Bridging the gap: Exploring the relationship between citizenship diversity of the employees and global innovation networks

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Abstract

Recent literature stresses the increasing importance of international and global innovation networks as a mechanism to organize innovation processes. This paper investigates why and to what extent citizenship diversity of the firm´s employees relates to the engagement of firms in international and global innovation networks (GINs). Citizenship diversity provides larger social networks to build GINs, a broader search space, and knowledge about the institutional context of other countries. Further, the paper examines how the absorptive capacity of firms mediates the relationship between citizenship diversity and global innovation networks. The empirical study is based on a linked employee-employer dataset with 7,921 observations of innovative firms in Sweden. It provides strong evidence that the engagement in international and global innovation networks is positively related to citizenship diversity, depending, however, on the absorptive capacity of firms.

1 Introduction

Innovation has long been conceptualized as the result of interactive learning with external sources of knowledge (Lundvall 1992). Firms innovate in open models (Chesbrough 2006) with strategic linkages to other firms, users (Laursen 2011; Lundvall 1988; Von Hippel 1988) and universities, among other actors. The geography of these knowledge linkages takes a lion´s share of innovation studies, particularly (but not exclusively) at the boundaries between economic geography and innovation studies. Scholars in the geography of innovation have greatly contributed to the understanding of localized learning processes (Maskell and Malmberg 1999) as well as the relevance of international knowledge linkages (Asheim and Isaksen 2002; Bunnell and Coe 2001). Related to this last strand of literature, a body of research on global innovation networks (GINs) has recently emerged, with a focus on knowledge flows and interactive learning between globally distant actors and their impact on innovation performance (Chaminade and Vang 2008; Cooke 2012; Parrilli, Nadvi, and Yeung 2013; Sachwald 2008; Van Egeraat and Kogler 2013; Cooke 2013; Ernst 2009; Herstad and Ebersberger 2015; Herstad, Aslesen, and Ebersberger 2014). Importantly, this literature on GINs does not devaluate localized learning processes but argues that GINs can play an important role as a complementary or compensatory mechanism to local or regional knowledge linkages (Fitjar and Rodríguez-Pose 2013; Grillitsch and Nilsson 2015; Chaminade and Plechero 2015).

This recent literature on GINs has contributed to our understanding about the factors that influence the engagement of firms in GINs, most importantly firm-specific factors such as human capital, research and development (Ebersberger and Herstad 2013), exports, foreign ownership, and strategy; the dominant knowledge base of an industry; and the regional and national context conditions (Chaminade 2011; Nam and Li 2012; Martin and Moodysson 2013; Plechero and Chaminade 2013; Liu, Chaminade, and Asheim 2013; Herstad, Aslesen, and Ebersberger 2014). With the sole exception of Solheim and Fitjar (2016), the issue of diversity of the labour force in terms of country of origin has been widely neglected as a factor influencing the propensity of firms to engage in GINs.

As firms are the nodes in GINs, this paper contributes conceptually to the growing literature on international and global innovation networks by introducing the citizenship diversity of the firm's employees as an enabler for the establishment of GINs. The proposed conceptualisation builds on the idea that individuals carry idiosyncratic social capital and knowledge about institutional contexts due to past experience and interactions in different social groups, which in turn is largely influenced by mobility between places of work, study, and living. The view adopted in this paper thus recognises the importance of individuals and their mobility in the process of establishing and maintaining GINs while taking the firms as the unit of analysis.

While the existing literature has contributed to our understanding of the relationship between citizenship diversity and firm performance and to a lesser extent between citizenship diversity and innovation, much less is known about the links between citizenship diversity and the propensity of firms to internationalize their innovation activities or their underlying mechanisms.

The paper addresses this gap by disentangling the mechanisms through which firm-level citizenship diversity affects the establishment, maintenance and creation of GINs. Citizenship diversity promotes firms' engagement in GINs by providing social networks to individuals and organisations located in other countries (Agrawal, Cockburn, and McHale 2006; Saxenian and Sabel 2008), a broadened search space of firms (Østergaard, Timmermans, and Kristinsson 2011; Laursen 2012; Ebersberger et al. 2011), as well as knowledge about the institutional context of other countries and increased capabilities to deal with institutional differences (Grillitsch 2015). The first two mechanisms are well covered in the literature on firms' innovation networks, whereas the third mechanism has received limited attention. This is surprising as much of the complexity of GINs relates to country-level institutional differences that firms have to bridge (Hsu, Lien, and Chen 2015; Alvandi, Chaminade, and Lv 2014; Dachs et al. 2012).

