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Re-examining Diversity as a Double-edged Sword for Innovation Process

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Key Words: ethnic diversity, cultural diversity, ethnic polarization, conflict, innovation, innovation process, diversity management, cross-cultural management

Abstract

Existing results on the relationship between ethno-cultural diversity and innovation remains mixed. The authors argue that these inconsistencies were partly due to conceptual and empirical confusion regarding two aspects of ethno-cultural diversity. By conceptually and empirically teasing apart these two aspects of diversity, the authors demonstrated that diversity arising from ethnic categorization (referred to as ethnic diversity) impairs innovation while diversity arising from cultural distance (referred to as cultural diversity) enhances innovation, but only when ethnic polarization is low. Consistent with the National Innovation System perspective, the present study using country-level data shows that structural innovation input positively contributes to innovation output. Furthermore, the authors found that ethnic diversity has a direct negative effect on innovation input, which in turn dampens innovation output. By contrast, cultural diversity has a direct positive effect on innovation output over and above the contribution of innovation input only when ethnic polarization is low.

Introduction

The workplace has witnessed a tremendous increase in ethno-cultural diversity over the last decades, and this trend is still growing. In today's ever-globalizing economy, creativity and innovation have a vital impact on business performance (Alstrom, 2010). In view of these developments, the question of how ethno-cultural diversity affects creativity and innovation has attracted much research attention. However, an unsettling problem in this literature is that there have been equivocal empirical findings concerning the effects of ethno-cultural diversity on creativity and innovation (Stahl, Maznevski, Voigt, & Jonsen, 2010). While some studies have shown that diversity positively affects creative processes and outcomes (e.g., Earley & Mosakowski, 2000; Niebuhr, 2010; Stahl, et al., 2010; Tadmor, Satterstrom, Jang, & Polzer, 2012), others have found a negative or null relationship (e.g., Bell, Villado, Lukasik, Belau, & Briggs, 2011; Harvey, 2013; Østergaard, Timmermans, & Kristinsson, 2011).

In their recent effort to resolve these inconsistencies, Stahl and associates (2010) summed up previous debates as depicting ethno-cultural diversity as a double-edged sword that can lead to both process gain and process loss. Particularly, Stahl et al. argued that, on the one hand, the divergence arising from ethno-cultural diversity can lead to process loss due to disagreements and disintegration, based on the similarity-attraction paradigm (Byrne, 1971; Williams & O'Reilly, 1998) and the social categorization perspective (Tajfel & Turner, 1986). On the other hand, divergence can also lead to process gain thanks to an increase in information, perspectives, and mental models, according to the information processing theory (Cox & Blake, 1991; Dahlin, Weingart, & Hinds, 2005) and cognitive diversity hypothesis (Horwitz & Horwitz, 2007).

While we concur with Stahl et al. (2010) and other researchers on theoretical grounds, we contend that previously unrecognized conceptual confusion and inadequate operationalization of

ethno-cultural diversity may also have contributed to the inconsistency in existing findings. First and foremost, there is a lack of distinction between diversity associated with social grouping categories and diversity associated with culture in the current literature. Specifically, we observe that while diversity arising from social grouping categories such as race, ethnicity, and nationality has been theoretically associated with the social categorization process thus negative outcomes, diversity of cultural contents (e.g., cultural knowledge, cognitive representations, worldviews, and implicit beliefs, and mental models) has typically been associated with creative benefits based on the information processing theory and cognitive diversity hypothesis. However, past studies have commonly used race, ethnicity, nationality, and culture interchangeably in their conceptual and operational specifications. To name but a few, Østergaard, Timmermans, & Kristinsson (2011) used ethnicity as a proxy for cultural background yet they measured ethnicity via country of origin. Similarly, Niebuhr (2010) reported that they operationalized cultural diversity using ethnic diversity; a closer inspection revealed that ethnicity is measured via nationality. Likewise, Watson, Kumar, & Michaelsen (1993) measured cultural diversity based on both nationality and ethnicity. Such conceptual mix-up is problematic; to make the matter worse, diversity of social grouping categories (e.g., race, ethnicity, and nationality) and diversity of culture are often operationalized using an identical measure of categorical variety (e.g., Bell et al., 2011; Cady & Valentine, 1999). While this approach is widely adopted for its simplicity, we argue that it fails to capture important information about culture, which we illustrate using Figure 1. Team A consists of three members from three ethnic groups, Vietnamese-American, Chinese-American, and Korean-American. Team B also consists of three members from three ethnic groups, German-American, Mexican-American, and Korean-American. Although categorically team A and team B are equally

diverse—they each have three ethnic groups and one culturally-unique member in each group—when cultural distance between each pair of ethnic groups is taken into consideration, we argue that team B is more culturally diverse than team A.

Insert Figure 1 about here

As we illustrated in the above example, the key objective of this paper is to conceptually and empirically distinguish between diversity associated with social grouping categories and diversity associated with cultural distance¹ or dissimilarity in terms of cultural contents such as cognitive representations, worldviews, and implicit beliefs. We will then theoretically map these two concepts onto two distinct mechanisms via which diversity influences creativity and innovation. Finally, we will empirically tease apart these two aspects of ethno-cultural diversity and test their respective effects on the innovation process using national level data.

Theoretical and Hypotheses Development

Clarifying key concepts and their relationships

As noted, although social grouping categories, i.e., nationality, race, and ethnicity, are frequently examined in diversity research, conceptual clarity regarding the exact kind of social group being studied is often taken lightly. To remedy this shortcoming, we first clarify the relationships among the concepts of nationality, race, ethnicity, and culture before developing hypotheses.

¹ In the economics literature, Fearon (2003) was the pioneer who initially proposed the idea that the construct of cultural diversity should reflect cultural distance and is distinct from ethnic diversity. He emphasized on the methodological aspect of this construct and also constructed a cultural diversity index which we use in our analysis here. Our focal argument regarding this construct is more at a conceptual and operational level.

People of the same nationality might be of different races or ethnicities. Also, one's nationality can change while one's race or ethnicity is relatively more stable. For this reason the concepts of nationality and race or ethnicity are distinctive. However, the distinction between race and ethnicity is a much fuzzier one. Theoretically, sociologists differentiate between race and ethnicity: race often implicates power differential and social dominance while ethnicity is associated with meaning, values, and ways of life (e.g., Fredrickson, 2002; Omi & Winant, 1994). However, others have argued that ethnicity and race are often entangled in reality and hence should not be seen as separate (Grosfoguel, 2004). Theoretical distinctions aside, of greater importance to our conceptualization is the fact that in everyday conversation and in a great deal of social science, medical, and biological research, lay people and professionals both use the terms race and ethnicity interchangeably or combine them in constructions such as racial-ethnic or ethno-racial (Markus, 2008). Therefore, regardless of their actual relationship, race and ethnicity arguably can influence people's social categorization in highly similar ways. Since our goal is to study lay people's spontaneous perception of social category in reality, we do not differentiate race and ethnicity, and use "ethnicity" throughout the present paper to include both race and ethnicity. Furthermore, we adopt the definition of ethnic groups as those that are "larger than a family and membership in the group is reckoned primarily by a descent rule" (Fearon, 2003, p. 200) and acknowledge that ethnicity is central to many people's identity (Phinney, 1989), and is often being used as a basis of social categorization, dividing people into "us" versus "them" (Chao et al., 2013).

