigger. Thus,

> ***Hypothesis 2b.*** *The positive effect of team size on team performance is accentuated only by the increase in the number of ethnic singulars.*

2.2.4 Knowledge integration: Legitimacy from tenure and common backgrounds

Although ethnic singulars do seem to provide more effective mechanisms in providing knowledge diversity with less potential challenges within ethnically diverse team members, there may exist several conditions under which the positive implications of ethnic singulars get more pronounced in leading to their comparative advantages. This is particularly critical for ethnic singulars because their (ethnically) unique positions within the team may challenge their legitimacy, partially due to the lack of the same ethnic team members (Kanter, 1977). Therefore, in what follows, I examine specific conditions that can increase the legitimacy of these ethnic singulars within a team and their relative efficacy in achieving effective collaboration performance.

On the one hand, tenures of ethnic singulars may affect the discussed relationship between ethnic singulars and team performance. More specifically, ethnic singulars who have long tenures within the firm are more likely to be effective in improving team collaboration performance due to their legitimacy within the firm. Longer tenured ethnic singulars have a certain level of trustworthiness toward their relevant knowledge and experience in the field by other team members from their long working history (Jones & George, 1998). Besides, as their long career also allows ethnic singulars to accumulate not only task-specific but also more general knowledge, these individuals can further develop the cognitive complexity that enables

them to be more flexible in collaborating with other team members (De Jong et al., 2016). Although spending sufficient time within a firm may generally have a positive impact on employees in their collaboration capability, this is particularly critical for ethnic singulars because these individuals may face legitimacy-related issues.

In addition, experience within a firm can further reduce the relative importance played by surface-level diversity, such as age or gender, and increase the effects of deep-level diversity, such as working attitude or value (Harrison, Price, & Bell, 1998). Besides, as these ethnic singulars can accumulate tacit knowledge and a shared understanding of other members' work habits or styles, they can better utilize their experience within the firm and thus collaborate more efficiently and effectively (Phinney, 1990; Ployhart & Moliterno, 2011). This is particularly important for ethnic singulars as they can avoid potential challenges from a lack of legitimacy within the firm. Collectively, longer-tenured ethnic singulars can avoid stereotypical prejudice from lack of understanding or unique ethnic backgrounds and thus improve performance. As such,

> ***Hypothesis 3a.*** *An increase of long-tenured ethnic singulars, compared to short-tenured ones, positively increases team innovation performance.*

On the other hand, the extent to which a team can benefit from its ethnic singulars may also depend on the level of common backgrounds among its ethnic singulars possess. In other words, while ethnic diversity can improve collaboration performance by providing unique but complementary knowledge that resides in various ethnic individuals in a team, successful collaboration may require at least a certain level of commonality, especially among ethnic singulars. This is because ethnic singulars who do not have any other team members who share the same ethnic backgrounds may find it challenging to gain legitimacy when they have no commonality with other team members. First, while language barriers among team members with different ethnic backgrounds may pose challenges in their collaboration due to difficulties

forming trust among team members (e.g., Tenzer, Terjesen, & Harzing, 2017), common cultural backgrounds or similar languages can facilitate friendly collaborations (Phinney, 1990) and faster decision-making (Horwitz & Horwitz, 2007) because they can facilitate trust-building and increase mutual understanding. Indeed, using specialized or not shared language or jargon can impede collective communication efficiency because involved individuals face difficulties in knowledge exchange (Maznevski, 1994; Grant, 1996). Thus, having a common language is necessary for any successful knowledge integration.

Furthermore, finding common grounds is crucial in facilitating knowledge integration and interactions (Tortoriello & Krackhardt, 2010). This is because team members without commonalities may have difficulties in collaboration partially due to their distinctive knowledge backgrounds. Given that multiple ethnic singulars are by definition from different ethnic backgrounds, it would be more beneficial for these individuals to share at least a certain level of commonality so that they can avoid too many potential challenges that arise from the absence of commonality among team members. In other words, while individuals could gain from collaborating with other ethnically diverse team members, there may be a limit in collaborating with too different or distinctive individuals with whom team members may find it almost impossible to collaborate. As such, while ethnic singulars may increase team ethnic diversity and potential for successful team performance, the positive implications of having ethnic singulars within a team may be moderated by the level of commonality these ethnic singulars possess. Put differently, the potential benefits of ethnic singulars may get more significant when these ethnic singulars share a minimum commonality and thus are not entirely challenging to communicate with other team members. Accordingly,

> ***Hypothesis 3b.*** *An increase of <u>less dissimilar ethnic singulars</u> of a team positively increases team innovation performance.*

2.3. DATA AND METHODOLOGY

2.3.1 Data and sample

The investigations of the theorized relationship in this study require a set of team-level data in which ethnically diverse individuals collaborate. Based on innovation research that informs the crucial roles played by diverse ethnic individuals in our modern knowledge-based society (e.g., Kerr et al., 2016), I examine inventor team collaboration by innovation-driven firms in the information and technology industry that have particularly benefited from diverse ethnic groups. As such, the empirical analyses of this study are based on patent collaboration data filed by 222 major firms in the S&P 500 over the 30-year-period (1986-2015). While the total number of ethnic minority inventors is generally increasing (Figure 2.2), the relative productivity of ethnic minorities compared to the ethnic majority in terms of granted patents is persistently higher (Figure 2.3).

[Insert Figures 2.2 and 2.3 about here]

Patent data were gathered from *Patentsview* (http://www.patentsview.org/), a data repository by the United States Patent & Trademark Office (USPTO) on all the patents filed and granted. This context not only provides a suitable research setting in which inventor collaboration and knowledge spillover can be adequately captured (Nerkar & Paruchuri, 2005; Breschi & Lissoni, 2009) but also enables to test of whether ethnic inventors indeed play active and crucial roles in innovative collaborations. It is noteworthy that I only considered firms that are headquartered in the United States to control for any institutional heterogeneity in patenting behaviors across countries (Cohen, Goto, Nagata, Nelson, & Walsh, 2002). Furthermore, I examined patents that were filed by more than two identifiable individuals, excluding patents filed by a sole inventor because these patents are not relevant to the purpose of this study. As such, from the initial list of 764,565 patents, the final dataset for the analyses contains 301,468 patent collaboration observations.

In order to examine the impact of ethnic diversity and ethnic singulars on team performance, it is necessary to gather inventor ethnicity information. Given that patent data does not provide this crucial piece of information, this study utilized the Ethnea dataset that was developed by Torvik and Agrawal (2016). More specifically, these authors use the nearest neighbor approach in ethnicity classification to identify all the instances of the most similar ones for given names with the results from PubMed, the leading biomedical literature database that references over 15 million abstracts. Then, these instances are coupled with their respective countries and probabilistically mapped to a set of 26 pre-defined ethnicities. There exist at least three benefits of using this dataset for this study. First, while it would be ideal to attain precise ethnicity information for all the inventors in the sample, it may not be practically feasible given the nature of the large-scale data. Second, it is possible to gather information about individuals for their dominant or dual ethnicities, for inventors may have names of mixed ethnicities for reasons such as marriages or migration. Lastly, while one may question the validity of using one's name to predict the exact and correct ethnicity, names do represent one's languages and customs (Fearon, 2003). Thus, while this categorization may not be able to capture all the details of ethnic-related elements of a person, it is plausible to expect that much information related to the ethnicity of the focal individual can be estimated. Furthermore, it is crucial to note that as I limit the sample to any inventor teams within the United States, I bifurcate the sample into two (*Anglo-Saxon English* or all the other ethnicities) and consider non-Anglo-Saxon individuals to be ethnic minorities. Figure 2.4 illustrates the trend of ethnic singulars, ethnic minorities, and team size of patenting teams.

[Insert Figure 2.4 about here]

2.3.2 Measures

2.3.2.1 Dependent Variable: Inventor Team Innovation Performance

Prior innovation research broadly suggests that forward citations of a patent can provide a good proxy for the focal patent's technological quality and innovation contribution (Trajtenberg, 1990; Jaffe et al., 1993; Nerkar & Paruchuri, 2005; Fischer & Leidinger, 2014). In this study, therefore, I calculate the *team innovation performance* as the total number of forward-citations that the focal patent received for the first five years after filing. While I use the total number of forward-citations as a main dependent variable, given that the forward citations patents receive may be highly skewed (Scherer & Harhoff, 2000), I further consider a logarithm transformation of the variable after adding one as a robustness check.

2.3.2.2 Independent Variables: Ethnic Singulars and Non-Singulars

To examine how individuals of ethnic minorities within a team can affect team performance differentially depending on their other team members, I consider the non-ethnic majority in two ways. First, the number of *ethnic singulars* is the total sum of all individuals who are uniquely identified in their own ethnicities and thus only one individual with the same ethnicities. Next, the number of *ethnic non-singulars* is calculated as the sum of individuals of ethnic minorities who are not ethnic singulars within the team and thus have other same ethnic individuals within the team.

2.3.2.3 Control Variables

I included several control variables in order to address various inventor team characteristics that may have an impact on the team performance. First, it is critical to control for the team size in investigating the impact of ethnically diverse individuals on innovation performance, as previous innovation research has emphasized the crucial roles played by various team members (e.g., Cannella, Park, and Lee, 2008; Ter Wal, 2013; Gruber et al., 2013). Thus, I calculated *team size* as the total number of inventors within a team and controlled for

all the analyses in the study. It is noteworthy that although this variable may be highly correlated with team ethnic richness (Parrotta et al., 2016), the relationship between this team size and the number of ethnic singulars within a team is not straightforward and less problematic. Innovation collaborations require team members with expertise and experience, which may also change over time and context. As collective team members' experience may have various facets, I calculated aggregated control variables for each team to capture the effects of the team member experience. More specifically, the analyses in this study included controls for the team member's collective patenting experience in two ways. First, I included *team members' average patent number* as the average of all team members' number of granted patents and controlled for the productivity of team members. The sum of total patent filing numbers by team members in that year is normalized by the size of the team. Second, the *team member cumulative patent number* is calculated as the total number of patents filed by all the team members before the focal patent at the team level. This variable captures the cumulative patenting experience of team members. In the innovation literature, it is a well-known phenomenon that information may decay as the geographic distance increases (Breschi & Lissoni, 2001; Nerkar & Paruchuri, 2005), or distant collaborations may yield better performance (e.g., Ahuja & Katila, 2004; Capaldo & Petruzzelli, 2014). Accordingly, the number of different geographic locations for a team, and *geographic diversity*, was calculated and controlled for the entire analysis in this study. Next, earlier studies suggest the importance of technological diversity of innovation and its performance. Hence, *technological diversity*, or the breadth of technological knowledge, refers to the extent to which inventors can generate new perspectives and insights (Lazear, 2009). Consistent with research on technological diversification (Nemet & Johnson, 2012), this study adopts a three-digit USPTO classification that distinguishes over 400 technology classes. The number of subgroup categories for patents has been calculated and controlled for in all analyses.

Finally, it is important to note that I excluded the *Blau index* as a control variable based on the consideration that the primary purpose of this study is to investigate the relationship between innovation performance and team ethnic diversity in terms of ethnic singulars and non-singulars. The Blau index is a concentration measure of various subgroups in economics, calculated as 1 - ∑pi2, where p is the proportion of individuals of one ethnicity, and i is the number of different ethnicities in a team (Blau, 1977). While this has been widely adopted in much of prior diversity research, the Blau index may also suffer from the issue of color blindness due to its mere consideration of the relative component size (e.g., Voas, Corckett, & Olson, 2002) and this may further obscure the potential benefits and threats of having ethnic singulars and non-singulars. Given that the main purpose of this study cannot be captured by this Blau index, however widely adopted in other studies, I did not include this index in the analyses of this study.

2.3.3 Analysis

I combine the ordinary least squares (OLS) analyses in this study. To test the impact of co-ethnic collaborations among individuals of diverse ethnic backgrounds on team innovation performance, I use a user-written STATA command *reghdfe* to consider potential unobservable errors that are fixed to certain factors, such as firm, year, and the focal patent's technological field, as well as the control variables. Including all the above dependent and independent variables as well as controls (where Φ represents controls and λ captures fixed effects), the final estimation of the current study is as follows:

$$Total\ Forward\ Citation = \alpha + \beta 1 * Ethnic\ Singular + \beta 2 * Ethnic\ Non\text{-}Singular + \Phi i + \lambda i + \varepsilon$$

2.4. RESULTS

Table 2.1 presents the descriptive statistics for the sample of this study. On average, the sample data suggest that the average team size is slightly above three people (3.5245), among

which more than one ethnic singular (1.5054). The ratio of ethnic inventors in a team is 60.45% in the sample with two different ethnic groups (although not reported, ethnic richness is 2.5138). As such, the data does suggest the crucial roles played by migrant individuals in the studied industry. In addition, on average, patents in the sample have more than one location (geographic diversity 2.45), showing the importance of distant collaborations.

[Insert Tables 2.1 and 2.2 about here]

In Table 2.2, Model 1 shows regression with all the control variables. The results show that team size does positively influence innovation performance. In Model 2, I decomposed the number of ethnic minorities into ethnic singulars and ethnic non-singulars, and the results show a clear contract between ethnic singulars and ethnic non-singulars. In order to examine the relationship further, I conducted several subgroup analyses. First, for firms that have ethnic singulars who are singulars within the whole firm, these individuals become ethnic singulars for any collaborations within the firm. Since the relationship may be affected by these ethnic singulars, in Model 3, I exclusively examine ethnic singulars who are not necessarily singulars due to other same ethnic individuals within the firm. The analysis in Model 3 shows the positive impact of ethnic singulars gets even more significant, however marginal, and the explanatory power of the model becomes bigger for this subgroup than the entire group, thus corroborating the idea of the positive impact of ethnic singulars, especially when they could have been ethnic non-singulars. In addition, previous management literature emphasizes the role of new members within a team in improving creativity (e.g., Soda et al., 2021). Hence, in Model 4, I investigate teams with ethnic singulars who are not new to the team members. The results suggest that the positive impact of ethnic singulars does not necessarily come from the rejuvenation of the team. While Hypothesis 1 predicts that ethnic non-singulars, that is, individuals who have other same ethnic team members, have a negative impact on team performance, Hypothesis 2a theorizes how ethnic singulars, unlike ethnic non-singulars, can

improve the focal team's innovation performance. The results of Models 2 and 3 collectively support Hypotheses 1 and 2a.

Furthermore, as has been shown in Model 1, previous innovation studies largely agree that the number of individuals within a team, that is, team size, can have a positive impact on innovation performance (Cannella et al., 2008; Ter Wal, 2013; Gruber et al., 2013). Thus, while other models in this study include team size as a control variable, Models 5 and 6 examine whether there is an interactive effect between the size of ethnic singulars within a team and the team size itself on the performance. Interestingly, while there exists a positive impact of having more ethnic singulars within a bigger team (Model 5), the effect does not apply to ethnic non-singulars (Model 6). In other words, when the number of inventors within a team is the same, one additional ethnic singular has a positive impact on the team performance, while one additional ethnic non-singular is detrimental to the team performance. Hypothesis 2b expects an interactive effect between the ethnic singulars and the team size on the team performance. The results of Models 5 and 6 collectively suggest that this is the case, thus supporting Hypothesis 2b.

[Insert Tables *2*.3 and *2*.4 about here]

I now investigate more detailed relationships between ethnic singulars and team performance in subsequent models. While Hypothesis 3a examines how tenure affects the previously discussed relationship between ethnic singular and team innovation performance, it is noteworthy that traditional interaction analysis of ethnic singulars and the average tenure may not provide relevant insights, given that a team can have multiple ethnic singulars. Thus, to address this relationship in the context of collaborations among ethnically diverse individuals, I incorporated the following three approaches. First, in Model 1 in Table **2.**3, I divided ethnic singulars and non-singulars within a team by those who have longer than eight years of tenure (Ethnic Singular 1) and who have less than eight years (Ethnic Singular 2). The

rationale for this cutoff point of 8 years of tenure is based on the average tenure of the entire inventors in the sample of this study, which is circa 7.5 years. The results of Model 1 suggest that while both ethnic singular subgroups can positively affect the innovation performance, the second group, that is, longer-tenured ones, are more significantly affecting the innovation performance. In contrast, ethnic non-singulars are both negative, yet the longer-tenured individuals are relatively less detrimental in achieving highly innovative team collaboration. Second, in order to examine the differential effects of having long-tenured ethnic singulars within a team, I created a dummy variable based on the average tenure of ethnic singulars within a team in Models 3, 4, and 5. This dummy variable gets 1 when the average tenure of singulars within a team is longer than eight years and 0 otherwise. Similarly, as a robustness check, another dummy variable for long-tenured ethnic non-singulars was created for Models 3 and 4. The results presented in Model 4 are not different from those of Model 2 and Model 3, both of which test the interaction effects separately. In Model 4, while the longer-tenured ethnic singulars do show a significant and positive impact on the team's performance, longer-tenured ethnic non-singulars have a significant but negative impact on the team's performance. In other words, while an increase of experienced ethnic singulars increases the team's collective performance, this positive effect is not a mere result of tenure but rather of the unique aspects of ethnic singulars, especially when compared to ethnic non-singulars. Lastly, there may exist inventors who have long tenures but are less active in patent-related work. Thus, in Models 5 and 6, I incorporated whether ethnic singulars have enough previous patenting experience in terms of being ethnic singulars and introduced a dummy variable that gets 1 when ethnic singulars within a team have more than ten times of previous patenting collaborations as ethnic singulars. While this dummy variable may seem to be similar to the previous dummy variable for tenures, the correlation of these two dummy variables is not highly correlated (0.2474) and therefore capture conceptually related but empirically distinctive aspects of ethnic singulars.

The positive and significant interaction term for ethnic singular and the dummy variable in Model 5 indicates that more experienced ethnic singulars do have a positive impact on team innovation. In addition, Model 6 tests the relationship for a subgroup that excludes teams with ethnic singulars who only have ethnic singular experiences. The rationale for this choice is based on the assumption that previous subgroup analysis may include ethnic singulars who could not have been ethnic non-singulars, and this may alter the analysis implications. However, as can be represented in the results of Model 6 that is more significant, the theorized relationship between the critical role played by previous experience and legitimacy can further increase the positive implications of ethnic singulars in innovation performance. Hypothesis 3a predicts a positive interactive relationship between ethnic singulars and legitimacy on performance. The analyses collectively support the positive interactive effects and their impact on team performance based on their legitimacy based on tenure or experience, providing support for Hypothesis 3a.

Table **2.**4 presents whether the level of commonality of ethnic singulars can affect the effectiveness of ethnic singulars on team performance. I test this relationship in two ways: continental vicinity and linguistic similarity. First, in Models 1, 2, and 3, I calculated the number of continents of ethnicities. The rationale for this choice is as follows. While ethnicity and continent may not provide accurate information for various people, it is more likely that individuals of ethnicities that are from the same continent to have more common backgrounds compared to individuals of ethnicities that are from various continents. For instance, when two ethnic singulars are both of European ethnicities, it is plausible to expect that these two ethnic singulars may have more common backgrounds compared to two different ethnic singulars of one Asian and one African. The results of Models 1 and 2 show that the effects of continental concentration among individuals of ethnic minorities or ethnic non-singulars are negative and significant, implying that in order to increase innovation performance, it is more beneficial to

have individuals who have more diverse ethnic backgrounds, even in terms of continents. Perhaps, these analyses largely support the core tenets of the benefits of human capital ethnic diversity. However, Model 3 shows an interesting but significantly different relationship between continental concentration and the benefits of ethnic singulars. The interaction team between continental concentration and the number of ethnic singulars is not negative as the others but positive and significant. In other words, it is better for ethnic singulars to have more similar ethnic backgrounds, even if they have distinctive ethnicities.

In order to examine how linguistic similarity can influence the benefits of ethnic singulars, I introduced a variable that captures any ethnic singulars in a group who have ethnicities that are of European heritage or use Romance languages, such as French, Italian, or Spanish. Interestingly, the results in Model 4 show that an increase in ethnic singulars who do not belong to this 'close to US' group, in terms of ethnicity, has a negative impact on innovation performance, while there is a positive and significant impact on an increase in ethnic singulars which are more closely related to US (Model 5). In Model 6, the ratio of ethnic singulars which are of European heritage or use Romance languages within ethnic singulars for a team is considered instead, and the results indicate that the higher proportion of ethnic singulars which are close to the US can increase innovation performance. The results in this Table collectively support Hypothesis 3b, which theorizes that more similar ethnic singulars can have a more positive impact on innovation performance. Thus, I find support for Hypothesis 3b.

The magnitudes and significance of control variables largely corroborate previous findings in the literature. As more productive inventors may have accumulated more relevant tacit knowledge about the focal patent, *team member average patent number* and *team member cumulative patent number* are both positive and significant throughout the analyses. The variable *geographic diversity of a patent* has a positive and statistically significant impact on performance, corroborating the established idea that distant collaborations can increase

knowledge diversity (e.g., Capaldo & Petruzzelli, 2014). Similarly, the *technological diversity of patents* has a positive impact on the team's performance.