Moreover, the paper acknowledges that the link between firm's engagement in GINs and firm-level citizenship diversity is contingent on the absorptive capacity of firms (Zahra and George 2002; Cohen and Levinthal 1990) as well as individual characteristics of employees with foreign citizenship (Fitjar

and Rodríguez-Pose 2014; Solheim and Fitjar 2016). Individual characteristics relate in particular to education as a means to deal with complexity and potentially increasing cognitive proximity in specific professions and to the position of employees with foreign citizenship in firms as not all positions are equally relevant for shaping innovation networks.

Empirically, the paper investigates the relationship between firms' engagement in GINs and firm-level citizenship diversity, as well as the mediating effect of absorptive capacity, on a representative sample of 7,921 observations of innovative firms generated from merging four waves of the Community Innovation Survey (CIS) in Sweden. The CIS provide information about the spatial configuration of firms' innovation networks as well as numerous control variables. This data is merged with linked employer-employee data provided by Statistical Office of Sweden (SCB) in order to measure diversity of the labour force. Instead of treating international linkages as a black box, this paper investigates the impact of diversity on innovation networks within Sweden, within Europe, Outside Europe and global (networks with partners in all geographical areas) thus truly investigating GINs. We consistently find that firms with a diverse labour force in terms of citizenship of its employees tend to engage more in GINs, dependent, however, on the level of absorptive capacity. The managerial implication of our theoretical discussion and empirical findings is that employing staff with different national backgrounds is an important mechanism to overcoming barriers for firms' participation in GINs.

The paper proceeds as follows: Section 2 elaborates on the concept of firm-level citizenship diversity, and in particular why and how citizenship diversity contributes to the engagement of firms in GINs. Section 3 presents the empirical strategy followed by a discussion of the results in section 4. Section 5 concludes the paper.

2 Literature Review

2.1 Citizenship diversity and innovation

The role of diversity of the labour force on firm performance has long been studied (Horwitz 2005), but it has only recently been used in connection to innovation performance (Østergaard, Timmermans,

and Kristinsson 2011; Solheim and Fitjar 2016). At a general level, existing empirical evidence suggests that the impact of *diversity on firm´s performance* is highly contingent on the type of diversity. Ruef, Aldrich, and Carter (2003) distinguish between ascribed and achieved attributes of diversity, the *ascribed* attributes being those related to demographic characteristics such as gender, age, ethnicity and nationality, while the *acquired* attributes are mostly related to education, experience or job function. The later are also referred to in the literature as job-related attributes. Generally speaking, job-related attributes of diversity, like educational background and functional background are positively related to performance[1] while the impact of other diversity attributes like gender, race or citizenship are often associated with conflicts and thus negative firm performance (Pelled 1996; Bell et al. 2010; Horwitz 2005) although the results are highly contingent on the group in which the analysis is performed (Shore et al. 2009). The negative impact of ascribed diversity on performance is generally explained in terms of conflicts, miscommunication and lack of trust of the different group or team members (Horwitz 2005; Shore et al. 2009). Of all demographic traits of diversity, ethnicity has the potential to positively impact performance by bridging the knowledge gap to potential markets (Cox and Blake 1991, cf Horwitz, 2005).

The relationship between *diversity and innovation* has far less been studied. Simonen and McCann (2008) provide evidence for a positive relationship between recruitment of labour from other regions and product and process innovations. Lee and Nathan (2010) find that workforce and ownership diversity contributes to product and process innovations. The study by Nathan and Lee (2013) reports a small but significant positive effect of diversity on firm innovation and surprisingly the effect is stronger for less knowledge-intensive sectors.

Interestingly, some of the attributes which are considered to impact firm performance negatively, are found to be positively related to innovation. Ozgen et al. (2013) show that the mix of foreign nationalities contributes to firm innovativeness and Parrotta et al. (2014) find that ethnic diversity is positively related to firms' patenting behaviour. Using the DISKO innovation survey matched with

[1] Diversity in educational level is however negatively associated to performance (Bell et al. 2010).

employer-employee data, Østergaard, Timmermans, and Kristinsson (2011) investigate the relationship between diverse measures of ascribed and achieved diversity such as gender, age, ethnicity and education on the likelihood of the firm to introduce product or service innovations. They found a positive relation between diversity in education years, education background and gender and a negative relation between diversity in age and innovation. The authors hypothesize that workforce diversity is positively related to innovation to the extent that it helps firms to tap into and combine different forms of knowledge needed to innovate thus pointing out to the role of innovation networks as a liaison between diversity and innovation. However, the mechanisms through which citizenship diversity relates to international and global linkages remain to be explored.

