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**Seeking variety across temporary clusters: The effect of conference
attendance diversity on firm-level innovation**

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Abstract

This paper builds on the recent notion that scientific and professional conferences act as temporary clusters. We seek to identify the effects of knowledge-related and geographic diversity across the temporary clusters attended by a firm on its innovation performance, and how this relationship is moderated by the firm's absorptive capacity. Our findings show that, overall, both knowledge-related and geographic diversity across temporary clusters have an inverted U-shape effect on a firm's innovation performance. However, the extent to which a firm experiences the benefits and costs associated with both types of diversity depends on its level of absorptive capacity. Our findings contribute to the literature on temporary clusters by highlighting their contingent value as channels through which firms access knowledge.

1. Introduction

Innovation is considered one of the few remaining, durable sources of competitive advantage, and its spatial manifestation remains a key domain of interest for scholars in the fields of regional economics and economic geography. Traditionally, research on the spatial organization of innovation has tended to stress the crucial role of clusters¹ (Gordon and McCann, 2000). More recently, studies of such “permanent” clusters are being complemented by research that emphasizes the importance of its temporary equivalents, or temporary clusters (Bathelt, 2012; Bathelt and Schuldt, 2008).

Temporary clusters (TC), in the form of trade fairs, conferences, and other types of industry gatherings, are increasingly recognized as important loci for establishing and sustaining processes of interactive learning, knowledge creation, and innovation (Bathelt and Schuldt, 2008; Rychen and Zimmermann, 2008; Stam, 2010). TCs enable participants to quickly and efficiently generate an overview of the current market frontier, and they facilitate access to technologically and geographically distant knowledge pools and markets (Maskell et al., 2006; Seringhaus and Rosson, 1994). As such, TCs function as temporary social contexts that enable participants to interact with other companies. In this regard, the knowledge-exchange mechanisms present at TCs are found to be similar to those observed in permanent clusters (Maskell et al., 2006).

Prior research has addressed the potential importance of TCs for firm innovation by focusing on the communication processes taking place at such events, but has yet to address the question of how firms should approach selecting appropriate events with the aim of increasing their innovative performance. In other words, what

¹ For the current paper we choose to apply the phrase ‘cluster’ as a generic term for models of regional/territorial innovation that adopt an interactive view of innovation and knowledge exchange (Moulaert and Sekia, 2003).

firm-level strategy of TC attendance is preferable in a context of enhancing innovative performance? Extant literature focuses on the learning benefits that firms may enjoy from participating in events that are characterized by diversity among attendees – or *diversity within events* – which presumably offers the benefit of a richer opportunity structure (Bathelt and Schuldt, 2008; Stam, 2010). However, firms typically attend more than one TC and may enjoy the benefits of innovation from participating in a variety of events, or *diversity across events*. Participation in various TCs gives firms access to knowledge with diverse geographical and technological origins, resulting in global pipelines to distant clusters and access to types of knowledge that are not found in the home region of the firm (Bathelt and Spigel, 2012; Bathelt and Schuldt, 2010; Maskell et al., 2006). In this article, we denote the latter as *knowledge diversity across events* and the former as *geographic diversity across events*. In addition, we explore the extent to which firms are heterogeneous in their ability to benefit from both types of diversity as a result of differences in absorptive capacity between firms (Cohen and Levinthal, 1990).

The current study examines firms' TC attendance in terms of knowledge-related and geographic diversity across events, and those firms' subsequent innovative performance. Firms spend a great amount of resources on TC attendance (Browning and Adams, 1988), and prior studies have indicated that TCs are significant determinants of a firm's sales performance (Seringhaus and Rosson, 2001; Gopalakrishna et al., 1995). Thus, a good understanding of how firms can maximize the innovation value stemming from TC attendance is highly valuable and conducive to better appreciate the role of TCs as channels through which firms access knowledge and other resources.

The main contributions of this study are twofold. First, we contribute to the TC literature by illuminating the role of TCs in sustaining innovation beyond the interactive learning dynamics active at such events. Relatively recently, economic geographers have started to appreciate the potentially crucial role of ensuring access to non-local sources of knowledge (Maskell et al., 2006; Bathelt et al., 2004; Boschma, 2005). This attention to non-local knowledge sources begs the questions of (1) how firms organize their access to such non-local knowledge bases; and (2) whether some forms of organizing are more effective for sustaining firm-level innovation. In short, the primary question of interest is whether firms should strive for access to diverse or homogenous non-local knowledge. TCs can be considered an important type of interface that allow firms to engage in “identifying, selecting, approaching, and interacting with new partners” (Maskell et al., 2006: 998) from distant places. Our study adds to this emerging literature by illuminating which types of non-local knowledge bases yield superior results in terms of innovative performance.

