The unlikely encounter: Is ethnic diversity in start-ups associated with innovation?

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Abstract

Several studies have sought evidence as to whether ethnically diverse teams promote a diversity in knowledge and perspectives which is beneficial for innovation. In multicultural societies, however, there are multiple opportunities for exchange between people from different ethnic backgrounds, and the extent to which such encounters actually imply cognitive diversity seems debatable. We propose to regard as diverse those combinations of ethnic backgrounds that are relatively unlikely to occur under a hypothesis of random allocation to firms, based on the distribution of nationalities at NUTS3 level. We label this measure “unusualness” and apply it to the study of innovation in newly founded firms in Germany. Our results reveal that unusualness has a robust positive association with the probability of a start-up introducing an innovation within the first two years of business, while diversity as measured by a standard Blau index is insignificant. The results are robust to a large set of robustness checks. We interpret these results as an indication that not all combinations of national origins matter for innovation, but only those that are associated with differences in cognitive approaches and knowledge.

Keywords: diversity, innovation, start-ups, unusualness

JEL codes: F22, O31, M13, J15.

1 Introduction

A firm's ability to be innovative depends on its capability to devise unique solutions to complex problems. Firms that manage to integrate a broader set of approaches to problem-solving are more likely to come up with creative solutions. Heterogeneous human resources can contribute to widening a firm's pool of information, knowledge, cognitive approaches, heuristics, and problem-solving abilities and sustain its innovation capacity (Hong and Page, 2001, Alesina and La Ferrara, 2005, Alesina et al., 2016). Scholars in different domains[1] have applied these arguments to study whether diversity in ethnic and cultural backgrounds is associated with innovation, thereby highlighting a fundamental trade-off. Indeed, diversity also entails communication and social categorization costs (e.g., Williams and O'Reilly, 1998; Lazear, 1999; van Knippenberg and Schippers, 2007). While regional-level analyses confirm a positive relationship of diversity with innovation, the evidence is less conclusive in firm-level studies, where the costs of diversity may prevail over its benefits (e.g., Østergaard et al., 2011; Coad and Timmermans, 2014).

In this paper, we dig deeper into the contribution of cultural diversity to firm-level cognitive and knowledge diversity, aiming to shed light on the nexus between cultural diversity and innovation. To this end, we focus our empirical analysis on start-ups, where we expect the trade-off to bend towards the positive effects of diversity, and propose a novel approach to measure diversity as "unusualness", arguing that the diversity in national origins only translates into cognitive diversity when the encounter is comparatively unlikely.

Indeed, standard diversity indices tend to ignore that cultural approaches to problem-solving in the workplace and an individual's knowledge evolve with interpersonal interaction (Webber

[1] Key contributions include, e.g., organization studies by Cox and Blake, 1991 and Williams and O'Reilly, 1998; management theory studies by Barney, 1991; Kamm et al., 1990 and Beckman et al., 2007; and, more recently, economic geography works by Niebuhr, 2010; Cooke and Kemeny, 2017; Kemeny and Cooke, 2018; Ozgen et al., 2014, 2017.

and Donahue, 2001). In multicultural societies, individuals from different ethnic backgrounds have many opportunities to interact, and national origin-specific culture and knowledge may be accessed in multiple ways. For instance, one could question that a German and a Turkish person working together in Berlin generate an unprecedented exchange of knowledge. Another example is the case of border regions, where geography accounts for the regular interaction between nationals of the neighboring countries. We argue that the interaction between individuals with different national origins increases creative potential only when a "diverse" background coincides with a cognitive approach that is non-redundant (Granovetter, 1973; Burt, 2004). In managerial terms, to contribute to innovation, diversity in ethnic backgrounds should translate into actually diversified cognitive approaches, skills, and knowledge bases (Kilduff et al., 2000; Wang et al., 2019).

The more frequent a given national origin is in the social and business networks of the stakeholders of a focal firm, the more likely it is that their cultural approaches and knowledge are known to the firm. Lacking data about the networks of acquaintances of entrepreneurs and employees, we approximate the probability that a given cultural perspective is known to the firm by the share of people with that specific origin at the most detailed administrative level available to us, i.e., at the NUTS3 level.

Ethnic diversity will entail more cognitive diversity in the firms where the encounter of national origins is comparatively less likely. Accordingly, "unusualness" measures diversity based on the likelihood that the observed combination of national origins occurs by chance. More unlikely encounters will concern more "diverse" knowledge and cognitive approaches, hence we expect that firms with more unusual combinations will be more likely to innovate. Coming closer to measuring the actual cognitive diversity in a firm, we expect that unusualness will outperform standard diversity indices in capturing the effects of diversity on innovation.

We test our arguments employing a unique longitudinal employer-employee database developed jointly by the Institute for Employment Research (IAB) and the Centre for

European Economic Research (ZEW)[2]. We focus on newly founded firms that involve more than one person[3] in Germany over 2007-2012, concentrating on their first two years of activity.

We expect the benefits from diversity to emerge more clearly in start-ups having gone through the selection of a tough pre-start-up process that involved comparatively high coordination, conflict resolution and teamwork abilities (e.g., Brixy et al., 2012; Bergmann and Stephan 2013). Their small size may require comparatively little diversity management abilities and mediating factors. Moreover, to a large extent, they are active in high-tech sectors and complex tasks, where the benefits from diversity are found to be greater (Cooke and Kemeny, 2017).

The remainder of the paper is structured as follows. Section 2 sets out the theoretical framework and outlines the hypotheses, and Section 3 covers our identification strategy. Section 4 introduces our data, Section 5 presents the results, and Section 6 draws implications and conclusions.

2 Ethnic diversity and innovation: theoretical framework

The seminal contribution by Hong and Page (2001) proved theoretically that a more heterogeneous group can outperform a more skilled but homogeneous group, due to a wider set of approaches to problem solving and heuristics. More heterogeneous cognitive approaches impose a deeper reasoning and more challenging argumentation effort to come up with an agreement (Williams and O'Reilly, 2006). The argument that new solutions arise from bridging the gap between unconnected social groups is also sustained by Burt (2004), according to whom "people who stand near the holes in a social structure are at higher risk of having good ideas" (p.349). The implication that cognitive diversity promotes productivity,

[2] Access to this database is restricted to registered users for data confidentiality reasons.
[3] As we focus on a group feature, we exclude solo-entrepreneurs from the analysis.

growth and innovation has since then been studied at a number of levels, e.g., gender, age, ethnicity, tasks.

Entailing a diversity in experiences, cultural approaches, heuristics and assumptions, ethnic diversity can be viewed as a factor that stimulates exchange and allows the emergence of new solutions and ultimately increase the set of problem-solving abilities in a group (Kochan et al., 2003). In addition to this, ethnic diversity may enlarge the knowledge pool of teams, considering that (skilled) migration and mobility have been proven to promote the transnational transfer of knowledge. Indeed, international hindrances to the diffusion of innovation-relevant knowledge persist (e.g. Maurseth and Verspagen, 2002; Picci 2010), and mobile inventors, scientists, and academics play an important role in overcoming these barriers (Faggian and McCann, 2006; Agrawal et al., 2008; Breschi et al., 2017; Freeman and Huang, 2015; Miguelez, 2016; Lawson et al., 2019; D'Ambrosio et al., 2019). Being rooted in two cultures, (skilled) migrants are ideally suited as between-group brokers. They may possess skills, knowledge and abilities gained in their country of origin (Ottaviano and Peri, 2006), while at the same time accessing localized (tacit) knowledge in the host economy (Lissoni, 2018). This is presumed to be of particular value for knowledge creation and innovation (Berliant and Fujita, 2008; Niebuhr, 2010). More generally, ethnic diversity may contribute to the complementarity of roles within a team, which is important for access to information and, ultimately, firm performance (Aven and Hillmann, 2018). Migrants' mobility increases the spatial, organizational and social proximity among qualified human capital and facilitates face-to-face interaction, augmenting the chances that an unprecedented exchange of knowledge takes place.

Yet, the results of studies addressing the correlation between ethnically diverse teams and innovativeness crucially depend on the level at which the phenomenon is analyzed. Analyses at regional level generally support positive effects of diversity (Gagliardi, 2015; Haas and Lucht, 2013; Brunow and Brenzel, 2012; Audretsch et al., 2010; Niebuhr, 2010; Ottaviano and Peri, 2006). Evidence at the firm level is far less clear. Cooke and Kemeny (2017) find a

positive effect, while Ozgen et al. (2017) find that diversity does not affect innovation once firm-level fixed effects are included. Most studies assume that only the diversity at the level of the (top) management affects firm strategies and behaviour (Finkelstein and Hambrick, 1990; Knight et al., 1999). Lee and Nathan (2013) find a positive and significant effect of top management diversity on innovation.