2.2 Citizenship diversity and global innovation networks

There is growing evidence on the relationship between the geography of innovation networks and innovation performance suggesting that international and even global linkages tend to promote radical innovations. The underlying rationale is that local and regional networks tend to provide access to similar knowledge (Visser and Boschma 2004; Asheim and Isaksen 1997) while international and global innovation networks enable firms to tap into new pools of knowledge (Laursen and Salter 2006; Plechero and Chaminade 2016; Herstad, Aslesen, and Ebersberger 2014). It follows from this line of argument that global innovation networks are desirable if the aim is to achieve higher degrees of novelty in technological innovations.

With the exception of Solheim and Fitjar (2016), the role of diversity, particularly citizenship diversity on the propensity to internationalize innovation activities has remained largely unexplored in the literature. Firm-level citizenship diversity is expected to be conducive for firms' engagement in GINs for at least three reasons: i) social network effects, ii) a broader search space, and iii) knowledge of the institutional context in other countries and increased capabilities to deal with institutional differences.

Citizenship diversity goes hand in hand with a greater breath of social networks, on which a firm can draw for engaging in GINs. The relevance of social networks in this regard is justified by the higher

likelihood of establishing social networks in close geographic proximity and the durability of social networks over time even if individuals change locations. Social networks are often forged when individuals interact face-to-face, at for instance university, their workplace or where they live. In this regard, it has been shown that regional labour mobility is an important factor explaining local knowledge spillovers (Breschi and Lissoni 2009) and that firms dominantly recruit regionally in order to source knowledge (Grillitsch, Tödtling, and Höglinger 2015; Plum and Hassink 2013). Geographic proximity can thus be seen as intermediary factor that increases the likelihood that people meet, interact, and build social relationships, even though not all individuals and firms in a given location are equally engaged in local networking or have equal access (Giuliani 2007; Morrison 2008).

Social networks facilitate the exchange of information and interactive learning, reduce the likelihood of opportunistic behaviour (Granovetter 1985, 2005) and contribute to overcoming geographic distance and institutional barriers (Boschma 2005). While co-location increases the propensity to build social networks, they are maintained when people move to other places (Agrawal, Cockburn, and McHale 2006; Saxenian and Sabel 2008; Trippl 2013). This implies that the social networks that individuals have built over time where they grew up, lived and worked can potentially be activated in order to facilitate the engagement of firms in GINs. As regards GINs, it can thus be expected that the social networks of employees with foreign citizenship to their home country are an important factor strengthening a firm's ability to engage and draw value from GINs (Oettl and Agrawal 2008).

Citizenship diversity and the related social networks translate into a broader information and knowledge search space of firms (Østergaard, Timmermans, and Kristinsson 2011; Laursen 2012). A wide search space in the context of GINs means that firms are able to draw on reliable information about potential collaboration partners for their innovation activities in different parts of the world. It can be assumed that employees with foreign citizenships have relatively good knowledge about the relevant organisations in their home country in the field of their professional experience. Social networks often help to gather such information or to receive such information in passing. Also, there might be country specific differences how to search for information. Thus, in all these ways, firm-level

citizenship diversity contributes to broadening the search space of firms in relation to the engagement in GINs.

Citizenship diversity also increases the ability of firms to cope with different institutional contexts. A defining feature of GINs is that it concerns activities crossing national boundaries and on a global scale (Parrilli, Nadvi, and Yeung 2013). This implies that firms have to overcome institutional barriers related to differences in laws and regulations such as intellectual property rights, business law, labour law, and environmental regulations; differences in how the legal system works; as well as more informal aspects such as divergent norms, values, beliefs and how to interact with business partners. Recent studies show that managing the complexity of different institutional contexts is one of the most important barriers for firms as regards their participation in GINs and that consequently the ability to cope with culturally different institutional environments should be positively related with the propensity of firms to engage in internationalization of production and innovation activities (Hsu, Lien, and Chen 2015; Alvandi, Chaminade, and Lv 2014; Dachs et al. 2012). This is the case for workers with a foreign citizenship who have a good understanding of their home country's culture (Solheim and Fitjar 2016). For such workers it will be relatively easy to establish new networks with partners in their home country, maintain networks and draw value from such networks. The reason is that employees with foreign citizenship can communicate in their native language and understand the social codes, which allows them to behave according to expectations and facilitates building trust-based relationships. Furthermore, they will be at an advantage in dealing with the legal and regulatory environment in their home country. Knowledge exchange and interactive learning over distance becomes more feasible, in other words, less is lost in translation.

Due to social network effects, a broader search space, and knowledge of the institutional context in other countries, we expect that:

Hypothesis 1: Firms with a high degree of citizenship diversity have a higher likelihood to participate in international and global innovation networks.