Following Chiu and Hong (2006), we define culture as a set of shared cognitive representations—such as knowledge, beliefs, worldviews, and thinking styles—that mark a collective group (e.g., an ethnic group). It is not our purpose to discuss whether ethnic group

memberships lead to shared culture or cultural sharedness bond people together in social groups. Regardless of the causal direction, the consensus in the literature is that culture tends to be demarcated by meaningful social boundaries such as ethnicity (Hong, Morris, Chiu, & Benet-Martinez, 2000; Nisbett, 2003; Peng & Nisbett, 1999), possibly because ethnic groups often live within close proximity to one another and share long-standing traditions that also shape their shared culture. As such, cultural diversity should mirror ethnic diversity in a given country, and countries with higher ethnic diversity should also have higher cultural diversity. That said, ethnic diversity alone does not reveal the full picture of cultural diversity because it does not capture cultural distance—or the extent to which cultural contents differ—between different ethnic groups. Distance provides additional information about the extent to which a group enjoys cultural diversity, which could have additional predictive power regarding outcomes above and beyond ethnic diversity, *per se*.

For the sake of clarity, we will refer to diversity arising from ethnic categories as *ethnic diversity* and diversity arising from cultural distance as *cultural diversity* in the present paper. In other words, ethnic diversity reflects the share of diversity coming from ethnic categorical variety; cultural diversity indicates the additional share of diversity arising from cultural distance between existing ethnic groups. This differentiation can be comprehended via Team A and Team B in Figure 1: both teams have equal ethnic diversity (or ethnic categorical variety) but Team B has greater cultural diversity (or total sum of cultural distance between groups).

Innovation process

Defining Innovation. Despite their distinctions, innovation is often discussed in close association with creativity. Following prior research, we define *creativity* as the production of novel and useful ideas and *innovation* as the successful implementation of creative ideas within

an organizing entity, such as a firm or a nation (Amabile, 1998; Perretti & Negro, 2007; Woodman, Sawyer, & Griffin, 1993). Innovation can be viewed and studied in terms of either a product or a process. Researchers holding the product view of innovation tend to examine it as a materialized final outcome, such as film production (Perretti & Negro, 2007), patents (Niebuhr, 2010), and trademarks (Mendonça, Pereira, & Godinho, 2004). Although the product view of innovation has been widely adopted in management research, it does not offer a comprehensive understanding of the complex dynamics of innovative process. Therefore, to fulfill our goal of analyzing the process of innovation, we adopt the national innovative capacity view (Furman, Porter, & Stern, 2002) and National System of Innovation (NIS) framework (Freeman, 1995).

The role of innovation input on innovation output. Both frameworks take a systematic approach to understanding how various structural factors contribute to the development of a macro innovation ecosystem that promotes innovation processes in a country. Particularly, national innovative capacity is “the ability of a country to produce and commercialize a flow of innovative technology over the long term” (Furman et al., 2002), and this framework focuses on the sources of the sustainability of innovative performance (Hu & Mathews, 2005). The development of a country’s national innovative capacity depends on three key factors. The first is strong national institutions, such as education systems, technical and scientific institutions, government policies, and industrial relations. The NIS framework also emphasizes this factor as the fundamental contributor to national innovative processes and performance (Freeman, 1995). The second factor is a strong industrial environment for innovation, such as private investment into research and development (R&D) and technical specialization. The final factor is a strong linkage between public institutions and industry.

We draw on these two frameworks to understand innovation processes and predict countries' innovative performance. Conceptually, we treat the innovation-facilitating factors in the national innovative capacity framework as key innovation input factors that *precede* the actual generation of innovation output such as patents². In other words, we conceptually separate innovation input from innovation output in the innovation process. We defined innovation output as the results of innovative activities within the economy. Considerable evidence has emerged to support a positive contribution of innovation input to innovation output and performance. For instance, Furman et al. (2002) found that R&D productivity including supporting policy, quality research activities, technological specialization, and the country's knowledge base strongly contributes to countries' innovation performance. Hu & Mathews (2005) tried to replicate the findings of Furman et al. (2002) in an exclusively East-Asian sample. They found some differences (e.g., public R&D funding is less important than private R&D funding in Asian countries, possibly due to its applied rather than basic R&D focus as a catch-up strategy), but the overall pattern held. In short, indicators of innovation input can be differentiated from those of innovation output, and the former are arguably the precursors of the latter.

We follow these theoretical arguments and empirical findings to theorize and empirically test how ethnic and cultural diversity directly and indirectly affect innovation input and innovation output. Figure 2a shows our proposed framework. To elaborate, achieving quality innovation input means success in innovative capacity building. Based on Woodman and associates' (1993) classic definition of organizational creativity as "the creation of a valuable, useful new product,

² An argument can be made such that innovation output can also contribute to innovation input: countries that succeed in generating innovation outcomes will gain more resources to reinvest into continued innovative capacity or innovation input building, forming a virtuous cycle. We fully acknowledge this argument. To rule out this reverse causation, we methodologically use innovation input in an earlier time to predict output at a later time. We discuss this in greater detail in the Methods section. To rule out this reverse causation, we methodologically use innovation input in an earlier time to predict output at a later time. We discuss this in greater detail in the Methods section.

service, idea, procedure, or process by individuals working together in a complex social system,” we, too, view the national innovative capacity building task as a highly complex one of creating a valuable new innovation-facilitating ecosystem in a complex social system, i.e., a nation, which involves multiple parties with diverse interests, preferences, and expertise. Although the prototypical structure of an effective national system of innovative capacity can be similar across nations, with their unique historical, natural, and demographic conditions, each nation faces unique challenges that require novel solutions. As such, we argue that the achievement of capacity or innovation input building depends heavily on creative problem solving and decision making at a collective level. In the following sections, we will develop hypotheses on how ethnic diversity and cultural diversity influence a country’s motivation and ability to engage in innovative capacity building. In the following sections, we will develop hypotheses on how ethnic diversity and cultural diversity directly and indirectly influence a country’s innovation output generation. We have also illustrated our predictions in Figure 2a.

Insert Figure 2a about here

Ethnic diversity and innovation

Despite their differences, when living together in one country, ethnic groups face the challenge of uniting to put their shared interests ahead of their disparate preferences and goals. In some cases, small group compromises may be necessary in making decisions that will serve shared long-term national interests and aspirations. For example, the Affirmative Action policy was introduced in the United States to promote national equality. The policy favors members of a

disadvantaged group in education and employment selections, sometimes at the expense of dominant or majority group members.

However, the ideal condition of inter-ethnic unification is difficult to achieve despite its many long-term benefits. As suggested by research on social identity and ingroup favoritism, one reason is that individuals tend to exhibit the psychological bias of viewing similar others, i.e., their co-ethnic members in this case, in more favorable light, hence increasing their proclivity to cooperate within an ethnic ingroup (Brewer, 1999; Tajfel, Billig, Bundy, & Flament, 1971). In addition, realistic reasons such as physical proximity, shared lifestyle and practices may also make it more convenient and practically meaningful for members of the same ethnic group to team up.

In the context of national innovative capacity building, ethnic diversity can become a retarding factor in collective decision making and implementation. Construction of a national innovation system is subsumed under other types of nation-building activities, such as the construction of infrastructure, strong educational and research institutions, governance systems, rules of law, and industrial relations. These tasks are highly complex and require ample cooperation and coordination among diverse stakeholder groups to facilitate good consensual decisions and subsequent implementation (Easterly & Levine, 1997). Meanwhile, individuals' preferences and interests are often shaped by their ethnic group membership and identity (Phinney, 1989). The more ethnic groups co-exist in one country, the more individual preferences and interests are represented at the aggregate level of ethnic group. As a result, these unique interests and goals at the ethnic-group level make consensus building difficult thus can hinder a country's ability to make swift and good decisions. Subsequent decision delay or deadlock is likely to result from the difficulty in aligning numerous sub-group interests (Héritier,

1999; Majone, 1995; Streeck, 1992). Incompatible goals among ethnic groups can also intensify political actions such as corruption, which hinders and distracts people from engaging in the actual tasks of infrastructure development essential for carrying out innovation (Mauro, 1995). If the country cannot swiftly make collective decisions and concerted effort to set up good rule of law and infrastructure, it is also less likely to stimulate investment in the Research and Development (R&D) facilities of the commercial sectors, which are an equally important part of the country's innovative capacity or input factors (Braczyk, Cooke, & Heidenreich, 1998). For this reason, we hypothesize that overall national innovative capacity or innovation input to suffer from a retardation effect of ethnic diversity.