These ambiguous outcomes of ethnic diversity may be explained by the two-sided nature of diversity. Multi-ethnic teams are more prone to conflicts stemming from different attitudes and values and from social categorization along ethnic lines (van Knippenberg and Schippers, 2007). Thus, contradicting effects of diversity can be expected and lead Milliken and Martins (1996, p.403) to speak of diversity as a “double-edged sword”. Reagans and Zuckerman (2001) argue that two different dynamics are at play: while similarity allows tight connectivity and communication within firms, diversity allows firms to benefit from synergies and complementarities. Which of the two prevails depends on the way conflicts are handled.

Conflicts are usually categorized as “affective” or “cognitive”. Affective conflicts are far-reaching and emotional in nature, whereas cognitive conflicts are task-related. Affective conflicts are often personal and destructive, whereas cognitive, task related conflicts are constructive and enhance the performance of teams and firms (e.g. Knight et al., 1999; Amason, 1996; Ensley and Pearce, 2001; Hülsheger et al., 2009; Kaiser and Mueller, 2015). Ethnically diverse teams are more prone to affective conflicts since biographically important factors, such as joint experiences, a similar background and a similar socialization, are limited, while the differences in values, experiences and beliefs are larger on average.

Furthermore, diversity can have different effects depending on the kind of diversity analyzed. Deep-level diversity involves attributes that are hard to detect, such as personalities, values and attitudes. Surface-level diversity, involving characteristics like sex and age, is easier to detect[4]. Meta-studies like Bell et al. (2011) and, very specifically for this paper, Wang et al.

4 Often race and ethnicity are also considered to be part of this type of diversity (e.g. Wang et al. 2019 or Bell et al. 2011), a classification

(2019), emphasize a positive relationship between deep-level diversity and team performance. Only multi-cultural deep-level diversity enhances a team's creativity, multi-cultural surface diversity does not.

One could argue that the costs of ethnic diversity are higher on average than those of other dimensions of diversity, such as sex, age or skill level, because the conflicts and ambiguity resulting from different languages and cultural perspectives can be profound and difficult to resolve. This is presumably the main reason why it seems to have less impact on firm performance than other dimensions of diversity (e.g. Østergaard et al., 2011).

Our empirical setting is peculiar in this respect. Indeed, in a team of founders that has successfully started a new venture, we may expect the costs of ethnic diversity to be comparatively low. The benefits from diversity emerge more clearly from the interaction on complex tasks (Cooke and Kemeny, 2017, Østergaard et al., 2011), which are likely to play an important role in our sample, where high-tech firms represent about 50%. Furthermore, start-ups in their early years can be expected to entail comparatively high coordination, conflict resolution and teamwork abilities, having gone through the selection of a tough pre-start-up process. Indeed, starting up a new firm is a rather long process during which the members of a founding team must develop a common understanding and reach a consensus on the strategic goals of the new business and of how to achieve them (Brixy et al., 2012; Bergmann and Stephan 2013). Founding teams that fail to resolve the related conflicts terminate the process and do not start the firm. Clearly, such conflicts can break out again later in time, but this is unlikely to be the case during the first two years after firm foundation. Therefore, in founding teams the positive aspects of diversity should prevail, at least at the beginning of the firms' lifecycle. This marks a distinction from studies focusing on working groups in larger corporations and leads to our first hypothesis:

that we find at least debatable.

Hypothesis 1: Ethnic diversity within the founding team exhibits positive effects on the firm's innovative performance.

A growing number of studies (Reagans and Zuckerman, 2001; Laursen et al., 2005; Østergaard et al., 2011) stress the importance of taking employee diversity into account when analyzing the overall human capital available in the firm. However, the empirical evidence of employee diversity often remains rather inconclusive unless the diversity measures are interacted with specific "mediating factors", such as open management structures (Kochan et al., 2003; Garfinkel, 2004), open firm culture (Østergaard et al., 2011) or a conducive economic environment (Richard et al., 2007).

As regards small firms, early employees possess many entrepreneurial characteristics and share similar backgrounds and personal aspirations with the founders (Roach and Sauermann, 2015). They are typically recruited using strong network ties, as human resource management is one of the last activities to be formalized (Aldrich and Ruef, 2006; Leung et al., 2006). Entrepreneurial traits and the social network ties lead us to expect a strong commitment and involvement in the firms' strategies and, considering the small size of the firms, a full contribution to its diverse perspectives. If this is the case, neglecting their contribution to innovation may lead to a misinterpretation of the sources of diversity in a firm.

Nonetheless, a firm's early employees, although selected, are new to the team. While they are certainly stakeholders of the new firm, they are not necessarily shareholders. Their experience of working as a team is gained only after recruitment. Hence, employees are more likely than the founding team to differ fundamentally in values and attitudes, which could jeopardize the new firm's ability to convert knowledge and ideas into innovation. Moreover, by hiring employees, firms introduce a hierarchy, a specific form of functional diversity (Williams and O'Reilly, 1998). Schubert and Tavassoli (2020) distinguish between top management and medium management teams in Swedish companies and find that the top management is responsible for the fundamental decision on whether to innovate, whereas the medium management is responsible for the success of the innovation process.

Translated into the context of entrepreneurial firms, this would imply that the core decisions about the goals of the new firms, including their innovation plans, accrue to the entrepreneurs, while the employees are in charge of the implementation of these goals. This is indeed very close to the approach of Coad and Timmermans (2014). The authors investigate such hierarchy in young firms using “entrepreneurial pairs”, differentiating between a founder and his/her first employee. Their results underline the importance of taking into consideration asymmetries due to hierarchies when studying diversity effects. The asymmetry between “planners” and “doers”, even if less clear-cut than in larger firms, implies that ideas and solutions arising from the employees’ side will have to be endorsed by the founders before impacting a firm’s activities, hence will be less directly affecting innovation. In addition to the possibly higher coordination costs, this leads us to our second hypothesis:

> *Hypothesis 2: Diversity among the employees will be associated to a lesser extent with the firm’s innovative performance than diversity in the founding team.*

Finally, as mentioned in the introduction, we argue that ethnic diversity is neither homogeneous, nor fixed over time and space. The available literature, indeed, assumes that ethnic diversity stems from the encounter of a set of “ascribed” individual characteristics (e.g., Ruef et al., 2003). However, while an individual’s birthplace and ethnic background are inherited and immutable, the same cannot be said of the cognitive diversity derived from them. If national origin drives cognitive diversity, it will presumably do so because ethnicity is a proxy for cultural diversity (Kilduff et al. 2000). In European contexts, ethnicity is often proxied by national origin. Equating ethnicity and national origin with culture, however, wrongly implies treating culture as a static attribute of the individual and societies. Instead, the cultural approaches to problem-solving in the workplace and an individual’s knowledge evolve as individuals interact (Webber and Donahue, 2001), and multicultural societies provide a wealth of opportunities for cultural exchange.

Cultures that are located close to each other have more opportunities for exchanging information and ideas than cultures that interact only rarely. To actually contribute to

innovation, “diverse” ethnic backgrounds must coincide with a non-redundant pool of knowledge and cognitive approaches, which stimulate deeper reflection due to the need to reconcile different perspectives (Richard et al., 2002). If this is not the case because the mainstream and the foreign culture interact frequently, then the scope for ethnic diversity to contribute to innovation and creativity is limited.

Non-native members of a start-up with such non-redundant knowledge can be expected to have a superior knowledge of the tastes of the people with whom they share the same ethnic background (Kochan et al., 2003). In regions where people of different ethnic origins have multiple opportunities to interact, their specific interaction within the firm will be less valuable. Simply put, a start-up located in Berlin may gather information about Turkish customers’ tastes via a number of channels other than a Turkish co-worker. Such information may be relevant for a wide range of products for which minorities represent a relevant share of the customers. Similar considerations apply to the know-how and experience gained in the country of origin (cf. Lissoni, 2018).