Individual characteristics of the employees with foreign citizenship are important when investigating their effect on firms' engagement in GINs. Fitjar and Rodríguez-Pose (2014) find that education increases the likelihood of Norwegian firms to establish international collaboration linkages at the expense of local links. This has to do with the complexity of GINs requiring firms to overcome geographic and institutional distance. Education increases the capacity of individuals to deal with such complexity. Furthermore, education in specific professions increases cognitive proximity, which facilitates overcoming other forms of distance (Boschma 2005). Furthermore, Solheim and Fitjar (2016) argue that citizenship may be related to performance and the propensity of firms to collaborate internationally to the extent to which they are highly educated or hold higher positions in the company. The argument is that lower positions shape innovation networks of firms to a lesser extent than higher positions.

Furthermore, the effect of firm-level citizenship diversity on the engagement in global innovation networks is mediated by the absorptive capacity of the firm (Zahra and George 2002; Cohen and Levinthal 1990). Cohen and Levinthal (1990, p. 129) argue that the premise of the notion "is that the organization needs prior related knowledge to assimilate and use new knowledge". This implies that firms with high absorptive capacity are able to benefit from innovation networks while firms with low absorptive capacity find little use in engaging in such networks. What is more, learning process become more difficult over geographic distance, in particular if geographic distance is combined with institutional distance (Boschma 2005). It follows that a higher degree of absorptive capacity is required in order to compensate for lacking geographic or institutional proximity. Lacking absorptive capacity, it will be difficult for firms to establish and draw benefits from GINs. Hence, firm-level citizenship diversity is expected to be largely ineffective for firms with low levels of absorptive capacity. At very high levels of absorptive capacity, it is, however, also conceivable that absorptive capacity can compensate for citizenship diversity. One reason for this can be found in Boschma's (2005) proximity argument where high cognitive proximity may compensate for high geographic, institutional, and social distance. Another reason is that high absorptive capacity (as citizenship diversity) should enable firms to deal with the complexities of GINs. Hence, we expect that the effect

of citizenship diversity increases with absorptive capacity but may level off at high levels of absorptive capacity. The extent to which this holds true will be investigated for Sweden.

Hypothesis 2): The relationship between citizenship diversity and firms' participation in international and global innovation networks increases with absorptive capacity.

3 Empirical strategy

3.1 Data sources

The study uses data provided by the Statistical Office of Sweden (SCB) comprising the Community Innovation Survey (CIS), longitudinal individual registry data, business registry data, firm and establishment dynamic data and business statistics data. The CIS is a large-scale European survey that captures innovation activities and innovation networks of firms. The methodology for the CIS has been developed by Eurostat and implemented by the national statistical offices of the participating countries. The CIS is conducted in two-year intervals. The dataset for this study is a merger of four waves covering the periods 2004-2006, 2006-2008, 2008-2010, and 2010-2012. The longitudinal individual registry includes among others data on individuals' occupations, education, citizenship, and respective employers for each individual registered in Sweden and aged above 16 years. The individual registry data is measured each year on the 31st of December except for some variables like employment for which the measurement is undertaken in November. In order to account for this, the analysis is performed on individual data one year before each CIS period. For instance, individual registry data for 2003 is used in combination with the CIS wave covering the period from 2004-2006. As the database includes all individuals registered in Sweden, important characteristics of the workforce of Swedish firms can be represented. In particular, it constitutes a highly reliable source for measuring citizenship diversity as well as human capital within a firm. The business registry data, firm establishment and dynamics data and business statistics data are used to construct the control variables as further explained below.

3.2 Dependent Variable

The dependent variables capture innovation collaborations of firms at different geographical scales. Firms are asked in the CIS whether they have cooperated on any of their innovation activities with other organisations, and if so at which spatial scale and with which type of organisation. We apply a strict operationalization of GINs where firms receive a value of 1 if they have reported innovation collaborations in all of the main world regions that can be identified through the CIS, namely Europe, USA, China or India, and others. All other firms receive a value of 0. The results for firms with GINs are compared to the results obtained for firms maintaining innovation networks outside Europe, innovation networks in Europe (but outside Sweden), and in Sweden.