Hypothesis 1a: *Ethnic diversity is negatively associated with innovation input of a country.*

Moreover, if innovation input is indeed a precursor for innovation output, ethnic diversity will also indirectly dampen innovation output through innovation input as well.

Hypothesis 1b: *Ethnic diversity has an indirect negative effect on innovation output mediated by innovation input, which has a positive association with innovation output.*

Ethnic diversity could also dampen innovation output directly because a lack of consensus can also worsen interactions and decision making at the industry and work team levels, thereby undermining the quality of innovation output. Therefore, it is also possible that ethnic diversity also has a direct negative effect on innovation output.

Hypothesis 1c: *Ethnic diversity has a direct negative effect on innovation output above and beyond its indirect effect via innovation input on innovation output.*

Cultural diversity and innovation

What would be the mechanisms that cultural diversity can contribute to the innovation of a nation? Scholars taking the information processing approach (e.g., Dahlin, Weingart, & Hinds, 2005) to creativity and innovation endorse the cognitive diversity hypothesis (Horwitz & Horwitz, 2007). Specifically, Miller, Burke, and Glick (1998) define cognitive diversity in a group context as the degree to which group members differ in expertise, experience, and perspective. Researchers in this camp argue that ethno-cultural diversity should lead to greater creativity and innovation because group members from diverse backgrounds can contribute more divergent interpretations, perspectives, and problem-solving styles. During the encoding, retrieval, and processing phases of information processing (Hinsz, Tindale, & Vollrath, 1997)—or what management scholars more commonly refer to as the accumulation, interaction, examination, and accommodation phases of collective cognition (Gibson, 2001)—diverse perspectives should allow more unique information and problem-solving approaches to surface and be combined to form novel ideas and solutions (Cox & Blake, 1991; Leung et al., 2008).

Building on these theoretical foundations, we argue that cultural diversity may add greater variety of perspective and ideas in the ethos of a country, and thus could potentially result in more creative and innovative solutions than cultural homogeneity (Hong, Morris, Chiu, & Benet-Martinez, 2000; Mannix & Neale, 2005; Nisbett, 2003; Peng & Nisbett, 1999; Stahl et al., 2010). Past experimental studies have demonstrated that even temporary exposure to diverse cultures or perspectives could result in higher creativity (e.g., Leung & Chiu, 2010; Leung, Maddux, Galinsky, & Chiu, 2008). This is because exposure to multiple cultures and their contradictory perspectives can help individuals overcome cognitive fixedness and thereby free themselves from automatic and routine approaches to problems to arrive at new solutions (Crisp & Turner, 2011; Leung et al., 2008). Furthermore, different cultural elements and perspectives

can also constitute rich ingredients that can be integrated in novel way to produce unconventional and effective solutions to existing problems.

More importantly, our argument emphasizes that the degree to which these cultural facets (i.e., culturally shaped cognitive representations such as lay beliefs, perspectives, or cognitive styles) are distinct also makes a difference, in addition to variety (i.e., how many different kinds there are). This is because if two or more cultural elements are highly similar, perceivers can be quick to dismiss their distinctions and cognitively treat them as one (Cheng & Leung, 2012).

Referring back to our two hypothetical teams in Figure 1, as the ethnic groups in team A (Vietnamese-American, Chinese-American, and Korean-American) might be viewed as highly similar hence dismissed as one big group of Asian Americans, their cultural uniqueness may be taken lightly or ignored altogether. In this case, the potential for creative synthesis is diminished. Conversely, the more contrasting the different ingredients are, the more likely they will stimulate attention and provoke increased cognitive processing, which in turn increases the likelihood of novel synthesis (Cheng & Leung, 2012). According to this view, cultural diversity arising from cultural distance between ethnic groups should be especially beneficial for promoting creative cognition and inspiring creative solutions to existing problems. These creative benefits at the individual level can further aggregate to yield higher collective creative ability at the national level to benefit both innovation input and output.

That said, the beneficial effect of cultural diversity on innovation is not unequivocal. Some scholars have raised concerns about cultural diversity's potential negative effect on creative problem solving (e.g., Harvey, 2013). According to this school of thought, having fundamentally disparate mental models can make shared cognition more difficult to achieve (Cronin & Weingart, 2007) hence challenge the convergent process in creative problem solving.

Also, work team members' disparate fundamental assumptions make creative integration difficult to achieve, especially when the motivation or the ability to engage in collective convergent processes is low (Harvey, 2013; Stahl et al., 2010).

One particular factor that impedes the convergent process is relational tension or conflict (Jehn, Northcraft, & Neale, 1999). Recent development in the economics literature suggests that the potential for inter-group relational tension or conflict tends to be heightened in a particular type of sub-group structure, i.e., polarization. Sub-group polarization reflects the extent the population is divided into sizable sub-groups by capturing the degree to which the sub-group distribution deviates from a bimodal distribution (Reynal-Querol, 2002; Montalvo & Reynal-Querol, 2005). Some researchers argue that ethnic polarization (but not necessarily ethnic diversity) potentiates inter-ethnic relational conflict because groups are only likely to mobilize into conflictual parties if they are relatively equal in power and have similar chances of dominating. For example, Horowitz (1985) argued that the amount of civil war or violence is lowest in highly homogeneous and highly diverse societies while Montalvo and Reynal-Querol (2005) showed that polarization significantly predicted civil conflict.

Connecting these two lines of research, we further the argument that inter-ethnic polarization can diminish the potential benefit of cultural diversity on innovation input and output. At high levels of polarization, potential for inter-ethnic tension may be higher. People witnessing or actually experiencing such tension or conflict will be less open to learn about and incorporate unique ideas, perspectives, and examples from other groups. This is because inter-ethnic conflict can induce the belief of inter-ethnic incompatibility in witnesses (Chua, 2012). This belief subsequently hinders individuals' ability to take advantage of multicultural resources for creativity gain (e.g., Chua, 2012). Furthermore, at the group-level, inter-ethnic conflict may

lead to greater distrust, thus dampening the motivation to engage in creative collaboration with outgroup members. Without such collaborative efforts, innovation workers cannot effectively integrate multicultural knowledge or clarify different assumptions and perspectives. Consequently, innovation input and output cannot benefit from the diverse cultural elements available in the country. In short, we expect that inter-ethnic polarization will be a moderator such that the positive effect of cultural diversity on innovation input and output will only be observed only when inter-ethnic polarization is low. Taken this as a whole, we hypothesize three interaction effects that are parallel to those of the ethnic diversity.

Hypothesis 2a: *Cultural diversity is positively associated with innovation input of a country but only when the inter-ethnic polarization is low.*

Hypothesis 2b: *Cultural diversity under a low inter-ethnic polarization context has an indirect positive effect on innovation output mediated by innovation input, which has a positive association with innovation output.*

Hypothesis 2c: *Cultural diversity under a low inter-ethnic polarization context has a direct positive effect on innovation output above and beyond its indirect effect via innovation input on innovation output.*

Methods

To test our hypotheses, we used three independent datasets: the Ethnic Fractionalization and Cultural Fractionalization Indices (Fearon, 2003), the Ethnic Polarization Index (Montalvo & Reynal-Querol, 2005), and the Global Innovation Index (GII), jointly published by Cornell, INSEAD, and the World Intellectual Property Organization (WIPO). Below, we describe each dataset, our target variables, and their operationalization.