Second, by adopting a firm-level perspective, we are able to discern firm-level heterogeneity that would otherwise remain obscured when adopting a cluster-level of analysis (Felin and Hesterly, 2007; Knoblen, 2009; Beugelsdijk, 2007). This point is particularly salient, because contemporary research on clusters shows that not all firms benefit equally from being located in a cluster (Hervas-Oliver and Alborns-Garrigos, 2009; McCann and Folta, 2011). By extending this insight from permanent clusters to TCs, it is reasonable to ask whether some firms benefit more from attending diverse TCs than others. By incorporating differences in the absorptive capacity of firms into the parameters of our study, we are able to move beyond the generic patterns characterizing the benefits of attending diverse TCs, to yield more

specific statements about which levels of TC diversity are optimal for specific types of firms. Doing so contributes to the literature on firm-level heterogeneity in cluster benefits (McCann and Folta, 2008), as well as to the literature on how firms can organize to benefit from externally residing knowledge and resources (Escribano et al., 2009).

2. Theory and hypothesis development

Professional gatherings – in the form of industry events, trade fairs, and scientific conferences – are prominent among the many methods available to help firms gain access to non-local knowledge (Bathelt and Schuldt, 2008). Whereas previous literature tended to treat TCs mainly as marketing instruments, recent contributions stress their value in terms of knowledge access and dissemination, especially in the case of science- or technology-based industries (Bathelt and Schuldt, 2010; Rinallo and Golfetto, 2011). In fact, such temporary gatherings are found to have many of the qualities associated with permanent clusters (Bathelt and Schuldt, 2010; Maskell et al., 2006; Stam, 2010). For instance, chance encounters at conferences have been found to often lead to long-term collaborations (Berends et al., 2011; Kreiner and Schultz, 1993). Further, TCs have been found to facilitate learning through interaction with – and observation of – competitors (Bathelt and Schuldt, 2008; Maskell et al., 2006), and to also grant participating firms access to new technologies, networking opportunities, and market trends (Bathelt and Schuldt, 2010). TC attendees find themselves in a dense, buzz-like web of highly specialized information and knowledge, in which they can strategically position themselves (Powell et al., 1996). TCs tend to represent the state of the art in specific knowledge or practice domains, thereby helping attendees to interpret and value future trends and opportunities

(Lampel and Meyer, 2008; Ozgen and Baron, 2007), and providing firms with rich opportunities for tacit knowledge interaction, which is a key ingredient for innovative performance (Gertler, 2003; Grant and Baden-Fuller, 2004).

Attending a TC enables a firm to learn in two distinct domains. First, as outlined in the previous paragraph, firms are exposed to the latest technological developments in their own or related industries. Through interaction with clients, and by observing competitors, attending firms generate subtle, yet valuable, insights about relevant technological or design-related developments. Second, TCs take place in particular localities, and the local relevant business community – both customers and competitors – tends to be well represented at such events. This representation gives firms visiting this locality an opportunity to become familiar with the unique local knowledge (Cyert et al., 1993; Maskell et al., 2006) “showcased” through local attendees. Additionally, TCs enable firms to learn about potential transaction partners from other clusters, gain a sense of the knowledge residing in other clusters in their specific domain of interest, and create global pipelines to these relevant knowledge hotspots around the globe (Bathelt et al., 2004; Maskell, 2014) in a relatively cost-efficient manner (Maskell et al., 2006). In particular, the value of tapping into a local knowledge base manifests when firms seek to expand internationally, and enter new foreign markets through joint marketing campaigns (Bathelt, 2005a). In such cases, benefiting from unique local patterns of knowledge interaction through local knowledge spillovers is pivotal.

TCs take place at varying locations and specialize in many knowledge/technological domains. As such, firms can potentially benefit from attending more conferences, thereby gaining access to geographically and technologically diverse knowledge. However, evidence from research on knowledge

diversity related to other topics – such as strategic alliances – suggests that gaining access to more diverse knowledge is not always beneficial for a firm’s innovative performance (Laursen and Salter, 2006; Oerlemans et al., 2013). As such, the question becomes, “What levels of *diversity across events* should firms strive for when attending TCs?”