To operationalize these arguments, we would need a proxy for the component of cognitive and knowledge diversity that could be attributed to the diversity in the ethnic backgrounds (cf. Kilduff et al., 2000). Taking into consideration that the more likely it is that two cultures interact, the less likely it is that their encounter will entail an unprecedented exchange, we base our proxy for diversity on the probability of individuals from different cultures meeting in their daily life. Diversity in ethnic backgrounds in a firm will be more likely to entail an unprecedented exchange of knowledge and approaches if each person in the firm has had less chances to interact with the ethnic origin of the other members. Hence, the cognitive diversity will depend on the frequency of each ethnic origin in the social and business networks of the stakeholders of a firm. The higher this frequency, the more likely that the culture-specific cognitive approaches and knowledge are already known to the firm. Hence, ethnic diversity is more likely to translate into cognitive and knowledge diversity by more

unlikely encounters. Unlikely combinations of national origins are the most likely to yield new ideas.

Lacking data about the networks of acquaintances of entrepreneurs and employees, we approximate the probability that a given cultural perspective is known to the firm by the share of people with that specific origin at the most detailed administrative level available to us, i.e., at the NUTS3 level.

Approximating the probability that a firm has been exposed to the cultural approaches and knowledge of an ethnic group by the frequency of the group at the NUTS3 level seems reasonable for several reasons. Social interactions, including inter-ethnic interactions, occur via networks of proximity (Rauch, 2001). Firm formation is generally a regional event (Feldman, 2001; Audretsch and Feldman, 2003) and regional labor markets and regional networks of firms play a fundamental role for agglomeration and urbanization economies (Jacobs, 1969; Beaudry and Schiffauerova, 2009). Moreover, it is well documented that founders rarely relocate in order to start a business (Dahl and Sorenson, 2009, 2012; Sternberg, 2009; Sorenson, 2018). Overall, the network of acquaintances and business contacts of the members of a start-up is likely to draw largely on the regional dimension; the rarer individuals of a particular ethnic origin are in a region, the more likely they are to be carriers of new ideas and problem-solving abilities for firms in this region. This leads to our final hypothesis:

> *Hypothesis 3: A more unusual combination of national origins in a firm is associated with a higher probability that the firm introduces an innovation.*

Computing the unusualness based on the NUTS3 level distribution of the population has an additional advantage. Because the distribution of the foreign-born population is highly heterogeneous sub-nationally, the probability that a firm hires a diverse workforce is heterogeneous by region, as we shall discuss more at length in the next section. Firms located in more culturally diverse areas will be unconditionally more likely to have a culturally diverse workforce. Neglecting these differences would imply that we erroneously attribute to

the firm a diversity that is inherent to the location, rather than to the firm (Trax et al., 2012; Kemeny and Cooke, 2018; Lee, 2015). To the extent that these perspectives contribute to innovation, it will be conceptually incorrect to attribute them to the diversity of the firm. From this point of view, the analysis of the relationship between cultural diversity and innovation departs from the analysis of the relationship between other types of diversity, such as gender and age diversity. The latter may reasonably be regarded to be less tightly bound to the gender and age distribution at the regional level.

Moreover, some nationalities might be rare at national level but quite common in some specific districts. For example, the Japanese community is highly concentrated in Düsseldorf. Measured at district level, Japanese nationals are not very rare in Düsseldorf, but they are rare in other parts of Germany. Their ways of doing business, their perspectives and culture-specific traits have permeated through society in Düsseldorf more than elsewhere, hence we expect them to affect the innovation of specific firms there less than they would in other districts. Thus, the unusualness of a nationality is context-specific and depends on the ethnic composition of the population in the region where the person lives.

3 Identification strategy

3.1 Measuring diversity

Diversity is by definition a structural property of aggregates and follows from the composition of individual attributes. The level of aggregation therefore has a significant impact on the results. Which individuals are considered for an aggregate depends on the research topic. The aggregate must first be complete in the sense that everyone who has responsibility in the matter analyzed must be included. Second, the unit must be precise, meaning it should not include individuals that are not in charge. In our case, we wish to study the relationship between diversity and innovation in start-ups. As anticipated, the major advantage of start-ups in this respect is that they are clearly defined units and, given the small size of most

start-ups, the members of the business are in contact with one another. Due to the firms' small size and the newness of their processes and routines, strategic decisions will usually be discussed with the employees, especially with those that are highly qualified (Aldrich and Ruef, 2006). These considerations would suggest taking the whole "enlarged founding team" as our natural unit of analysis (Roach and Sauermann, 2015; Leung et al., 2006). However, taking into account the asymmetry and the plausible hierarchy implied by the, even blurred, distinction between the founders and their early employees, as discussed in section 2, we will also study the diversity of the founding team and the early employees separately.

Most studies linking diversity to innovation employ a Blau index (e.g. Biemann and Kearney, 2010), also known as fractionalization index (Easterly and Levine, 1997; Alesina and La Ferrara, 2005; Alesina et al., 2016), that is calculated as one minus a Herfindahl concentration index of the squared shares (s) of each nationality (i).

$$Div = 1 - \sum_{i=1}^{I} (s_i)^2$$

Such a measure basically treats all ethnicities equally, is "color blind" and may fall short of measuring a firm's actual cognitive diversity. Similar considerations apply to other widely used measures of diversity, such as the Shannon-Weaver entropy index, the Simpson index and the co-location index (Ozgen et al., 2017).

Moreover, as anticipated above, there are significant regional differences in the distribution of immigrants, leading to differences in expected levels of diversity. Ruef (2002) and Ruef et al. (2003) highlight that each observed combination of ascribed and achieved characteristics in the firm should be analyzed in relation to the likelihood of each specific combination occurring randomly. For example, immigrants tend to cluster in cities and are relatively rare in the periphery; hence, firms in cities and in the periphery do not have the same probability of being diverse. This is not controlled for in such indices. Because the foreign-born population remains a minor proportion of the overall population, the likelihood of observing a German-German composition is, by default, the greatest, even when homophily dynamics

are disregarded. Moreover, path dependency and preferential attachment dynamics bias migration flows in such a way that some ethnic groups grow faster than others. This implies, for example, that the large proportion of people of Turkish origin living in Germany makes it more likely to observe firms with a German-Turkish managing team than, say, a German-Maldivian managing team[5]. Based on the arguments outlined above, the knowledge and cognitive diversity that can arise from the encounter of the two may be different. Therefore, we propose to employ a measure of diversity that would more closely approximate the cognitive and knowledge diversity that can plausibly be associated with a variety of ethnic backgrounds, rather than the actual number of nationalities in a firm. We regard as more "diverse" those firms that would be *less* likely to form under a hypothesis of random allocation of people into firms. We refer to this kind of diversity in firms as "unusualness" to distinguish it from more conventional measures of diversity such as the Blau index. If the ethnicities that make up the firm would be relatively unlikely to meet, we will assume there is a larger "structural hole" to be bridged than in the case of a more likely combination, hence more potential for innovation.

To this end, we refer to probability theory and consider each ethnic group as an elementary event associated with a probability p that depends on the size of that ethnic group in a reference population. The likelihood of a specific ethnic combination in a firm of size r is a joint probability that can be computed by the multiplication rule, assuming statistical independence among the groups - this is the probability of random assignment into firms as calculated in structural events analyses of firm composition, such as in Ruef (2002) and Ruef et al. (2003). In other words, we calculate the likelihood of a given combination of ethnic origins occurring at random, conditional on the proportion of the ethnic group in the population. Denoting as n_i the number of people of ethnic group i in a specific firm of size r

[5] Data availability issues underlie the definition of ethnicity that we apply in this study. As regards the managing team, the categories are based on a question in the German Start-up Panel asking "What national origins are represented in the founding team?" As regards the Employment History Panel, we use the notifications of the employers on the nationality of the employees in the firms. This implies possibly underestimating the actual ethnic diversity in the firms as we will neglect foreign-born workers who have acquired German nationality. However, this is a standard problem in migration studies.

and as *p(n$_i$)* the share of ethnic group *i* in the reference population, the sampling distribution of joint structural events is given by the multinomial formula:

$$P(E|r) = \frac{r!}{k_1!\,k_2! \times \ldots \times k_s!} \times [p(n_1)^{k_1} \times p(n_2)^{k_2} \times \ldots \times p(n_k)^{k_k}] \qquad (1)$$

where the total team size r computes as $r = k_1 + k_2 + \cdots + k_k$ and corresponds to the sum of the k_s ethnic groups. For instance, if the combination is drawn from a population of entrepreneurs that is 80% German *(G)*, 10% Turkish *(T)* and 10% Chinese *(C)*, the risk set of a start-up team of three people will contain the following combinations:

$s = \{GGG, TTT; CCC, GTT, GGT, GCC, GGC, TCC, TTC, GTC\}$.

Each combination will be associated with a different probability of occurrence.