In this study, I conducted several additional robustness checks. First, as discussed, ethnic singulars, which are not only unique in a team but also within the firm, may represent different phenomena. In other words, when ethnic singulars within a team are indeed the only individuals of that ethnicity within the firm, then it may imply their highly capable ability or difficulties of working with other same ethnic individuals within a firm due to lack of supply or rarity of the ethnicity. Thus, in various models, I incorporated subgroup analyses that only consider teams that have ethnic singulars who could have been ethnic non-singulars but singulars in that particular team due to their previous non-singular experience or existence of other same ethnic individuals within the firm for that year. The results, as shown in Model 6 in Table 3, for instance, do not change from the main regression analyses in this study. Second, team size and the number of ethnic singulars or non-singulars within a team may suffer from multicollinearity issues due to conceptual relationships. Thus, I conducted a multicollinearity detection method using the VIF function of STATA 15 to address the multicollinearity issue. Previous studies suggest that the threshold in detecting evidence of severe multicollinearity is, as a rule of thumb, VIF that is bigger than 10 (Cohen, Cohen, West, & Aiken, 2003). The mean VIF for the variables in the study is 1.83, while the biggest VIF is the number for team size was 2.68. Thus, analyses in this study do not suffer from multicollinearity issues. Next, as the size of forward-citation for patents may be sensitive to the length of the calculation window, which can cause a bias in the dataset, different time spans for forward-citation have been tested. The results with shorter and longer performance windows show that the main variables have essentially the same effect and significance irrespective of different measuring patent performance. In addition, additional regression analyses based on logarithm transformation of forward-citation do not show any difference in the results. Lastly, it is possible that some outlier inventor teams

in the dataset may cause a bias in the analysis. For instance, there may be patents with unreasonably many inventors due to either peculiar practices of a firm or data inaccuracy. Indeed, there is a patent that has more than 70 inventors. To investigate whether these outliers influence the analyses in the study, I ran additional regressions after excluding patents that were filed by relatively many inventors. These tests without outliers did not change the results in any significant ways.

2.5. DISCUSSION AND CONCLUSION

Although recent knowledge-driven societies are characterized by the prevalence and significance of diverse ethnic individuals in various organizational settings and their essential roles in performance (Jones, 2009; Kerr et al., 2016), the management literature is still without a definite answer to questions on the implications of human capital ethnic diversity on team innovation performance (e.g., Horwitz & Horwitz, 2007; Shemla et al., 2016). This study provides one crucial way of tackling this impasse by considering ethnic homophily and ethnic diversity concurrently. In particular, I examined how ethnic singulars, who are ethnically unique in an inventor team, are better positioned than individuals who have other co-ethnic team members to enable more innovative collaborations. By investigating how ethnic singulars can utilize cognitive benefits from ethnically diverse individuals while avoiding potential conflicts between the same ethnic individuals within a team, the results of this study address call for examinations of the mechanisms through which human capital diversity creates values in diversity research (Van Knippenberg & Mell, 2016).

2.5.1 Theoretical Implications

This study extends the current knowledge in innovation research in the context of ethnic migration and inventor mobility. Recently, innovation research has increasingly focused on crucial roles played by ethnic individuals in advancing the innovation frontier in various

organizational settings (e.g., Almeida et al., 2015; Choudhury & Kim, 2019). Previously, innovation scholars have largely focused on geographic factors and knowledge spillover among inventors (e.g., Jaffe et al., 1993; Breschi & Lissoni, 2001). The results of this study extend this tradition by considering why human capital ethnic diversity can be a critical source of enabling a team to achieve knowledge diversity and thus improve innovation collaborations. In so doing, this study also examines conditions under which ethnic diversity can be a burden to a team by providing potential conflicts within the ethnic boundary of the team members. More specifically, while previous innovation research has largely considered human capital ethnic diversity to be a source of knowledge diversity, this study adds more nuanced aspects to the relationship between the ethnic inventor dynamics and team innovation performance by demonstrating how individuals with ethnic minorities may encounter challenges with collaborating with the same ethnic team members. As such, by explicating how ethnic singulars can be distinctively effective in bringing the benefits of ethnic diversity to the team's innovation performance, the results of this study submit a need to examine more detailed aspects of human capital ethnic diversity.

I further intend to contribute to the team diversity literature by providing potential reconciliations of the previous conflicting findings in the management literature on the benefits of ethnic diversity by jointly examining ethnic diversity and homophily, especially within ethnic minorities. In particular, the findings of this study extend the conceptualization of ethnic diversity in that ethnic singulars can play a notably critical role in increasing team innovation performance. The results of this study show how ethnic singulars can benefit from ethnic diversity while avoiding potential detrimental effects among ethnically diverse team members. Perhaps, the lack of consideration on this aspect may be one potential reason for the previous fruitful debates on either support or disproof of the benefits of ethnic diversity (e.g., Tsui et al., 1992; Milliken & Martins, 1996; Bell et al., 2011; Horwitz & Horwitz, 2007; Shemla et al.,

2016). The results further suggest why considering roles played by ethnic singular can better explain the benefits of ethnic diversity. Indeed, it has long been suggested that heterogeneous team compositions are more likely to result in better outcomes (e.g., Earley & Mosakowski, 2000; Alesina & La Ferrara, 2004; Richard et al., 2007).

Moreover, this study is the first attempt, to the author's knowledge, to document the evidence of the importance of team member ethnic composition and ethnic singulars with a large-scale dataset. While previous research on diversity has provided various insights to the field, this study may further push potentials in diversity research that can account for interesting aspects of ethnic diversity and ethnic singulars within a team by examining archival data of patent collaborations of firms. While archival data may not provide superior research context for many diversity studies, focusing on previously overlooked aspects among team members within, for instance, patent collaboration data, can surely broaden potential avenues for future diversity research.

The findings in this study also contribute to the strategic human capital literature and microfoundations of knowledge creation (Felin & Foss, 2005). Previous research in the field has largely focused on the implications of inventor mobility, network, and more general characteristics such as educational backgrounds on innovation performance (e.g., Gruber et al., 2013; Breschi & Lenzi, 2016). The results of the current study augment this literature by explicating the link between how team ethnic compositions, in particular, co-ethnic collaborations, is crucial in understanding the value of the human capital of the firm. While we know the importance of human capital from the extant literature, relatively little is known about dynamics between and across ethnically diverse individuals within innovation performance. This study provides microfoundational evidence that corroborates the broader literature on human capital complementarity and non-redundancy (Arora & Gambardella, 1990). by examining how same ethnic individuals may respond to other same ethnic team members and

what are the unique aspects of ethnic singulars within a team, examining the effects of additional same ethnic individuals in a team.

2.5.2 Practical Implications

Some practical insights to managers and inventors can also be drawn. The results of this study provide the importance of how many ethnicities a team is composed of, rather than human capital diversity per se, that matters in a team's innovation performance. In addition, while previous innovation research suggests the positive performance implications of various ethnic groups within a team, findings in this paper suggest that maintaining as many ethnic singulars as possible within a team can be a critical source of successful team collaboration. For instance, while geographic proximity among team members has been suggested to improve collaboration performance (Agrawal et al., 2008), the results of this study seem to suggest that the same ethnic individuals within a team may not necessarily increase team performance and, therefore it may be a superior way to obtain geographic dispersion among these same ethnic individuals. In short, findings in this study suggest that, when other conditions are equal, it is advisable to mix diverse ethnic individuals in a group to make ethnic individuals ethnic singulars.

2.5.3 Limitations and Boundary Conditions

One potential concern of this study may hinge on the possibility that ethnicity may affect team member composition. For instance, when the same ethnic individuals prefer to collaborate due to their high ethnic homophily (e.g., Ertug et al., 2022), then the findings in this study may not be able to explain the causal relationships in this case. However, the analyses in this study are based on the assumption that corporate contexts would not easily allow the self-selection of collaborators. In other words, it is relatively managers' role to design team members and, therefore, team members' ethnic compositions rather than individual inventors. Thus, the concerns for reverse causality based on ethnic homophily may not be a serious threat to the findings in this study. Relatedly, there may exist other omitted variables that this study could

not consider. For example, previous successful collaborations may determine a continuation of subsequent collaborations with the previous members. Indeed, any large-scale study may face difficulties observing "what really happened" in a team. However, it is critical to note that an inventor team is not entirely determined by individual-level self-selection of inventors and thus less likely to be severely biased by any self-selection issues. Even so, in order to address potential endogeneity issues, I used fixed-effect specifications with considering various controls and examined potential interaction effects from relevant aspects within a team or subgroup analyses by excluding teams that theoretically could have only ethnic singulars due to their existence within the firm. However, further examinations of the effects of having more ethnic singular inventors in the team in a more experimental context, such as lab-based experiments, would provide a fruitful avenue for future research.

Next, although the number of forward-citations a patent receives has been widely adopted in management and innovation research so far (e.g., Jaffe et al., 1993), it may be the case that other aspects of innovation, such as employee welfare or the level of satisfaction of individuals provide different insights (e.g., De Dreu & Weingart, 2003). While supplementary analyses show similar results, given that ethnic singulars do seem to provide a positive influence on team innovation while individuals who are not singular are negatively affecting team innovation performance, investigating other key facets of collaborations among ethnically diverse individuals would be an exciting steppingstone for further research.

2.5.4 Conclusion

While recent innovation research on diversity highlights the importance of human capital ethnic diversity in enabling diverse knowledge, we also know the difficulties of ethnic diversity from the literature. By combining insights from studies on ethnic homophily and the potential threats of ethnic diversity, I submit a previously less studied yet essential aspect of team ethnic diversity: ethnic singulars. By examining how team ethnic composition can affect team

innovation performance, this study finds evidence for an essential dimension of ethnic diversity that has long been assumed yet less discussed (e.g., Hamilton, 1787; Alesina & La Ferrara, 2004). With understanding this critical facet of ethnic diversity, managers and inventors may decide and craft their team compositions more judiciously and strategically.

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2.7. TABLES AND FIGURES

Table 2.1. Descriptive Statistics

	Obs	Mean	S. D.	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Forward Citation	300,915	6.1572	13.7128	0	574	1.0000								
(2) Ethnic Singulars (ES)	300,915	1.5067	0.9539	0	8	0.0122	1.0000							
(3) Ethnic Non-Singulars (ESX)	300,915	0.6257	1.2905	0	33	-0.0186	-0.3264	1.0000						
(4) Team size	300,915	3.5287	1.8649	2	70	0.0186	0.2793	0.4879	1.0000					
(5) Patent Number Mean	300,915	5.1209	8.4369	0	171.19	-0.0144	0.0143	0.0798	0.0447	1.0000				
(6) Patent Number Cum	300,915	23.1746	42.6614	0	933	-0.0382	0.0103	0.0484	0.0214	0.7421	1.0000			
(7) Geographic Diversity	300,915	2.4529	1.2706	1	23	0.0216	0.2464	0.1719	0.6178	0.0522	0.0205	1.0000		
(8) Technology Diversity	300,915	5.6670	6.7349	1	178	0.0640	0.0442	0.0321	0.0718	0.0977	0.1335	0.0483	1.0000	
(9) Year	300,915	2004.90	6.8209	1985	2015	-0.1780	0.0730	0.1401	0.0850	0.1558	0.2221	0.0263	0.1273	1.0000

Table 2.2. The Regression Models on Ethnic Singulars and Non-Singulars

VARIABLES	(1) Model 1 OLS	(2) Model 2 OLS	(3) Model 3 OLS(*1)	(4) Model 4 OLS(*2)	(5) Model 5 OLS	(6) Model 6 OLS
Ethnic Singulars (ES)		0.149***	0.155***	0.170***	-0.406***	0.152***
		(0.0315)	(0.0411)	(0.0510)	(0.0520)	(0.0315)
Ethnic Non-Singulars (ESX)		-0.175***	-0.134***	-0.205***	-0.157***	-0.00753
		(0.0266)	(0.0304)	(0.0382)	(0.0267)	(0.0310)
Team size	0.105***	0.166***	0.0923***	-0.0134	-0.0234	0.253***
	(0.0166)	(0.0213)	(0.0243)	(0.0301)	(0.0255)	(0.0228)
ES * Team size					0.122***	
					(0.00910)	
ESX * Team size						-0.0245***
						(0.00231)
Patent Number Mean	0.0247***	0.0267***	0.0281***	0.0205***	0.0280***	0.0265***
	(0.00422)	(0.00423)	(0.00492)	(0.00647)	(0.00423)	(0.00423)
Patent Number Cum	0.00207**	0.00191**	0.000382	0.00123	0.00178**	0.00199**
	(0.000884)	(0.000884)	(0.00105)	(0.00145)	(0.000884)	(0.000884)
Geographic Diversity	0.258***	0.205***	0.122***	0.407***	0.171***	0.151***
	(0.0254)	(0.0259)	(0.0331)	(0.0403)	(0.0260)	(0.0263)
Technology Diversity	0.167***	0.166***	0.169***	0.139***	0.165***	0.165***
	(0.00382)	(0.00382)	(0.00474)	(0.00611)	(0.00382)	(0.00382)
Constant	4.034***	3.832***	4.097***	3.619***	4.701***	3.631***
	(0.0619)	(0.0665)	(0.0834)	(0.116)	(0.0927)	(0.0691)
Observations	300,913	300,913	174,127	116,200	300,913	300,913
R-squared	0.122	0.122	0.138	0.108	0.123	0.123
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Tech Field FE	Y	Y	Y	Y	Y	Y

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(*1): A subsample that includes ethnic singulars who have the same ethnic individuals within the firm but work as ethnic singulars for team collaborations.
(*2): A subsample that includes ethnic singulars who have previous collaboration experience with the focal team members and thus not considered as novel to the other team members.

Table 2.3. The Regression Models on Ethnic Singulars and Legitimacy from Tenure

VARIABLES	(1) Model 1 OLS	(2) Model 2 OLS	(3) Model 3 OLS	(4) Model 4 OLS	(5) Model 5 OLS	(6) Model 6 OLS (*4)
Ethnic Singulars (ES)		0.107***	0.150***	0.107***	-0.0302	-0.0212
		(0.0332)	(0.0315)	(0.0332)	(0.0434)	(0.0535)
ES Short Tenure	0.126**					
	(0.0489)					
ES Long Tenure	0.156***					
	(0.0329)					
Ethnic Non-Singulars (ESX)		-0.180***	-0.154***	-0.158***	-0.169***	-0.188***
		(0.0268)	(0.0272)	(0.0274)	(0.0273)	(0.0342)
ESX Short Tenure	-0.321***					
	(0.0597)					
ESX Long Tenure	-0.146***					
	(0.0287)					
ES Long Tenure (*1)		-0.320**		-0.317**		
		(0.142)		(0.142)		
ES * ES Long Tenure Dummy		0.311***		0.311***		
		(0.0766)		(0.0766)		
ESX Long Tenure (*2)			0.361	0.356		
			(0.294)	(0.294)		
ESX * ESX Long Tenure Dummy			-0.311***	-0.313***		
			(0.109)	(0.109)		
ES Experience (*3)					0.540***	-0.266*
					(0.100)	(0.147)
ES * ES Experience					0.105*	0.654***
					(0.0544)	(0.0844)
Team size	0.166***	0.167***	0.169***	0.170***	0.182***	0.0715***
	(0.0213)	(0.0213)	(0.0213)	(0.0213)	(0.0213)	(0.0270)
Patent Number Mean	0.0252***	0.0286***	0.0257***	0.0276***	0.0245***	0.0454***
	(0.00431)	(0.00429)	(0.00424)	(0.00430)	(0.00423)	(0.00676)
Patent Number Cum	0.00232**	0.00135	0.00220**	0.00163*	0.000599	0.00455***
	(0.000915)	(0.000913)	(0.000890)	(0.000918)	(0.000889)	(0.00136)
Geographic Diversity	0.206***	0.203***	0.204***	0.202***	0.214***	0.385***
	(0.0259)	(0.0259)	(0.0259)	(0.0259)	(0.0259)	(0.0338)
Technology Diversity	0.166***	0.166***	0.166***	0.166***	0.164***	0.180***
	(0.00382)	(0.00382)	(0.00382)	(0.00382)	(0.00382)	(0.00535)
Constant	3.826***	3.875***	3.823***	3.866***	3.734***	3.798***
	(0.0666)	(0.0689)	(0.0667)	(0.0691)	(0.0764)	(0.0927)
Observations	300,913	300,913	300,913	300,913	300,913	197,930
R-squared	0.122	0.122	0.122	0.122	0.123	0.119
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Tech Field FE	Y	Y	Y	Y	Y	Y

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

(*1): A dummy variable for ethnic singulars who have on average 8 years or more of tenure

(*2): A dummy variable for ethnic non-singulars who have on average 8 years or more of tenure

(*3): A dummy variable for ethnic singulars who have more than 10 times of previous ethnic singular experience

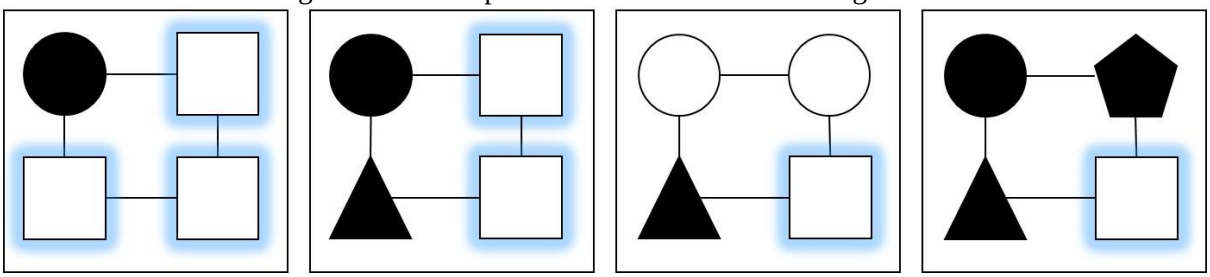
(*4): A subgroup that has ethnic singulars who have experienced ethnic non-singulars in previous collaborations

Table 2.4. The Regression Models on Ethnic Singulars and Commonality from Continental Concentration (CC) and Linguistic Similarity (LS)

VARIABLES	(1) Model 1 OLS	(2) Model 2 OLS	(3) Model 3 OLS	(4) Model 4 OLS	(5) Model 5 OLS	(6) Model 6 OLS
Ethnic Singulars (ES)		0.219***	0.0779**	0.334***	0.0630	-0.115**
		(0.0340)	(0.0356)	(0.0487)	(0.0415)	(0.0516)
Ethnic Non-Singulars (ESX)		-0.292***	-0.182***	-0.147***	-0.184***	-0.108***
		(0.0776)	(0.0267)	(0.0273)	(0.0272)	(0.0326)
CC Minority	1.886***					
	(0.199)					
Ethnic Minority	0.172***					
	(0.0354)					
CC Minority * Ethnic Minority	-0.846***					
	(0.0701)					
CC ESX		2.961***				
		(0.308)				
CC ESX * Ethnic Non-Singulars		-0.551***				
		(0.0953)				
CC ES			-1.088**			
			(0.552)			
CC ES * Ethnic Singulars			0.695***			
			(0.219)			
Non-Romance ES				0.114*		
				(0.0623)		
Non-Romance * ES				-0.105***		
				(0.0231)		
Romance ES					-0.0313	
					(0.0723)	
Romance ES * ES					0.0643**	
					(0.0292)	
Romance ES Ratio						-0.547***
						(0.142)
Romance ES Ratio * ES						0.403***
						(0.0950)
Team size	0.220***	0.240***	0.162***	0.164***	0.163***	0.395***
	(0.0221)	(0.0220)	(0.0213)	(0.0213)	(0.0213)	(0.0246)
Patent Num Mean	0.0261***	0.0273***	0.0270***	0.0271***	0.0269***	0.0309***
	(0.00423)	(0.00423)	(0.00423)	(0.00423)	(0.00423)	(0.00454)
Patent Num Cum	0.00203**	0.00196**	0.00192**	0.00195**	0.00195**	0.00223**
	(0.000884)	(0.000884)	(0.000884)	(0.000884)	(0.000884)	(0.000944)
Geographic Diversity	0.185***	0.146***	0.203***	0.205***	0.203***	0.0363
	(0.0261)	(0.0263)	(0.0259)	(0.0259)	(0.0259)	(0.0283)
Technology Diversity	0.166***	0.165***	0.166***	0.166***	0.166***	0.163***
	(0.00382)	(0.00382)	(0.00382)	(0.00382)	(0.00382)	(0.00404)
Constant	3.571***	3.537***	3.926***	3.637***	3.920***	3.808***
	(0.0759)	(0.0742)	(0.0704)	(0.0791)	(0.0777)	(0.0965)
Observations	300,913	300,913	300,913	300,913	300,913	268,805
R-squared	0.122	0.123	0.122	0.122	0.122	0.119
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Tech Field FE	Y	Y	Y	Y	Y	Y

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 2.1. Conceptual Illustrations of Ethnic Singulars



* Note: While the left two and the right two teams have the same number of individuals of the ethnic majority (three and one, respectively), the number of ethnic singulars for these teams all differ.