2.1. Knowledge-diversity across events

Because firm-level innovation is heavily dependent on the variety of knowledge input and the capability to combine disparate knowledge sources (Cohen and Levinthal, 1990; Wuyts and Dutta, 2012), it makes sense to seek a certain level of knowledge diversity when attending industry events. First, seeking input from a greater variety of TCs in terms of knowledge backgrounds reduces the risk of knowledge redundancy and increases the probability that truly novel knowledge and information is accessible. This increased diversity of knowledge, in turn, increases the potential for making novel interactions between disparate pieces of knowledge, which will result in higher innovative performance (Baum et al., 2000). Second, a firm can create value by combining knowledge from distinct TCs, and thus profit from synergies that are not available to firms attending only a single TC or a small number of TCs (Lavie, 2007). Finally, greater diversity is likely to widen one’s perspective and enhance creative thinking, due to the recombination of knowledge across various knowledge domains (Wuyts and Dutta, 2012).

Seeking knowledge-based variety in event attendance may very well enhance firm innovativeness, but applying this strategy also comes at a cost. The increase in information and knowledge richness offers ample opportunity for novel combinations, but may also create a situation of information overload (Wuyts and Dutta, 2012;

Ahuja and Morris Lampert, 2001), by making the task of implementing these novel combinations more complex (Koka and Prescott, 2008). Koput (1997) presents three related reasons why information overload has negative performance effects: (a) an absorptive capacity problem – there are too many ideas to manage and choose from; (b) a timing problem – the inflowing knowledge and ideas come at the wrong time or in the wrong place to be fully exploited; (c) an attention allocation problem – because there are too many ideas, none or few of them receive the attention necessary to implement them. In other words, in the case of attending a very diverse set of TCs, the cognitive limits of the innovating firms are more easily reached, yielding negative performance effects. Combining these two sets of arguments results in the following hypothesis:

Hypothesis 1: The level of knowledge diversity across events has an inverted U-shaped effect on firm-level innovation performance.

2.2. Geographic diversity across events

For a long time, research in economic geography has stressed the importance of local collaborations for firm innovation performance. However, more recent research has also emphasized the risk of relying heavily on local partners (Boschma, 2005). The probability that an innovating firm can find all required or new knowledge locally is usually not very high, and relying on local partners further increases the risk of technological lock-in (Narula, 2002). Linking with geographically diverse parties can help a firm overcome these problems by providing it with access to new knowledge and ideas that are not present in its local cluster of residence (Bathelt et al., 2004; Maskell, 2014). Moreover, as knowledge asymmetries manifest spatially (Cyert et al.,

1993), firms are likely to benefit from sourcing to several locations characterized by unique patterns of firm interaction (Almeida and Kogut, 1999). Linking to geographically diverse parties can provide firms with information about global market conditions and global technological developments, equipping them to adapt to these conditions more effectively (Lavie and Miller, 2008). This increased access to information improves a firm's ability to make informed choices in pursuing future innovation trajectories (Wuyts and Dutta, 2012), a skill that is vital given the inherently risky and costly nature of innovation. In short, attending temporary clusters in the form of industry events and conferences offer firms the opportunity to access such distant parties and create so-called "geographic holes," a term first coined by Bell and Zaheer (2007) analogous to Burt's (1992) notion of the "structural holes" concept. The term refers to the notion that through geographically diverse partnerships, firms can gain access to knowledge that is not necessarily readily available to other firms in its home cluster.

The above arguments all emphasize the benefits of attending geographically diverse TCs. However, attending a geographically diverse set of TCs also yields potential liabilities with negative impacts on innovative performance. First, maintaining a presence at multiple geographically dispersed TCs requires a greater investment of time and resources, including time and money spent searching for the right TC with the right knowledge to meet a firm's current innovation objectives (Sorenson and Stuart, 2001). Thus, increasing geographic diversity of TCs is associated with an increase in associated search costs. Second, due to different appropriability regimes between countries, the risk of undesired spillover increases with the level of geographic diversity of TCs a firm attends. Third, differences in scientific cultures and codes of conduct across geographical locations may hamper

trust-building, commitment, and knowledge exchange if firms attend multiple geographically dispersed TCs (Bathelt, 2005b). Fourth and finally, with diversifying its TC attendance, the resources that a firm allocates to reaping the benefits of TC attendance are being spread thin. Given that firms allocate a fixed amount of resources to maximize learning from TCs, distributing these resources too widely results in diseconomies of scale (Lahiri, 2010).