Global Innovation Index

The Global Innovation Index (GII) is an annual report on country-level innovation since 2007. Its most recent edition in 2014 covers 143 economies and accounts for 94.9% of the world's population and 98.7% of the world's Gross Domestic Product in US Dollars. Data reported in the GII were gathered from more than 30 sources, including both quantitative and qualitative assessments. It mainly draws from objective data and has included a small amount of subjective data obtained from five survey questions in the calculation of the innovation indicators. One drawback of this data source is that its framework has improved over the years and only stabilized in 2012, making year 2012 through 2014 the only data usable for our purpose. Importantly, because we assume that innovation input is a precursor of innovation output, we followed the norm in the literature to create a two-year lag between the two variables in order to rule out reverse causality. Therefore, we used innovation input in 2012 and innovation output in 2014 in the present paper.

The GII approach separates innovation input from output based their respective roles in the national innovation system. Particularly, the factors included as innovation input “define aspects of the environment conducive to innovation within an economy” (p. 44) while innovation outputs are “the results of innovative activities within the economy” (p. 49). These definitions map well onto our respective conceptual definitions of innovation input as national innovative capacity and innovation output as innovative performance based on the National Innovation System view (Freeman, 1995) and the National Innovative Capacity framework (Furman et al., 2002). Innovation input is measured via its five pillars: institutions, human capital and research, infrastructure, market sophistication, and business sophistication. Each of these five pillars is measured by a number of lower-level indicators. For instance, the business sophistication pillar captures the degree to which the environment is conducive for firms to carry out innovation

activity. This pillar consists of three key indicators. First, the quality of knowledge workers is measured via items such as the percentage of knowledge-intensive employment and amount of R&D financed and performed by business as a percentage of the country's GDP. The second indicator illustrates the linkage between different sources of innovation such as collaboration between university and industry and R&D financed from abroad. Finally the knowledge absorption indicator shows how much knowledge is "consumed" by the country to further its innovative endeavors, including high-tech imports less re-imports and communication, computer and information services imports. To capture the overall level of innovation input in each country, we used the overall innovation input score (average of all five pillars) in our analysis.

Innovation output comprises of two pillars: knowledge and technology outputs and creative outputs. Similar to innovation input, each of these two pillars is measured by three lower-level indicators. Indicators of knowledge and technology output consist of knowledge creation, knowledge impact, and knowledge diffusion. Creative output captures intangible assets, creative goods and services, and online creativity. Similar to our treatment of innovation input, we used the overall innovation output core in our analysis. We used each country's percentile rank, a continuous variable, for all variables in our analysis. The percentile rank is a normalized score ranging from 0 to 100.

Fractionalization Indices

Fractionalization is a commonly used diversity measure in economics research (e.g., Alesina et al. 2003; Fearon, 2003; Montalvo & Reynal-Querol, 2005). Its computation formula is identical to the commonly used Blau's Index in the management literature (Blau, 1977), therefore we operationalized diversity using fractionalization indices in the present paper.

To compute an index of ethnic or cultural diversity, the basis of ethnicity classification must first be identified. Many economists have pointed out the difficulty in constructing an ethnic fractionalization or diversity index given the lack of consensus on ethnic group definition. Debates about what constitutes an ethnic group abound. Previously adopted criteria include language, religion, and color (Reynal-Querol, 2002). Although there is increasing consensus on using either biological descent or language as the basis of ethnic grouping, the issue of level of disaggregation further complicates this endeavor (Alesina et al., 2003; Fearon 2003). Take the United States as an example. Would it be better to lump Mexican-Americans, Puerto-Rican Americans, and Cuban-Americans into one ethnic group called Hispanics, or treat them as distinct ethnic groups? As consensus on this matter is rare, different fractionalization datasets differ in their criteria and level of ethnic group classification, which then result in different final fractionalization values for the same country. We compare and contrast these datasets in Table 1 as a reference.

Insert Table 1 about here

Some scholars have noted that different levels of disaggregation are useful for answering different research questions. To test our hypotheses, we contend that Fearon's ethnic and cultural fractionalization indices are most appropriate because they meet four important considerations in our selection criteria. First, Fearon's indices are based on 822 groups in 160 countries with populations of at least 500,000 in 1996, hence providing adequate sample size and relatively recent demographic information. Moreover, Fearon's definition of ethnicity closely resembles the lay definition of ethnicity on a racial-descent basis and his empirical grouping criterion is a

relatively “pure” one that is less confounded by related but distinct features such as language, religion, shared beliefs, and even nationality (Alesina et al., 2003; Fearon, 2003; Fearon & Laitin, 2000; Montalvo & Reynal-Querol, 2005; Reynal-Querol, 2002), as compared to other datasets such as the one provided by Alesina and associates (2003). In addition, Fearon’s choice of disaggregating ethnic groups based on “self-consciousness as a group” (Fearon, 2003, pp. 202) is highly relevant for our research purpose of analyzing ingroup identification and inter-group collaboration. Finally and most importantly, Fearon’s dataset is the only dataset that computed a measure of cultural fractionalization beyond ethnic fractionalization to capture the concept of cultural distance, which is essential for testing our hypotheses.

Ethnic fractionalization. Ethnic fractionalization is the most commonly used measure of aggregate ethnic diversity. It is defined as the probability that two randomly selected individuals from a population will be from two distinct ethnic groups (Fearon, 2003). It is calculated as

$$F \equiv 1 - \sum_{i=1}^n p_i^2, \text{ with } p_1, p_2, p_3, \dots, p_n \text{ denoting the shares of the ethnic groups in the population.}$$

The ethnic fractionalization value F ranges from 0 to 1, with larger values indicating a higher level of fractionalization and diversity. Furthermore, empirical distribution of F is not highly skewed. The average value of 0.48 for 160 countries means that in a randomly selected country, any two randomly selected individuals have about a 50-50 chance of belonging to different ethnic groups.

Cultural fractionalization. Fearon (2003)’s measure of cultural fractionalization corresponds closely to our conceptualization of cultural diversity. Specifically, Fearon calculated cultural fractionalization based on the similarities of the native language of ethnic groups in a country and the assumption that the structural distance between two languages spoken by two

groups as their respective first language³ reflects their cultural distance (Fearon & Laitin, 2000; Laitin, 2000). Fearon's assumption is backed by substantial theories in the linguistics literature. It is argued that language is a cultural tool that aids in communication and social coordination; therefore, language embodies important cultural routines, conventions, beliefs, and patterns of thought in the society where it is used (Maffi, 2005; Mills, 1939; Semin, 2001). For example, people's cognitive frames of reference in spatial orientation and time representation closely align with their linguistic frames of reference across cultures (Boroditsky, 2001; Majid, Bowerman, Kita, Haun, & Levinson, 2004). As another example, the Japanese words *tatema* and *honne* mean "what you pretend to believe" and "what you actually believe" respectively. Such a distinction is not made in English, because the cultures in English speaking countries do not require one to pretend to believe. In other words, in some cultures, a belief is a personal and truthful idea while in others, belief can be a social pretense. By the same token, Wierzbicka (1985a, 1985b) points out that indirect requests for action (such as "can you pass me the salt?") exist only in languages in Western society, where individual autonomy is valued as a crucial part of the cultural schemata. In more collectivist societies that emphasize conformity, languages do not allow for such indirect requests, but instead require more directive "orders". Therefore, thoughts that are easily expressed in one language may be harder to express in another language, despite being translatable (Hunt & Agnoli, 1991). Based on the theories and findings of culture-language correspondence, many scholars commonly use linguistic diversity as a proxy for cultural diversity (for a review, see Maffi, 2005).

³ One caveat of Fearon's (2003) cultural classification is that he does not explicitly consider the consequence of language loss in the case of migration or under other socio-political forces. For instance, some children of immigrant parents adopt an assimilationist approach to their host cultures (Berry, 1997) and fail to master their native languages. Or some ethnic minorities (e.g., Tibetans) opt to teach the majority language (i.e., Mandarin Chinese) to their children for better career opportunities. Taking such instances into account, Fearon's cultural fractionalization index may have overestimated cultural diversity in some countries. Readers should bear this limitation in mind when interpreting the results for the cultural diversity-innovation input link.