In this example, denoting the number of Germans in the region as n_1, of Turkish nationals as n_2, and of Chinese nationals as n_3, and the respective probabilities as $p(n_1) = 0.8;\ p(n_2) = 0.1$ and $p(n_3) = 0.1,$ then the expected probability of obtaining, say, a three-member founding team comprising one German and two Chinese nationals under an assumption of statistical independence is $p(E|3) = \frac{3!}{2! \times 1!}(0.8^1 \times 0.1^2) = 0.024$. By comparison, the probability of obtaining a three-member team that consists only of German nationals is: $p(E|3) = \frac{3!}{3!}(0.8^3) = 0.512$. Obviously, the GCC team is rarer or more “unusual” than the German-only team.

As it is the case for other diversity measures, our unusualness variable depends on the size of the group. For instance, the probability of four German people starting up a business jointly is 0.410, smaller than in the case with three people. Hence, in empirical models, the effect of unusualness alone may be confounded by the effect of size, considering that larger firms will also be more unusual by construction. To address this issue, we follow Ruef et al. (2003) and include size dummies (up to 10) in the estimates in order to capture size-specific factors. This approach also enables us to capture the heterogeneity across firms that is due

to size. Indeed, as argued by Coad and Timmermans (2014), a firm composed of two people may differ substantially from one that is composed of three[6].

To obtain the probabilities $p(n_i)$, as discussed, we employ the NUTS3 level distribution of nationalities and recognize that the ethnic composition of the population differs between regions, as does the likelihood of the expected ethnic composition of the founding teams: the probability of achieving a particular ethnic composition in a very cosmopolitan city may differ considerably from that in a relatively ethnically homogeneous rural region. Thus, the degree of unusualness differs regionally for the same ethnic composition of founders. Due to the availability of the whole universe of individual employment histories in Germany, we have a regionally representative, accurate measure of the distribution of the active population by ethnicities compared to what could be provided by the survey data derived from the Start-up Panel. Based on all these considerations, we use the distribution of employees' ethnicities in the 402 NUTS3 regions (districts) to compute the probabilities $p(n_i)$. To simplify interpretation, we subtract this measure from one such that the higher the value, the rarer (more "unusual") an observed combination is. In section 5.2 we check the robustness of our measure to using the distribution of ethnicities at NUTS2 level instead of the NUTS3 level. For tractability, we aggregate the nationalities to a set of six groups corresponding to the most frequent regional areas of origin in Germany: Germany, Western Europe, Eastern Europe, Middle East and Central Asia, Southeast Asia, Other[7].

A specificity of our application refers to the rather small average size of the firms in our sample. Indeed, about 52% of the start-ups in our sample are composed of 3 people or less. In the case of small firms, diversity measures such as the Blau index take on a fixed set of values (e.g. Biemann and Kearney, 2010; Coad and Timmermans, 2014), which make the

[6] Statistical power considerations relating to our sample size and the relatively small proportion of firms that display some ethnic diversity do not allow us to run separate analyses for each firm size as they suggest.

[7] We aggregate the countries into nine macro-regions, reflecting as far as possible the results of the GLOBE Study (House, R.J. et al., 2004) and, of these, we take the four most strongly represented ones and aggregate the others into a residual category. We use these five categories plus the German origin as the set of roles for our "ethnic composition". Thus, we use the term "ethnic composition" for simplicity. A more precise wording for what we call "ethnic composition of start-ups" would be the "composition of start-ups by macro-areas of origin".

diversity measures de facto dummies or categorical variables. An advantage of the unusualness index is its ability to take on a wider range of values compared to standard measures even for small firms. To illustrate this, consider a firm composed of two people with a German founder. The Blau index could only take on two values, one for the case that the other founder is also German, and one for the case that she is not. Our measure, even in this very simple case, can take on 6 different values depending on whether the other founder is German, from Eastern Europe, from Western Europe, from East Asia, from Northern Africa and the Middle East, or from the residual set of countries of origin. Furthermore, the value taken by our index is specific to the NUTS3 region, so it is not even fixed across different regions. The left-hand panel of Figure 1 illustrates the distribution of the unusualness index for small and large firms, where small firms consist of fewer than 10 people. As emerges clearly from the figure, the main implication arising from the small size of the firm is the strongly polarized distribution of unusualness around very high or very low values. Because even the largest minority in Germany does not account for more than 10% of the population, the probability of a combination involving at least one foreigner is much lower than the probability of not having any foreigners. As a consequence, the unusualness index is low if there are no foreigners in the firm and it increases considerably as soon as we compute the probability of one single foreigner being in the firm (either as a founder or as an employee). On average, the unusualness index of the German-only firms is 0.16, while the unusualness index of firms with one foreigner is 0.76. The polarization of this distribution forces us to acknowledge the bimodal distribution of the unusualness index. For this reason, in the empirical analysis we include a dummy for whether the firm has at least one foreigner or not. As is revealed clearly in the right-hand panel of Figure 1, instead, no such polarization is observed for larger firms, where the broader range of values that the unusualness index can take allows more mass around the central values of the distribution.

< Fig. 1a and Fig. 1b about here >

The unusualness of German-only firms is not fixed, because it depends not only on the size of the firm but also on the share of Germans in the reference population. German-only firms in more diverse regions score higher unusualness values than German-only firms in more homogeneous regions. We regard this implication of our unusualness measure as coherent with our approach. However, in line with some applications of the Blau index that consider only the diversity of the foreign population (Alesina et al., 2016), we also run a set of robustness checks where we set to zero the unusualness of German-only firms.

In line with the arguments outlined above and with those e.g. in Schubert and Tavassoli, 2020, Coad and Timmermans (2014) and Kaiser and Mueller (2015), we allow for differentiated effects of the diversity among founders and among employees that may be due to hierarchy. We compare a model specification in which the diversity and unusualness of the founding team and that of the employees are included separately with a model in which the two are combined into a single, firm-level index, which would represent the "enlarged" founding team.

3.2 Hypothesis testing

Hypotheses 1-3 refer to the link between diversity and innovation and are tested by examining the probability of a start-up introducing an innovation conditional on a vector of firm-level characteristics which include a set of diversity measures. The empirical analysis is conducted using a set of simple logit models:

$$Pr(inno = 1|x) = e^{\theta' x}/(1 + e^{\theta' x})$$

where x is a vector of firm-level variables including our diversity measures (specifically, a dummy for whether at least one foreigner is in the firm, the Blau index associated with the firm, and our unusualness index calculated as $1 - p[E|r]$, where $p[E|r]$ is the conditional probability of occurrence of the combination of ethnicities observed in the firm and r is the size of the team). Vector x also includes other variables that may correlate with innovation, i.e. single team-size dummies for up to 9 people in the firm, a dummy for firm size over 9

people, the logarithm of turnover and investments, dummies for whether at least one of the owners is a woman, has management experience or had a patent registered before the start-up of the firm, industry dummies, year dummies, as well as binary controls for firms with a legal form equivalent to an incorporated company, whether the founder's motive for starting up the firm was to escape unemployment, foreign ownership of the firm and a specific stratification variable (see table A.1). We center the unusualness measure using the mean of the two groups: German-only firms and firms with ethnically mixed teams, and do so for two reasons. First, we control for the greater unusualness of firms with at least one foreigner and only examine the deviations from the average of the relevant group. Second, we greatly reduce collinearity issues with related variables. We expect innovation to be observed more frequently in firms that depart more significantly from the "norm", i.e. in firms whose ethnic composition would have been less likely to occur by chance.

Nevertheless, there are some points that should be considered for the interpretation of our results. Besides the technical implications for the measurement of diversity, the small size of the firms in our sample bears implication for the external validity of our results. It portrays the typical size distribution of most entrepreneurial teams (cf. Coad and Timmermans 2014 and references therein) and allows us, to some extent, to control for the size heterogeneity in firms. This implies that our findings generalize to pairs, triads, or at most small groups. Due to the close interaction in small groups, for instance, diversity in start-ups may require less managerial effort in terms of coordination than diversity in larger groups; the implications regarding diversity and unusualness that we can draw from our sample cannot necessarily be generalized to cover larger companies. Moreover, as we shall explain, all the "diverse" firms in our sample have at least one German member. Hence, our study ultimately looks at how the presence of other cultures complements the natives' approach to problem solving in pairs, or small groups, where one member is German and another is a foreigner. We cannot extend our inference to foreign-only firms, which, lacking the intermediation of German members, may experience higher costs due to being non-local (e.g. Dahl and Sohrenson, 2012).