Together, these liabilities limit effective knowledge exchange, and this limitation in turn limits the positive impact of attending geographically diverse TCs on the firm's innovation performance. Combining these arguments results in Hypothesis 2.

Hypothesis 2: The level of geographic diversity across events has an inverted U-shaped effect on firm-level innovation performance.

2.3. Absorptive capacity and the benefits of TC diversity

The anticipated inverted U-shaped effects of knowledge and geographic diversity across events on innovative performance suggest that firms should seek an optimal balance in terms of the diversity of TCs it attends. However, given the complexities and uncertainties surrounding innovation in general, and the additional complexity of assessing diverse knowledge flows across organizational boundaries (Lin et al., 2012), it seems likely that firms differ in their capacities to deal with and benefit from attending a diverse set of TCs. A key capability in this regard is a firm's level of absorptive capacity (Zahra and George, 2002), which is defined as a firm's ability to recognize the value of new information, assimilate it, and apply it to commercial ends (Cohen and Levinthal, 1990).

2.3.1. Knowledge diversity across events and absorptive capacity

Firms must circumvent the limitations associated with bounded rationality and local search (Cohen and Levinthal, 1990; March and Simon, 1958) in order to produce successful innovations (Wuyts and Dutta, 2012). As such, firms must develop sufficient absorptive capacity to benefit from sourcing across various knowledge domains, which implies that they must sufficiently invest in developing a diverse internal knowledge base in order to prevent overspecialization and myopia of learning (Levinthal and March, 1993). In other words, a firm can enhance its absorptive capacity by broadening its internal knowledge base in a cumulative and path-dependent manner (Cohen and Levinthal, 1990), enabling itself to better evaluate and assimilate current technological developments (Lane and Lubatkin, 1998; Zahra and George, 2002).

Hypothesis 1 anticipates an inverted U-shaped association between knowledge diversity across events and innovative performance. In cases of low absorptive capacity, a firm has expertise in a small number of knowledge domains and is therefore only able to process knowledge from a limited number of knowledge domains. In this case, the theoretical rationale underlying Hypothesis 1 applies; firms with low absorptive capacity will initially experience an increase in innovation performance as knowledge diversity across events increases, but after a certain threshold level will begin to experience the costs and complications associated with increased amounts of knowledge diversity across events. In cases of high levels of absorptive capacity, firms are likely to have developed a more diverse internal knowledge base. Higher absorptive capacity makes it more probable that incoming external knowledge relates to a firm's knowledge base (Lahiri, 2010), but the

potential value of new external technological knowledge generated through TCs is likely to be more minor in the context of an already diverse internal knowledge base. Although a firm with high absorptive capacity will hardly experience the costs and complexities associated with increased levels of knowledge diversity, its internal knowledge base will also act as a substitute for external knowledge sourcing activities, thereby decreasing the impact on innovative performance by knowledge diversity across events. Based on the logic outlined above, we propose that increased levels of absorptive capacity will shift the inverted U-shaped curve to the right, and flatten the curve. This proposition leads us to hypothesize the following:

Hypothesis 3: The greater a firm's level of absorptive capacity, the less positive the impact of knowledge diversity across events on innovative performance, and the less it will experience the disadvantages associated with increased levels of knowledge diversity across events.

Figure 1 provides a stylized illustration of the anticipated impact of knowledge diversity across events on innovation performance for firms at varying levels of absorptive capacity.

- Figure 1 about here -

2.3.2. Geographic diversity across events and absorptive capacity

At low levels of geographic diversity across events, the impact of differences in absorptive capacity between firms is expected to be minor, because the low diversity levels of the accessed external knowledge makes it relatively easy to capture its value

and assimilate it in the firm. However, once geographic diversity exceeds a certain (moderate) threshold level, processing new knowledge relevant for innovation is expected to become more difficult due to low levels of absorptive capacity, as illustrated by the downward sloping part of Hypothesis 2. However, firms with high levels of absorptive capacity are positioned to distill the most valuable knowledge from geographic diversity across events and have the capability to create synergies between these geographically varied bodies of knowledge (Sarkar et al., 2009). As such, for these firms, the negative effects of high levels of geographic diversity are expected to materialize later. Firms with high levels of absorptive capacity are expected to benefit from high levels of geographic diversity, as their absorptive capacity allows them to recognize valuable external resources across geographically dispersed TCs. This ability aids successful combination of external and internal resources, resulting in better and more novel products and, ultimately, higher levels of innovative performance (Vasudeva and Anand, 2011; Oerlemans et al., 2013).