Using tree diagrams, a common linguistic representation of structural relationships between languages, Fearon (2003) computed r_{ij} of each language pair based on the quantity and position of common classifications provided by Grimes & Grimes (1996). Early divergence between two languages in the language tree signifies more cultural distance. For instance, English, Swedish, and Dutch are all Germanic languages, and each language group is labeled as e, s, and d. The cultural resemblance between an English-speaking group and a Swedish-speaking group, r_{es} , is lower than that between an English-speaking group and a Dutch-speaking group, r_{ed} , since Swedish diverges from English earlier in the language tree than Dutch. Nevertheless, r_{es} is much higher than the cultural resemblance factor between two languages that come from completely different families (e.g., Indo-European and Altaic); in this case, their cultural resemblance factor will be zero. r_{ij} is 1 when the two ethnic groups speak the same language.

In the second step, they constructed a measure of “cultural fractionalization” analogous to the above-described ethnic fractionalization measure. The cultural resemblance of two randomly selected individuals can be computed for each r_{ij} using the method described in step one. Subtracting the total resemblance score from 1 would result in a “cultural fractionalization” score analogous to the ethnic fractionalization measure, i.e., $1 - \sum_{i=1}^n \sum_{j=1}^n p_i p_j r_{ij}$. The greater the score value, the more cultural diversity.

Although Alesina et al. (2003) have also provided ethnic fractionalization and language fractionalization indices, we chose Fearon’s (2003) indices for two advantages. First, Alesina et al. relied on ethno-linguistic differences as the basis of ethnic grouping; hence there is not clear distinction between their ethnic and language fractionalizations. Fearon instead derived his ethnic grouping solely on the basis of descent. Second, only Fearon took linguistic distance into

consideration in the computation of cultural fractionalization, which maps onto our conception of cultural distance.

Ethnic Polarization Index. To test our predictions, we also need to find an indicator that reflects the potential inter-ethnic tension. Esteban & Ray (1994) first proposed polarization as a measure of the sum of *interpersonal antagonism*, which consists of one's extent of self-identification toward ingroup and the degree of alienation toward outgroups. Their initial

formulation is $P(\pi, y, k, \alpha) = k \sum_{i=1}^N \sum_{j \neq i} \pi_i^{1+\alpha} \pi_j |y_i - y_j|$, where the π 's are the sizes of each ethnic

group in proportion to the total population, the term $|y_i - y_j|$ measures the differences in the amount of interpersonal antagonism two groups feel toward each other; i and j , and α and k are two sets of parameters. A drawback of this formula is that it is very difficult to directly measure subjective concepts like identification and alienation on a large scale. To solve this problem,

Montalvo & Reynal-Querol (2005) assumed that each group feels equally antagonistic toward all

outgroups to simplify the formula to its current form: $Q = 1 - \sum_{i=1}^N \left(\frac{0.5 - \pi_i}{0.5} \right)^2 \pi_i$, where π_i denotes

the size of each ethnic group in proportion to the total population (see Montalvo & Reynal-Querol, 2005 for detailed derivation). This formula is used to calculate the Ethnic Polarization Index. Accordingly, the potential for inter-ethnic tension is highest when a nation has two ethnic groups of similar sizes, and lowest when a nation has either a large ethnic majority group or numerous small ethnic groups.

Presently, the Ethnic Polarization Index of Montalvo & Reynal-Querol (2005) is the only comprehensive data on ethnic polarization. This dataset has been widely used in economics research (e.g., Bhavnani & Miodownik, 2009; Gören, 2014; Montalvo & Reynal-Querol, 2010). While constructing this index, Montalvo & Reynal-Querol based their ethnolinguistic

classification on the World Christian Encyclopedia (WCE) alone. For compatibility purposes, we offer a brief comparison between the Ethnic Polarization Index and our choice of Ethnic and Cultural Fractionalization indices (Fearon 2003). While Fearon (2003) and Montalvo & Reynal-Querol (2005) based their ethnic groupings, or classifications, on different sources, their underlying grouping principles are comparable. Fearon used national sources to resolve discrepancies found between international data sources; Montalvo & Reynal-Querol similarly relied on the WCE, which is entirely based on national sources. Moreover, when countries differed in their emphases on particular dimensions of ethnicity, which made the classification criteria inconsistent, both Fearon and Montalvo and Reynal-Querol ultimately based their ethnic classifications on people's group identity and awareness. By exercising these cautions, a greater degree of local relevance and accuracy was captured in their final ethnic classifications⁴.

Control variables

As measures in the Global Innovation Index have already been normalized with regard to relevant economic and social factors such as gross national product (GDP) and population size, these factors need not be controlled for in the present study.

We control for industrial structure because past research has shown that innovation is more common in some industries (e.g., those that produce physical products or where scale economies is important) (Nelson & Winter, 1977). Since countries in our sample differ in their industry representation, it is important to rule out the influence of industrial structure on innovation. We follow Shane's (1993) example to control for percentage of total value add accounted for by industries typically generating large numbers of innovations. This variable was taken from the World Bank database and constructed by taking a percentage of GDP and the

⁴ See Montalvo & Reynal-Querol (2005), p. 304 – 307 for empirical evidence distinguishing ethnic fractionalization and ethnic polarization.

total value added in manufacturing industries (International Standard Industrial Classification divisions 15 – 37). This ratio shows the tendency of a nation to have an industrial structure composed of industries most likely to innovate. We took the 2011 values for this variable for the practical reason of preserving our overall sample size because substantially more missing data are present in the 2012 and 2013 data. This should not distort our results as the 2011 values were highly correlated with those in 2012 and 2013 ($r = .99$ and $r = .99$ respectively). Furthermore, we control for political rights using the Gastil index⁵ and a number of geographically factors (i.e., proportion of country that is mountainous, non-contiguous territory, and land lock) commonly used as control variables in economic research on ethnicity and economic development to rule out spuriousness.

Analysis and Results

As discussed in Methods, GII data from 2012 through 2014 were useful for our purpose. We used innovation input 2012 to predict innovation output 2014 to rule out reverse causality. Simple correlation results show that ethnic fractionalization and cultural fractionalization are highly correlated ($r = .77, p < .01$), as expected of Fearon's formulation discussed earlier. As we emphasized, our purpose in this study is to examine the independent effects of cultural fractionalization by excluding its common variance with ethnic fractionalization. To this end, we partialled out ethnic fractionalization from cultural fractionalization using regression and used the residual as a new unique cultural fractionalization variable. By doing so, we removed the common variance within cultural fractionalization that was shared by ethnic fractionalization, thereby eliminating the multicollinearity concern (Graham, 2003)⁶. We performed all subsequent

⁵ Higher values being less democratic.

⁶ As can be seen from the bivariate correlation results in Table 2, the original ethnic fractionalization and cultural fractionalization correlate highly ($r = .77, p < .01$). However, after partialing out their shared variance, ethnic fractionalization does not correlate with the residual score of cultural fractionalization ($r = .00, ns$). Moreover,

analyses using the residual value of cultural fractionalization. Table 2 shows the descriptive statistics, number of observations and bivariate intercorrelations of the variables included in the analysis. The maximum number of observations in our sample was 146. However, we only included countries that have data on all variables of interest, including innovation input and output, ethnic and cultural fractionalization, ethnic polarization, and all control variables, in testing the hypotheses (see specific N's in each of the analyses). Based on this selection criterion, a final set of 75 countries were included in the hierarchical regression analysis.