Another limitation of our approach concerns the presence of selection in our sample. As mentioned, starting up a new firm is a rather long process which involves a large amount of entrepreneurial problem-solving (Harper, 2008; Brixy et al., 2012; Bergmann and Stephan, 2013). The diverse groups that we observe should be more able on average to handle conflicts as they have passed through a tough selection process. We do not observe teams that presumably perform less well, are less able to solve the potential conflicts arising in this process and are forced to drop out. In principle, coordination problems in the pre-start-up phase should be higher for diverse teams. Hence, the outcome of this process should be a set of diverse founding teams which are comparatively more able to handle conflicts than other diverse teams. On the other hand, it is unclear a priori whether their ability to handle conflicts should be regarded as better or worse compared to less diverse start-ups. Lacking data on the firms that fail to start up, we can only acknowledge this limitation.

We cannot rule out the possibility that unusual combinations are endogenous with respect to innovation. Indeed, the pre-start-up phase, when the founding teams are formed and the idea begins to take shape, is entirely unobserved by us. Hence, it seems hard to provide a unique interpretation of whether the team or the potentially innovative idea comes first. In all cases, however, both the team of founders and the original business idea must develop considerably in order to reach the stage of a fully-fledged business plan, to obtain suitable financing and to become operational. No matter in what order the idea and the team may have formed, at start-up the two will have interacted and may have changed, to the point that they are empirically indistinguishable in our setting. For this reason, we do not seek to gather causal evidence but rather to explore the conditional correlations between diversity and innovation.

4 Data

To investigate the significance of each part of the young firms' knowledge base, a database is needed that provides information on the social and occupational background of

entrepreneurs and early employees. To this end, we constructed a unique linked employer-employee database (LEED) on start-ups that allows us to compare the effects of diversity at different levels within the same firm: employer-employee diversity; diversity in the owner/manager founding team; diversity in the employee teams; and overall diversity in the start-up.

This database combines information on the founders' origins, the origin of the employees, the human capital in the firm both among the employees and at the founding-team level as well as the firms' innovative outcomes (e.g. product and process innovations). The database, the IAB-ZEW-Start-Up Panel[8], was jointly developed by the Institute for Employment Research (IAB) and the Centre for European Economic Research (ZEW). It combines data from a panel survey of 13,400 start-ups between 2005 and 2012 (IAB-ZEW-Start-Up Panel) with administrative data from the Integrated Employment Biographies (IEB) of the Institute for Employment Research (IAB) on all employees joining one of the firms surveyed[9]. The resulting LEED contains information about the origins of both the employers and the employees and about other demographic or "ascribed" attributes that are likely to affect their cognitive diversity, such as gender and age. It also contains data on the skills and tenure within the organization, which are likely to affect the "acquired" dimension of cognitive diversity. The firms were contacted in a first wave during their first year of existence and again about one year later. The question about innovation concerns the calendar year preceding the second contact, thereby proxying the first year.

When the questionnaire was compiled, particular emphasis was placed on the firms' innovative activities. The questions are based on the principles and ideas of the Oslo Manual (OECD and Eurostat 2005). In particular, a distinction is made between product and process innovations. The exact questions depend on the sector[10].

8 See: http://www.gruendungspanel.de/en/mannheimer-gruendungspanel/results.html

9 See http://fdz.iab.de/en/FDZ_Individual_Data/integrated_labour_market_biographies.aspx for more information about this data-source

10 There are two binary questions in the Start-up Panel which were asked each year and were developed. One about product or service innovations: "Did you introduce new products or services in [year] which were new for your business or which were substantially improved?"

The data provide information about whether the firm has introduced product or process innovation; whether the innovation represents a novelty at the regional, national or global level; whether the founders have filed patent applications during the previous year; and whether they had been granted a patent before the start-up was launched.

To avoid that our results are confounded by learning effects about diversity (Webber and Donahue, 2001) and unobserved history effects of the firm (Raymond et al., 2010; Clausen et al., 2011), we focus on the first two years of the firms' activities.

Notwithstanding the young age of the firms in our sample, the literature suggests that we can expect firms to innovate even very early in their lifecycle. Indeed, although innovative start-ups constitute a rather small share of all entries (Geroski, 1991), new firms tend to innovate more than the incumbents because they concentrate in innovative industries and often lead to the emergence of new markets (Geroski, 1995; Audretsch, 1995). Also, innovation may be needed to build corporate identity and develop the customer base. The literature on the timing of innovation confirms that the likelihood to innovate varies over the firms' lifecycle and that entrants are especially innovative (Huergo and Jaumandreu, 2004; Coad et al., 2016; Cucculelli, 2018). According to Klepper (1996), this process will be mainly driven by innovations in products rather than processes. In the services sector, however, the distinction between the two may not be straightforward (Gallouj and Savona, 2008; Witell et al, 2016). For this reason and due to the limited numerosity of our sample, we aggregate our innovation variables to form a single binary variable equal to 1 if the firm has introduced any kind of innovation, and to 0 otherwise, while controlling for previous patenting experience among the regressors.

The interviewer provided a special explanation if they dealt with trading companies: "This question is about new products from the point of view of the company (=product innovations). These can be, but do not have to be, market innovations. The simple sale of innovations that are produced by other companies does not count as a product innovation. An innovation of a retail company would be, for example, an extension of shop opening hours."
The other question is about process-innovations and reads: "Did you introduce in [year] new procedures in production or service provision not used by your company so far? Thirdly we exploited questions about patents and identified firms that had been granted patents after the company was founded.

Start-ups in the high-tech sector are oversampled in this database: some 50% of the firms surveyed belong to this sector. The above-mentioned variables are available for a total of 4,062 firms, 2,825 of which are employers. In order to obtain evidence referring to a group feature, i.e. diversity, we eliminated one-person firms from the sample, leaving 3,287 firms for the analysis. Of these, 766 are ethnically “mixed” firms (i.e. including both Germans and foreigners) and only nine are foreign-only firms. Such a distribution is plausible considering the strong role of the high-tech sectors in our sample. In order to ensure greater homogeneity of our results, and taking into account that it would be hard to derive any inference from such a small sample of foreign-only entrepreneurs, we decided to drop the 9 foreign-only firms from the analysis. Therefore, as mentioned, our results have to be interpreted as relevant for diverse firms where at least one person is German; the implications do not necessarily apply to foreign-only firms. The summary statistics of our variables are reported in table A1 in the Appendix.

5 Results

5.1 Diversity and innovation in start-ups

In table 1 we report the results of our first set of estimates. In column (1) we report the control-only specification. The main drivers of innovation seem to be the size of the firm, both in terms of turnover and in terms of employment, the patenting experience before foundation and the presence of university graduates in the firm.

Previous management experience of the founders is also positively and slightly significantly associated with the probability of introducing an innovation. As expected, start-ups founded to avoid unemployment are significantly less likely to introduce an innovation. In column (2) we add a dummy for whether there is a foreigner in the firm. Its coefficient is insignificantly different from zero, implying that, on average, there is no difference in the propensity to innovate between firms with and without foreigners. In column (3) we add the Blau index

calculated separately for the founding team and the early employees, which also yields insignificant results that do not support hypothesis 1 for this measure[11].

Hypothesis 1 finds instead some support in model (4), where we add our unusualness measure calculated separately for the founding team and for the early employees. Here, the team-level unusualness results are positively and significantly related with innovation at the 7% significance level. Moreover, in line with hypothesis 2 that, if there is an asymmetry in the ability of the founding team and of the early employees to affect innovation, this is in favor of the founding team.

< Table 1 about here >

In columns (5) – (7) the Blau index and the unusualness variables calculated separately for founding teams and early employees are replaced by their respective firm-level counterparts, first included one at a time and then jointly. While the Blau index still results insignificant when calculated across all stakeholders in the firm (founders and employees), the unusualness index becomes highly significant and positive when computed on the basis of the whole firm. The remaining coefficients are robust. Overall, our results do not support the presence of diversity effects as measured by the Blau index. However, they do provide sound evidence of diversity effects as measured by unusualness, supporting hypothesis 3 and qualifying hypotheses 1 and 2. Comparing the AIC in columns (7) and (4), the focus on the whole of the enlarged founders' team is supported[12].

[11] The results are similar when the Blau index is substituted by categorical variables indicating whether the index is above 0.5, below 0.5 and by a categorical variable capturing the number of national origins in the firm.