In short, firms with high levels of absorptive capacity are expected to more successfully handle increasing amounts of geographic diversity across events, resulting in higher levels of innovative performance, whereas firms with low absorptive capacity may sooner suffer the complexities associated with increasing levels of geographic diversity across events, and will therefore experience lower levels of innovative performance. As a result, the anticipated inverted U-shape relationship between geographic diversity and innovative performance (Hypothesis 2) is expected to shift to the right, and its top is expected to increase, as a firm's absorptive capacity increases. Based on these characteristics, we formulate the following hypothesis:

Hypothesis 4: The greater a firm's level of absorptive capacity, the more positive the impact of geographic diversity across events on innovative performance, and the later it will experience the disadvantages associated with increased levels of geographic diversity across events.

Figure 2 provides a stylized illustration of the anticipated impact on innovation performance by geographic diversity across events, at varying levels of absorptive capacity.

- Figure 2 about here -

3. Methods

3.1. Research setting

The empirical setting for our study is the electronics industry (NAICS 3-digits codes 335, 334). This industry was chosen for three reasons. First, firms in the electronics industry engage in an intensive and continuous R&D process, which requires constant learning and extramural knowledge sourcing (Chandler et al., 2005). Second, innovation activities among firms in the electronics industry are systematically documented by means of patents. Previous research has established that patent data is a legitimate and reliable measure for the innovation performance of firms in this industry (Hagedoorn and Cloudt, 2003). Third and finally, the knowledge and innovations produced by such companies tend to be well represented in available databases, and that representation benefits empirical inquiry.

3.2. Sampling and data collection

The present study used a three-stage process to determine the final sample of companies and associated conference participation. At stage 1 we identified all organizations that attended conferences on electronics topics. At stage 2, we selected small and medium-sized firms conducting operations in the electronics industry, which formed our sample. At stage 3, we identified all other conferences (other than those on electronics-related topics) in which the firms in our sample participated. We used the semantic method of *fuzzy string matching* to assemble the large amount of data from various databases into one integrated database (Thoma et al., 2010).

In stage 1, our first step was to search for and identify all professional and scientific conferences in the Web of Science's (WOS) CPCI database that were held in the period 1991–2012, and were associated with the electronics industry, using the "Engineering, Electrical & Electronic" WOS category. This search resulted in a sample of 4116 events, including conferences organized by the Institute of Electrical and Electronics Engineers (IEEE). The next step was to collect all published proceedings from these conferences, using unique identification parameters for the events in our sample (i.e., event name, location, and dates) and identify all authors' affiliations that correspond to for-profit firms (i.e., excluding all universities and other non-firm organizations).

At stage 2, we narrowed down the population to small and medium-sized enterprises (SMEs) that have operations in the electronics industry. We undertook this procedure to decrease the probability of selecting multi-location firms, and to omit firms with extreme values of patenting activity. Additionally, SMEs are expected to be more heterogeneous in terms of resource scarcity and absorptive capacity. Specifically, we matched the names of organizations with the LexisNexis database to

identify firms that (a) are categorized under NAICS codes 335* (ELECTRICAL Equipment, Appliance, and Component Manufacturing) and 334* (Computer and Electronic Product Manufacturing) and (b) have less than 500 employees. For firms that could be successfully matched, we collected available firm-level data from LexisNexis and data on patents from the Derwent Innovation Index (DII) database. After excluding cases with missing data, the final sample consisted of 484 unique and independent firms, most of which were located in the United States (45.1 percent), followed by Japan (8.3 percent), Germany (6.8 percent), Russia (5.8 percent), and Italy (5.6 percent).

At stage 3, we collected additional conference attendance data for the firms in the resultant sample, in order to capture conference participation outside the “Engineering, Electrical & Electronic” domain. To this end, we searched for relevant proceedings in the WOS CPCI database using the company names in our sample, uncovering 5167 additional conferences that were attended by the firms in our sample.