 Insert Table 2 about here

Direct Effects of ethnic and cultural fractionalization on innovation input

We conducted hierarchical multiple regression to test the effects of ethnic fractionalization and the interaction effects of cultural fractionalization and ethnic polarization on innovation input (see column 2, Table 3). In the first step, we regressed innovation input onto the control variables. In the second step, we entered ethnic fractionalization, cultural fractionalization, and ethnic polarization into the model. Results in step 2 of the second column of Table 3 shows that after controlling for industrial composition, political rights, mountainous proportion, non-contiguous territory, and landlock, ethnic fractionalization is negatively associated with innovation input ($\beta = -.39, p < .05$), supporting H1a. Cultural fractionalization and ethnic polarization are not significantly associated with innovation input ($\beta = .04, ns$; $\beta = -.13, ns$). Finally, in the third step, we entered the interaction term between cultural fractionalization and ethnic polarization into the model. The result shows that the interaction

this residual cultural fractionalization score is still highly correlated with the original cultural fractionalization score ($r = .64, p < .01$), demonstrating that the residual cultural fractionalization score is true to the original measure.

term for cultural fractionalization with ethnic polarization was not significant in predicting innovation input ($\beta = -.25, ns$), thus H2a is not supported.

Insert Table 3 about here

Mediated effect of ethnic fractionalization on innovation output via innovation input

According to Baron and Kenny (1986), four conditions are necessary to establish mediation: (1) the independent and mediating variables must be significantly related; (2) the independent and dependent variables must be significantly related; (3) the mediator and dependent variable must be significantly related; and (4) the relationship between the independent variable and dependent variable should be non-significant or weaker when the mediator is added. We follow this procedure to test the mediation mechanisms proposed in this paper.

To test Hypothesis 1b, we first evaluated whether the four conditions of Baron and Kenny (1986) have been met. The first condition is met as ethnic fractionalization significantly predicts innovation input ($\beta = -.31, p < .05$, as shown in the second column of Table 3). The second condition is not met because ethnic fractionalization is not associated with innovation output ($\beta = -.13, ns$, as shown in Model 1 of Table 3). However, in recently years many researchers have argued that this condition is often redundant hence unnecessary (e.g., Shrout and Bolger, 2002; Collins, Graham, and Flaherty, 1998). Hence not meeting this condition does not rule out the possibility of innovation input mediating the effect of ethnic fractionalization on innovation output. The third condition is met as innovation input significantly predicts innovation output ($\beta = .29, p < .05$, as shown in Model 2 of Table 3). Finally, the last condition is also met because when innovation input is included in the model (Model 2), ethnic

fractionalization does not have a significant relationship with innovation output ($\beta = .02, ns$).

Based on meeting the three essential conditions of mediation, we further validated the mediation effect using Sobel's (1982) test for indirect effect. Results show that the intervening effect of innovation input is significant ($z = -2.02, p < .05$), suggesting that the effect of ethnic fractionalization on innovation output is completely mediated by innovation input. Taken together, H1b was supported.

Moderated Mediation effect of cultural fractionalization on innovation output via innovation input

To test Hypothesis 2b, we also evaluated the results against the four conditions of Baron and Kenny (1986). The first condition is not met because the interaction term between cultural fractionalization and polarization does not significantly predict innovation input ($\beta = -.25, ns$, as shown in the second column of Table 3). Not meeting this essential criterion indicates that the moderated effect of cultural fractionalization by ethnic polarization on innovation output is not mediated by innovation input. To further validate this conclusion, we conducted a moderated mediation analysis using bootstrapping following Edwards and Lambert's (2007) approach. If Hypothesis 2b were to be supported, we would expect the indirect effect of cultural fractionalization in the low polarization condition (shown in Table 4) to not contain zero. However this is not the case (bias-corrected 95% $CI = -.04$ to 1.01), hence converging results from the Baron and Kenny (1986) approach and the Edwards and Lambert (2007) approach do not support our Hypothesis 2b. That is, the interaction effect of cultural fractionalization and ethnic polarization on innovation output is not mediated by innovation input.

Insert Table 4 about here

Direct Effects of ethnic and cultural fractionalization on innovation output

Model 2 (last column of Table 3) shows the hierarchical multiple regression conducted for testing the direct effects of ethnic fractionalization and the interaction effects of cultural fractionalization and ethnic polarization on innovation output. Specifically, we entered all five control variables in the first step, followed by ethnic fractionalization, cultural fractionalization, and ethnic polarization in the second step, and followed by the interaction term between cultural fractionalization and ethnic polarization in the third step, and finally, innovation input and its interaction with ethnic polarization in the last step. Results reveal that ethnic fractionalization does not predict innovation output directly ($\beta = -.02$, *ns*), not supporting H1c.

By contrast, the interaction term between cultural fractionalization and ethnic polarization significantly predicts innovation output ($\beta = -.30$, $p < .01$). Following Aiken and West (1991), we plotted this significant moderating effect and conducted simple slope tests. Figure 3 illustrates that when ethnic polarization is low (1 *SD* below the mean), cultural fractionalization is positively related to innovation output ($b = 1.36$, $p < .01$), whereas when ethnic polarization is high (1 *SD* above the mean), the relationship became non-significant ($b = -.02$, *ns*). These findings support H2c.

To further validate this conclusion, we also conducted a moderated mediation analysis using bootstrapping following Edwards and Lambert's (2007) approach. The result shows that cultural fractionalization has a direct positive effect on innovation when ethnic polarization is low ($b = 1.36$, bias-corrected 95% *CI* = .41 to 2.68) but not high ($b = -.02$, bias-corrected 95% *CI* = -.43 to .31). This finding further validates the simple slope test result to support H2c.

Insert Figure 3 about here

Robustness Test. We also conducted a robustness test to gain additional confidence of our findings. Given that the Sub-Saharan Africa region typically stands out for its extremely high ethnic diversity and poor economic development (Alesina et al, 2003; Easterly & Levine, 1997; Fearon, 2003), we also tested the robustness of our model excluding this region. As can be seen from results summarized in Table 5, excluding Sub-Saharan Africa did not alter our primary findings. Specifically, the results regarding ethnic fractionalization was identical to those reported above such that ethnic fractionalization significantly predicts innovation input ($\beta = -.39$, $p < .05$), which in turn significantly predicts innovation output ($\beta = .47$, $p < .01$). When innovation input is entered into the model, ethnic fractionalization does not have a significant relationship with innovation output ($\beta = -.09$, *ns*), suggesting there is not a significant direct effect of ethnic fractionalization. Together with this evidence, Sobel test result confirms that the mediating effect of innovation input is significant ($z = -2.30$, $p < .05$). In sum, like before, robustness test results supported H1a and H1b but not H1c.

Results regarding the interaction of cultural fractionalization and ethnic polarization again were very similar to those reported in the main analysis except that the interaction term has a significant relationship with innovation input ($\beta = -.46$, $p < .05$), supporting H2a. Moreover, innovation input is significantly associated with innovation output ($\beta = .47$, $p < .01$). Lastly, when innovation input is entered into the model, the effect of the interaction term between cultural fractionalization and ethnic polarization on innovation output is reduced ($\beta = -.40$, $p < .01$). However, the Sobel test result shows that this apparent mediation effect is not significant ($z = -1.90$, *ns*). Therefore, H2b was not supported, consistent with the findings in the main analysis.

Instead, cultural fractionalization has a direct and significant positive effect on innovation output when ethnic polarization is low ($\beta = 2.94, p < .01$) but not when ethnic polarization is high ($\beta = .07, ns$), hence supporting H2c again. Taken together, our robustness test by region by and large replicated the results found in our main analysis.

Insert Table 5 about here

Discussion

In the present study, we aimed at addressing the long-standing debate on the relationship between diversity and innovation. Our theoretical model and results are summarized in Figure 2b below. Using country-level data, our findings revealed that ethnic diversity negatively affects innovation input (supporting H1a), which in turn dampens innovation output, and this link is a complete mediation (supporting H1b). This is consistent with our expectation that greater ethnic diversity can retard consensual decision making and infrastructure construction, both of which are crucial for innovative capacity building. As a result, innovation-supporting infrastructure cannot be swiftly and thoroughly developed to promote downstream innovative performance.