Figure 2.2. The Total Inventor Size in the Sample

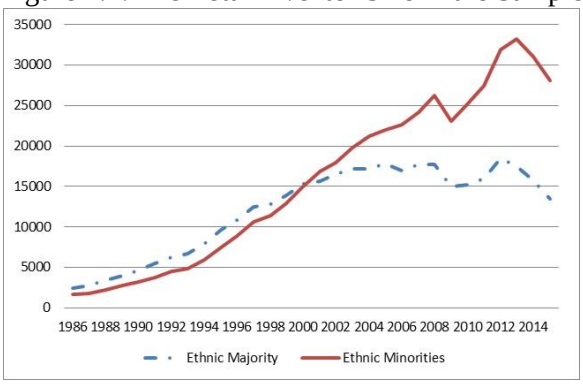


Figure 2.3. The Average Number of Patents by Inventors

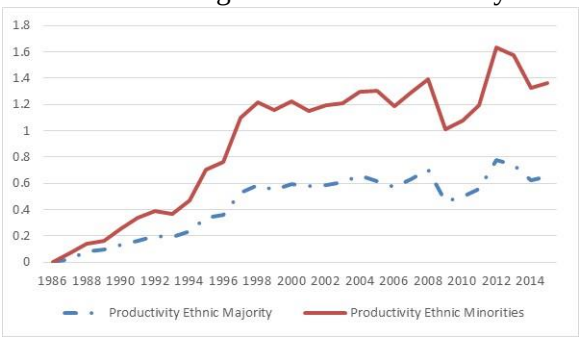
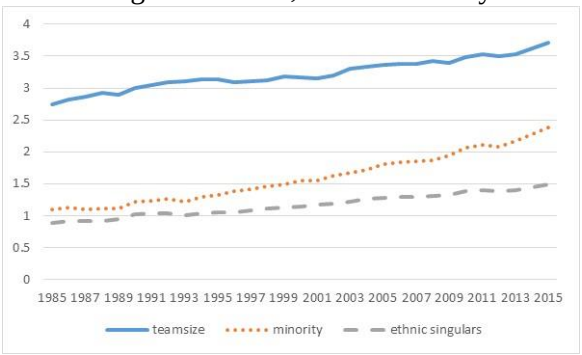


Figure 2.4. Trend of Average Team Size, Ethnic Minority and Singular Members



CHAPTER III. THE CHALLENGES OF RELOCATIONS WITHIN THE FIRM: LEARNING-BY-HIRING, INTERNALLY?

Abstract

Although research on strategic human capital and resource redeployment suggests that within-firm mobility is more effective in enabling knowledge transfer and collaborations than between-firm mobility, geographic relocations may have differential implications on mobile individuals due to personal and interpersonal complications and potentially reduce the comparative advantages of within-firm mobility. Empirical analyses of individual-level patent data on inventor mobility and their performance within the major U.S. technology firms confirm that individuals who change their locations within their firms (within-firm mobility) experience more significant performance reductions than those who change their locations and firms at the same time (between-firm mobility). Sub-group analyses further explicate how the two types of mobility affect mobile individuals differently, suggesting the necessity of careful redeployments of mobility of (un)impactful employees.

Keywords:

Strategic Human Capital; Resource Redeployment; Internal Hires; Learning-by-hiring; Star Employees; Knowledge Integration

3.1. INTRODUCTION

Recent strategic management scholars have paid extensive attention to the potential "redeployability" of resources across business units within the firm (e.g., Folta, Helfat, & Karim, 2016; Sakhartov & Folta, 2014). Studies on strategic human capital also suggest that firms can benefit from redeploying their human capital through within-firm mobility as it can be more effective in increasing firm performance (e.g., Bidwell, 2011) and enabling knowledge transfers (e.g., Karim & Williams, 2012; Choudhury, 2017) compared to between-firm mobility. Yet, within-firm mobility may not necessarily occur within the same geographic locations in various global firms. Although geographic relocations may pose various challenges to mobile individuals (e.g., Artuc, Docquier, Özden, & Parsons, 2015), we still do not know how within-firm geographic mobility influences mobile individuals and thus the relative benefits of within-firm mobility vis-à-vis between-firm mobility.

In this study, I examine how geographic relocations can influence the relative benefits of within-firm mobility over between-firm mobility by comparing the post-mobility innovation performance of individuals who experience within and between-firm mobility that requires the same geographic relocations. By building on the resource-based view and resource redeployment research in particular (Penrose, 1959; Barney & Wright, 1998; Coff & Kryscynski, 2011; Sakhartov & Folta, 2014), I first investigate how the challenges that mobile individuals within the firm may face can have differential performance implications compared to mobile individuals who change their firms with geographic relocations. More specifically, given both the competitive and collaborative natures of innovation activities, I consider whether mobile individuals experience differential collaboration patterns due to internal competition and signaling effects upon mobility. Next, to examine why these negative performance implications of within-firm geographic mobility may be related to career stability within a firm, I consider individual tenures at the mobility. As such, I investigate potential

challenges related to dual affiliation and promotion opportunities for those individuals who stay and experience mobility within the firm in their critical career stages. Lastly, while research on learning informs us that pre-mobility performance can have significant effects on the post-mobility performance of mobile individuals (e.g., Argote, McEvily, & Reagans, 2003), individuals may fail to maintain their performance levels upon mobility (Groysberg, Lee, & Nanda, 2008). Thus, I consider how within-firm and between-firm mobility may differentially affect highly impactful and the least impactful individuals and their innovation performance.

Testing these hypotheses requires a setting in which individuals experience within-firm mobility, between-firm mobility, or both. As such, I investigate patent data by inventors in US-based multinational firms that are active in the information technology industry. As these firms operate in various locations worldwide, analyzing inventors in these firms provides an excellent setting for this paper. Importantly, I used a matched sample to consider the potential systematic difference between individuals who engage with within-firm mobility and those who experience between-firm mobility. The empirical analyses of panel data show somewhat nuanced facets of within-firm mobility. Specifically, when individuals are geographically relocated, those who stay in the same firm may lack sufficient effort to build new careers within the same firm and thus suffer relatively more than individuals who change their firms in terms of innovation performance. These negative performance implications may be more pronounced for those who suffer from internal competition upon mobility or whose work-related signals are not strong. In addition, subgroup analyses suggest that individuals who are in their critical career stage and thus more susceptible to uncertainties related to their careers seem to get the most significant impact from within-firm geographic mobility. Lastly, quantile regression results show differential performance implications of within-firm geographic mobility depending on pre-mobility performance. While highly impactful individuals generally suffer from mobility, the performance drop would be smaller for within-firm mobility. In contrast,

whereas less impactful individuals can improve their performance after mobility in general, the positive effects are less significant for within-firm mobility.

This article offers several contributions. First, it contributes to the strategic management studies on resource redeployment and human capital by explicating the comparative advantages and disadvantages of within-firm mobility over between-firm mobility. While the extant research has documented evidence for the benefits of between-firm mobility as learning-by-hiring (Song, Almeida, & Wu, 2003, Slavova, Fosfuri, & De Castro, 2016; Jain, 2016), other scholars have also emphasized the relative benefits of within-firm mobility over the between-firm mobility (Bidwell, 2011, Benson & Rissing, 2020). By investigating the relative benefits and potential threats of within-firm geographic mobility and its implications on individuals, this study aims to combine insights from these streams and augment previous theoretical developments on human capital geographic mobility.

Second, the study's findings contribute to innovation research by illustrating why and how successful integration is crucial in achieving superior innovation performance. The management literature has long acknowledged that knowledge diversity can increase innovation performance (Edström & Galbraith, 1977; Perry-Smith & Shalley, 2003). While both types of mobility lead to knowledge diversity of collaborations, the relative advantages of within-firm mobility may hinge on the importance of effective integrations and collaborations in innovation performance. Lastly, the results of this study further inform us of the importance of microfoundational constructs such as employee mobility in explaining more collective innovation performance within the firm (Felin & Foss, 2005). By explicating how within-firm mobility can differentially influence individuals depending on their pre-mobility performance, the findings in this study suggest why understanding within-firm mobility vis-à-vis between-firm mobility in a more detailed manner can provide strategic and managerial insights on innovation performance.

3.2. THEORY DEVELOPMENT

3.2.1 Literature Review: Resource redeployment of human capital

The importance of human capital has attracted extensive scholarly interest in the strategic management literature (Penrose, 1959; Robins & Wiersema, 1995; Barney & Wright, 1998), considering that a firm's knowledge resides primarily within individuals (Grant, 1996; Felin & Foss, 2005). While a rich body of research has documented how knowledge within individuals can translate into the focal firm's asset (Song et al., 2003; Slavova et al., 2016; Jain, 2016), knowledge may be sticky (Szulanski, 1996) and difficult to transfer across firm boundaries (e.g., Call et al., 2015; Reagans & McEvily, 2003). As such, several studies on resource redeployment compare within-firm mobility and between-firm mobility and examine the relative benefits of the two types of human capital mobility.

Broadly speaking, previous studies on human capital mobility and resource redeployment have emphasized the relative efficacy of within-firm mobility in knowledge transfer and recombination over between-firm mobility. This is because within-firm mobility can improve collaboration performance when mobile individuals utilize firm-specific skills and tacit knowledge, which are difficult to codify and communicate (Benson & Rissing, 2020; Folta et al., 2016; Kogut & Zander, 1992). Within-firm mobility can also foster the circulation and recombination of tacit knowledge between geographically dispersed workplaces (e.g., Choudhury, 2017; Madsen, Mosakowski, & Zaheer, 2003) while being less costly than external hires (Bidwell, 2011). Indeed, within-firm mobility and internal hires are common practices in many firms (Althauser & Kalleberg, 1981; Dewhurst, Pettigrew, & Srinivasan, 2012). However, even though firms may have geographically dispersed branches, the extant literature is somewhat silent on the potential challenges that are associated with such geographic relocations (Feldman & Tompson, 1993; Shaffer, Kraimer, Chen, & Bolino, 2012). To better

understand the associated challenges, thus, I investigate whether within-firm mobility and between-firm mobility across the same locations have different implications on mobile individuals and their innovation performance.

3.2.2 The Double-Edged Nature of Within-Firm Geographic Mobility

As innovative collaborations are generally both collaborative and competitive, previous research on strategic human capital and resource redeployment has largely emphasized why within-firm mobility can better facilitate successful team collaborations than between-firm mobility. First, individuals within the same firm boundary may possess shared cultures to facilitate successful knowledge sharing (Kogut & Zander, 1996). For instance, in their study on a successful Japanese car manufacturer, Dyer and Nobeoka (2000) propose that individuals who identify with a larger collective, that is, the firm they are working for, show a tendency to be more efficient in knowledge creation and integration. Second, and relatedly, within-firm mobility may further fortify the organizational cultures that value within-firm mobility and effective collaborations. For instance, firms retain and reinforce their existing organizational practices and working patterns by circulating their key employees via within-firm mobility (Madsen et al., 2003) and further promote shared organizational goals among employees (Karim & Williams, 2012). Besides, by providing additional training (Tung, 1987), within-firm mobility can promote an organizational culture that reinforces solid networks and collaborations among individuals, both of which can enhance collaboration effectiveness. Lastly, within-firm mobility allows individuals to accumulate firm-specific assets from gaining relational capital and task-related knowledge upon mobility via dense formal and informal networks (Hocking, Brown, & Harzing, 2004; Benson & Rissing, 2020) and by allowing mobile individuals to observe and experience certain managerial practices or decision-making processes in various settings of the firm (Chattopadhyay & Choudhury, 2017). By acquiring

tacit knowledge and accumulating firm-specific assets, thus, within-firm mobility can facilitate knowledge sharing for effective collaboration.

However, while these relative benefits of within-firm mobility may prevail at firms that have rather homogeneous cultures or firm-specific assets, this may not hold for large international firms with various regional or global branches. As knowledge is often geographically localized (Breschi & Lissoni, 2001), geographically dispersed organizations may have various branches that have heterogeneous knowledge bases and sufficiently distinctive cultures. Thus, while it is arguably challenging to accurately estimate the potential benefits and challenges of any geographic mobility due to information asymmetry (Hill & Jones, 1992), higher expectations for shared identities and commonalities toward within-firm mobility than between-firm mobility (Kogut & Zander, 1996; Benson & Rissing, 2020) may hinder the relative benefits of within-firm mobility compared to between-firm mobility.

There exist several reasons why the relative benefits of within-firm mobility may be difficult to be realized within a firm that has various branches across geographic locations. First, individuals who have already established their careers within the firm may get less proactive once they need to repeat the career establishment within a new location after within-firm geographic mobility. This is because these individuals who are already established within the firm may get less likely to exert enough effort to build their new careers in their new environments (Amabile & Kramer, 2011, Call et al., 2015). As such, while potential negative performance implications of within-firm mobility on individuals who were not willing to experience mobility may be less difficult to expect, even those who wanted within-firm mobility may also experience a performance drop. Given the critical role of knowledge integration in knowledge transfer and innovation performance (e.g., Singh & Agrawal, 2011), failing to have proactive collaboration attitudes may result in particularly detrimental

performance implications. Thus, rather than benefiting from the shared culture or accumulation of firm-specific skills, within-firm geographic mobility may pose challenges.

Furthermore, within-firm mobility triggers network-based competition toward the incoming individuals. While both between-firm and within-firm mobility may make mobile individuals be 'outsiders' in the receiving teams (Not Invented Here syndrome: Katz & Allen, 1982), individuals in the receiving teams get more cautious with the incoming individuals via within-firm mobility as within-firm employee networks allow comparisons among employees within the firm and thus make within-firm mobile individuals more salient and comparable. Thus, as innovative collaborations are generally both collaborative and competitive, mobile individuals within the firm boundary may find it challenging to successfully collaborate with individuals in the receiving team and thus perform their innovation activities.

Lastly, individuals who are internally hired may suffer from 'weak status signals' upon mobility due to different hiring processes. In other words, unlike externally hired individuals who must successfully pass the official hiring system, individuals who are transferred within the firm may find it challenging to send strong signals on their pre-mobility achievement or capability. As such, internally hired individuals are less likely to be recognized by their new colleagues in their receiving teams except for individuals who are able to send work-related solid signals. Yet, given the nature of innovative collaborations to be both collaborative and competitive, failing to achieve such recognition can be critical in achieving successful collaborations upon within-firm mobility. As such, while previous studies have emphasized the relative benefits of within-firm mobility, within-firm geographic mobility in a more globally active firm context has more nuanced aspects and poses particular challenges for individuals who experience within-firm geographic mobility. Therefore,

> ***Hypothesis 1.*** *Within-firm geographic mobility reduces the innovation performance of mobile individuals compared to between-firm mobility that requires the same geographic relocation.*

3.2.3 Challenges of Within-firm Geographic Mobility for Career Stability

Career stability is one of the critical sources in increasing one's performance (e.g., Cruz-Castro & Sanz-Menéndez, 2010; Shaffer et al., 2012). Geographic relocation, however, can cause career-related uncertainties for those in the crucial stages of developing their career, primarily when the relocation occurs with within-firm mobility. In particular, mobile individuals who are in the crucial stage for the development of their career may have additional challenges from experiencing within-firm geographic mobility when compared to between-firm mobility due to career-related uncertainties. First, while it is difficult to accurately estimate potential benefits and challenges from within-firm geographic mobility due to information asymmetry (Hill & Jones, 1992), as discussed, these impacts can be particularly detrimental to those individuals who need their career stability within the firm. In general, individuals who are in the critical period for the development of their career may decrease their performance upon mobility if they cannot accurately estimate the challenges of geographic relocations of within-firm mobility when compared to individuals who can better expect difficulties of between-firm geographic mobility. One may suppose, for example, that individuals who only change their locations within the firm may expect fewer challenges compared to people who change their firms and locations at the same time. This is because individuals who move to another firm that is in a different geographic location are more likely to focus on potential challenges rather than benefits from their between-firm mobility, at least for work- related issues. Yet, by underestimating the potential challenges of geographic relocations, individuals who are in their critical career stages may fail to benefit from staying within the firm (Artuc et al., 2015; Feldman & Tompson, 1993) but face career-related challenges from mobility.

Second, within-firm mobility can further complicate the career stability of mobile individuals as these individuals may not necessarily increase promotion opportunities. Although it is crucial to enable individuals to learn from other geographically dispersed

organizations for successful knowledge flow within the firm (Ghoshal & Bartlett, 1990), and thus individuals may achieve increasing promotion opportunities from within-firm mobility (Fey & Furu, 2008), studies suggest that staying within the firm may not necessarily result in promotions within the firm (e.g., Bidwell & Briscoe, 2010). Indeed, it has long been suggested that within-firm mobility may reduce subsequent promotion opportunities (Tung, 1987). This is because these mobile individuals become 'out of sight and out of mind' in the home office, making them less likely to be adequately recognized for their contributions and thus promoted (Black & Gregersen, 1999). This problem is exacerbated by within-firm mobility challenges across geographic locations without reliable and valid assessment tools (e.g., Shaffer, Harrison, & Gilley, 1999; Harvey & Moeller, 2009). Therefore, within-firm mobility may be a barrier to promotion and cause career derailment, especially for those in their critical career stages.

Finally, within-firm mobility may result in challenges from having dual affiliation within the firm (Andreason & Kinneer, 2005; Kraimer & Wayne, 2004). Unlike individuals who change their firms, that is, those who experience between-firm mobility, cannot legally work for their previous employers, individuals who move within the firm may reduce their performance as they may not immediately discontinue their previous roles upon mobility but rather are often required to be involved with both their previous and new positions, albeit temporarily (Haslberger, 2005). As having a dual affiliation can harm one's career stability, dual affiliation issues can be particularly detrimental to individuals who are in the crucial career stages (Cruz-Castro & Sanz-Menéndez, 2010). In addition, studies show that prolonged involvement and continuation of previous positions or temporary job-related circulations may further reduce the benefits of within-firm mobility (Shaffer et al., 2012). As communicating with individuals who are geographically distant is generally more challenging (Storper & Venables, 2004), the challenges of dual affiliation due to within-firm geographic mobility gets more pronounced for those who are in their crucial career stages. In contrast, externally hired

individuals can avoid these cognitive challenges and collaboration difficulties related to the 'dual affiliation' because this is not only disadvised but also generally infeasible for individuals who change their firms. In sum, within-firm mobility that requires geographic relocations of the individuals who are in a critical stage of their career development may lead to a decrease in performance due to a lack of career stability, even when compared to individuals who experience between-firm mobility. Thus,

> ***Hypothesis 2.*** *Within-firm geographic mobility is particularly detrimental to the innovation performance of mobile individuals who are in their critical career stages.*

3.2.4. Pre-mobility Performance and Non-uniform Effects of Within-firm Mobility

As ability and opportunity can be primary determinants of successful performance (e.g., Argote et al., 2003), I now bifurcate mobile individuals into highly impactful and the least impactful individuals to examine whether pre-mobility performance can differentially influence mobile individuals and their subsequent performance. First, highly impactful individuals are better positioned than individuals from between-firm mobility because they know their firm-specific resources better (Kogut & Zander, 1992; Benson & Rissing, 2020). As such, it is plausible to expect that highly impactful individuals are relatively more capable of utilizing and benefiting from these resources. In addition, internally hired individuals are more likely to be already embedded in a firm's internal networks (e.g., Mitchell et al., 2001; Groysberg et al., 2008). Thus, as previous studies suggest potential difficulties of successfully transfering superior productivity of star employees across firm boundaries (Narin, 1993; Call et al., 2015), there exist reasons to believe that highly impactful individuals within the firm to have comparative advantages over externally hired individuals in overcoming the negative outcomes of geographic relocations by utilizing their firm-specific resources and networks.

Furthermore, studies show that highly impactful individuals tend to get a less significant amount of compensation for their within-firm mobility compared to externally hired

individuals (Peltokorpi & Froese, 2009). Indeed, firms tend to hire individuals from outside the firm by compensating generously (Harding, 1998), although these individuals sometimes fail to outperform internally hired individuals (Bidwell, 2011). In addition, due to high visibility, these externally hired individuals can further cause feelings of unfairness among incumbents in the receiving teams (Harding, 1998). As such, within-firm mobility, compared to between-firm mobility, can alleviate potential challenges associated with geographic relocations of highly impactful individuals.

Lastly, highly impactful individuals who are mobile across firm boundaries thus can trigger feelings of threats to individuals in the receiving teams as they may leave again for a different option. Recent management studies document boomerang employees who manage to return to their previous employers due to their disproportionately high performance (Breschi, Lissoni, & Miguelez, 2020; Keller, Kehoe, Bidwell, Collings, & Myer, 2020). As these highly impactful individuals use interorganizational mobility as an opportunity to be promoted (e.g., Bidwell & Briscoe, 2010), highly impactful individuals from different locations within the firm may effectively avoid trust-related issues by showing their loyalty to the firm and thus form more constructive collaboration relationships. In sum, while mobility with geographic relocations may generally pose some difficulties for highly impactful individuals in maintaining their successful performance, within-firm mobility provides mechanisms to alleviate potential negative impacts compared to between-firm mobility. Thus,

> ***Hypothesis 3a.*** *Within-firm mobility is more effective in maintaining the innovation performance of highly impactful mobile individuals than between-firm mobility.*

Next, individuals who were less impactful may respond to mobility differently, as performance is generally considered a function of motivation, opportunity, and ability of the individuals (Argote et al., 2003). Although previous studies suggest that mobility may be deployed as a corporate strategy for providing various learning opportunities (Ibarra, 1995) or

achieving a better fit (Bidwell, 2011), it is more likely to expect that individuals who were less effective or successful in their performance before mobility may continue to be relatively less successful even after mobility.