[12] Considering the wide literature on the relationship between diversity and innovation, one may argue that the relationship is subject to mediating factors, e.g. firm size, skills level of the (foreign) workers, technological intensity of the firm. We have run a series of tests to test these ideas without identifying significant interaction effects. We cannot interpret these results as an indication that our unusualness holds irrespective of boundary conditions, but rather as a result of the relatively limited variation in these variables in our sample. We believe that interesting insights could be yielded if future research employing larger samples addressed the role of mediating factors.

In terms of economic significance, computation of the elasticity associated with the marginal effects of our variable of interest for the average firm in our sample reveals that a 1% increase in the firm unusualness is associated with a 0.01% increase in the probability of innovating. This is a relatively small yet non-trivial change, considering that the standard deviation of the centered unusualness variable is 0.19. Hence, a one-standard-deviation increase in the unusualness would be associated with an approximate 0.11% increase in the probability to innovate. The average firm in our sample has a 34% probability to innovate, which would accordingly increase to 38% percent.

In table 2 we check the robustness of our results to other sources of diversity. With model (1), we address a possible flaw in our measure which arises from the fact that two people of the same non-German ethnicity in the same firm would increase unusualness but not necessarily increase the variety of perspectives in the firm. Hence, we include a dummy variable that we call "homophily". Homophily is equal to 1 if, within a firm, the same non-German nationality is observed both in the founding team and among the employees – though this ethnicity is not necessarily the only one in the firm; it is also set to 1 if a single non-German nationality is present in a founding team of more than one person. We would expect homophily to decrease the effect of unusualness. Indeed, the coefficient of the variable is negative but insignificant, while the coefficient of unusualness remains robust. In column (2) we add the age range in the firm together with its quadratic term[13]. The quadratic term of the age range coefficient is negative and significant, implying a negative correlation of age diversity on the firm's innovation capacity. The results for unusualness are robust.

In column (3) we add the foreigners' human capital to the picture[14]. Conditional on the presence of at least one graduate in the firm, the presence of highly qualified foreigners

[13] Due to missing data issues affecting the age variable, we have imputed the age range with the sample mean in the few cases where it was missing.

[14] The structure of our data causes a slight asymmetry between the two measures. On the side of the founding team, the data do not allow us to relate the founder's nationality to her skill level, hence we compute a dummy variable equal to 1 if there are foreigners in the firm and at least one person has a

yields insignificant effects. No significant additional effects of foreigners' skill levels can be found either when transforming the employee-level variable into a dummy equal to one if there is at least one highly qualified foreigner in the firm, or when combining the two dummy variables into a single firm-level measure. In column (4) we combine the homophily dummy, age range and foreign education dummies and further include two categorical variables indicating the range of educational qualifications and the number of subjects of the qualifications held by the founding team members. The variables are also insignificant, while unusualness remains robust. Moreover, throughout all the specifications, the dummy for female founders/share of women in the firm is never significant, suggesting that gender diversity is not driving the results.

< Table 2 about here >

5.2 Robustness checks

In table 3 we implement a set of robustness checks to confirm the internal validity of our measure for the issue at hand. In columns (1) and (2) we address the issue that the unusualness of firms relates closely to the presence of at least one migrant in the firm and to the presence of different nationalities in the firm.

In column (1) we remove the dummy "at least one foreigner in the firm" and in column (2) we remove both the dummy and the Blau index. The results are robust. To address the role of size in driving the unusualness index, in column (3) we remove all firms with more than 9 people, for which we did not have enough cases to introduce a dummy. The results are less precise but still robust. In column (4) we replace the unusualness of German-only firms with zero. The results are robust, and the coefficient of unusualness becomes even larger in

university degree. On the side of the employees, on the other hand, we can link the skill level with the nationality, so we include the number of foreign-born full-time equivalents with a high qualification.

magnitude than in the standard case. In columns (5) and (6) we report the results of the estimates obtained by computing the unusualness on the basis of the NUTS2 level distribution of ethnicities, including unusualness as a whole and with the unusualness of German-only firms set to zero. The results are attenuated in terms of significance but remain robust.

< Table 3 about here >

Finally, in column (7), we follow Biemann and Kearney (2010), according to whom a standard Blau index systematically underestimates diversity, particularly by small group sizes. Replacing the index with its bias-corrected counterpart does not affect our results.

6 Summary and conclusions

In this paper, we examine the relationship between firm-level diversity and innovation from a new perspective. We question an implicit assumption of the previous literature that underlies the most common measures of ethnic diversity, i.e. that heterogeneity in ethnic backgrounds implies heterogeneity in information, knowledge and cognitive approaches. In multicultural societies, where individuals of different ethnic backgrounds have multiple opportunities to meet, this may fall short of capturing the actual knowledge and cognitive diversity available to a firm. Because the likelihood that new and non-redundant information is exchanged decreases with the frequency of the encounter, we regard as more “diverse” the ethnic combinations that are relatively less likely to occur by random allocation to firms. The occurrence probability of each ethnic combination in a given firm is drawn from the NUTS3 level distribution of the national origins. We label this measure “unusualness” and apply it to the study of innovation in newly founded firms, whose small size ensures interaction among co-workers in the firm.

Our results support the above arguments: it is the ethnic unusualness of the firms’ stakeholders that matters for innovation. The unusualness of the combination of ethnic

backgrounds is robustly related with the probability that a newly founded firm introduces an innovation within the first two years of its activities, while diversity as measured by a standard Blau index is insignificant. The magnitude of the estimated elasticity is also non-trivial and implies a 0.11% increase in the probability to innovate for a one-standard-deviation increase in the average firm's unusualness.

We interpret these results as an indication that not all combinations of ethnicities matter for innovation, but only those that entail differences in cognitive approaches and knowledge. In other words, only non-redundant exchanges are likely to promote innovation, in line with the seminal arguments by Granovetter (1983) and Burt (2004). On the contrary, more "usual" combinations, even if composed of a variety of ethnic origins, are less likely to yield unprecedented exchanges, as their origin-country-specific approaches, information and knowledge have had multiple opportunities to spill over to the general society.

Our application allows us to provide empirical support to a debated theoretical argument, i.e. that ethnic diversity breeds innovation within firms. Employing the unusualness index allows us to more accurately attribute the underlying mechanism to the expansion in the pool of knowledge and abilities that derives from different knowledge and cultural approaches (e.g. Kochan et al., 2003; Williams and O'Reilly, 2006; van Knippenberg and Schippers, 2007). Given the interest that this research question has raised, this finding may serve a broad set of disciplines ranging from management and organization studies to economic geography.

At the same time, we point to a substantial flaw in the operationalization of these arguments in previous works. Our findings call for measures of diversity that capture the extent to which non-redundant information exchanges arise from the encounter of nationalities. This may not be the case of standard measures such as the Blau index that essentially counts nationality shares and may end up providing too simplistic an approximation. Explicitly questioning whether ethnic diversity implies cognitive diversity (in line with Kilduff et al., 2000), we complement the findings by Bell et al. (2011) and Wang et al. (2019) on the distinction between surface-level diversity and deep-level diversity. Along their lines, we confirm that

ethnic diversity is only promoting innovation when it is associated with diversity in knowledge, values and attitudes. We add to this by offering a simple operationalization of the extent to which surface-level ethnic diversity is associated with deep-level cognitive diversity. It may otherwise be very challenging to measure deep-level diversity on large samples and to isolate the component that is attributable to ethnic origin, as it involves individual attributes and knowledge that are typically unobserved.

By questioning the implicit assumption that diversity in ethnic backgrounds implies knowledge and cognitive variety, we effectively shed new light on the conflicting results of the previous literature and the nature of diversity as a “double-edged” sword. The contradictory findings in the literature may not only be explained by the two sides of the trade-off, but also by the extent to which standard measures of diversity accurately portray the phenomenon that they intend to capture.

Under which conditions will standard measures such as the Blau index accurately proxy for the cognitive component of ethnic diversity? We may argue that, as long as countries have a relatively short experience with immigration, the assumption that all national origins contribute to cognitive diversity is reasonable. In this case, the unusualness index and the Blau index will capture similar phenomena. However, the correspondence between the two becomes less and less accurate as the ancestry and size of specific minorities increase and, more generally, as globalization offers different opportunities to access information about foreign cultures. In multicultural societies, measuring diversity via a Blau index on ethnic origins may fall very short of its objective.