3.3 Independent variables

The operationalization of diversity depends on the conceptual idea this construct represents. Harrison and Klein (2007) distinguish between diversity understood as separation, variety or disparity. Separation aims to capture differences in position or opinion between group members that potentially reduce cohesiveness and introduces conflict. Variety conceptualises diversity in a positive manner as complementary types of knowledge or experience. Disparity concerns differences in the share held by individual agents in socially valued assets such as income, power, or status. In the context of this paper, citizenship diversity is conceptualised as a proxy for variety in social networks, knowledge about different institutional contexts and search spaces, which facilitate the engagement of firms in GINs. Hence, the Blau index, a typical and frequently used operationalization of diversity, is used to operationalise citizenship diversity:

$$Citizenship\ Diversity = 1 - \sum_{k=1}^{K} p_k^2$$

where p denotes the share of highly qualified individuals belonging to citizenship groups $k = 1, \ldots, K$ in the total of qualified staff of a firm.

The focus on highly qualified individuals is justified as research has shown that education and position of employees with foreign citizenship are essential when examining their effects on GINs (Fitjar and Rodríguez-Pose 2014; Solheim and Fitjar 2016). Highly qualified individuals refer to those who are in a position and able to influence innovation networks. Highly qualified individuals are identified using occupational data available in the longitudinal individual register. The Swedish classification of occupations SSYK 96 follows the International Standard Classification of Occupations ISCO-88 and orders occupations in a hierarchical framework. It captures the "set of tasks or duties designed to be executed by one person", "the degree of complexity of constituent tasks", and "the field of knowledge required for competent performance of the constituent tasks" (SCB 1998 p. 17). SSYK classifies occupations in 10 major groups out of which group one (managers), two (professionals) and three (technicians and associate professionals) contain occupations that are very relevant in innovation processes and require high skill levels. Individuals classified in one of these three groups are thus identified as highly qualified. Occupational data has important advantages over educational data because it captures the actual work individuals are performing at present while educational data may refer to qualifications that were required long time back or that are not utilised in the activities and tasks of an employee. The citizenship groups provided by the longitudinal individual registry comprise: Sweden, Nordic countries (but Sweden), Europe (but Nordic countries), Africa, North America, South America, Asia, and other.

As absorptive capacity is a precondition for appropriating and using new knowledge acquired through innovation networks (Zahra and George 2002; Cohen and Levinthal 1990), it is included in the analysis as mediating factor. Two measures capture absorptive capacity: Intramural R&D, a classic proxy for absorptive capacity, is measured in million Swedish Kronas (SEK) per employee. The measure is cubic root transformed due to the fact that the large majority of firms reported zero intramural R&D, which is not suitable for the common log transformation. In addition, this implies that all firms that do not report R&D are assumed to have no absorptive capacity, which clearly is problematic in particular for smaller firms and firms with innovation processes that are not driven by R&D. Therefore, as an alternative proxy, human capital is used and measured as share of highly

qualified staff in the total staff of a firm. Highly qualified staff, following the definition above, performs tasks that require high levels of skill and knowledge, which enables them to assimilate and use new knowledge. This measure is more relevant for smaller firms that may not earmark expenses for R&D while still employing individuals possessing the required prior knowledge.

The measurement and data source of all control variables used in the study are described in Table 1 and Annex 1 reports descriptive statistics.

Insert Table 1 approximately here

4 Results

4.1 Descriptive statistics

Table 2 presents basic distributional statistics. The total sample comprises 15,577 observations out of which half are from innovative firms. Out of the observations for innovative firms 42% have networks with Swedish partners, 31% with partners in Europe but outside Sweden, 19% with partners located outside Europe, and 6% are truly global with networks in all world regions covered by this study. Overall the employment of non-Swedish staff is rather common among innovative firms. It turns out to be most likely (68%) for firms that maintain GINs compared to 44%, 51%, and 58% for firms with network partners in Sweden, Europe, and outside Europe respectively. However, the share of non-Swedish staff tends to be rather low and ranges between 2.85% for firms with innovation networks in Sweden and 4.15% for firms with GINs. The mean number of unique citizenship groups in a firm ranges between 1.8 and 2.7 for firms with Swedish and GINs respectively. The measure for citizenship diversity takes the lowest value for firms with networks in Sweden (0.0463) and turns out highest for firms with GINs (0.0743). Hence, the descriptive statistics show the expected tendencies.

Insert Table 2 approximately here

4.2 Empirical analysis

Data on innovation networks is per definition only available for firms that are innovation active, thus potentially causing a selection bias (Heckman 1979). Consequently, a Heckman selection model is applied similar to other studies using CIS data (Ebersberger and Herstad 2012; Frenz and Ietto-Gillies 2009; Lööf and Heshmati 2002; Herstad, Aslesen, and Ebersberger 2014) with the following selection model:

$$innovation\,active = \alpha + \beta firm + \delta metropolitan + \gamma industry + \lambda time + \varepsilon$$