However, unlike highly impactful individuals who can benefit from within-firm mobility, there exist at least two reasons why the least impactful individuals may not benefit from within-firm mobility relatively more than between-firm mobility. First, the effects of signaling from mobility may differ depending on the types of mobility. As discussed, within-firm mobility is associated with 'weak status signals' for mobile individuals as they are not transferred via official hiring systems. Besides, while externally hired employees tend to have a relatively higher general performance for the same position (Bidwell, 2011), internally mobile individuals without strong records would suffer more severely after mobility. As such, less successful individuals who experience within-firm mobility may fail to increase their performance as much as their colleagues from outside the firm would do due to their precarious positions in their new environment.

Furthermore, whereas within-firm mobility provides relative advantages in utilizing firm-specific assets and pre-existing social networks at the firm, it may be the case that relatively less impactful individuals *did not* have a good understanding of how to utilize crucial resources at the firm. The very fact that these individuals were not successful may hinge on their lack of effective utilization of firm-specific skills (Kogut & Zander, 1992; Benson & Rissing, 2020). In other words, it is difficult for the least impactful individuals to benefit from within-firm mobility if these individuals have *nothing to lose* as well as *nothing to use* after mobility. Rather, the lack of understanding of the firm may act as a burden to the mobile individuals who were not impactful before the mobility within the firm. However, individuals who change their firms and thus experience between-firm mobility may be better situated to achieve additional learning opportunities (Ibarra, 1995) and thus improve their fit with the new

environment (Farrell, 1983; Bidwell, 2011). In short, while less impactful individuals may not be able to immediately improve their innovation performance after mobility, within-firm mobility, compared to between-firm mobility, may act as a burden to the mobile individuals and thus has a more detrimental impact on the innovation performance of the mobile individuals after mobility. Therefore,

> ***Hypothesis 3b.*** *Within-firm mobility is more detrimental to the innovation performance of the least impactful mobile individuals than between-firm mobility.*

3.3. DATA AND METHODOLOGY

3.3.1 Data and sample

The empirical analysis of this study utilizes individual-level patent data, following the long tradition of the innovation management literature on inventor collaborations and knowledge spillover (Trajtenberg, 1990; Breschi & Lissoni, 2009). However imperfect, patent information has been considered to provide a rich data source for innovation activities and inventor collaborations with detailed information on assignees (Nerkar & Paruchuri, 2005) and previously built knowledge (e.g., Trajtenberg, 1990; Fischer & Leidinger, 2014). For this study, I examined granted patents filed by major information and technology firms in the S&P 500 from *Patentsview* (http://www.patentsview.org/), a data repository by the United States Patent & Trademark Office (USPTO) on all the patents filed and granted. The selection of this sample is primarily motivated by the following two reasons. First, investigating the context in which individuals were actively mobile both within and across firm boundaries and collaborating with other inventors allows the comparison of the theorized natures of the two types of mobility and their differential impacts on the individuals. Second, by limiting the analysis to the firms that are headquartered in the same country, the United States, the analyses in the study can control for institutional variations in patenting behaviors across countries (Cohen, Goto, Nagata,

Nelson, & Walsh, 2002). As such, I first collected 577,529 granted patents filed by 222 firms in the S&P 500 headquartered in the United States over 30 years (1986-2015).

While patent data provide detailed disambiguated information on inventors and locations, previous studies also suggest that there still may exist identification issues on unique identifiers or inventors or locations (e.g., Ge, Huang, & Png, 2016; Melero, Palomeras, & Wehrheim, 2020, Li et al., 2014). For instance, while one person may have multiple identifiers due to incorrect information or discontinuation of patenting activities, any incorrect location information can also lead to wrong identifications of the theorized effects of mobility. Therefore, I first examined the USPTO disambiguation identifiers for inventors and geographic locations, and then I additionally refined the dataset by considering the following criteria. First, considering previous collaborations, assignees, and locations, I refined the original individual identifiers and yielded 295,911, not 298,693, unique inventor identifiers for 577,529 patents. Second, I followed several steps to identify the geographic information of inventors correctly. Although the USPTO dataset provides assignee location data, there exist several patents without an accurate location or coordinate information. A more critical issue is related to correctly identifying actual mobility. For instance, a city that can have multiple labels or two neighboring cities within a commutable range should not be considered as mobility for this study. Thus, meticulous refinement processes and manual verifications yielded 1,652 unique cities in 108 countries.

Next, as the purpose of this study is to match exact city pairs for geographic relocations and compare the implications of the two types of mobility, that is, within-firm mobility and between-firm mobility, it is important to consider mobility events that have the same geographic city pairs for both types of mobility. Relatedly, I excluded mobility events that change employers within the same geographic regions as mobility between firms yet within the same geographic locations does not provide insights for the study for a similar reason.

Accordingly, the final dataset is reduced to 33,436 individuals, 20,340 of which have experienced within-firm geographic relocations and 15,893 of which have experienced between-firm mobility (hence, 2797 have experienced both types of mobility). Figures 3.1 and 3.2 illustrate the annual trend of inventor numbers and the associated mobility distance for within-firm and between-firm mobility in the sample. The remaining misclassification errors that exist may be unavoidable due to the nature of exploiting large-scale samples.

[Insert Figures 3.1 and 3.2 about here]

3.3.2 Measures

3.2.1 Independent Variable

Within-Firm Geographic Mobility. Following the standard practice in the innovation literature on patents, I used information on patent data to determine mobility events and mobility type by examining two chronologically consecutive patents (e.g., Hoisl, 2007; Singh & Agrawal, 2011; Ganco, Ziedonis, & Agarwal, 2015; Melero et al., 2020). More specifically, I consider any new patent of the same inventor in a different geographic location as the mobility of mobile individuals and consider the most recent mobility event affects mobile individuals until any subsequent mobility events.

Accordingly, the *within-firm geographic mobility* variable gets 1 if the inventor does not change the employer but changes the geographic locations; the variable gets 0 if the inventor changes both employers as well as locations, making the geographic mobility a between-firm one. As I compare the impact of between and within-firm mobility on the individuals, all inventor-year observations have values indicating either within-firm or between-firm geographic mobility depending on the most recent mobility events. Thus, any mobility events that occur within the same region (between-firm mobility within the same location) are excluded from the sample, as discussed previously.

Some potential caveats related to this mobility detection using patent data may merit further consideration. First, it is difficult to correctly detect the exact point in time of the actual moves by the inventors since the patent application takes a certain time to be granted (e.g., Ge et al., 2016). Indeed, considering the exact timing of mobility of inventors may be crucial in tracing how the inventors perform throughout their careers. However, as the purpose of the current study is to compare the individual's performance before and after mobility, the question of 'when did the mobility happen' gets somewhat less critical as long as the data provides suitable comparisons consistently. Second, inventors may be active in multiple locations at a given time. This may arise from either inaccurate identification with which different inventors are considered the same inventors due to the similar names or specific types of collaborations or contract R&D ("circulating inventors": Ge et al., 2016). To mitigate this difficulty, this study first followed the standard chronological practices in the literature to detect mobility events (Hoisl, 2007; Melero et al., 2020), and then, by utilizing refined information on the geographic locations of inventors, I assigned the involved individuals to be commuting when the geographic distance of locations that are associated with a mobility event is within a commutable range. When an inventor id is associated with multiple locations in a consecutive manner, I assigned the different individual identifiers for these individuals, as it is challenging to assume that these events can be achieved by one person. Further implications of mobility distance are discussed in the result section. In addition, this study considers mobility among firms under the same mother company or any acquisition-related mobility to be between-firm mobility as there may exist heterogeneity in terms of working environments across different business entities (Almeida & Phene, 2004). Lastly, patent data may lead to a sampling bias toward high-skilled inventors or observation censoring for inventors who stop patenting activities after specific periods (e.g., Melero et al., 2020). First, as this study also accounts for the various pre-mobility performance of the individuals, the sampling bias issues toward high-

skilled individuals are not critical. In addition, the analyses in this study by using patent data lead to an underestimation, not an overestimation, of the theorized mobility effects. In other words, individuals who change their roles after mobility and thus are not involved with any more innovation activities are not considered, and thus, the tests in this study are more stringent in examining the negative impact of mobility.

Career Stages (Novice, Middle, and Mature). To examine how mobility can have differential implications on individuals with different career stages, I consider the average tenure of inventors in the sample (7.5 years) and introduce three career categories at the time of mobility: *career novice* inventors are those who have less than three years of career, *middle* inventors are those who have more than four years to seven years, and *mature* inventors are those who have longer than eight years of tenure.

Collaboration difficulty and Solo patenting ratio. To test the possibility of within-firm mobility that leads to internal competition, I introduce the *collaboration difficulty* variable to compare the number of average collaborators before and after the mobility of mobile individuals. This is because the number of collaborators and team size in innovation are not only considered to be crucial in determining collaboration performance (Raffiee & Byun, 2020) but also the level of integration (Singh & Agrawal, 2011). As such, by comparing the average number of collaborations before and after mobility, this measure captures how mobile individuals can collaborate with other team members relatively well after mobility.

Similarly, I consider the extent to which mobile individuals tend to file a patent as a *solo patenting ratio* by the inventor by calculating the ratio of solo patenting at a specific year after mobility divided by the ratio of solo patenting before the mobility by the inventor.

Weak signal (impact and productivity). To examine whether mobile individuals have different implications from mobility depending on their signals, I first consider *weak signal impact* as a binary variable that gets 1 for those with patents that have, on average less than one

citation before their mobility. In addition, to consider how mobility can influence those individuals who were less productive before mobility, I introduce *weak signal productivity* as a binary variable and assign 1 for those who have less than one patent a year before mobility.

Innovation impactfulness of the inventor. Lastly, in addition to the quantile regressions of the pre-mobility impactfulness of innovation performance on post-mobility performance, I introduce binary variables for the highly impactful and the least impactful inventors. I consider inventors to be highly impactful if they could produce highly cited patents (more than ten citations per patent while the average of the sample is 6.34), while inventors with no previous forward citation are the least impactful inventors.

3.2.2 Dependent Variables: *Innovation Performance*

As the first dependent variable, I consider how the innovation performance of mobile individuals changes after mobility. In the management and innovation literature, the number of forward-citation has been widely adopted as a measure of technological and economic value because it can present the importance of innovation and potential economic values (Hall, Jaffe, & Trajtenberg, 2000). Following this tradition, I calculate the annual *innovation performance of the inventor* as the total number of forward citations that all the patents by the individuals received within the first five years after the patent grant. It is important to note that inventors who do not have any patents for a specific year get 0 for this variable for that specific year as these individuals were not active in innovative activities. However, as shown in Figure 3, the patent citation numbers can be highly skewed (e.g., Scherer & Harhoff, 2000). As such, I examined the innovation performance by introducing a logarithm transformation of the variable by adding 1. The following is the numerical expression for the innovation performance for a given individual *i* for a given year *j*.

$$Innovation\ Performance_{ij} = \frac{\sum Forward\ Citations_{ij}}{Total\ Number\ of\ Patent_{ij}}\ \textit{(for a given individual i in year j)}$$

In all analyses, any innovation performance of inventors prior to their first mobility is excluded as the focus of the study is to see the change in their performance after mobility (either within-firm or between-firm). Similarly, individuals who change their roles after the mobility and thus do not produce any more patents are excluded in the final analyses.

[Insert Figure 3 about here]

3.2.3 Control Variables

In this study, a set of individual-level controls has been introduced. First, I consider the *number of collaborators* before and after mobility to be factors that can affect the analyses, and thus they were controlled for in the subsequent analyses. Management studies inform the importance of team size and the number of collaborators in measuring the level of integration amongst various individuals (Singh & Agrawal, 2011) and the performance of collaboration itself (Raffiee & Byun, 2020). In addition, the technological diversity of a patent represents the breadth of the patent with respect to its technological elements, representing the extent to which inventors can generate new perspectives and insights (e.g., Lazear, 2004; Nemet & Johnson, 2012). Therefore, I calculate *technological diversity* as the average degree of technological diversity in terms of the three-digit USPTO classification for all patents filed by mobile individuals and control for the individual. In addition, as previous mobility experience can affect the post-mobility performance of mobile individuals, I introduce variable *cumulative mobility* as the total number of mobility experiences of the individual before that mobility and control for throughout the analyses. The rationale is twofold: while previous involvement with similar projects is an essential factor in the future success of the project (Tung, 1987), previous mobility experience can also affect how well the individuals can perform innovation after mobility. Next, I calculated the variable for *tenure* at the firm for each inventor-year pair was controlled for as the length of tenure can play a crucial role in delivering the performance upon mobility. Lastly, a binary variable *location familiarity* was introduced to consider whether

mobility occurs in the city in which the individual has previous experience. This is to account for relevant factors that affect the successful mobility of the individuals, such as family issues and adjustment (e.g., Kraimer et al., 2001; Haslberger, 2005). Thus, I set the value to 1 when the individual had previously worked in the same city and 0 otherwise.

3.3.3 Analyses

To compare the effects of between-firm mobility and within-firm mobility that are associated with the same geographic relocation, I tested the hypotheses in the paper with panel data analyses based on the ordinary least squares (OLS) using coarsened exact matching (CEM). CEM is a causal effect estimation technique that reduces imbalance among covariates between treated and control groups (Blackwell, Iacus, King, & Porro, 2009). As the matching criteria, I used deciles of individuals' tenure, the average number of collaborators, the average level of innovation performance, and the size of branches that mobile individuals work with prior to any mobility. After dropping unmatched observations, the final sample contains 71,584 for between-firm mobility and 91,664 for within-firm mobility. The L1 distance of the CEM is below 0.1, suggesting well-balanced matching.

Although this study adopts various controls for the individual-level factors, there may still be certain unobservable errors that are fixed to a specific individual, year, firm, or city. Therefore, the analyses in this paper controlled for these variables and fixed effect variables by using a user-written STATA command *reghdfe*. In this way, the analyses in this study address previously discussed city pairs of geographic relocations. Lastly, quantile regressions on different performance levels prior to the mobility also used the same user-written STATA command *reghdfe* with main and interaction terms for each group.

3.4. RESULTS

Summary statistics are shown in Table 3.1. The mean value of within-firm geographic mobility (0.5596) indicates that within-firm geographic mobility is relatively more common than between-firm mobility, corroborating the importance of the phenomenon. In addition, the high correlation between innovation performance and average team size after mobility suggests the crucial role played by team collaborations in successful innovation performance.

[Insert Table 3.1 about here]

Table 3.2 presents the results of the analyses on the effects of within-firm mobility on innovation performance. While Model 1 contains only the control variables, the results in Model 2 suggest negative consequences of within-firm mobility on the innovation performance of mobile individuals. However, as explained earlier, there may exist systematic differences between individuals who engage with within-firm and between-firm mobility. Thus, I used a matched sample based on tenure, the number of collaborators, innovation performance, and the branch size of their pre-mobility. Unlike the non-significant coefficient in Model 2, the coefficient for the within-firm geographic mobility in Model 3 now gets a significant and negative impact on the innovation performance, providing support for the validity of the matched sample in this study.

[Insert Tables 3.2 and 3.3 about here]

Now we turn to the impact of within-firm mobility on innovation performance in a more detailed manner. Regression analyses in Table 3.3 examine whether within-firm mobility is particularly detrimental to mobile individuals if the mobility increases competition among employees in the receiving teams and thus leads to collaboration difficulties. While there exist several reasons to expect a positive relationship between within-firm mobility and an increase in collaboration efficiency due to pre-existing firm-specific assets or shared culture among employees, it is possible that certain mobility may not end up in a hospitable environment but

rather a hostile one due to the increased competition from the receiving teams. In such a case, mobile individuals may continue their patent-related roles, yet with fewer collaborators in their new environments.

To test this idea, I first examine whether mobile individuals show a tendency to work alone after mobility. Results in Model 1 suggest that while the ratio of solo patenting by the inventors is positively affecting the innovation performance in general, the interaction term between this variable of solo patenting rate and within-firm geographic mobility has a negative and significant coefficient, suggesting that if the individuals move across locations within the firm and if this mobility makes them have more solo patents rather than collaborations, mobile individuals reduce their innovation performance drastically. Furthermore, I then compare the number of average collaborators before and after mobility. Model 2 shows that while the decrease in the number of collaboration (collaboration difficulty) generally affects innovation performance negatively, the detrimental influence gets more significant when within-firm mobility leads to a decrease in the number of collaborators for the individuals. The results from Models 1 and 2 suggest that when the individuals tend to have more solo patenting or have fewer collaborators upon mobility, the detrimental impacts of within-firm mobility get more drastic.

Then, I investigate how within-firm mobility can differentially affect mobile individuals who lack strong signals of their pre-mobility career. In particular, while I consider individuals with less impactful pre-mobility achievement in Model 3, I examine less productive individuals before mobility in Model 4. While Hypothesis 1 predicts that within-firm geographic mobility reduces the subsequent innovation performance of mobile individuals, the results from Models 3 and 4 indeed suggest that due to collaborations difficulties of internal competition or weak status signals, within-firm mobility reduces the innovation performance of the mobile

individuals. Thus, regressions analyses in Tables 3.2 and 3.3 collectively provide support for Hypothesis 1.

[Insert Table 3.4 about here]

Next, Table 3.4 represents how career uncertainty from within-firm mobility can differentially affect mobile individuals and their subsequent innovation performance depending on the development stages of their career within the firm. Hypothesis 2 predicts that within-firm geographic mobility is particularly detrimental to individuals who are in their critical career stages due to associated career uncertainty. While the interaction terms of career categories and within-firm geographic mobility in Models 1 and 3 are not statistically significant, Model 2 shows a significant and negative coefficient for the interaction term of within-firm geographic mobility and the career category variable, even though the category variable has a significant and positive impact on innovation performance. In other words, the results suggest that within-firm mobility that makes mobile individuals move to a different geographic location is particularly detrimental for those individuals who are in the critical stage of their career development (that is, four to seven years of tenure). However, the results do not provide systematic implications on relatively longer tenured individuals (longer than eight years) or novice individuals who have less than three years of career. Thus, I found support for Hypothesis 2.

[Insert Table 3.5 about here]

Finally, I examine the differential impacts of within-firm mobility depending on the pre-mobility performance of mobile individuals in Table 3.5. First, by using quantile regressions, I consider the impact of the within-firm mobility on innovation performance in Model 1. The results in Model 1 suggest that highly impactful individuals prior to the mobility are relatively more impactful after mobility, while individuals who experience within-firm mobility do have a better performance after mobility than those who experienced between-firm mobility. In

contrast, the least impactful individuals do not gain from within-firm mobility. However, the coefficients in Model 1 should be interpreted with caution as the dependent variable is the innovation performance after mobility, implying that highly impactful inventors must be relatively more impactful compared to the rest, for instance. Therefore, I further examine the relationship by using interaction effects.

More specifically, Models 2 and 3 test highly impactful inventors and the least impactful inventors, respectively, and Model 4 includes both the interaction terms. The results in Models 3 and 4 indeed suggest differential implications of within-firm mobility depending on their pre-mobility impactfulness. Within-firm mobility is more beneficial in increasing the innovation performance of highly impactful individuals, while it is detrimental to the innovation performance of the least impactful individuals. Hypothesis 3a predicts that highly impactful individuals can benefit from within-firm mobility due to their knowledge within the firm, while Hypothesis 3b expects that the least impactful individuals, who generally gain from mobility, may get more detrimental impact from within-firm mobility due to their lack of capability. The results in the Models provide support for both Hypotheses 3a and 3b. Figure 3.4 shows the distributions of subgroup analyses.

[Insert Figure 3.4 about here]

The coefficients of control variables are in accordance with the established theoretical developments in the field. For instance, while tenure seems to affect innovation performance negatively, the average number of collaborators after mobility has a positive impact on innovation performance, providing support for the importance of team collaboration and embeddedness (Burt, Kilduff, & Tasselli, 2013). In addition, the positive and significant location familiarity variable suggests that individuals can increase innovation performance as they work in locations in which they previously worked. Lastly, as new perspectives and insights are crucial in innovative activities (e.g., Lazear, 2004; Nemet & Johnson, 2012), the

positive and significant coefficients for technological diversity suggest that individuals with more diverse technological backgrounds generally have higher performance.

Several additional robustness checks were conducted. First, the discussed different impacts between within-firm and between-firm mobility may come from not the mobility per se but certain systematic patterns amongst the involved individuals. For instance, particularly highly impactful individuals may tend to engage with within-firm or between-firm mobility. If this is the case, then a systematic difference among individuals who experience these two types of mobility may bias the relationships theorized in this paper. While the average performance levels of individuals who experience the two types of mobility show no significant difference, I presented regression results with the matched sample data based on tenure, patent technological diversity, the number of collaborators, and previous innovation performance of mobile individuals. Although CEM can reduce causal estimation error and bias (Blackwell et al., 2009), some of the analyses in this paper may lose statistical significance due to the matching sensitivity. Hence, I used the entire inventor sample to run the analyses in the study, and I found no significant changes. This suggests that the results presented in this paper are not biased due to the unobservable differences among individuals from one type of mobility over the other.