It is worth highlighting that these arguments apply to the interpretation of diversity as a source of information variety, which we argue to have an intrinsically dynamic and context-specific character. Standard measures force us to treat an individual’s ascribed characteristic, i.e., ethnic background, as an indicator of an acquired and inherently dynamic trait, i.e., knowledge, and may perform very poorly in this regard. On the other hand, measures like the Blau index may be more accurate in approximating the social

categorization effects of diversity, if these are more persistent and associated with the visible attributes of ethnic diversity (van Knippenberg and Schippers, 2007; Easterly and Levine, 1997).

For these reasons, two sides of the diversity trade-off, i.e., positive or negative, may end up not being equally represented in existing diversity indices. The Blau index will approximate the effects of diversity as information variety as well as of social categorization as long as most ethnic origins add non-redundant information. In this case, the sign of its correlation with the outcome of interest will depend on which effect prevails. When instead the cognitive variety component is not captured by the Blau index, this will tend to be more representative of social categorization effects, hence of the costs rather than the benefits of diversity. The differing extent to which diversity measures in previous studies accurately approximated the cognitive variety associated with ethnic diversity may explain part of the inconclusive results of the literature. In turn, the unusualness index may be less suited to capture the "negative" effects of diversity. These need not depend on whether national origins carry non-redundant information.

For this reason, we may regard each measure as giving more weight to either one of the two complementary aspects of the innovation-diversity nexus. In our application, the social categorization side was assumed negligible, and, indeed, the Blau index turned out insignificant. In other settings, where the costs of diversity are higher, we may observe that the unusualness and the Blau index have opposite signs, as they portray partially different phenomena. Hence, rather than supplanting measures like the Blau index, our approach intends to complement them with a more accurate operationalization of the information variety effects of diversity.

Along with our core contribution, we provide a few additional insights to the literature. First, we propose a measure of diversity that is less prone to the flaws of standard diversity measures in small groups. Second, we show that the enlarged founders' team is the relevant unit for studying the effects of diversity for innovation in young firms.

Third, we recognize that the ethnic diversity in a firm depends partly on the diversity of its location. This substantiates - though from a different perspective - the results obtained by Kemeny and Cooke (2018) and Trax et al. (2012) regarding the spillovers from diversity in cities and regions: they found puzzlingly stronger effects of diversity at the regional level than at the level of the firm or plant. Our results suggest that greater diversity at the regional level would ceteris paribus reduce the unusualness of the combination at the firm level, hence its specific contribution to innovation, and more generally, to economic performance.

Our novel exploration of the link between diversity and innovation is not exempt from limitations. Indeed, as we mentioned, our arguments should ideally be operationalized at the level of the networks of the firm's stakeholders. Hence, conditional on data availability, network analysis approaches would be the elective avenue for further exploring our arguments. Moreover, while the measure of unusualness that we propose links diversity to the regional distribution of national origins, our sample size did not allow us to take regional heterogeneity fully into account. Also, our results do not necessarily generalize to larger firms with higher costs of diversity. For all these reasons, it may be very instructive that future research replicates this exercise on larger samples and larger firms.

Furthermore, for tractability, we had to aggregate ethnic background into six national aggregates. However, cultural differences can have many dimensions (language, religious beliefs, attitudes concerning trust, etc.), which are not fully captured by such large aggregates. In addition, future research should address the issue of the self-selection of the founders in (diverse) teams, which is likely to lead to a sample of start-ups whose coordination and management ability is comparatively higher than in the (currently unobserved) set of firms that failed to reach the start-up stage.

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References

Agrawal, A., Kapur, D., McHale, J., 2008. How Do Spatial and Social Proximity Influence Knowledge Flows? Evidence from Patent Data. Journal of Urban Economics 64, 258–269.

Aldrich, H. E., Ruef, M., 2006. Organizations Evolving. Thousand Oaks London, New Delhi (Sage).

Alesina, A., Harnoss, J., Rapoport, H., 2016. Birthplace Diversity and Economic Prosperity. Journal of Economic Growth, 21, 101-138.

Alesina, A., La Ferrara, E., 2005. Ethnic diversity and economic performance. Journal of Economic Literature 43, 762-800.

Amason, A. C., 1996. Distinguishing the effects of functional and dysfunctional conflict on strategic decision making: Resolving a paradox for top management teams. Academy of Management Journal 39(1), 123-148.

Audretsch, D. B., 1995. Innovation, growth and survival. International Journal of Industrial Organization 13(4), 441-457.

Audretsch, D., Feldman, M., 1996. R&D Spillovers and the Geography of Innovation and Production. The American Economic Review 86(3), 630-640.

Audretsch, D., Dohse, D, Niebuhr, A., 2010. Cultural diversity and entrepreneurship. A regional analysis for Germany. The Annals of Regional Science 45, 45-85.

Aven, B., Hillmann, H., 2018. Structural Role Complementarity in Entrepreneurial Teams. Management Science, 64(12):5688-5704.

Beaudry, C., Schiffauerova, A., 2009. Who's right, Marshall or Jacobs? The localization versus urbanization debate. Research Policy 38(2), 318-337.

Bell, S. T., Villado, A. J., Lukasik, M. A., Belau, L., & Briggs, A. L., 2011. Getting Specific about Demographic Diversity Variable and Team Performance Relationships: A Meta-Analysis. Journal of Management 37(3), 709–743.

Bergmann, H., Stephan, U., 2013. Moving on from nascent entrepreneurship: measuring cross-national differences in the transition to new business ownership. Small Business Economics 41(4), 945-959. doi:10.1007/s11187-012-9458-4.

Berliant M.; Fujita M., 2008. Knowledge Creation as a square dance on the hilbert cube. International Economic Review 49, 251-1295.

Biemann, T., Kearney, E., 2010. Size does matter: How varying group sizes in a sample affect the most common measures of group diversity. Organizational research methods 13(3), 582-599.

Breschi, S., Lissoni, F., Miguelez, E., 2017. Foreign-origin inventors in the USA: testing for diaspora and brain gain effects, Journal of Economic Geography 17(5), 1009-1038.

Brixy, U., Sternberg, R.; Stüber, H., 2012. The selectiveness of the entrepreneurial process. Journal of Small Business Management 50(1), 105-131.

Brunow, S., Brenzel, H., 2012. The effect of a culturally diverse labour supply on regional income in the EU. Empirica 39, 461-485.

Burt, R.S., 2004. Structural Holes and Good Ideas. American Journal of Sociology 110, 349-399.

Clausen, T., Pohjola, M., Sappraserty, K., Verspagen, B., 2011. Innovation strategies as a source of persistent innovation. Industrial and Corporate Change 21, 553–585.

Coad, A., Timmermans, B., 2014. Two's Company: Composition, Structure and Performance of Entrepreneurial Pairs. European Management Review 11(2), 117-138.

Coad, A., Segarra, A., Teruel, M., 2016. Innovation and firm growth: Does firm age play a role? Research Policy 45(2), 387-400.

Cooke, A., Kemeny, T., 2017. Cities, immigrant diversity and complex problem solving. Research Policy 46, 1175-1185.

Cucculelli, M.J., 2018. Firm age and the probability of product innovation. Do CEO tenure and product tenure matter? Journal of Evolutionary Economics 28, 153-179.

D'Ambrosio, A., Montresor, S., Parrilli, M. D., Quatraro, F., 2019. Migration, communities on the move and international innovation networks: An empirical analysis of Spanish regions, Regional Studies 53(1), 6-16.

Dahl, M. S., Sorenson, O., 2009. The embedded entrepreneur. European Management Review 6(3), 172-181.

Dahl, M. S., Sorenson, O., 2012. Home Sweet Home: Entrepreneurs' Location Choices and the Performance of Their Ventures. Management Science 58(6), 1059-1071.

Easterly, W.; Levine, R., 1997. Africa's growth tragedy: policies and ethnic divisions. Quarterly Journal of Economics 111, 1203-1250.

Ensley, M. D., Pearce, C. L., 2001. Shared cognition in top management teams: Implications for new venture performance. The International Journal of Industrial, Occupational and Organizational Psychology and Behavior 22(2), 145-160.

Faggian, A., McCann, P., 2006. Human capital flows and regional knowledge assets: a simultaneous equation approach. Oxford Economic Papers 58 (3), 475-500. doi: 10.1093/oep/gpl010.

Feldman, M. P., 2001. The Entrepreneurial Event Revisited: Firm Formation in a Regional Context. Industrial and Corporate Change 10(4), 861-891.

Finkelstein, S.; Hambrick, D., 1990. Top-management-team tenure and organizational outcomes: the moderating role of managerial discretion. Administrative Science Quarterly 35, 484–503.