The dependent variable captures firms that are innovation active and is a function of firm characteristics (*firm*), effects of location in a metropolitan area (*metropolitan*), industry effects (*industry*), time effects (*time*) and random errors (ε) with ε □ $N(0,1)$. As regards firm characteristics, the selection equation includes human capital, foreign market presence, size, the capacity to finance innovations and whether the firm is new. The latter two variables are the instruments used in the selection equation. Previous research has shown that new firms tend to be more innovative than mature firms (Huergo and Jaumandreu 2004). However, new firms can equally well have global networks as becomes evident for instance in the literature on born global (Knight 2010). The capacity to finance innovations is relevant due to the costs and uncertain outcomes associated with innovations (Bloom and Van Reenen 2002). Comparable to the cost of engaging in innovations, the higher transaction costs in terms of communication and transport with global partners can be considered marginal. We further corroborated the validity of these two instruments by checking for significance if they were included in the outcome equation.

The function is estimated with a probit regression applying standard errors clustered at the level of the firm in order to adjust them for repeated observations. The coefficients of the selection equation are presented in Table 3. As expected human capital, foreign market presence and firm size are positively related to the probability that firms are innovation active. Also, firms with a strong financial capacity

and firms that have been established within three years before the respective CIS wave are more likely to be innovation active. Somewhat surprising is the negative effect of being located in a metropolitan area, suggesting that negative agglomeration economies outweigh positive ones. A potential interpretation is that one of the main effects of metropolitan areas, namely access to a thick labour market, may be absorbed in the human capital indicator at the level of the firm[2].

Insert Table 3 approximately here

The inverse Mills ratio (*imr*) is calculated from the above probit regression:

$$imr = \frac{e^{-0.5\hat{y}^2}}{\sqrt{2\pi}\Phi(\hat{y})}$$

where $\hat{y}$ stands for the linear predictors of the selection function. The inverse Mills ratio is included as one of the explanatory variables in the outcome model:

$$inet = \alpha + \varphi diversity + \beta firm + \delta metropolitan + \zeta imr + \gamma industry + \lambda time + \varepsilon$$

The outcome model explains the engagement of firms in innovation networks (*inet*) as a function of citizenship diversity (*diversity*), a set of firm characteristics (*firm*), the effect of location in a metropolitan area (*metropolitan*), the inverse Mills ratio (*imr*), industry characteristics (*industry*), time effects (*time*) and random errors (ε) with $\varepsilon \sim N(0,1)$. The firm characteristics include human capital, human capital square, intramural R&D, intramural R&D square, foreign ownership, foreign market presence, and size. The model is estimated applying probit regression and standard errors clustered at

[2] We thank an anonymous reviewer for this insight.

the level of the firm. The insignificance of the Mills ratio suggests that selection effects do not substantially influence the results.

Table 4 presents the full model and shows a highly significant positive relationship between citizenship diversity and firms' engagement in innovation networks outside Europe and in GINs, the latter captures firms that maintain innovation networks in all world regions covered by the CIS (support for hypothesis 1). The relationship is only weakly significant for European innovation networks and insignificant for innovation networks in Sweden. The coefficient turns out largest for GINs, however, the difference between the coefficients for GINs and networks outside Europe is not significant. The subsequent analysis focusses on GINs.

As regards the control variables, intramural R&D and firm size are most significantly correlated to firms' engagement in innovation networks. Intramural R&D is estimated with a positive but decreasing marginal effect on innovation networks. Also, not surprisingly, large firms have a higher likelihood to participate in innovation networks at all investigated geographical scales. Human capital turns out to be significant at 5% with a curvilinear relationship like intramural R&D as regards engagement in GINs. Foreign ownership plays a role for innovation networks with European partners but not for GINs and is negatively associated with innovation networks in Sweden. A reason may be that no distinction is possible by the location of foreign owners. If many foreign owners are located in European countries, the variable will be relevant for European innovation networks but to a lesser extent for GINs. Foreign market presence tends to be positively related to firms' participation in innovation network, which, however, is statistically significant only for networks in Europe and outside Europe (not for engagements in GINs). A location in a metropolitan area is not positively related to the likelihood that firms engage in innovation collaborations. This result might reflect the fact that agglomeration benefits (access to educated employees, and employees with international experience) are already controlled for in the analysis.

Before discussing in more detail the magnitude and meaning of these results for firms' engagement in GINs, table 5 and 6 provide an indication about their robustness. Table 5 shows how sensitive the

coefficient for citizenship diversity is to the exclusion of the other control variables. It unveils that the single most important factor is intramural R&D, the exclusion of which make the coefficient for citizenship diversity rise from 1.0190 to 1.3027. Excluding any of the other independent variables would only have a minor effect on the coefficient of citizenship diversity. Table 6 presents the results if single CIS-waves are used. While the coefficients for citizenship diversity are positive for all CIS waves, the statistical significance varies. In 2006, citizenship diversity is significant at a 5% level, and in 2010 and 2012 it is significant at a 10% level, while it is not significant in 2008. Thus, combining the four CIS waves is reasonable as i) it allows for more accurate estimations with smaller standard errors and ii) there are no apparent structural changes in the data across the CIS waves.