Insert Figure 2b about here

By contrast, our results indicate that cultural diversity has a direct *positive* effect on innovation output over and above the positive contribution of innovation input, but only when ethnic polarization is low (supporting H2c). This finding supports the information processing theory (Cox & Blake, 1991; Dahlin, Weingart, & Hinds, 2005) and cognitive diversity

hypothesis (Horwitz & Horwitz, 2007) with a conditional twist: variation in group members' cultural cognitive representations (e.g., cognitive styles, perspectives, and implicit beliefs, etc.) can trigger novel solutions that result from unconventional combinations and adaptations of distinct existing ones, only when the group structure is not polarized hence less susceptible to inter-group relational tension or conflict.

Meanwhile, our results do not seem to support a direct negative association between ethnic diversity and innovation output (H1c). This finding could suggest that the negative impact of innovation input alone would sufficiently retard innovation-generating activities and diminish any potential for producing innovative outcomes. On the contrary, the lack of empirical support for a positive effect of cultural diversity on innovation input in the low polarization condition (H2a) may suggest that innovation input construction may be a more standardized process which can be achieved once groups come together to agree on it. Therefore, creativity is of little importance to innovation input construction, as compared to its crucial role in the actual generation of innovative outcomes.

By showing that countries' structural innovation input, or innovative capacity, strongly positively contributes to their innovation output or performance, our findings affirm the National Innovation System view (Freeman, 1995) and the National Innovative Capacity framework (Furman et al., 2002), which reason that innovation performance in a country heavily relies on early stages of capacity-building and innovation-supporting policies, systems, and infrastructure.

Theoretical implications

In this paper we made the first attempt to conceptually and empirically disentangle the unique influences of two aspects of ethno-cultural diversity, ethnic grouping categories and cultural distance. That is, we teased apart ethnic (categorical) diversity and cultural diversity (as

reflected in cultural distance) and demonstrated that these two sources of diversity have opposite impacts on innovation process: ethnic diversity negatively affects innovation while cultural diversity positively contributes to innovation (under environment of low inter-ethnic polarization). This clarification helps to resolve some empirical inconsistencies in the diversity-creativity literature.

Moreover, our results showed that although ethnic diversity by itself would already dampen innovation, the beneficial effect of cultural diversity would be eliminated when ethnic polarization is high. In conjunction with the economics literature on sub-group polarization, our theoretical model and findings call for rethinking about the automatic association between diversity and intergroup conflict in contemporary diversity research (e.g., Pelled, 1996). Instead, we argue that group structure matters. Such an insight has been shared by recent strategy research on factional groups, or those in which members are representatives of a small number of (often just two) social entities. This research reasoned that factional groups, which exhibit the polarization structure examined in this paper, are especially prone to conflicts (Li & Hambrick, 2005). Therefore we urge management research on team diversity to pay greater attention to the structural composition of sub-group membership such as ethnicity. Specifically, a team that consists of many ethnicities with no majority clustering (e.g., five ethnicities represented by two members each) are highly diverse in a fragmented manner whereas a team that consists of several large ethnic clusters (e.g., four of ethnicity A, five of ethnicity B, and one of ethnicity C) have a polarized structure. These two types of group structures have very different implications for team dynamics, with polarization being more likely to potentiate relational tension or conflict (Gören, 2014; Montalvo & Reynal-Querol, 2005).

Finally, our study departs from the prevalent micro approach of studying the diversity-creativity relationship and instead examines the relationship at a macro, national level. Specifically, we drew insights from the economics literature and used the lens of National Innovation System to view innovation as a process from input creation to output generation (Freeman, 1995, Furman et al., 2002). By doing so, we are able to answer questions of how and at what stage diversity influences the overall innovation process. Our findings show that in the larger process of innovation, ethnic diversity does not directly impact innovation output. Instead, it asserts an indirect effect on innovation output via innovation input. In other words, ethnic diversity makes a difference in the quality of innovation-supporting infrastructures and capacities a country can build, and these infrastructures and capacities then directly determine the level of innovation performance and output. On the contrary, cultural diversity directly contributes to innovation output in addition to the positive effect of innovation input, when ethnic polarization is low. These findings show that ethnic diversity and cultural diversity affect different stages of the innovation process.

Managerial implication

Although our findings confirmed a negative impact of ethnic diversity on innovation, they also validate that workforces that are diverse in cultural practices have a positive effect on innovation, as long as groups are not structured in a polarized manner. Therefore, our findings suggest that managers should not shy away from diversity in the workplace as doing so could curtail opportunities for innovation. That said, although we were able to tease apart ethnic diversity and cultural diversity in our analysis by removing their shared variance from cultural diversity, these two aspects of diversity are highly intertwined in reality (as demonstrated by the $r = .77$ bivariate correlation between ethnic fractionalization and cultural fractionalization in

Table 2). Therefore successful diversity management requires minimizing the negative effects of ethnic diversity while maximizing the positive effects of cultural diversity. How can managers achieve that?

We believe that in order to minimize the negative effects of ethnic diversity, managers should find ways to prevent subgroup preferences and interests from overtaking common goals. For instance, managers can override subgroup division by creating a salient common organizational identity (e.g., Hinds & Mortensen, 2005) and uniting employees around a shared vision and goal (e.g., Hülshager, Anderson, & Salgoda, 2009). Furthermore, research on racial essentialism has shown that people who believe that racial categories are fixed and deterministic of individual behaviors are more inclined to use salient categorical markers to differentiate self and other (e.g., Chao et al., 2013) and are more closed-minded and less creative (Tadmor et al., 2012). We therefore suggest that organizations can guide employees to adopt a less essentialist belief about race and ethnicity. By doing so, we believe employees in diverse organizations can focus on common organizational identity and shared vision in interactions with others, rather than subgroup preferences and interests. Managers can take measures to mitigate the potential negative impact of ethnic diversity on one hand and stimulate constructive conflict (Kirchmeyer & Cohen, 1992) to help reap the benefits of having more diverse ideas contributed by people from different backgrounds.

Moreover, managers should take special note that the more remotely related two cultures are, the more likely it is that the combination of their cultural elements will be novel and helpful for overcoming cultural blind spots. Therefore, it is more helpful to build teams with culturally distant rather than similar members. However, care should also be taken to minimize the potential for inter-group tension and conflict. Specifically, managers should be particularly wary

of a polarized organizational structure, i.e., having two large and opposing sub-groups. Aside from ethnic polarization, other types of major oppositions (e.g., high-income management versus low-income labor, veterans versus new blood, etc.) should also be avoided. Polarization can be most likely in cases of merger and acquisition and international joint ventures, where two equally large groups become one (Li & Hambrick, 2005). Professionals handling such organizations should try to bring in third-party individuals or other visible groups to possibly attenuate the polarizing intergroup structure.

Limitations and future directions

Since we relied on existing data sets, this study is limited by its small sample size. Also, only country-level analyses were performed, as those were the only data available. Further research using larger samples of organization-level data is needed to corroborate and extend our findings. For example, future studies could examine other types of cultures (e.g., disciplinary and generational cultures) and cultural distances in terms of mental models, cognitive styles, and implicit beliefs (e.g., Hong et al., 2000; Nisbett, 2003; Stahl et al., 2010; van de Ven, Rogers, Bechara, & Sun, 2008). Cultural distance between a pair of professional disciplines could be computed, for example, similar to our measure of cultural diversity based on language distance. In this way, the cultural distance between Physics and Chemistry could be assigned a much greater resemblance score than that between Physics and Mass Communication or History. Finding a positive relationship between this measure of disciplinary cultural diversity and innovation among work teams would further support the information processing perspective of diversity.