3.3. Measures

3.3.1. Dependent variable

We assessed innovation performance using the data on firm’s patenting activity, measured as number of patents granted within a one-year period $t+1$. This measure is widely regarded as a legitimate proxy for innovation performance, especially in cases where a specific industry sector and similar firms (e.g., small and medium-sized) are considered (Hagedoorn and Cloudt, 2003; Hausman et al., 1984).

3.3.2. Independent variables

We measured *knowledge diversity across events* by calculating the Blau index (Blau, 1977) for knowledge domains of events at which a particular firm participated during a period t . We used standard WOS categories as a proxy for the knowledge domains of individual events. Each conference that has proceedings in CPCI database is coded with one WOS category. For the conferences in our sample that are not pre-assigned to categories in the CPCI database, we manually coded the knowledge domains based on the most frequent topics of related proceedings. In order to make knowledge diversity across events comparable between time periods and across firms, we normalized the absolute value on the theoretical maximum of diversity for a particular firm at a given time period (Jiang et al., 2010). We measured knowledge diversity across events using the following equation:

$$D_{it} = \frac{K_{it}}{K_{it} - 1} \left(1 - \sum_{k \in K_{it}} p_{itk}^2 \right),$$

where p_{itk} denotes the ratio of events related to knowledge domain k to the overall number of events in which firm i participated during time period t ; K_{it} is the list of knowledge domains to which firm i has access through event participation within time period t ; and term $\frac{K_{it}-1}{K_{it}}$ is thus the theoretical maximum.

To measure *geographic diversity across events*, we used the number of distinct (i.e., unique) countries where events took place in which firms participated during time period t (Goerzen and Beamish, 2005). The reason for this operationalization is that firms that are specialized in a particular knowledge domain often go to the same conferences in the same countries year after year (e.g., the PITTCON conference always takes place in the United States, and often in Pittsburg). Therefore, we argue

that geographic diversity across events depends less on the number of events attended during time period t , and more on how many distinct countries were visited during time period t .

In order to measure a firm's degree of *absorptive capacity*, we calculated a variable capturing the breadth of the knowledge base of the firm, which represents a firm's capability to absorb new knowledge, and has been found to influence innovation in previous studies (Cohen and Levinthal, 1990). We measured this variable using the normalized Blau index calculated on the basis of subclasses of patents that were granted to a particular firm during the five years preceding period t . The five-year interval was chosen based on the average innovation life-cycle, from knowledge development to receiving a patent for that knowledge (Hagedoorn and Cloudt, 2003). We used the first four characters from the International Patent Classification (IPC) codes assigned to each patent, to proxy knowledge domains in which a particular firm that possesses these patents has some expertise. Depending on the breadth of the patent's coverage, it can receive several codes at the same time. Every code represents the knowledge areas in which a given firm is proficient, assuming that if a firm is granted a patent in a particular knowledge domain, it is an expert in this domain (Lahiri, 2010).

3.3.3. Control variables

To ensure a reliable estimation of the model, we included several controls to cover other factors that might be driving innovation performance. In order to control for *firm size*, we included the logarithms of employee number and annual turnover (available from the LexisNexis database). In order to control the extent to which a firm is scientifically oriented, we included the *number of publications* each firm has

in refereed journals during period t , excluding conference proceedings. It was important to control for this possible effect, because firms' scientific orientation is one of the innovation determinants in high-technology industries (e.g., Romijn and Albaladejo, 2002). We also introduced variables to control for the *primary and non-primary business activities* of the firm. To account for the primary business activity, we created dummy variables using three-digit NAICS codes. We then measured the number of non-primary activities using the total *number of secondary NAICS codes* registered by a firm. In order to control for the *economic environment* and location of the firm, we included a variable of logarithm of GDP per capita using data from the World Bank. We also included *city size* as a proxy for local agglomeration benefits a firm may accrue from being located in or near a large city, because the availability of local resources could explain variance in firm innovation. We measured city size as the logged value of the number of people living in a firm's city of residence, which was obtained from the Geonames.org database.

4. Results

We tested our model using negative binomial regression with fixed effects specification. Negative binomial distribution is a proper assumption for the probability density function of our dependent variable, because we operationalize it as the number of patents granted for a firm in a given year, and it represents count data characterized by large over-dispersion (Hausman et al., 1984). We estimated the model using the maximum likelihood method in STATA, implemented hierarchical regression modeling, and applied likelihood-ratio tests. Fixed effect specification is based upon the assumption that unobserved factors, such as idiosyncratic firm features, can correlate between time periods. In order to test fixed effects specification, we used the Hausman test against estimates of our model with random

effect specification (for the model with all variables and moderators – i.e., Model 5 at Table 2: $\chi^2(15) = 143.24, p > \chi^2 = 0.000$).