Overall, the above analysis provides support that firms with a high level of citizenship diversity also have a higher likelihood to engage in GINs. As a next step, we consider the interrelationship with human capital and intramural R&D. This is done by including interaction variables in the base model. We take into consideration a linear interaction (citizenship diversity x human capital; citizenship x intramural R&D) as well as a curvilinear interaction by including the squared term of the interaction variable. In line with Brambor et al. (2006), we also include all the components of the squared term in the model. The main interest of such interaction models is on identifying the relationship between citizenship diversity and engagement in GINs under the condition of certain levels of either human capital or intramural R&D. Hence, we report in the text the respective average marginal effects and put the full models for information in the annex 2. It is not uncommon that the average marginal effect of a variable at certain levels of the specified condition is significant although the interaction term itself is insignificant. The analysis should therefore focus on the marginal effects and not the interaction terms (Brambor, Clark, and Golder 2006).

Table 7 presents the average marginal effects of citizenship diversity on firms' engagement in GINs conditional to certain levels of human capital (Model 1 and 2) and intramural R&D (Model 3 and 4). As regards human capital, it should be noted that firms without highly qualified staff have by definition a value of zero citizenship diversity, as the latter variable is constructed using the citizenships of highly qualified staff. It is therefore not meaningful to assess the effect of citizenship

diversity for firms that have no highly qualified staff. However, firms that employ highly qualified staff differ in the degree of citizenship diversity. Using a linear interaction (Model 1), the effect of citizenship diversity becomes significant for firms with 40% human capital (average is 45% in the sample). The average marginal effects increase from 0.0782 at 40% to 0.1574 at 100% human capital (7% of the firms in the sample have 100% human capital).

Table 8 assists in the interpretation of the size of the effect. The left part of table 8 illustrates the values of the citizenship diversity indicator for firms with 15 qualified employees. If all 15 employees belong to one citizenship group, the diversity indicator is 0. If one employee is associated with a different citizenship group, the indicator shows a value of 0.124, and so on. The right part of the table shows the increase in the average probability of GINs for specific values of citizenship diversity and average marginal effects.

Interpreting Model 1, this implies that a firm with 50% human capital has on average a higher probability to engage in GINs of approximately 2 percentage points if it has a medium level of citizenship diversity (0.240) and of 4 percentage points if it has a high one. As 5.6% of the firms in the sample engage in GINs, the effect is important in magnitude. The prediction changes substantially after introducing a curvilinear interaction (model 2). The results suggest a strong increase of the effect of citizenship diversity as human capital augments from low to medium levels, while levelling off at high levels of human capital, which is illustrated in figure 1. The highest average marginal effect of citizenship diversity is calculated at approximately 70% human capital (27% of the firms in the sample have 70% or more human capital).

Comparing these results with model 3 and 4, which interact the citizenship diversity variable with intramural R&D, the most important difference is found in the linear interaction as citizenship diversity has a positive effect also if intramural R&D is zero (model 3). The average marginal effect of citizenship diversity increases from 0.0795 at zero intramural R&D to 0.1403 at 0.6 intramural R&D, i.e. it almost doubles in this range of values for intramural R&D, which comprises 88% of the firms. The average marginal effects level off for firms with the highest levels of intramural R&D.

Introducing a curvilinear interaction (model 4), the results point to a strong increase of the effects as intramural R&D augments from low to medium/high levels but flattening at the highest levels of intramural R&D. This is illustrated in figure 2. The largely increasing confidence interval beyond intramural R&D of 1 is due to few observations (only 3.5% of the firms have a value higher than 1).

Figure 3 and 4 illustrate the magnitude of the effects as per table 7 model 2 and 4. The figures show the predicted percentage points change in probability that firms engage in GINs for firms with low (0.124), medium (0.240) and high levels (0.444) of citizenship diversity (see table 8) as compared to firms with zero citizenship diversity. According to figure 3, the probability increase is highest conditional to 70% human capital and amounts to 4, 8 and 15 percentage points for firms with low, medium, and high levels of citizenship diversity respectively. The effect of citizenship diversity tends to decrease at the highest levels of human capital. Figure 4 shows increasing probabilities in the range of significant values (up to a value of intramural R&D of approximately 1.1). Conditional to a value of 1 for intramural R&D, the probability increase is on average 6, 12, and 21 percentage points for firms with low, medium, and high levels of citizenship diversity respectively. At 0.5 intramural R&D the respective probability increases are 3, 7, and 12 percentage points. The results, therefore, confirm that that the effect of citizenship diversity increases with the level of absorptive capacity but levels off at high levels of absorptive capacity (support for hypothesis 2). The predicted relationship holds for the largest range of values of human capital and intramural R&D and the predicted magnitudes of the effects are relatively similar if the respective models are compared.