Our diversity data pose two other limitations. First, only one batch of diversity data was available, so we could not perform a multi-year analysis to test our model and gain the additional

confidence of reliability. To address this issue, we used an alternative method, i.e., excluding the most diverse Sub-Saharan Africa sample, to test the robustness of our findings. Results from this test replicated the findings from the main analysis, demonstrating robustness. A second limitation is that the time lag between the diversity data and the innovation data is large: Diversity data from 1996 was used to predict innovation from 2012 to 2014. This large gap raises the question of whether the ethnic and cultural demographics in 1996 are truly representative of those in 2012 onward. Although we admit that this year lag is not ideal, we believe it should not substantively alter our results and interpretation for two reasons. First, some diversity scholars have noted that ethnic group compositions in a country are often relatively stable over a 20 to 30 year horizon (e.g., Alesina et al., 2003), so it is reasonable to assume the diversity level in our sample today is not fundamentally different from the 1996 data we used, despite increasing levels of short-term population mobility today (e.g., expatriate assignment and educational exchange). Furthermore, as innovative capacity building and infrastructure development are complex and time-consuming processes, diversity should be expected to influence this process over time rather than immediately. Therefore, at the country level of analysis, 16 years of lag should still be considered acceptable. With these considerations in mind, future studies should aim to replicate our results using a longitudinal design at the organizational level and a smaller time lag between diversity measures and innovative outcomes.

Conclusion

The present research conceptually and empirically differentiated between ethnic and cultural diversity to test their opposite effects on innovation based on existing theories on social categorization and information processing. Using a moderated mediation model and national-level data, we found that (1) ethnic diversity dampens innovation input which in turn impairs

innovation output; (2) cultural diversity has a direct enhancing effect on innovation output over and above the contribution of innovation input, only when ethnic polarization (hence the potential for inter-ethnic tension and conflict) is low. Taken as a whole, this research sheds light on how and under what contextual factors (sub-group polarization in this case), ethnic and cultural diversity in a country could jeopardize or enhance innovation processes.

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Table 1.

Comparison of commonly used recent ethnic fractionalization datasets

	Fearon (2003)	Alesina et al. (2003)	Montalvo & Reynal-Querol (2005)
Year of data	1996	2001	1980
Number of countries	160	190	138
Number of ethnic groups	822	650	Unknown
Criteria for ethnic grouping	1) Descent basis 2) Self-awareness as a group	1) Racial characteristics 2) Linguistic characteristics	1) Self identification
Level of disaggregation	Multilevel disaggregation used to identify the relevant level	Only the highest level of disaggregation	Ethnolinguistic families
List of data sources	1) CIA's World Factbook online 2) Encyclopedia Britannica 3) Library of Congress Country Study 4) Minority at Risk III Dataset 5) Ethnologue: Language of the World 6) Some national censuses	1) Encyclopedia Britannica 2) CIA's World Factbook 3) Levinson (1998) 4) Minority Rights Group International (1997) 5) Some national censuses	World Christian Encyclopedia

Table 2

Means, Standard Deviations, and Intercorrelations for all variables

	M	SD	N	1	2	3	4	5	6	7	8	9	10	11
Industrial composition														
1 2011	13.87	6.90	113	1										
2 Political rights 2011	3.33	2.08	146	.01	1									
3 Mountainous Proportion	16.26	20.42	133	.01	.14	1								
4 Non-Contiguous Territory	0.17	0.37	133	.03	-.14**	-.05	1							
5 Landlock	0.23	0.42	142	-.17	.14	.24**	-.17*	1						
6 Ethnic Fractionalization	0.45	0.25	130	-.34**	.27**	.01	-.25**	.05	1					
7 Cultural Fractionalization	0.30	0.20	130	-.25**	.24**	.01	-.17	.09	.77**	1				
8 Residual of Cultural Frac	0.00	0.13	130	.02	.05	.01	.02	.08	.00	.64**	1			
9 Ethnic Polarization	0.51	0.25	110	-.10	.20*	.11	-.20*	.03	.54**	.44**	.03	1		
10 Innovation Output2014	0.50	0.29	143	.28**	-.52**	-.22*	-.23**	-.16	-.35**	-.24**	.05	-.22*	1	
11 Innovation Input2012	0.40	0.19	141	.08	-.45**	-.25**	-.09	-.16	-.33*	-.21*	.06	-.35*	.47**	1

Note. Residual of Cultural Frac = Residual of Cultural Fractionalization.

* $p < .05$; ** $p < .01$.

Table 3

Regression Results for Testing Moderation and Mediation for Innovation Input and Innovation Output

		Innovation Output 2014	
Factor and statistics	Innovation Input 2012	Model 1	Model 2
Step 1: Control variables			
Industrial composition	.19	.23*	.13
Political rights	-.38**	-.45***	-.33**
Mountainous Proportion	-.15	-.10	-.08
Non-Contiguous Territory	.10	.25*	.18
Landlock	-.01	-.01	.01
Step 2: Predictor variables			
Ethnic Fractionalization	-.31*	-.13	-.02
Residual of Cultural Frac	.04	.09	.08
Ethnic Polarization	-.13	-.04	-.02
Step 3: Interaction terms			
C x P	-.25	-.36**	-.30*
Step 4: Mediator and its interaction term			
Innovation Input 2012			.29*
II x P			-.11
F	4.86***	7.27***	6.04***
R ²	.40	.49	.51
Adjusted R ²	.32	.42	.43

Note. C x P = Residual of Cultural Fractionalization x Ethnic Polarization; II x P = Innovation Input 2012 x Ethnic Polarization.

N = 75.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4

Bias corrected 95% Confidence Interval of path coefficients of indirect and direct effect of cultural fractionalization on innovation output

	Indirect effect	Direct effect	Total effect
	Unstandardized path coefficient		
	[Lower CI - Upper CI]		
	Predictor: Residual Cultural Fractionalization		
High Polarization	-0.01	-0.02	-0.02
	[-0.13 to 0.03]	[-0.43 to 0.31]	[-0.46 to 0.30]
Low Polarization	0.39	1.36**	1.75***
	[-.04 to 1.01]	[0.41 to 2.68]	[0.77 to 2.90]

Note. Numbers in bold fonts indicate confidence intervals not including zero hence statistically significant results.

** $p < .01$; *** $p < .001$.

Table 5

Robustness Test: Regression Results for Testing Moderation and Mediation for Innovation Input and Innovation Output, when excluding Sub-Saharan Africa

Factor and statistics	Innovation Input 2012	Innovation Output 2014	
		Model 1	Model 2
Step 1: Control variables			
Industrial composition	-.08	.34**	.36**
Political rights	-.40**	-.41**	-.33**
Mountainous Proportion	-.23	-.13	-.01
Non-Contiguous Territory	.06	.24	.21
Landlock	-.06	.10	.11
Step 2: Predictors variables			
Ethnic Fractionalization	-.39*	-.31	-.09
Residual of Cultural Frac	.04	.09	.08
Ethnic Polarization	-.05	-.04	.06
Step 3: Interaction terms			
C x P	-.46*	-.61**	-.40*
Step 4: Mediator and its interaction term			
Innovation Input 2012			.47**
II x P			.00
F	4.82***	6.07***	6.68***
R ²	.50	.55	.64
Adjusted R ²	.40	.46	.54

Note. C x P = Residual of Cultural Fractionalization x Ethnic Polarization; II x P = Innovation Input 2012 x Ethnic Polarization.

N = 54.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 1. Two teams with identical degree of ethnic diversity but differing degrees of cultural diversity. The distance in between the circles representing ethnic groups denotes their cultural distance or dissimilarity.

Figure 2a. Proposed moderated mediation model of how ethnic and cultural diversity affects national innovation.

Figure 2b. Results for the proposed moderated mediation model of how ethnic and cultural diversity affects national innovation. Supported hypotheses are shown with solid lines while unsupported hypotheses are shown with dotted lines.

* $p < .05$. ** $p < .01$.

Figure 3. Simple slope plot with ethnic polarization as the moderator variable on the cultural diversity-innovation output relationship for year 2014. High polarization and low polarization groups were created using median split.