Next, another issue may arise from using a panel dataset that may contain years with no record, that is, no record for any patent by mobile individuals for a certain period. While the proportion of these inactive years of inventors is not substantial in the sample data, inactive years may bias the regression analyses in the paper. As such, the main regressions presented above are based on the dataset with imputations with no performance for years of inactivity, as discussed earlier. However, I also checked the robustness of the test with other imputation methods, in which I employed different ways of extrapolating or assigning zero for inactive years. The results from these various imputations did not change the results in any significant

ways. As another way to test the robustness of the test, I ran additional regressions with the inventor-city aggregated measures instead of the inventor-year unit of analysis. More specifically, I collapsed all the patenting activities by mobile individuals within a city and introduced a measure for their performance throughout all the years within the city. By so doing, I could further examine instances with which certain inactive years by the individuals are due to reasons other than unsuccessful patenting activities, such as non-inventing positions. The results of these analyses were not different from the tables shown in the study. Next, as the size of forward-citation for patents may be sensitive to the size of the window of calculations, I tested different window sizes (i.e., 3, 7, and 10 years). In addition, as quantile regressions may be sensitive to the relative size of the subgroups, I checked different sizes for subgroups (i.e., 5%, 20%, and 33%). There was no meaningful difference from the results presented here.

3.5. DISCUSSION AND CONCLUSION

Do individuals improve after geographic relocations within the firm? Who can benefit from within-firm geographic mobility, and who may suffer from it? The current study tries to answer questions regarding within-firm geographic mobility. While within-firm mobility may potentially enable firms to utilize their existing knowledge stocks in a more efficient manner, it has been less studied in recent strategic management studies (e.g., Choudhury, 2020; Bidwell, 2011; Argyres & Silverman, 2004). To advance our understanding in the field, this study investigates how two types of geographic mobility, within and between firms, can differentially affect mobile individuals and their post-mobility innovation performance. The findings in this study show that seemingly beneficial within-firm mobility may come with the hidden cost of performance drop due to internal competition and associated career uncertainty. Furthermore, subgroup analyses of individuals based on their pre-mobility performance illustrate how within-firm mobility has more nuanced non-uniform impacts on the individuals. In other words,

while within-firm mobility is more effective in protecting the innovation performance of the highly impactful individuals compared to between-firm mobility, it is less effective in improving the innovation performance of the least impactful individuals compared to between-firm mobility.

3.5.1 Contributions

The findings in this study contribute to strategic management and human capital research by delineating the relative benefits and threats of within-firm geographic mobility, which has been suggested as a viable resource redeployment (Folta et al., 2016; Sakhartov & Folta, 2014). So far, several management scholars have shown evidence for the benefits of combining diverse knowledge by hiring knowledge workers (e.g., Song et al., 2003; Slavova et al., 2016; Jain, 2016) or by utilizing individuals within the firm (e.g., Madsen et al., 2003; Bidwell, 2011; Karim & Williams, 2012). However, we still do not know how within-firm mobility with geographic relocations would affect the individuals and their post-mobility performance. This study provides a systematic comparison between these two mobility types and illustrates how within-firm geographic mobility may no longer be relatively advantageous over between-firm mobility, mainly due to challenges from the internal competition and career uncertainties associated with geographic relocations within the firm. The results of the study provide an interesting augmentation to the established strategic human capital literature, given the unique opportunities and threats of within-firm mobility.

Findings in this study also contribute to innovation and diversity research by suggesting the importance of knowledge diversity and its successful integration. While various management studies highlight the importance of knowledge diversity (e.g., Perry-Smith & Shalley, 2003; Haas, 2006), we do not know much about why within-firm and between-firm mobility can differentially affect subsequent performance in terms of integration. The results

of this study suggest that knowledge diversity from mobility and how collaborations among team members have been executed are both crucial in achieving successful performance.

In addition, research in microfoundations proposes that firm-level outcomes may be better explained with individual-level constructs, such as certain actions such as mobility, are understood closely (e.g., Felin & Foss, 2005; Abell, Felin, & Foss, 2008). This study also contributes to the microfoundation research by delineating how individual-level within-firm mobility can affect crucial corporate-level innovation performance by suggesting the vital relationship between individual-level phenomena of within-firm mobility and the implications of innovation performance of these individuals on the collective corporate innovation performance.

Some practical insights on effective human capital utilization can also be drawn. Arguably, mobility results from managerial decisions in general, either by the individual or the manager, or both. The findings in the study suggest that while less impactful inventors may benefit from any mobility, it is the between-firm mobility that the individuals can increase innovation performance. In contrast, highly impactful individuals may not maintain a high level of innovation performance after any mobility, yet individuals may suffer less from within-firm mobility than between-firm mobility. These findings may provide insights to the practitioners in their decisions around human capital mobility. In short, managers may want to be of utmost careful when deploying within-firm mobility for more successful individuals in their innovation performance.

3.5.2 Limitations and Boundary Conditions

To measure how within-firm mobility affects the innovation performance of the individual, this study examined the average forward citation of the patent that has been widely adopted to capture the quality or the impact of the innovative activities (e.g., Jaffe, Trajtenberg,

& Henderson, 1993). However, it is possible that within-firm mobility also affects other aspects of innovation activities. For instance, as theorized in this paper, mobility may cause more difficulties in adjustment or even direct communications with incumbents. In this regard, future studies may broaden our understanding by conducting more direct measurements such as interviews or questionnaires to investigate how individuals respond to mobility. Understanding more various facets of the impact of mobility on innovation performance will provide a fruitful avenue for future human capital research.

Another limitation of the study may come from the assumption of no *a priori* relationship between motivation for mobility and subsequent performance, albeit there is no theoretical rationale for this relationship. However, it is still possible that motivation can affect the dynamics in complicated ways. For instance, the individual may have changing levels of mobility motivation over various mobility experiences. Perhaps, other factors, such as their previous performance or marital status, affect the dynamics. As such, understanding the intertwined nature between mobility motivation and performance would further broaden our knowledge of human capital in more general ways.

Going further, given that mobility can be affected by a multitude of factors, it would be interesting to consider contexts in which mobility only happens entirely exogenously. However, finding these contexts with a large-scale dataset may not be trivial. For instance, while a firm bankruptcy may seem to provide exogenous settings, this may not be ideal due to the inside information. Another possibility from merge and acquisition may further cause a setting in which individuals from one place move to different places altogether, making a case for co-mobility (e.g., Marx & Timmermans, 2017). In this regard, research on exogenous mobility, possibly based on small-scale experimental settings, will provide an essential avenue for future research.

Lastly, this study did not consider detailed mobility types for individual status or positions. However, previous studies show that mobility periods or purpose (Choudhury, 2017) and types of mobility such as contract-based or mutual collaborations (e.g., Ge et al., 2016) may have different implications. In addition, it is not difficult to expect differential impacts from the status and positions of mobile individuals. In sum, a fruitful avenue awaits the future.

3.5.3 Conclusion

While recent management research on human capital examines the relative benefits of within-firm mobility as a viable way of redeploying firms' resources, we still do not know whether or how geographic relocations of human capital can influence the relative benefits of within-firm mobility. This study examines how within-firm and between-firm geographic mobility can have differential implications on the inventor's post-mobility performance. The findings of the study imply why firms need more scrutiny in engaging within-firm vis-à-vis between-firm mobility and to whom to consider for the mobility, depending on the pre-mobility performance of the individuals. By understanding more effective and sustainable mobility strategies for human capital and innovation, the results of this study suggest the crucial role of within-firm geographic mobility on innovation performance.

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3.7. TABLES AND FIGURES

Table 3.1. Descriptive Statistics

	Obs	Mean	S.D.	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Innovation Performance	158,138	0.7624	1.1413	0	6.80	1.0000							
(2) Within-firm Geo Mobility (WG)	158,138	0.5596	0.4964	0	1	0.0299	1.0000						
(3) Tenure	158,138	9.6644	5.7123	1	30	-0.1029	-0.1761	1.0000					
(4) Cumulative Mobility	158,138	2.5838	1.0454	2	16	0.0344	0.0354	0.2132	1.0000				
(5) Avg Team Size Before	158,138	2.0373	1.3532	1	27	0.0246	0.0689	-0.0726	0.0855	1.0000			
(6) Avg Team Size After	158,138	1.4537	1.5623	0	27	0.3798	0.0503	-0.0689	0.1082	0.1688	1.0000		
(7) Location Familiarity	158,138	0.0834	0.2764	0	1	0.0909	0.0594	-0.0503	0.3945	0.0657	0.1641	1.0000	
(8) Tech Diversity	158,138	3.4271	2.2476	1	37	0.1455	-0.0123	0.2323	0.2201	0.0146	0.0752	0.0499	1.0000

Table 3.2. The Effects of Within-firm Mobility on Innovation Performance

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3 (1*)
Within-firm Geographic Mobility (WG)		-0.00562	-0.0147**
		(0.00716)	(0.00730)
Tenure	-0.0298***	-0.0299***	-0.0315***
	(0.000545)	(0.000551)	(0.000585)
Cumulative Mobility	-0.0112***	-0.0111***	-0.0137***
	(0.00319)	(0.00319)	(0.00344)
Avg. Team size Before	-0.0276***	-0.0275***	-0.0272***
	(0.00221)	(0.00221)	(0.00237)
Avg. Team size After	0.272***	0.272***	0.269***
	(0.00178)	(0.00178)	(0.00181)
Location Familiarity	0.123***	0.123***	0.133***
	(0.0103)	(0.0103)	(0.0104)
Tech Diversity	0.0696***	0.0696***	0.0711***
	(0.00142)	(0.00142)	(0.00147)
Constant	0.492***	0.495***	0.516***
	(0.0101)	(0.0110)	(0.0112)
Observations	160,023	160,023	158,138
R-squared	0.297	0.297	0.308
Firm FE	Y	Y	Y
City Pair FE	Y	Y	Y

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(1*) Note 1: Model 3 tests on matched sample.

Table 3.3. The Effects of Collaboration difficulties and Signals on Performance (Matched)

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Within-firm Geographic Mobility (WG)	-0.00151	0.00284	0.00493	0.0295***
	(0.00735)	(0.00768)	(0.00861)	(0.0101)
Solo Patenting Ratio	0.349***			
	(0.00657)			
WG * Solo Patenting Ratio	-0.0921***			
	(0.00812)			
Collaboration Difficulty		-0.162***		
		(0.00220)		
WG * Collaboration Difficulty		-0.0422***		
		(0.00306)		
Weak Signal Impact			-0.139***	
			(0.0101)	
WG * Weak Signal Impact			-0.0579***	
			(0.0131)	
Weak Signal Productivity				0.0685***
				(0.0102)
WG * Weak Signal Productivity				-0.0743***
				(0.0128)
Tenure	-0.0296***	-0.0354***	-0.0327***	-0.0322***
	(0.000575)	(0.000597)	(0.000586)	(0.000605)
Cumulative Mobility	-0.0182***	0.00612*	-0.00246	-0.0103***
	(0.00337)	(0.00351)	(0.00346)	(0.00353)
Avg. Team size Before	-0.000577		-0.0313***	-0.0273***
	(0.00236)		(0.00237)	(0.00237)
Avg. Team size After	0.271***		0.269***	0.269***
	(0.00178)		(0.00181)	(0.00181)
Location Familiarity	0.115***	0.199***	0.139***	0.135***
	(0.0102)	(0.0106)	(0.0104)	(0.0104)
Tech Diversity	0.0635***	0.0748***	0.0698***	0.0721***
	(0.00145)	(0.00151)	(0.00147)	(0.00150)
Constant	0.414***	0.932***	0.562***	0.468***
	(0.0112)	(0.0103)	(0.0117)	(0.0135)
Observations	158,138	158,138	158,138	158,138
R-squared	0.333	0.275	0.312	0.309
Firm FE	Y	Y	Y	Y
City Pair FE	Y	Y	Y	Y

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.4. The Effects of Career Uncertainty on Innovation Performance (Matched)

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3
Within-firm Geographic Mobility (WG)	-0.0140	-0.00615	-0.0124*
	(0.00890)	(0.00786)	(0.00751)
Career Novice (1*)	-0.0631***		
	(0.0108)		
WG * Career Novice	0.00728		
	(0.0129)		
Career Critical (2*)		0.0285**	
		(0.0119)	
WG * Career Critical		-0.0469***	
		(0.0161)	
Career Mature (3*)			0.0594***
			(0.0161)
WG * Career Mature			-0.00340
			(0.0229)
Tenure	-0.0335***	-0.0315***	-0.0323***
	(0.000641)	(0.000588)	(0.000606)
Cumulative Mobility	-0.0213***	-0.0136***	-0.0105***
	(0.00359)	(0.00352)	(0.00350)
Avg. Team size Before	-0.0272***	-0.0272***	-0.0269***
	(0.00237)	(0.00237)	(0.00237)
Avg. Team size After	0.269***	0.269***	0.269***
	(0.00181)	(0.00181)	(0.00181)
Location Familiarity	0.120***	0.133***	0.132***
	(0.0105)	(0.0104)	(0.0104)
Tech Diversity	0.0714***	0.0712***	0.0714***
	(0.00147)	(0.00147)	(0.00147)
Constant	0.576***	0.510***	0.508***
	(0.0139)	(0.0118)	(0.0114)
Observations	158,138	158,138	158,138
R-squared	0.309	0.308	0.308
Firm FE	Y	Y	Y
City Pair FE	Y	Y	Y

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(1*) Note 1: Individuals who have tenures less than 3 years at the time of their mobility.
(2*) Note 2: Individuals who have tenures of 4 to 7 years at the time of their mobility.
(3*) Note 3: Individuals who have tenures more than 8 years at the time of their mobility.

Table 3.5. Within-firm Mobility and Pre-mobility Innovation Performance (Matched)

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
WG	-0.0766***	-0.0316***	0.000366	-0.0167*
	(0.0134)	(0.00792)	(0.00811)	(0.00910)
Quantile 3	-0.0159			
	(0.0194)			
Quantile 4	-0.00531			
	(0.0211)			
Quantile 5	0.0739***			
	(0.0162)			
Quantile 6	0.106***			
	(0.0190)			
Quantile 7	0.118***			
	(0.0185)			
Quantile 8	0.120***			
	(0.0180)			
Quantile 9	0.204***			
	(0.0179)			
Quantile 10	0.186***			
	(0.0174)			
WG * Quantile 3	0.0596**			
	(0.0252)			
WG * Quantile 4	0.102***			
	(0.0274)			
WG * Quantile 5	0.0566***			
	(0.0212)			
WG * Quantile 6	0.0730***			
	(0.0248)			
WG * Quantile 7	0.0703***			
	(0.0240)			
WG * Quantile 8	0.130***			
	(0.0235)			
WG * Quantile 9	0.0441*			
	(0.0234)			
WG * Quantile 10	0.0791***			
	(0.0225)			
Highly Impactful		0.155***		0.139***
		(0.0118)		(0.0123)
WG * Highly Impactful		0.101***		0.0873***
		(0.0156)		(0.0162)
Least Impactful			-0.0983***	-0.0656***
			(0.0113)	(0.0117)
WG * Least Impactful			-0.0720***	-0.0585***
			(0.0147)	(0.0152)
Tenure	-0.0334***	-0.0323***	-0.0322***	-0.0327***
	(0.000590)	(0.000585)	(0.000586)	(0.000585)
Cumulative Mobility	0.00293	-0.00581*	-0.00774**	-0.00243
	(0.00349)	(0.00344)	(0.00345)	(0.00345)
Avg Team Size Before	-0.0313***	-0.0305***	-0.0310***	-0.0328***
	(0.00238)	(0.00237)	(0.00238)	(0.00237)
Avg Team Size After	0.269***	0.270***	0.269***	0.269***
	(0.00181)	(0.00181)	(0.00181)	(0.00181)
Location Familiarity	0.139***	0.137***	0.136***	0.139***
	(0.0104)	(0.0104)	(0.0104)	(0.0104)
Tech Diversity	0.0682***	0.0715***	0.0703***	0.0708***
	(0.00148)	(0.00147)	(0.00147)	(0.00147)
Constant	0.433***	0.477***	0.544***	0.500***
	(0.0141)	(0.0115)	(0.0116)	(0.0121)
Observations	158,138	158,138	158,138	158,138
R-squared	0.312	0.312	0.310	0.313
Firm FE	Y	Y	Y	Y
City Pair FE	Y	Y	Y	Y

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Figure 3.1. Inventors Numbers of Within-Firm and Between-Firm Mobility

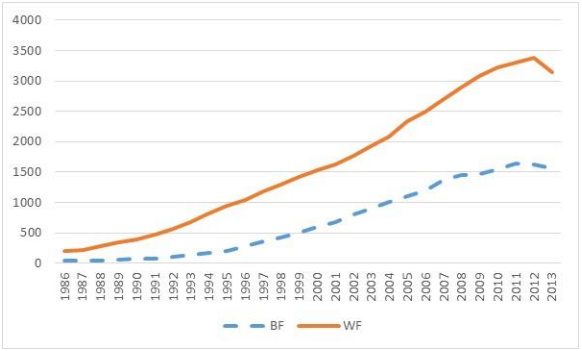


Figure 3.2. Mobility Distance (km) for Within-Firm and Between-Firm Mobility

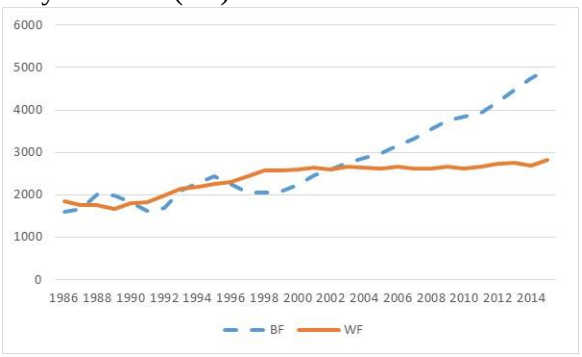


Figure 3.3. Distribution of Average Forward Citations for Inventors

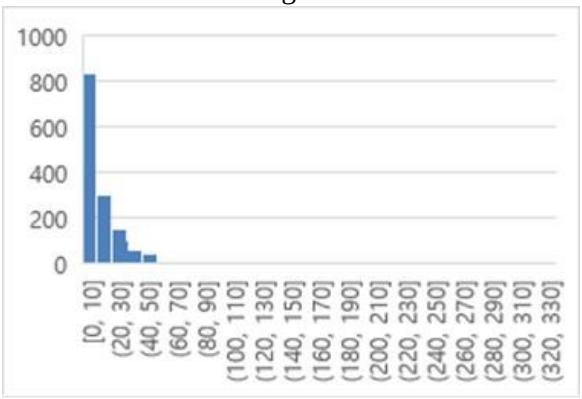
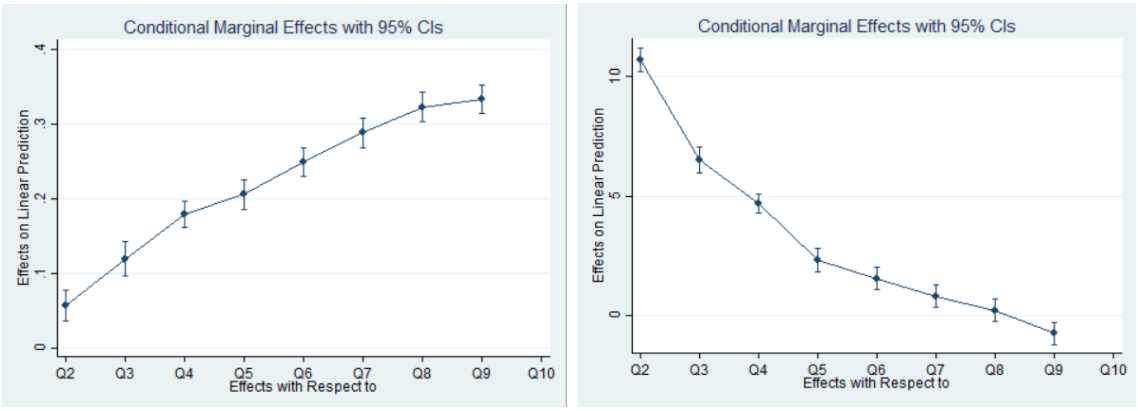


Figure 3.4. Distribution of Subgroup Coefficient on Absolute and Relative Performance
(Table 3.5, Models 1 and 2)



CHAPTER IV. INTEGRATING ETHNIC DIVERSITY: THE IMPACT OF ETHNIC DIVIDE IN COLLABORATION PATTERNS ON FIRM INNOVATION PERFORMANCE

Abstract

Although research on skilled migration and ethnic diversity has discussed the benefits and drawbacks of increasing human capital diversity in achieving innovation performance, prior innovation literature has largely focused on the compositional element of diversity without examining the operational element of diversity, that is, its integration. However, even equally diverse firms can have heterogeneous collective performance depending on how they can integrate and therefore incorporate the knowledge that resides in ethnically diverse individuals. In this study, I examine how firm-level innovation performance is determined by the level of ethnic (dis-)integration in collaborations. The empirical analyses of the patent data from all U.S. firms illustrate how and why ethnic integration is a critical lens to realize the potential benefits of human capital ethnic diversity.

Keywords:

Human Capital; Knowledge Collaboration; Diversity and Integration; Firm Innovation Performance; Ethnic Diversity; Spectral Segregation Index

4.1. INTRODUCTION

While management scholars have long advocated the crucial roles played by knowledge recombination in achieving successful innovation (Grant, 1996; Fleming, 2001; Carnabuci & Operti, 2013), recent innovation scholars on skilled migration and ethnic diversity broadly agree that a firm's possession of human capital and ethnic diversity are critical sources of innovation performance (Almeida, Phene, & Li, 2015; Choudhury & Kim, 2019; Bahar, Choudhury, & Rapoport, 2020). However, equally ethnically diverse firms may have fairly different collaboration patterns in terms of how they collaborate with the same and different ethnic individuals. As such, the innovation performance is determined not only by human capital ethnic diversity but also by the way these individuals collaborate within the firm.