Freeman, R. B., Huang, W., 2015. Collaborating with people like me: Ethnic co-authorship within the US. Journal of Labor Economics 33**,** S289-S318.

Gagliardi, L., 2015. Does skilled migration foster innovative performance? Evidence from British local areas. Papers in Regional Science 94, 773–794.

Gallouj F., Savona M., 2008. Innovation in services: a review of the debate and a research agenda. Journal of Evolutionary Economics 19, 149.

Garfinkel, M., 2004. On the stability of group formation: Managing the conflict within. Conflict Management and Peace Science 21, 43-68.

Geroski, P., 1991. Market dynamics and entry. B. Blackwell.

Geroski, P. A., 1995. What do we know about entry? International Journal of Industrial Organization 13(4), 421-440.

Global Entrepreneurship Research Association, 2017. Global Report of the Global Entrepreneurship Monitor 2016/ 2017. http://www.gemconsortium.org/report.

Granovetter, M., 1983. The strength of weak ties: A network theory revisited. Sociological Theory 1, 201-233.

Haas, A., Lucht, M., 2013. Heterogeneous firms and imperfect substitution. The productivity effect of migrants. Norface Migration Discussion Paper, 2013-19.

Harper, D. A., 2008. Towards a theory of entrepreneurial teams, Journal of Business Venturing 23(6), 613-626.

Hong, L., Page, S. E., 2001. Problem solving by heterogeneous agents. Journal of Economic Theory 97(1), 123-163.

House, R. J., Hanges, P. J., Javidan, M., Dorfman, P. W., Gupta, V. (eds.), 2004. Culture, Leadership, and Organizations. The GLOBE Study of 62 Societies. Thousand Oaks, London, New Delhi (Sage).

Huergo, E., Jaumandreu, J., 2004. How Does Probability of Innovation Change with Firm Age? Small Business Economics 22, 190-207.

Hülsheger, U. R., Anderson, N., Salgado, J. F., 2009. Team-level predictors of innovation at work: a comprehensive meta-analysis spanning three decades of research. Journal of Applied psychology 94(5), 1128-1145.

Jacobs, J., 1969. The Economies of Cities. Random House, New York.

Kaiser, U., Müller, B., 2015. Skill heterogeneity in startups and its development over time. Small Business Economics 45(4), 787-804.

Kemeny, T.; Cooke, A., 2018. Spillovers from Immigrant Diversity in Cities, Journal of Economic Geography, 18(1), 213–245.

Kilduff, M., Angelmar, R., Mehra, A., 2000. Top management-team diversity and firm performance: Examining the role of cognitions. Organization Science 11, 21-34.

Klepper, S., 1996. Entry, Exit, Growth, and Innovation over the Product Life Cycle. The American Economic Review 86, 562-583.

Knight, D., Pearce, C. L., Smith, K. G., Olian, J. D., Sims, H. P., Smith, K. A. and Flood, P., 1999. Top management team diversity, group process, and strategic consensus. Strategic Management Journal 20, 445-465.

Kochan, T., Bezrukova, K, Ely, R., Jackson S., Joshi, A., Jehn, K., Leonard, J., Levine, D., Thomas, D., 2003. The effects of diversity on business performance: Report of the Diversity Research Network. Human Resource Management 42, 3-21.

Laursen, K., Mahnke V., Vejrup-Hansen, P., 2005. Do Differences Make a Difference? The Impact of Human Capital Diversity, Experience and Compensation on Firm Performance in Engineering Consulting, DRUID Working Papers 05-04.

Lawson, C., Salter, A., Hughes, A., Kitson, M., 2019. Citizens of somewhere: The geography of foreign and native-born academics' engagement with external actors. Research Policy 48(3), 759-774.

Lazear, E., 1999. Culture and language. Journal of Political Economy 107, 95-126.

Lee, N., 2015. Migrant and ethnic diversity, cities and innovation: Firm effects or city effects? Journal of Economic Geography 15(4), 769–796.

Lee, N., Nathan, M., 2013. Cultural Diversity, Innovation, and Entrepreneurship: Firm-level Evidence from London. Economic Geography 8, 367-394.

Leung A., Zhang J., Wong P.K., Foo, M. D., 2006. The use of networks in human resource acquisition for entrepreneurial firms: Multiple “fit” considerations. Journal of Business Venturing 21, 664-686.

Lissoni, F., 2018. International Migration and Innovation Diffusion: An Eclectic Survey. Regional Studies 52(5), 702-714.

Maurseth, P. and B. Verspagen, 2002. Knowledge Spillovers in Europe: A Patent Citations Analysis. Scandinavian Journal of Economics 104(4), 531–45.

Miguélez, E. 2016, Inventor Diasporas and the Internationalization of Technology, The World Bank Economic Review 32(1), 41-63.

Milliken F. J., Martins L. L., 1996. Searching for Common Threads: Understanding the Multiple Effects of Diversity in Organizational Groups. Academy of Management Review 21, 402-433.

Niebuhr, A., 2010. Migration and innovation: Does cultural diversity matter for regional R&D activity? Papers in Regional Science 89, 563-585.

OECD and Eurostat, 2005. Oslo Manual - Guidelines for Collecting and Interpreting Innovation Data. Paris.

Østergaard, C., Timmermans, B., Kristinsson, K., 2011. Does a different view create something new? The effect of employee diversity on innovation. Research Policy 40, 500-509.

Ottaviano, G., Peri, G., 2006: The economic value of cultural diversity: Evidence from US cities. Journal of Economic Geography 6, 9-44.

Ozgen, C., Nijkamp, P., Poot, J., 2017. The elusive effects of workplace diversity on innovation. Papers in Regional Science 96, 29-49.

Picci, L., 2010. The internationalization of inventive activity: A gravity model using patent data. Research Policy 39, 1070–1081.

Rauch, J. E., 2001. Business and social networks in international trade. Journal of Economic Literature 39(4), 1177-1203.

Raymond, W., Mohnen, P., Palm, F., Schim van der Loeff, S., 2010. Persistence of innovation in Dutch manufacturing: Is it spurious? The Review of Economics and Statistics 92, 495-504.

Reagans, R., Zuckerman, E.W., 2001. Networks, Diversity, and Productivity: The Social Capital of Corporate R&D Teams. Organization Science 12, 502–517.

Richard, O., Kochan, T., McMillan-Capehart, A., 2002. The impact of visible diversity on organizational effectiveness: Disclosing the contents in Pandora's black box. Journal of Business and Management 8, 265-292.

Richard, O., Murthi, B., Ismail, K., 2007. The impact of racial diversity on intermediate and long-term performance: The moderating role of environmental context. Strategic Management Journal 28, 1213-1233.

Roach, M., Sauermann, H., 2015. Founder or Joiner? The Role of Preferences and Context in Shaping Different Entrepreneurial Interests. Management Science 61, 2160-2184.

Ruef, M., 2002. A structural event approach to the analysis of group composition. Social Networks 24, 135-160.

Ruef, M., Aldrich, H. E., Carter, N. M., 2003. The Structure of Founding Teams: Homophily, Strong Ties, and Isolation among U.S. Entrepreneurs. American Sociological Review 68, 195-222.

Schubert, T., Tavassoli, S., 2020. Product Innovation and Educational Diversity in Top and Middle Management Teams. Academy of Management Journal 63(1), 272–294.

Sorenson, O., 2018. Social networks and the geography of entrepreneurship. Small Business Economics 51(3), 527-537.

Sternberg, R., 2009. Regional Dimensions of Entrepreneurship. Foundations and Trends in Entrepreneurship 5(4), 211-340.

Trax, M., Brunow, S., Suedekum J., 2015. Cultural diversity and plant-level productivity, Regional Science and Urban Economics 53, 85-96.

Van Knippenberg, D., Schippers, M. C., 2007. Work group diversity. Annual Review of Psychology 58, 515-541.

Wang, J., Cheng, G. H.-L., Chen, T., Leung, K., 2019. Team creativity/innovation in culturally diverse teams: A meta-analysis. Journal of Organizational Behaviour 40, 693-708.

Webber S.S., Donahue L.M., 2001. Impact of highly and less job-related diversity on work group cohesion and performance: A meta-analysis. Journal of Management 27, 141-162.

Williams, K., O'Reilly, C., 1998. The complexity of diversity: A review of forty years of research. Research in Organizational Behavior 21, 77-140.

Witell, L., Snyder, H., Gustafsson, A., Fombelle, P., Kristensson, P., 2016. Defining service innovation: A review and synthesis. Journal of Business Research 69, 2863-2872.

Appendix

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