Previous research has indicated that a three-year period is an appropriate time period to explain subsequent firm innovation performance in terms of patents granted, especially for a setting like the electronics industry (Hagedoorn and Cloudt, 2003). We therefore present a model specification in which independent variables represent an aggregation of a three-year period, and the dependent variable represents the following year (i.e., a one-year lag). We also performed comparative analysis for models with various time periods for the dependent and independent variables, as well as for various time lags, which largely exhibit the same patterns in terms of direction and significance of effects.

Table 1 shows descriptive statistics and correlations. The mean value of innovation performance is 2.29 patents per year with a standard deviation of 6.21, which indicates over-dispersion and determines the choice of the estimated analytical model. The mean value of knowledge diversity across events is 0.05 (SD = 0.20). The mean value of geographic diversity across events is 0.61 (SD = 1.49).

- Table 1 about here -

Table 2 presents the hierarchical regression models used to test for Hypotheses 1 and 2, both separately and jointly. Model 1 contains the control variables only; Model 2 separately tests the linear effect of knowledge diversity across events on innovation performance, whereas Model 3 tests the curvilinear effect of knowledge diversity across events on innovation performance. Models 4 and 5 have the same setup, but test the inverted U-shape effect of geographic diversity across events. Model 6 jointly

tests the curvilinear effects of both geographic- and knowledge diversity across events on innovation performance.

- Table 2 about here -

Model 3 confirms Hypothesis 1, which anticipates an inverted U-shape effect of knowledge diversity across events on subsequent innovation performance. Figure 3 presents the estimated innovation performance with confidence intervals (CI) at various levels of knowledge diversity across events. Model 5 confirms Hypothesis 2, anticipating a curvilinear relationship of geographic diversity across events with subsequent innovation performance, as shown in Figure 4. However, when knowledge and geographic diversity are considered jointly, the effect of knowledge diversity across events drops in significance and becomes monotonically positive. This result indicates that after accounting for geographic diversity across events, the residual variation in innovation performance is only explained by the linear term of knowledge diversity. It implies that costs associated with high geographic diversity across events outweigh the costs associated with high knowledge diversity.

- Insert Figure 3 here -

- Insert Figure 4 here -

Next, we tested Hypotheses 3 and 4, both of which anticipate that the relationship between knowledge-related and geographic diversities across events and subsequent innovation performance will be moderated by absorptive capacity. In

order to test these hypotheses, we divided our sample into three subsamples according to several levels of absorptive capacity. We chose the values of mean absorptive capacity a firm has during the entire time period and divided the entire sample into tertiles. Subsample (a) comprises 160 firms with relatively low absorptive capacity ($< .88$); subsample (b) includes 141 firms with relatively moderate absorptive capacity ($.88 \leq \text{absorptive capacity} \leq .95$); and subsample (c) contains 183 firms with relatively high absorptive capacity ($> .95$).

Table 3 presents the results for this analysis, using the model estimation on the subsamples. Models 7a, 7b, and 7c estimate the linear effects of both knowledge and geographic diversity for the corresponding subsamples (a), (b), and (c). Models 8a, 8b, and 8c estimate the curvilinear effects of both knowledge and geographic diversity for the corresponding subsamples (a), (b), and (c).

Hypothesis 3 is largely supported on the basis of models 7a, 7b, and 7c as well as models 8a, 8b, and 8c. For low levels of absorptive capacity, we found a significant inverted U-shape relationship with knowledge diversity across events. For moderate levels of absorptive capacity, the curvilinear effect becomes insignificant (Model 8b). However, the linear effect alone remains significant (Model 7b). Given an additional increase in absorptive capacity, the linear effect becomes slightly more pronounced and increases in significance (Model 7c). However, a comparison of slopes test for Models 7b and 7c shows that there is no significant difference between the slopes of knowledge diversity across events for firms with moderate and high levels of absorptive capacity ($Z = 1.41, P > |Z| = 0.16$). Figure 3 illustrates the moderation effect for each subsample. The figure was created based on estimated marginal means at different values of knowledge diversity across events for Models 8a, 7b, and 7c (Dawson, 2014).