In this paper, I simultaneously consider the implications of ethnic diversity and integration to investigate whether firms can increase innovation from ethnic diversity. Although recent management studies acknowledge the critical roles of ethnic diversity in accounting collaborations patterns and their subsequent performance (AlShebli, Rahwan, & Woon, 2018) and suggest that ethnically diverse firms can benefit from having access to diverse knowledge that may reside in ethnically diverse individuals (e.g., Choudhury & Kim, 2019), we also know that having diversity may result in conflicts in various organizational settings (Mannix & Neale, 2005; Horwitz & Horwitz, 2007). More importantly, although ethnic diversity and the integration of diversity are seemingly interchangeable (Roberson, 2006; Shore, Cleveland, & Sanchez, 2018), diversity is a characteristic that refers to demographic differences among members (McGrath, Berdahl & Arrow, 1995), while integration or inclusion is a concept that describes accessibility, participation, and empowerment (Mor Barak, Cherin, & Berkman, 1998). As such, in this paper, I examine whether ethnic integration can both affect the collaboration efficiency among individuals and condition the influence of ethnic diversity on a firm's innovation performance. For instance, contrary to traditional beliefs, firms with

higher levels of ethnic diversity or the level of integration may not necessarily achieve superior innovation performance.

In examining the implications of having ethnic diversity and integration at a firm, a definition of ethnicity would be useful because clear demarcations of constructs related to ethnicity may not necessarily be trivial (Phinney, Horenczyk, Liebkind, & Vedder, 2001; Fearon, 2003). For instance, while national boundaries may not well-aligned with ethnic boundaries (Brubaker, 2009), the race is more of a category or phenotype that may be different from an ethnicity that tends to mean certain status as a proxy for racial classification or immigrant status, (Jensen, 1980; Helms & Talleyrand, 1997). Thus, to avoid potential confusion with other constructs, I define *ethnicity* as a kinship with the majority of people who share common cultural traditions, such as names and languages (Brubaker, 2009), and ethnic *integration* as a situation in which ethnically diverse individuals are not marginalized but can sufficiently collaborate with individuals of the ethnic majority within the firm.

I first examine whether ethnically homogeneous collaborations, which can benefit from communication and collaboration efficiency, may be conditioned by potential pitfalls such as knowledge redundancy and cognitive lock-ins in ethnically homogeneous collaboration. Also, in light of organizational flexibility (Cox & Blake, 1991), I consider whether lack of ethnic integration in collaborations may potentially reduce collaboration performance due to the less flexible and close-minded majority of the individuals within the firm. Next, I study whether this integration of ethnically diverse individuals is unequivocally yielding superior innovation performance by examining appropriate levels of ethnic integration. In particular, I suggest that the level of integration among ethnically diverse individuals may be a double-edged sword that necessitates the interplay of collaboration efficiency and knowledge diversity. In other words, in order for a firm to benefit from its ethnically diverse employees, it is not by having too much ethnic divide that does not integrate ethnically diverse individuals nor excessive levels of ethnic

integration that may over-represent ethnic minorities, but rather by achieving sufficient levels of ethnic integration that represent the ethnic composition within the firm.

Given the nature of these prepositions, this study requires a setting in which actual collaboration patterns can be accurately captured and further understood with their relative performance. To explore the implications of the human capital ethnic diversity and the level of ethnic integration simultaneously, I examine the ethnic diversity and the patterns of integration in collaborations among 940 firms in the United States and their innovation performance. In addition, I incorporate the Spectral Segregation Index (SSI: Echenique & Fryer, 2007) to estimate how individuals of diverse ethnic backgrounds collaborate with various other individuals at the firm. As this index can capture the patterns of collaboration among individuals in terms of the level of network connectivity with other individuals of the same ethnicity compared to different ethnic individuals, analyzing how individuals at a firm collaborate with the same and different ethnic individuals can incorporate actual collaboration patterns among individuals and provide insights on firm performance.

The empirical analyses suggest that a certain level of ethnic homogeneity (that is, ethnic divide) does have a positive impact on innovation performance, partially due to the costs of ethnic diversity that impair collaboration efficiency. Yet, the benefits of the ethnic divide have diminishing returns. In other words, while the same ethnic collaborations may positively impact performance at first, without integrating ethnically diverse human capital, firms may have limited benefits from having human capital ethnic diversity. Also, achieving a sufficient level of ethnic integration that can well-represent the proportion of diverse ethnic individuals at more diverse firms can lead to superior innovation performance. The empirical results in this study provide implications for research on skilled migration, human capital diversity, organizational knowledge recombination, and micro-foundations of the firm.

4.2. THEORY AND HYPOTHESES

4.2.1 Literature Review: Human capital ethnic diversity

As human capital has gained broad scholarly interest as a source of competitive advantages and superior performance in strategic management so far (e.g., Barney, 1991; Hatch & Dyer, 2004), scholars are increasingly emphasizing the critical benefits of having human capital diversity, such as race, gender, or age (e.g., Plummer, 2003; Pitts, 2009), for superior firm performance (for reviews see Joshi, Liao, & Roh, 2011; Mathieu, Tannenbaum, Donsbach & Alliger, 2014). Relatedly, recent management research focuses on the benefits of ethnic diversity in explaining much of scientific collaboration patterns and performance (AlShebli et al., 2018) and in providing distinctive expertise based on specific ethnic backgrounds (e.g., Almeida et al., 2015; Choudhury & Kim, 2019), both of which can further explain how firms increase collective innovation performance.

In examining the implications of having ethnic diversity, more micro-level management scholars have suggested the critical roles of managerial practices that emphasize the integration and inclusion of diverse individuals (e.g., Mor Barak et al., 1998; Gilbert, Stead, & Ivancevich, 1999; Ferdman, 2014; Shore et al., 2018). According to this stream of research, it is crucial to distinguish diversity from integration (Roberson, 2006; Shore et al., 2018) and to investigate the role of diversity as well as the integration of diversity. However, we know that diverse individuals may find it difficult to form close cohesion with different others (e.g., Mannix & Neale, 2005; Horwitz & Horwitz, 2007; Ertug et al., 2022). As such, the management literature is still without concrete answers to a simple but crucial question: how can a firm benefit from its human capital diversity? As such, in what follows, I focus on how ethnicities, irrespective of nationalities or race, of individuals and the level of integrations can collectively influence the firm's innovation performance.

4.2.2. The significance of (co-)ethnicity in innovative collaboration

To examine the performance implications of ethnic diversity and the integration of ethnically diverse individuals, it would be beneficial first to consider conditions under which a firm lacks ethnic diversity and, thus, is ethnically homogeneous. Various studies suggest that people are generally attracted by individuals with similar characteristics and attitudes (Similarity Attraction paradigm: Byrne, 1971), while different characteristics may trigger a tendency to identify boundaries between in-group and out-group (Social identity theory: Ashforth & Mael, 1989) due to self-categorization and in-group favoritism (Turner, 1975). In short, people may prefer to work with similar others (Williams & O'Reilly, 1998) with whom they can maintain a relatively strong collective identity (Griffith & Neale, 2001) and mutual awareness and trust (Cramton, 2001). While these ethnically homogeneous collaborations can benefit from mutual trust and positive attitudinal outcomes from the shared cultural values and history (Tsui, Egan, & O'Reilly, 1992) or harmonious consensus based on shared experience (Nemeth & Staw, 1989; Phinney et al., 2001), there exist additional values in ethnically homogeneous collaboration in the context of innovation collaboration.

As successful team interactions in knowledge sharing are crucial (Jones, 2008), there exist several reasons why languages can facilitate supreme innovation performance. First, ethnically homogeneous collaborations can benefit from having shared languages and thus increase collaboration efficiency, ceteris paribus. While previous scholars have been somewhat silent (e.g., Deumert & Vandenbussche, 2003), using the same language in communication is a powerful benefit for ethnically homogeneous individuals and their collaborations, similar to having standards in manufacturing for facilitating a consistent and reliable delivery (e.g., Russell, 2005). Because the same ethnic individuals form a cultural community within which people share a common language, history, and customs (Fearon 2003), these same ethnic individuals are less likely to suffer from difficulties in communication and interactions

(Tortoriello & Krackhardt, 2010) or trust-building among team members (Maznevski, 1994; Tenzer, Terjesen, & Harzing, 2017), when other things are equal. Therefore, firms can increase innovation performance from ethnically homogeneous collaborations in which individuals can communicate more efficiently and effectively.

Another benefit of sharing a common language and traditions among individuals of the same ethnicity is related to the generation of social orders. As certain standards enable a set of rules that regulate involved individuals (Kerwer, 2005), individuals of the same ethnicity share not only their common language but also specific social orders that are innate to their own ethnic groups. For instance, while certain ethnic minorities may have enough linguistic skills to understand and communicate with others in a common language, such as English, it may not be trivial for these ethnic minorities to fully capture how native speakers of English process their ideas or develop their relationship, both of which can be highly relevant to cultures (e.g., McGrath et al., 1995). After all, challenges of ethnic diversity may not merely be related to linguistic issues (Deumert & Vandenbussche, 2003). Collectively, due to linguistic commonality, ethnically homogeneous collaborations have relative benefits over heterogeneous ones and thus can eventually increase collective collaboration performance.

However, if a firm only facilitates ethnically homogeneous collaborations, the positive outcomes of collaboration efficiency may be of diminishing returns. This is because ethnically homogeneous individuals may not possess a diverse set of knowledge or different experience (Williams & O'Reilly, 1998). Indeed, recent innovation research is increasingly focused on the benefits of ethnic diversity in providing various knowledge sources (Almeida et al., 2015; Choudhury & Kim, 2019; Bahar et al., 2020) and thus reducing redundant knowledge among the same ethnic individuals. In essence, a collaboration by ethnically diverse individuals can not only increase creativity and problem-solving capability (Cox & Blake, 1991) but also reduce the risks such as groupthink (Jehn & Mannix, 2001). As such, if individuals at a firm

only collaborate with the same ethnic individuals, the collective innovation performance of the firm may not solely benefit from collaboration efficiency but also suffer from a lack of knowledge diversity and potential risks of being too similar.

Furthermore, when individuals at a firm only tend to collaborate with the same ethnic individuals while excluding different ethnic individuals, it is likely that these become less flexible and closed-minded. As individuals who experience diverse ethnic individuals and their backgrounds tend to form more flexible attitudes (Cox & Blake, 1991; Pelled, Eisenhardt, & Xin, 1999), ethnic homogeneity among employees may result in potential 'lock-in' effects as these individuals are more likely to lack openness or flexibility (Crescenzi, Nathan, & Rodriguez-Pose, 2016). While negative effects of ethnic diversity may diminish over time from mutual experience (e.g., Harrison, Price, Gavin, & Florey, 2002), the lock-in tendency among similar individuals are likely to grow over time, partially due to their limited and shared experiences (Perry-Smith & Shalley, 2003). As such, when individuals at a firm tend to collaborate with the same ethnic individuals, this lack of ethnic diversity in collaboration can damage organizational flexibility and thus reduce collective performance.

Lastly, individuals of ethnic majority may put greater trust in knowledge from their ethnic group while downplaying the importance of other ethnic individuals, posing a greater risk of knowledge redundancy and lack of flexibility. Innovation studies suggest that collaboration performance may suffer from individuals who are overly embedded in their own group and thus downplay other ethnic groups (Almeida et al., 2015). As such, highly homogeneous collaborations within an organization pose a potential threat to the firm-level innovation performance when ethnically diverse individuals are not well-integrated. In short, although ethnically homogeneous individuals can benefit from sharing common ethnic backgrounds that can enable more efficient and effective collaborations within the ethnic groups, the benefits of

co-ethnic collaborations by the dominant ethnic group members at the firm are at a diminishing return due to the potential risks of redundancy and flexibility. Thus,

> ***Hypothesis 1***. *There is an inverted U-shaped relationship between the level of ethnic divide and the firm innovation performance.*

4.2.3. Representations in the level of ethnic integration

In addition to the benefits of knowledge diversity, sufficient levels of integration by ethnically diverse individuals can further facilitate successful collaborations due to fair representations. First, although learning or legitimacy are all important elements of diversity, studies suggest that the discrimination and fairness perspective is the most fundamental element in realizing the benefits of the diversity of individuals (Ely & Thomas, 2001). This is because the lack of fairness or the existence of discrimination can have a direct and significantly negative impact on the performance of any firm with diverse individuals. Second, fair representations of ethnically diverse individuals can facilitate successful innovation performance by conferring ethnically diverse individuals with psychological inclusions. Individuals who are psychologically included within the firm can trust and respect the behaviors of other individuals due to psychological safety, a shared belief, and interpersonal norms within the firm (Edmondson, 1999). Due to social norms of reciprocity, such as obligations, expectations, and structural trust (Coleman, 1988), the importance of the psychological inclusions among ethnically diverse individuals at a firm can further result in superior firm innovation performance. In addition, firms that promote psychological inclusion and safety by achieving sufficient levels of ethnic integration can benefit further from a strong collective identity among employees (Adler & Kwon, 2002). As such, because having a strong collective identity can influence how they assimilate to the norms of the firm, irrespective of their status (Nishii, 2013; Ferdman, 2014, Winters, 2014), sufficient levels of ethnic integration

within a firm can positively affect the way employees participate and thus lead to superior performance within the firm.

In deciding a sufficient level of integration for being fair, the proportion of ethnic minorities within the firm can be crucial as it shapes the perception of how individuals within the firm consider the necessary level of diversity (Dwertmann, Nishii, & Van Knippenberg, 2016). Once there becomes a consensus among employees that ethnically diverse individuals do get representations within the firm, these individuals can also equally collaborate within the firm and thus lead to firm-level superior innovation performance. However, achieving sufficient integration levels of individuals of various ethnic backgrounds into the dominant ethnic group members at the firm is not trivial and thus requires sufficient efforts of coordination at the firm (Felin & Hesterly, 2007). For instance, individuals with specialized expertise or different backgrounds must be successfully coordinated (Boland & Tenkasi, 1995; Carnabuci & Operti, 2013) and have ample communication (e.g., Reagans & McEvily, 2003) to increase willingness and motivation for sharing tacit knowledge with other individuals and recombining diverse perspectives.

In essence, firms can positively address the benefits and challenges of ethnic diversity by successfully coordinating and achieving a successful level of integration of ethnic diverse human capital. In other words, firms with less divided or successfully integrated ethnically diverse individuals can benefit from openness and flexibility among individuals and avoid potential lock-in effects that can arise due to ethnic homogeneity or lack of integration (e.g., Crescenzi et al., 2016). However, if a firm fails to integrate its ethnically diverse individuals, certain marginalized individuals at the firm get excluded from getting crucial information or having opportunities in organizations (Ibarra, 1993; Pettigrew & Martin, 1987). Without sufficient integration, firms may impose specific pre-established organizational values and norms within the firm without appreciating pluralistic perspectives that already exist in the firm

(Mor Barak et al., 1998). Exclusion or marginalization of certain groups of individuals at a firm may further hinder the likelihood of active participation and thus full contributions of more employees within the firm. This can pose a critical problem as it limits the extent to which collaborations among diverse individuals can achieve. Given the importance of combining any distinct knowledge that resides in various human capital within the firm (Grant, 1996; Hatch & Dyer, 2004), failing to achieve sufficient levels of ethnic integration will not only hamper the potential benefits of human capital diversity but also negatively affect the environment in which diverse individuals interact. In addition, the diminishing returns of the benefits of co-ethnic collaborations by the dominant ethnic group members seem to further suggest the necessity of integrating ethnically diverse individuals in collaboration. In short, by integrating ethnically diverse individuals to the point where individuals do perceive fairness in collaborations, that is, above the proportion of ethnic minorities at the focal firm, the focal firm can better appropriate the potential benefit of having human capital ethnic diversity. As such, the integration of ethnically diverse individuals is a prerequisite for successful collaboration performance, while the lack of appropriate levels of ethnic integration, that is, ethnic divide, results in detrimental firm-level collective implications. Accordingly,

> ***Hypothesis 2.*** *A disproportionate ethnic divide (that is, an ethnic divide that is above the nominal proportion of the dominant ethnic group within the firm) decreases the firm's innovation performance.*

4.2.4 Ethnic integration at highly diverse firms

Although ethnic diversity and integration have distinctive implications on firm-level performance based on theoretical differences (McGrath, Berdahl & Arrow, 1995; Mor Barak et al., 1998), more in-depth investigations may be required as the two constructs are connected in various and critical ways. For instance, two firms with the same level of diversity in their human capital ethnic composition may have totally different levels of integration, while similarly integrated two firms may have different demographic compositions. Therefore, in

what follows, I examine how the relationship of these two constructs can influence the collective firm-level performance and why an increase in the level of the ethnic divide is particularly detrimental when the firm is ethnically more diverse.

While more employees at a firm may positively impact the firm's collective innovation performance, in theory, many other factors may affect the actual relationship. For instance, research on labor economics shows that human capital is valuable only if individuals can create values evaluated in the market (Peteraf & Barney, 2003). Similarly, research on strategic human capital concurs with the idea that human capital should contribute values to the focal firm. Put differently, individuals at a firm are valuable only if their capital, knowledge, skills, abilities, and other characteristics (KSAOs) can increase firm performance (Wright & McMahan, 2011; Barnes, Jiang, & Lepak, 2016). In other words, when explaining the relationship between the size of human capital and the focal firm's performance, it is the role of the actual contribution of individuals, not the mere presence of individuals, that matters. Likewise, in the context of human capital diversity, several reasons exist to suspect the detrimental impact of having an insufficient or lack of integration within more ethnically diverse individuals on the firm-level innovation collective performance.

First, when a firm is ethnically more diverse in terms of the diversity of employee ethnic backgrounds, given the potential conflicts among ethnically diverse individuals, successful management of ethnically diverse human capital becomes even more critical. Broadly speaking, ethnically diverse individuals may find it challenging to collaborate with different others because high levels of ethnic diversity may trigger higher tensions between and within various ethnic subgroups at a firm. Previous studies suggest that collaborations among individuals with multiple ethnic groups may engender potential conflicts due to identification processes (Roccas & Brewer, 2002), in-group favoritism (Turner, 1975; Webber & Donahue, 2001), or faultlines that divide individuals by their ethnic groups (Lau & Murnighan, 1998). While the critical role

of a sufficient level of ethnic integration has been discussed throughout this paper, these studies show the importance of ethnic integration gets even more significant when the firm has higher ethnic diversity.

In addition, high levels of ethnic diversity may make the realization of potential benefits of ethnic diversity more challenging due to the challenges of successful integration. Suppose there are more ethnically diverse individuals who are not sufficiently integrated into the entire organization, ceteris paribus. In such a case, the focal firm essentially has more individuals who find it challenging to contribute their unique values, partially due to the lack of opportunities to communicate with others at the firm. While a group of individuals can increase performance and have a firm-specific human capital resource with sufficiently distinctive skillsets (Lazear, 2009), the collaboration outcome among these individuals is not a simple summation of their skills but depends on how successful these individuals could interact and collaborate. Even positive consequences from accumulating collaboration experience, such as efficient and effective collaborations (e.g., Harrison et al., 1998; Ployhart & Moliterno, 2011), may only be attainable when the focal firm achieves an adequate level of ethnic integration. As discussed, achieving the socially accepted level of ethnic integration within the firm can enhance the inclusion of both previously excluded groups and dominant ones (Nishii, 2013; Ferdman, 2014). Thus, when a firm is composed of more ethnically diverse individuals who are not collaborating in an integrated way, the potential benefits of its human capital diversity may be difficult to be realized. As such, although achieving superior collective outcomes may be a result of successful interactions among diverse individuals (Felin & Hesterly, 2007), in particular, for tasks that require collaboration for highly interdependent tasks (Ndofor, Sirmon, & He, 2015), a failure of sufficient level of ethnic integration may only trigger intensified tensions and conflicts among individuals at the focal firm and inevitably lower collective performance level. In short, the detrimental impact of having insufficient ethnic integration

gets more pronounced when the level of ethnic diversity is higher due to increased conflicts and unrealized potential benefits of ethnic diversity. Then, the focal firm is likely to underperform due to the enlarged negative impact of the failure to achieve sufficient ethnic integration among its employees. Therefore,

> ***Hypothesis 3****. The negative effect of the ethnic divide on the firm's innovation performance is accentuated by the higher level of ethnic diversity at the firm.*

4.3. DATA AND METHODOLOGY

4.3.1 Data and sample

To test these key hypotheses regarding the influence of ethnic integration and ethnic diversity on firm performance, I chose the context of patent collaborations by all the listed firms in the United States that have been active during the period of this research sample, that is, any firms that have at least one patent in all consecutive years during the sample window. The selection of this research setting is motivated by the following three reasons. First, this research setting is particularly adequate in examining the impact of ethnic diversity and integration among various firms, given the essential roles played by highly skilled ethnic individuals in a knowledge-based economy (e.g., Nathan 2015; Kerr et al., 2016). While not all firms engage in patenting activities, the crucial role played by firms with patents in various industries can justify the rationale of this research setting (Trajtenberg, 1990; Breschi & Lissoni, 2001). Relatedly, even if the ethnicities of individual inventors may not be the only selection criteria for collaborations, such as patenting teams within a firm, the nature of the large-scale data can provide a more suitable setting for examining how the level of ethnic integration in collaborations can influence firm-level innovation performance. Lastly, I selected a setting in which I can examine how micro-level different levels of integrative collaboration patterns among individuals who are ethnically diverse can be captured and explain the collective firm-level innovation performance. This choice of research setting allows the investigation of the

link between micro-foundational constructs' explanations for firm-level consequences (e.g., Felin & Foss, 2005). In so doing, even though knowledge within the firm arguably resides within individuals (Grant, 1996) and most of the decisions at work are also made by individuals in the first place (Felin & Foss, 2005), I examined how collaboration patterns within the firm can affect firm-level outcomes.