5 Conclusions

In the last decades, we have witnessed an increase in the global distribution of innovation networks (De Prato and Nepelski 2012; Herstad, Aslesen, and Ebersberger 2014) and a number of studies have shown how GINs significantly contribute to the innovativeness and economic performance of firms (Plechero and Chaminade 2016). This paper advances a discussion on the relationship between firms' engagements in GINs and firm-level citizenship diversity. It is argued that this relationship rests on three main mechanisms: i) social network effects, ii) a broader search space, and iii) knowledge of the

institutional context in other countries and increased capabilities to deal with institutional differences. The empirical study indeed provides robust evidence for a positive relationship between firm-level citizenship diversity and the propensity of firms to engage in GINs.

The paper, however, also carves out that this relationship depends on the absorptive capacity of firms, which is a precondition to identify, absorb, and use new knowledge through innovation networks (Cohen and Levinthal 1990; Zahra and George 2002). Therefore, absorptive capacity is introduced as essential factor mediating the relationship between firm-level citizenship diversity and firms' engagement in GINs. The results indicate that without a minimum level of absorptive capacity, firms will not be able to successfully search, capture and integrate the knowledge acquired through global networks and manage the complexity of internationalization. As absorptive capacity increases, captured by the qualification of the labour force, the relationship between firm-level citizenship diversity and engagement in GINs becomes stronger. The results further suggest that this increases levels off at very high levels of absorptive capacity. Two reasons are identified that may explain this pattern. First, a high level absorptive capacity potentially increases cognitive proximity between partners in the network, thereby compensating for other forms of distance, most importantly geographical, institutional and social (Boschma 2005). Second, a high absorptive capacity also contributes (as does citizenship diversity) to deal with the complexities of engaging in GINs.

This raises an important point for studies that investigate factors driving firms' engagement in GINs: looking at the unconditional effects only (not considering the mediating effect of absorptive capacity) may render the analysis meaningless. The insignificance of factors for firms with a low absorptive capacity is mixed up with the significance of factors for firms with a high absorptive capacity, leading to a diluted result.

The paper connects to the literature by discussing why firm-level citizenship diversity is related to the breath of social networks (Agrawal, Cockburn, and McHale 2006; Saxenian and Sabel 2008) and breath of search space (Østergaard, Timmermans, and Kristinsson 2011; Laursen 2012; Ebersberger et al. 2011), thereby promoting GINs. Additionally, the paper discusses the role of citizenship diversity

in reducing the institutional distance with foreign partners thus facilitating the formation of GINs. Firms that engage in GINs have to bridge country-level institutional differences and this is one of the main barriers for firms (Hsu, Lien, and Chen 2015; Alvandi, Chaminade, and Lv 2014; Dachs et al. 2012). By employing staff from different countries, firm-internal knowledge about the institutional context of other countries is enhanced and the capacity to deal with institutional differences increased.

The limitations of our empirical analysis relate by and large to the availability of more fine-grained data. The measurement of GINs is limited to the existence of global innovation linkages. We have poor data about the breadth and depth of GINs or their quality. Furthermore, the measurement of firm-level citizenship diversity is limited to citizenship groups. Data about single countries or how long individuals have lived in Sweden is not accessible. Following the theoretical discussion, it can be expected that singling out the countries of citizenship and GIN involvement should yield even stronger results than was possible with the data used in this study. Furthermore, ideally, longitudinal data would be available that allowed observing whether a change in firm-level citizenship diversity leads to more engagement in GINs, thereby better addressing the issue of endogeneity. Although there are repeated observations in the different waves of the CIS, these relate mainly to large firms with limited variability over time. Thus, the empirical analysis cannot claim to have identified causality.

In conclusion, our discussion and analysis provide novel inputs to the emergent scholarly work on global innovation networks by providing insights into the mechanisms through which firm-level citizenship diversity is expected to stimulate firms' participation in GINs as well as evidence of their positive relation. Our evidence shows that firm-level citizenship diversity is positively related to international collaboration for innovation but that the final impact is mediated by the initial level of absorptive capacity of the firm.

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