The patent data was gathered from *Patentsview* (http://www.patentsview.org/), a data repository by the United States Patent & Trademark Office (USPTO) for all filed patents. Other firm-related data such as annual research and development spending is gathered from *Compustat*, a database published by Standard & Poor's. More specifically, I gathered patent information from the firms with at least one patent application each year from the year when they went public until the year they were acquired, delisted, or exited. In innovation research, previous studies suggest the importance of differences across countries (Breschi, 2000). Similarly, institutional variations in patenting behaviors may further pose difficulties in comparing patents from different countries (Cohen, Goto, Nagata, Nelson, & Walsh, 2002). Hence, I excluded firms headquartered outside of the United States and patents that are filed by individuals who are located outside of the United States. The final sample contains 11,080 firm-year patent data for 940 firms over the period of 1990 to 2015.

Although patent data provides detailed information regarding individuals, assignees, and dates for filing and grants, it lacks one crucial aspect for the purpose of this study: the ethnicities of individual inventors. Thus, I utilized the Ethnea dataset that was developed by Torvik and Agrawal (2016). While using inventor names to estimate individual ethnicity is not without error (e.g., Mateos, 2007), using names in determining one's ethnicity is theoretically justifiable (Fearon, 2003; Brubaker, 2009) and particularly useful given its broad applicability and accuracy in measuring ethnic diversity and the level of integration in collaborations in large scale data (Torvik & Agrawal, 2016). This dataset classifies individual ethnicities by adopting

the nearest neighbor approach, and identify similar instances for given names within 15 million abstracts in PubMed, a biomedical literature database. Thus, I use inventor names from the USPTO and 26 pre-defined ethnicities from the Ethnea dataset.

4.3.2 Measures

4.3.2.1 Dependent Variable: Firm Innovation Performance

Innovation research has widely adopted the idea of using the number of forward citations of a patent to be a good proxy for its innovative contribution and impact (Trajtenberg, 1990; Fischer & Leidinger, 2014). Following this tradition, I measure the *firm innovation performance* as the total number of forward citations that all the patents by the focal firm received for the first five years after filing. I use a logarithm transformation after adding one due to the highly skewed nature of the distribution of forward citations (Scherer & Harhoff, 2000). In the robustness check section, I discuss additional regression analyses on distinct yet theoretically relevant dependent variables such as the average of the patent value that are granted by the focal firm (Kogan, Papanikolaou, Seru, & Stoffman, 2017) or the total number of patents by the focal firm.

4.3.2.2 Independent Variables

Ethnic Richness. In this study, I adopt the number of different ethnicities of the firm, that is, ethnic richness, in examining the implications of a firm's ethnic diversity instead of the Blau index. There exist several theoretical rationales for this choice. First, recent innovation research increasingly finds evidence of the critical role played by diversity in terms of unique source distinctive knowledge sources (e.g., Almeida et al., 2015; Choudhury & Kim, 2019). Similarly, regional economic studies suggest the importance of considering the number of unique countries within the firm (e.g., Ozgen C., Nijkamp, P., Poot, 2011; Parrotta, Pozzoli & Sala, 2016). More importantly, although widely adopted in various contexts, the Blau index

may have limited isolating mechanisms in that it is difficult to consider how many categories and ethnicities in this study can be observed in the sample. Besides, previous studies also suggest that the Blau index cannot provide much beyond the proportions of different ethnic groups due to its color blindness (e.g., Voas, Corckett, & Olson, 2002). However, the main research questions rather aim to investigate whether having distinctive ethnic knowledge sources within individuals (that is, ethnic diversity) or how the level of ethnic integration can concurrently influence firm-level innovation performance. Thus, I define ethnic richness as *the number of distinct ethnic groups at the firm*. Figure 4.1 illustrates the trend of diversity and ethnic richness over the same period.

[Insert Figure 4.1 about here]

Ethnic divide. This study aims to examine how firm performance can be jointly influenced by 1) ethnic diversity and 2) the level of ethnic integration in collaboration patterns at the firm. Although it is not trivial to directly measure the strength or willingness of ethnic homogeneity or segregation at the firm level, I assume that collaboration patterns of employees at a firm will disclose how well the firm is ethnically integrated or not. This is because the level of ethnic divide (or the lack of ethnic integration) can explicate the tendency of individuals to collaborate with other same ethnic individuals by analyzing how individuals often collaborate with the same ethnic individuals. Figure 4.2 shows the conceptual illustrations of ethnic integration and ethnic divide, where different shapes represent different ethnicities and connected lines show inventing collaborations.

[Insert Figures 4.2 and 4.3 about here]

To measure the level of the ethnic divide, I adopted the Spectral Segregation Index (SSI: Echenique & Fryer, 2007) and calculated the *ethnic divide* as the SSI value for the ethnic majority of the focal firm. Among various indices of ethnic integration in various literature, the SSI is particularly meaningful as it measures network connectivity that captures the extent to

which an individual is segregated based on the level of segregation of the focal person and his(her) direct neighbors weighted by the proportions of interaction. The rationale for the adoption of this index is motivated by both theoretical and practical reasons. Theoretically, this index provides a measure that considers not only the level of ethnic divide (or lack of ethnic integration) of each individual within a group but also the patterns of ethnic divide by the collaborators of the focal individual (Echenique & Fryer, 2007). In addition, as the perception of individuals can also influence how individuals collaborate with others (Hagendoorn, 1995), I specifically focus on individuals of the dominant ethnic groups. By so doing, I can capture the dynamics of the ethnic integration or segregation (divide) of the focal firm in terms of the *majority* and *the others*. Practically speaking, this index is defined on the group level but can be easily decomposed to the individual level and higher levels (Bojanowski & Corten, 2014). Thus, using this index can better explain how individuals interact with others and how the focal firm is composed of individuals of various ethnic backgrounds. Figure 4.3 shows the trend of SSI for the ethnic majority and all the others.

Disproportionate Ethnic Divide (binary variable). To account for the insufficient level of ethnic integration, I introduce a binary variable that captures the level of ethnic integration of the focal firm. More specifically, this variable sets to 1 when the dominant ethnic group individuals have higher SSI values than their numerical proportion within the firm and 0 when otherwise. The rationale for this variable is two-fold. Theoretically, SSI represents the proportion of all the individuals within a category (ethnicity in this study) devoted to others from the same group on average (Bojanowski & Corten, 2014). Thus, when a group of people has a higher than their proportion within the team, that is, a higher SSI value than its proportion within the firm, it indicates more segregation of the firm than it should probabilistically be. Practically, one can directly calculate the level of ethnic divide by comparing the proportion of the ethnic majority and their SSI within the firm.

4.3.2.3 Instrumental Variable: State-level Number of Permanent Residents (LPR)

The ethnic diversity of the focal firm may not be entirely exogenous to the focal firm's innovation performance because highly productive firms can also attract highly productive potential individuals with diverse ethnic backgrounds (e.g., Nathan & Lee, 2013). In addition, to study how ethnic diversity and the integration level in collaboration patterns can jointly influence a firm's collective innovation performance, it is crucial to introduce an instrumental variable that can determine only one of these explanatory variables while not influenced by the outcome variable of firm performance. To this end, I consider the number of individuals who have been granted lawful permanent residents (LPR) in each state and calculate the number of LPR for each firm by year. More specifically, I first calculated the number of new LPR for each state for each year, and I generated the total number of LPR from all the states that a firm is operating in that specific year as firms with various branches across states are likely to be influenced by all of these states. It is important to note that other than extreme cases of no immigrant or fully immigrant-based firms, this LPR cannot influence the level of ethnic integration in collaboration patterns at the firm but only can affect the level of ethnic richness of a firm that operates in related states for that year. In addition, as this variable does not consider lagged stocks of a variable, this is distinctive from the conventional Bartik instrument that utilizes past settlement information (e.g., Jaeger, Ruist, & Stuhler, 2018). As such, the final set of analyses includes this instrument to address potential endogeneity issues of reverse causality.

4.3.2.4 Control variables

To consider the focal firm's characteristics that may influence innovation performance, I incorporated the following firm-level control variables. First, to reflect the vast literature linking firm performance with its R&D spending (Romer, 1990), I calculated *research and development (R&D)* as the logarithm transformation of a firm's R&D spending over its sales

and controlled for. In addition, previous studies suggest the crucial role played by the size of a firm in determining various organizational characteristics such as organizational structures or technological paths (Josefy, Kuban, Ireland, & Hitt, 2015). In relation to this study, understanding the impact of having more employees, particularly inventors who can file a patent, on collective firm-level innovation performance would be essential. Therefore, I controlled for the number of inventors by considering the number of different locations of the firm. In other words, *the average number of inventors at the focal firm* is calculated by the total number of unique inventors at the focal firm over the number of different geographic locations for a given year. Next, given that individuals, in general, have the heterogeneous capability to achieve innovative activities, such as patenting (Tzabbar, Cirillo, & Breschi, 2021), I calculated *the average inventor productivity* as the total number of patents filed by the firm divided by a total number of inventors within the firm for each year and controlled for. Lastly, while analyses in this study are based on the ethnic richness variable in determining the level of ethnic diversity within the firm, I included *Blau's index* (1977), calculated as $1 - \sum p_i^2$, where p is the proportion of individuals of one ethnicity and i is the number of different ethnicities at the firm, ranging from 0 to 1, in some analyses as a control.

4.3.3 Analysis

I examine panel data on firm-level innovation performance with ordinary least squares (OLS) and two-stage instrumental variable (2S IV) analyses with firm clustered standard errors. Unobservable errors related to factors such as firm, year, and geographic locations have been considered by using a user-written STATA command *reghdfe* and *ivreghdfe*.

For two-stage instrumental variable analyses, I introduce the previously described state-level number of LPR as an instrumental variable to address potential endogeneity concerns related to the level of the ethnic diversity of the focal firm and its innovation performance. This

is particularly crucial for the purpose of this study in that this instrumental variable can only affect the level of ethnic richness of the focal firm without affecting, at least in theory, the level of ethnic integration (or ethnic divide). As such, I instrument this variable on ethnic richness diversity and plug them into the original regression as follows.

$$Ethnic\ Richness = \alpha + \beta_1 LPR_i + \Phi_i + \lambda_i + \varepsilon$$

The main analyses in this study are primarily divided into three parts. First, I examine how the firm's performance is determined by the level of ethnic divide by using the square term and test whether there exists an inverted U-shape in the relationship between ethnic divide and firm performance. Second, I introduce a binary variable that captures the disproportionately divided collaboration patterns at a firm based on the numerical proportion of the ethnic majority at the firm. Here, I aim to examine how a higher level of ethnic divide compared to the proportion of ethnic minorities within the firm can negatively affect the collective performance and to investigate the sufficient level of ethnic integration. Lastly, I consider conditions under which ethnic divide may be particularly detrimental to firm-level performance. Here, I examine whether there exist negative interaction effects between ethnic divide and 1) the number of inventors at the firm and 2) the level of ethnic richness of the firm. To this end, I use ordinary least square regressions that include all relevant variables and interaction terms (where Φ represents controls and λ captures fixed effects) as follows:

$$log(ForCit+1) = \alpha + \beta_1 * Ethnic\ Richness + \beta_2 * Ethnic\ divide +$$

$$\beta_3 * Ethnic\ divide * Testing\ Variables + \Phi_i + \lambda_i + \varepsilon$$

4.4. RESULTS

The descriptive statistics and a correlation matrix for all variables in this study are shown in Table 4.1. Due to similar conceptualizations such as ethnic divide, ethnic diversity, and ethnic richness, I conducted a variance inflation test (VIF), with which any variable above 10

may suggest a critical multicollinearity issue (e.g., Neter, Kutner, Nachtsheim, & Wasserman, 1996). However, as the largest variable for the variance inflation test is 3.54, with the mean VIF being 1.80, multicollinearity is not a critical concern in this study.

[Insert Tables 4.1 and 4.2 about here]

The results presented in Table 4.2 are based on ordinary least square regression analyses. As can be shown in Models 1 and 2, the *Blau index* and *Ethnic Richness* may affect each other and are highly correlated (0.5179). Hence, from Model 3, I only included *Ethnic Richness* in most of my analyses in this study. While I included *Ethnic Richness* and *Ethnic Divide* in Model 4, I also included the square term of *Ethnic Divide* in Model 5. As the level of integration among ethnically diverse individuals can also be influenced by how firms are geographically dispersed, I analyzed a sub-sample of firms that have only one geographic location in Model 6. The results do not change even though the number of observations got reduced significantly (Note the reduction of r-square). Hypothesis 1 expects an inverted U-shape between the level of ethnic divide and the firm innovation performance. The positive coefficient for the variable *Ethnic Divide* and the negative coefficient for the square term of the same variable suggest an inverted U-shape of the *Ethnic Divide* and firm performance measured by forward citation. Thus, I found support for Hypothesis 1. Figure 4.4 provides a graphical illustration of this relationship. As can be seen, the level of an ethnic divide within a firm, which ranges from 0 to 1, has an inflection point, after which the positive impact of the ethnic divide diminishes, suggesting that the relationship is indeed inverted U-shaped.

[Insert Figure 4.4 and Table 4.3 about here]

Next, Table 4.3 presents the results of regression analyses based on ordinary least square and two-stage regression models. As the level of ethnic diversity may be confounded with the firm-level performance, I introduced an instrumental variable of LPR that can only affect the level of the ethnic diversity of a firm, not the level of ethnic integration of the collaboration

patterns of the firm. Model 1 presents the first stage regression model by using this variable. The results of the first stage analysis show that there is a significant and negative relationship between the number of new permanent residents in the state and the ethnic richness of the firm. F-statistic for this instrument is 237.53, suggesting that it does not suffer from a weak instrumental variable. Model 2 shows a positive and significant coefficient for the variable of *Ethnic Richness* and suggests that this variable indeed can increase firm-level innovation performance. As the other Models in this Table 3 have the same instrumental variable, I do not report the first stage regressions in this Table. While the sizes of coefficients are different, the results of Model 3 also support the inverted U-shape relationship between the *Ethnic Divide* and firm-level performance.

Furthermore, I introduced one additional variable that captures whether the level of an ethnic divide within the firm is disproportionately high, that is, higher than the proportion of ethnic majority within the firm. I labeled the variable as *Disproportionate Ethnic Divide (DED)* and included it in Models 4 and 5. This is because any SSI values higher than the actual proportion of specific subgroup members represent a lack of integration in their collaborations, and thus by comparing the level of ethnic divide and the proportion of the ethnic majority within the firm, I could measure whether the level of the ethnic divide is disproportionate or not. While the negative and significant coefficient of DED in Model 4 suggests that having a disproportionately high ethnic divide compared to the proportion of ethnic majority within the firm is generally detrimental to the firm's performance, the negative and significant coefficient of the interaction term in Model 5 implies that it is particularly negative when *Ethnic Divide* is more than the proportion of the ethnic majority within the firm. Figure 4.5 provides an illustration of this relationship. The decreasing line in the Figure suggests the negative impact of an *Ethnic Divide* when the ethnic divide is disproportionately high (DED). Hypothesis 2 predicts a disproportionately high level of the ethnic divide can have a negative impact on firm-

level performance. As can be seen in these models in Table 4.3, the *Ethnic Divide* is particularly detrimental to firm-level performance when it exceeds the level of a numerical proportion of the ethnic majority within the firm (DED). Thus, the findings collectively corroborate Hypothesis 2.

[Insert Figure 4.5 and Table 4.4 about here]

Lastly, Table 4.4 shows the results of fixed-effect OLS analyses on the further interaction effects related to the ethnic divide. The results of Model 1 suggest that the *Disproportionately high Ethnic Divide (DED)* can have a particularly negative impact on the firm performance when the level of diversity at the firm is higher, as measured by the Blau index. In addition, Model 2 shows the analyses of the interaction term between the *DED* and the level of ethnic richness of the firm, measured by the number of different ethnic groups within the firm. Recent research on labor economics emphasizes the role of ethnic richness in explaining group characteristics, based on the assumption that individuals of the same ethnic background are more likely to share a similar way of thinking or behavior when compared to individuals with different ethnicities (Ozgen, Nijkamp, & Poot, 2011; Parrotta, Pozzoli & Sala, 2016). Similar to the previous Model, the results of this regression corroborate the idea that an increase in the level of the ethnic divide is particularly detrimental when the firm has a higher level of ethnic diversity. Thus, the results collectively support Hypothesis 3.

As a robustness check, I examined whether the illustrated relationships among ethnic richness, ethnic integration, and firm performance remain the same when holding the diversity index of Blau constant. Although both the Blau index and ethnic richness essentially measure ethnic diversity, what they capture may show differences. For instance, while the Blau index is mainly about the proportions of various ethnic groups within the firm, ethnic richness represents the extent to which the focal firm can access various ethnic backgrounds within its employees. However, given the conceptual similarities, differentiating these constructs and

interactions with the ethnic divide may be challenging. Regressions results on other ethnic diversity measures are presented in Table 4.5.

[Insert Tables 4.5 and 4.6 about here]

In addition, instead of a patent citation, several other performance measures such as average patent value or the total number of patents have been examined in Table 4.6. The results of the regressions show similar patterns. While Model 1 uses the aggregated value of all the patents that are filed by the focal firm in that specific year (Kogan et al., 2017), Model 2 represents how the level of *Ethnic Divide* can influence the number of patents that the focal firm files. While the size of coefficients of variables is not identical, the results of these two Models are similar, suggesting that the results are robust to different dependent variables.

Next, I further exploited several ways of calculating the comparisons between the *Ethnic Divide* by the dominant ethnic groups (SSI) and the proportion. While the regressions illustrated in this paper used the difference, I also examined other methods by using ratio or category variables, which did not show any difference in results. Also, as the dependent variable of forward citations of patents may be sensitive to the window of calculation, I examined different periods of windows to calculate the number of forward citations (3 and 7 years). The results of these additional checks do not show any significant difference from the one presented in this study.

Lastly, the illustrated results may differ for situations in which the ethnic compositions are different from the ones that I examined. In other words, the results may not hold for firms that are mainly composed of migrants, such as Chinese or Indian. While this may not be common in firms that are headquartered in the United States, I analyzed subsamples that have high proportions of migrants within the firm amongst their inventors. Yet, the results of the subgroup analyses show that even migrant-dominant firms hold the discussed relationships.

4.5. DISCUSSION AND CONCLUSION

By examining the role of ethnic integration (or lack thereof) in collaborations among ethnically diverse individuals, I have advanced efforts to incorporate the aspects of human resource integration in enabling the benefits of human capital diversity. The results of this study suggest that the seemingly beneficial outcomes of ethnic divide due to communication efficiency are of diminishing returns and that achieving sufficient levels of ethnic integration among ethnically diverse individuals provides crucial mechanisms through which ethnic diversity can be adequately realized at the firm level. By so doing, this paper addressed the importance of concurrent examinations of ethnic diversity and integration and how micro-level collaboration patterns among ethnically diverse individuals can better explain collective firm-level performance.

4.5.1 Theoretical Implications

This study makes three primary theoretical contributions. First, through the examinations of the collective implications of human capital ethnic diversity and the sufficient level of ethnic integration, this paper has addressed calls for the need to bridge human capital literature and the research on human resource management (Wright & McMahan, 2011; Ployhart et al., 2014). While one of the main tenets of both the strategic human capital literature and the human resource management literature is centered on the importance of human capital, these two streams of research have been developed in somewhat distinctive ways (Delery & Roumpi, 2017; Boon et al., 2018). For instance, while the strategic human capital literature considers human capital as a resource that enables firms to generate economic values (Peteraf & Barney, 2003; Felin & Foss, 2005), research on human resource management emphasizes the critical roles of certain management practices in hiring and developing employees' KSAOs (Wright & McMahan, 2011; Ployhart et al., 2014). In addition, both streams of research require concurrent

examinations of how human capital diversity can facilitate superior organizational outcomes. As such, to bridge these two research traditions on human capital, I examined why and how integrating ethnically diverse individuals at a firm can provide viable mechanisms through which the focal firms can benefit from their human capital diversity. Furthermore, by examining how the focal firm is affected by the level of ethnic integration and specific conditions under which the negative impact of insufficient ethnic integration gets more detrimental, the results of this study offer a more comprehensive assessment of the value of bridging these research traditions.

The results of this study also contribute to the diversity literature by proposing potential explanations for the previously mixed findings on the benefits of ethnic diversity. Broadly speaking, the extant management studies have shown considerable evidence of positive, negative, or not significant outcomes of having human capital ethnic diversity (Horwitz & Horwitz, 2007; Mathieu et al., 2014; Ertug et al., 2022). The results of this study suggest that perhaps what we need to study is not the direction of the significance of the effects of ethnic diversity but rather the nature and the degree of the issues at hand that should be understood. Put differently, to capture the link between ethnic diversity and the focal firms' innovation performance, it is crucial to examine the level of the ethnic divide rather than discussing whether ethnic homogeneity (divide) or ethnic diversity (integration) is beneficial. To this end, I investigated first, how the innovation performance can be determined by the level of ethnic divide by the dominant ethnic group at the focal firm, and second, what is an appropriate level of ethnic integration in order to benefit from the ethnic diversity within the firm, and I found evidence on the diminishing returns of the benefits of ethnic divide and a negative impact of lack of ethnic integration within the firm. Indeed, the results of this study suggest that one possible explanation for the proliferated diversity studies with conflicting findings is because

the nature of the question on the benefits of ethnic diversity lies in the extent, not in directions or boundary conditions.

Furthermore, by demonstrating the relationship between micro-level collaboration patterns among employees and the focal firm's collective innovation performance, the study also extends the microfoundation of human capital-based advantages (Felin & Foss, 2005). While the nature of the data in this study does not provide an opportunity to examine the dimensions related to human behaviors, such as individual preference or motivation for ethnic integration or divide, the collective results of the analyses on the relationship between firms and micro-level collaboration patterns within these firms do allow investigation of the crucial roles played by the level of ethnic integration and diversity within the firm. In addition, while gaining much scholarly interest in other fields, to the author's knowledge, this is the first study that adopts this Spectral Segregation Index (SSI) in examining how micro-level constructs of collaborations among ethnically diverse individuals can affect collective firm performance. This is particularly important in that it is possible to capture not only the level of integration (or divide) within the same ethnic group of individuals but also the collective level of integration for various ethnic groups within the firm. Hence, by closely examining the individual-level construct of the level of ethnic integration, this study proposes the importance of understanding microfoundations of a firm's innovation performance.

4.5.2 Practical Implications

The finding that a sufficient level of ethnic integration among ethnically diverse individuals in their collaborations should be of great interest to practitioners at firms, given the prevalence of highly skilled ethnic individuals in any organizational setting (e.g., Foley & Kerr, 2013; Nathan, 2015; Kerr et al., 2016). While the importance of integration of human resources has been suggested in various scholarly traditions, this paper can provide particularly relevant

insights thanks to the research setting that examines the large-scale data on innovation collaboration by U.S. firms. By addressing the critical role of a sufficient ethnic integration level to realize the benefits of ethnic diversity and by providing support for the idea that the lack of ethnic integration is particularly detrimental to firms with more diverse employees (ethnic majority and ethnic minorities alike), the results show why and when firms should be more careful with the level of ethnic integration.

This study also suggests a simple yet crucial measure of the level of the ethnic divide of the firm. When the level of the ethnic divide at the firm, based on the SSI value from collaboration patterns, is higher than the proportion of the dominant ethnic groups within the firm, the negative impact of a lack of ethnic integration gets more pronounced. While this provides a theoretically sound measure for the construct (Bojanowski & Corten, 2014), this index can provide a clear but meaningful measure to understand the necessary level of ethnic integration. As such, the findings from this study can allow practitioners to gauge the level of ethnic integration by using these two indices for the collaboration patterns among the employees within the firm. Hence, when other conditions are equal, it is recommended to have a sufficient level of ethnic integration, at least, compared to the proportion of the dominant ethnic groups within the firm, in order to benefit from ethnic diversity.

4.5.3 Limitations and Boundary Conditions

I examined how firms benefit from ethnic diversity and ethnic integration in improving their innovation performance by utilizing their patenting activities. Although many scholars in the innovation tradition have examined patent data in conducting various analyses related to knowledge spillover and collaborations among inventors (e.g., Trajtenberg, 1990; Breschi & Lissoni, 2001; Tzabbar et al., 2021), this context may exclude collaborations that did not lead to successful patents. The problem can be two-fold. On the one hand, this can lead to the

exclusion of non-patent activities. However, this is not a serious concern given the research context that explores how firms achieve better innovation performance. On the other hand, unsuccessful patenting activities are also excluded. Yet, this may pose a serious concern only if there exist reasons to suspect that ethnic diversity or divide, when other things are being equal, can deterministically affect the patent grant probability, which is implausible.

In addition, given that this research is based on all the patenting firms within the U.S., it is difficult to suspect systematic bias caused by ethnic diversity or integration. Therefore, this study rather focuses on why firms face a different level of innovation performance based on their patterns of ethnic integration within diversity. While this study provides crucial insights on the firm's overall innovation performance based on its ethnic diversity and integration, further research situated in small-scale examinations on integration effects needs to be conducted to extend the results of the current study and also to disentangle the mechanisms through which ethnic integrations bestow collective performance.

Also, although widely adopted by innovation studies (e.g., Trajtenberg, 1990; Fischer & Leidinger, 2014), the number of forward citations as a proxy for the innovation performance of the focal patent may not capture the more-micro level implications of the ethnic diversity or ethnic integration. For instance, employee mobility or motivations for collaboration may also influence team composition and thus their performance (e.g., Felin & Foss, 2005). As such, examining broader contexts of various other antecedents of successful or insufficient ethnic integration will enrich our understanding of the field in a crucial way.

4.5.4 Conclusion

In recent years, many societies have observed active participation by and prevalence of multitudes of individuals who are no longer ethnically homogeneous. Although scholarly efforts have been given to this very issue for a long time, the findings have been rather *diverse*.

To advance our knowledge of the collective implications of having ethnic diversity in organizations, this study puts forward the necessity of considering the ethnic integration of ethnically diverse individuals at a firm. While previous studies have (rightfully) suggested the benefits of both ethnic diversity and ethnic divide (ethnic homogeneity) in collective performance, I propose that more nuanced examinations of these constructs can resolve this seemingly contradictory understanding of the field. In essence, the results of this study suggest that while a certain level of the ethnic divide can be beneficial, the benefits come at diminishing returns. Moreover, a lack of sufficient level of ethnic integration can be particularly detrimental when the focal firm is with more individuals or more ethnically diverse. In short, ethnic integration is indeed critical in achieving a superior firm's innovation performance. Perhaps, we do not need further *diversity* in studies but more *integration*.

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4.7. TABLES AND FIGURES

Table 1. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Forward Citation	11,349	5.2577	1.8469	0.6931	11.5349	1.0000							
(2) R&D Spending	11,349	17.9279	1.7489	0.0000	23.2314	0.5641	1.0000						
(3) Inventor Productivity	11,349	0.6203	0.2802	0.0909	7.5000	0.1827	-0.0780	1.0000					
(4) Avg Inventor Number	11,349	12.6722	16.5354	0.5000	425.0000	0.5093	0.4441	0.0383	1.0000				
(5) Ethnic Richness	11,349	7.1971	5.2423	1.0000	24.0000	0.7051	0.7845	-0.0032	0.5951	1.0000			
(6) Ethnic Divide (E.D.)	11,349	0.5892	0.2436	0.0000	1.0000	-0.2129	-0.3521	-0.1144	-0.3645	-0.4806	1.0000		
(7) Disproportionate ED	11,349	-0.4986	0.8525	-1.0000	1.0000	-0.1898	-0.1442	-0.0311	-0.1001	-0.1384	0.3205	1.0000	
(8) Year	11,349	2002	7.0300	1990	2014	-0.1943	0.1919	-0.0780	0.1025	0.2115	-0.2092	0.0976	1.0000

Table 2. The Regression Models on Ethnic Divide (OLS)

VARIABLES	(1) Model 1 OLS	(2) Model 2 OLS	(3) Model 3 OLS	(4) Model 4 OLS	(5) Model 5 OLS	(6) Model 6 OLS
R&D Spending	0.464***	0.0750***	0.0923***	0.0805***	0.0784***	-0.0879***
	(0.00964)	(0.0121)	(0.0121)	(0.0118)	(0.0117)	(0.0263)
Inventor Productivity	1.148***	1.004***	1.069***	1.196***	1.242***	0.837***
	(0.0466)	(0.0426)	(0.0428)	(0.0418)	(0.0418)	(0.0752)
Avg Inventor Number	0.0307***	0.0127***	0.0144***	0.0163***	0.0181***	0.0151***
	(0.000863)	(0.000875)	(0.000875)	(0.000852)	(0.000863)	(0.00172)
Blau Index	0.585***	-1.374***				
	(0.0954)	(0.0965)				
Ethnic Richness		0.216***	0.188***	0.217***	0.207***	0.219***
		(0.00458)	(0.00417)	(0.00420)	(0.00427)	(0.0206)
Ethnic Divide (E.D.)				1.387***	3.315***	2.498***
				(0.0537)	(0.180)	(0.353)
E.D. * E.D.					-1.885***	-1.357***
					(0.168)	(0.350)
Constant	-4.352***	2.027***	1.402***	0.489**	0.177	3.096***
	(0.168)	(0.204)	(0.202)	(0.199)	(0.200)	(0.432)
Observations	11,349	11,349	11,349	11,349	11,349	1,752
R-squared	0.544	0.620	0.613	0.635	0.639	0.427
State F.E.	Y	Y	Y	Y	Y	Y
Industry F.E.	Y	Y	Y	Y	Y	Y

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3. The Regression Models on Ethnic Divide and Disproportionate Ethnic Divide (OLS/ 2SLS)

VARIABLES	(1) Model 1 IV- First Stage	(1) Model 2 IV-Second Stage	(3) Model 3 2SLS	(4) Model 4 2SLS	(4) Model 5 2SLS
Ethnic Richness		0.359***	0.355***	0.346***	0.337***
		(0.0184)	(0.0192)	(0.0166)	(0.0164)
LPR (IV)	3.5302***				
	(0.000)				
R&D Spending	1.6785***	-0.197***	-0.197***	-0.179***	-0.168***
	(0.000)	(0.0394)	(0.0393)	(0.0352)	(0.0351)
Inventor Productivity	-0.5891	1.202***	1.218***	1.059***	1.121***
	(0.655)	(0.101)	(0.101)	(0.0971)	(0.101)
Avg Inventor Number	0.7544***	0.00525***	0.00589***	0.00822***	0.00943***
	(0.000)	(0.00191)	(0.00203)	(0.00175)	(0.00169)
Ethnic Divide (E.D.)	-3.2567***	1.863***	2.551***	3.226***	2.907***
	(0.000)	(0.0997)	(0.313)	(0.168)	(0.167)
E.D. * E.D.			-0.673**		
			(0.318)		
Disproportionate E.D. (DED)				-2.250***	-1.240***
				(0.161)	(0.196)
E.D. * DED					-2.194***
					(0.252)
Observations		11,349	11,349	11,349	11,349
R-squared		0.446	0.449	0.496	0.507
F-Statistic	237.53				
State F.E.		Y	Y	Y	Y
Industry F.E.		Y	Y	Y	Y
Firm Cluster		Y	Y	Y	Y

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

Table 4. The Regression Models on Ethnic Divide and Interactions (OLS)

VARIABLES	(1) Model 1 OLS	(2) Model 2 OLS
R&D Spending	0.527***	0.0847***
	(0.0320)	(0.0247)
Inventor Productivity	1.098***	1.081***
	(0.116)	(0.0978)
Avg Inventor Number	0.0315***	0.0125***
	(0.00424)	(0.00166)
Disproportionate E.D. (DED)	0.572**	0.475***
	(0.240)	(0.144)
Blau Index	-1.641***	
	(0.200)	
DED * Blau Index	-1.548***	
	(0.513)	
Ethnic Richness		0.172***
		(0.00795)
DED * Ethnic Richness		-0.0908***
		(0.0195)
Constant	-4.584***	1.626***
	(0.550)	(0.422)
Observations	11,349	11,349
R-squared	0.558	0.616
State F.E.	Y	Y
Industry F.E.	Y	Y
Firm Cluster	Y	Y

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

Table 5. Supplementary Regression Models on Ethnic Diversity Measures (OLS)

VARIABLES	(1) Model 1 OLS	(2) Model 2 OLS	(3) Model 3 OLS	(4) Model 4 OLS	(5) Model 5 OLS	(6) Model 6 OLS	(7) Model 7 OLS	(8) Model 8 OLS
R&D Spending	0.464***	0.0750***	0.0582**	0.0647***	0.0923***	0.0196	0.0697***	0.0709***
	(0.0299)	(0.0242)	(0.0228)	(0.0229)	(0.0231)	(0.0243)	(0.0226)	(0.0225)
Inventor Productivity	1.148***	1.004***	1.180***	1.173***	1.104***	1.280***	1.121***	1.113***
	(0.109)	(0.0933)	(0.104)	(0.105)	(0.102)	(0.0825)	(0.104)	(0.103)
Avg Inventor Number	0.0307***	0.0127***	0.0158***	0.0155***	0.0145***	0.0144***	0.0148***	0.0154***
	(0.00379)	(0.00177)	(0.00206)	(0.00209)	(0.00195)	(0.00272)	(0.00218)	(0.00227)
Ethnic Richness		0.216***	0.230***	0.228***	0.253***	0.222***	0.240***	0.237***
		(0.00828)	(0.00801)	(0.00733)	(0.00732)	(0.00697)	(0.00714)	(0.00721)
Ethnic Divide (E.D.)			1.752***	1.654***	1.353***	1.275***	1.284***	1.234***
			(0.0920)	(0.0895)	(0.0890)	(0.0936)	(0.0903)	(0.0914)
Disproportionate E.D.			-0.275***	-0.266***	-0.215***	-0.199***	-0.200***	-0.182***
			(0.0198)	(0.0189)	(0.0176)	(0.0178)	(0.0174)	(0.0172)
Blau Index	0.585***	-1.374***	-0.333**					
	(0.178)	(0.175)	(0.167)					
Polar				-0.691***				
				(0.139)				
Shannon H					-0.884***			
					(0.0683)			
Even						-2.349***		
						(0.186)		
Simpson							-1.842***	
							(0.154)	
Dominance								2.414***
								(0.199)
Constant	-4.352***	2.027***	0.571	0.810**	0.874**	2.595***	1.326***	-1.189***
	(0.516)	(0.415)	(0.405)	(0.395)	(0.390)	(0.449)	(0.391)	(0.429)
Observations	11,349	11,349	11,349	11,349	11,349	11,029	11,338	11,349
R-squared	0.544	0.620	0.650	0.652	0.668	0.672	0.666	0.668
State F.E.	Y	Y	Y	Y	Y	Y	Y	Y
Industry F.E.	Y	Y	Y	Y	Y	Y	Y	Y
Firm Cluster	Y	Y	Y	Y	Y	Y	Y	Y

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

Table 6. Supplementary Regression Models on Other Dependent Variables (OLS)

VARIABLES	(1) Model 1 OLS Patent Value	(2) Model 2 OLS Patent Number
R&D Spending	0.602***	0.160***
	(0.0452)	(0.0120)
Inventor Productivity	0.992***	1.002***
	(0.0829)	(0.0719)
Avg Inventor Number	0.0111***	0.0159***
	(0.00299)	(0.000967)
Ethnic Richness	0.196***	0.192***
	(0.0118)	(0.00404)
Ethnic Divide	2.942***	1.989***
	(0.292)	(0.124)
Ethnic Divide * Ethnic Divide	-2.044***	-1.416***
	(0.281)	(0.111)
Constant	-9.433***	-2.491***
	(0.754)	(0.215)
Observations	11,349	11,349
R-squared	0.754	0.914
Firm F.E.	Y	Y
Year F.E.	Y	Y
Firm Cluster	Y	Y

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

Figure 1. The Trend of Ethnic Diversity within Firms

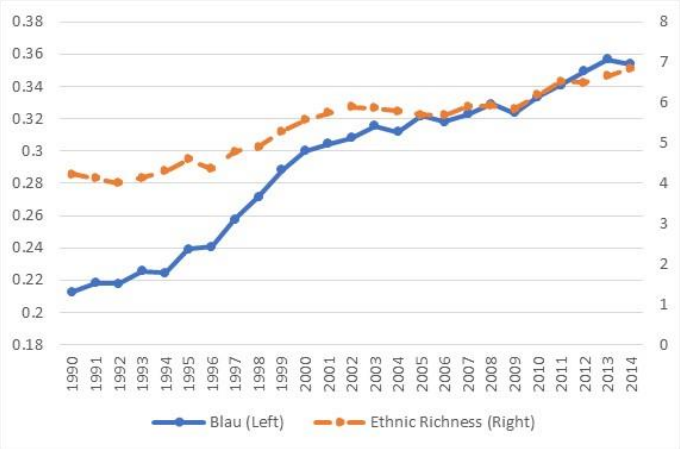
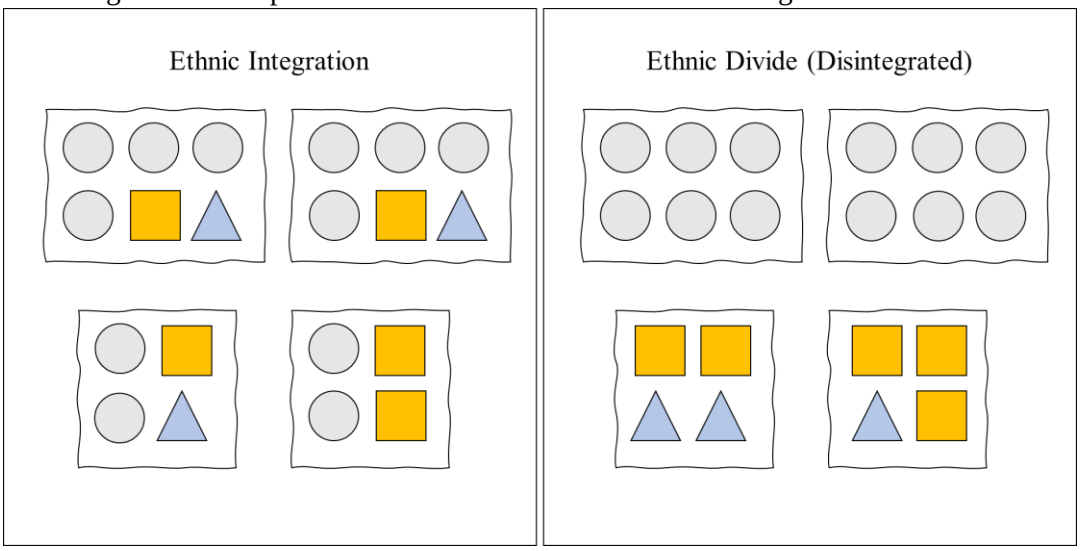


Figure 2. Conceptual Illustrations of Firms with Ethnic integration and Divide



* Note that different shapes represent different ethnic group members

Figure 3. The Trend of Spectral Segregation Index for Ethnic Majorities and Others

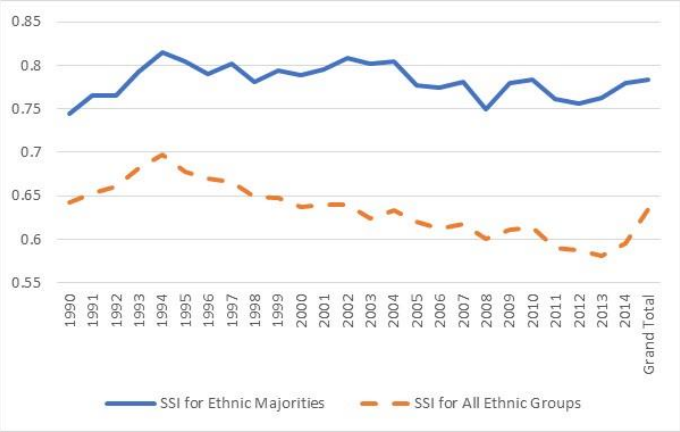


Figure 4. The Inverted U-Shape of the Impact of Ethnic Divide on Firm-level Performance

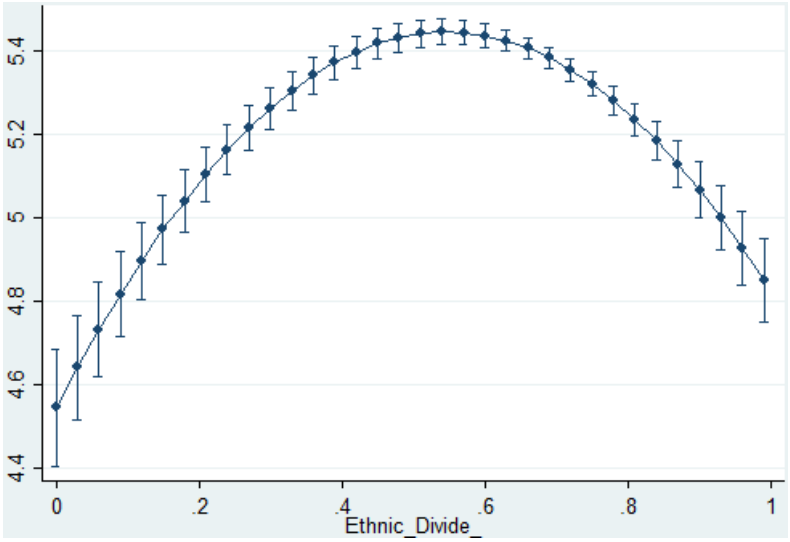


Figure 5. The Negative Impact of Excessive Ethnic Divide on Firm-level Performance