Our findings indicate that firms with low levels of absorptive capacity will benefit heavily from knowledge diversity across events, as illustrated by the steep slope in Figure 5. However, these benefits only accrue up to a relatively low degree of knowledge diversity across events, after which increased knowledge diversity will negatively affect innovation performance. Firms with moderate and high levels of absorptive capacity also derive benefits from knowledge diversity across events, but not as much as firms with low levels of absorptive capacity. This finding supports the argument that the internal knowledge represented by high levels of absorptive capacity is partly a substitute for external knowledge diversity. However, unlike firms with low levels of absorptive capacity, firms with higher levels of absorptive capacity are able to benefit from very high levels of knowledge diversity across events, lending support to the traditional argument regarding absorptive capacity.

- Insert Figure 5 here -

We find support for Hypothesis 4 based on models 8a, 8b, and 8c. Comparing the coefficients of the squared term of geographic diversity for different subsamples implies a diminishing effect of the curvilinear relationship, with an increase in absorptive capacity only up to a certain point. Model 8c shows that with a relatively higher level of absorptive capacity, the curvilinear effect becomes insignificant, indicating that as absorptive capacity increases, the inverted U-shape curve of geographic diversity flattens and becomes linear – as illustrated in Figure 6 – which lends support to Hypothesis 4. Increasing the absorptive capacity flattens the positive slope of the geographic diversity curve and shifts the inflection point of the inverted U-shaped curve to the right.

- Insert Figure 6 here -

5. Discussion

In this study, we examined the extent to which both knowledge-related and geographic diversity across events impact firm-level innovation. Although prior studies already addressed the potential importance of attending TCs (e.g., Bathelt and Schuldt, 2010, 2008; Stam, 2010), none have addressed the effects of *diversity across events* on firm innovation. Put simply, we found evidence for the hypothesized inverted-U shaped effects of both knowledge-related and geographic diversity across events on firm-level innovation performance (Hypotheses 1 and 2). Further, the analysis showed that absorptive capacity impacts the extent to which firms benefit in terms of innovation performance from both knowledge-related (Hypothesis 3) and geographic diversity across events (Hypothesis 4).

The results suggest that firms can actively pursue a TC attendance strategy that fosters firm-level innovation; this finding is the first main contribution of this study. This contribution is interesting when viewed from the current debate on the danger of regional lock-in (Bathelt et al., 2004; Boschma, 2005). TCs appear to be vital nodes in the global political economy (Bathelt and Schuldt, 2008), allowing firms to observe the current market frontier and engage in non-local interactions with extra-cluster firms – in other words, firms beyond the local cluster. Provided sufficient levels of absorptive capacity, attendance at a range of TCs diverse in terms of knowledge and geography appears to yield additional value over being embedded in a permanent cluster (Bathelt et al., 2004), permitting firms to span “geographic holes” (Bell and Zaheer, 2007) efficiently and effectively. The current study thus extends this line of

research by showing that firms indeed benefit from accessing knowledge sources outside the cluster of residence (Owen-Smith and Powell, 2004).

Furthermore, the present study shows that TC-attendance strategy can be a very effective tool for gaining access to extra-cluster knowledge and related innovation enhancement. One possible explanation is that firms can tap into industry buzz (Storper and Venables, 2004) across TCs by purposefully seeking geographic and knowledge-related diversity across events (Asheim et al., 2007). As such, we conclude that although geographic distance may create boundaries, TCs can be considered an effective means for tapping into knowledge flows and pools that extend beyond the boundaries of a firm's locality. These findings also have implications for the literature on firm location strategies, which has posited that highly capable firms might benefit from being located outside of established clusters, thereby minimizing the risk of spill-outs of their knowledge (Shaver and Flyer, 2000). However, such a strategy also implies a lack of access to cluster benefits (Funk, 2013). By attending temporary clusters, rather than being located permanently in one, firms may still be able to tap into relevant external knowledge sources – in other words, they may have their proverbial cake, and eat it too.

Our second main contribution follows from adopting the firm as the level of analysis, thereby discerning specific drivers of firm innovation performance that would have remained unobserved if we adopted a higher-level spatial construct (Beugelsdijk, 2007; Martin and Sunley, 2003). We developed a spatial perspective of innovation that considers the role of the firm's spatial behavior manifested through the selection of temporary space, rather than analyzing space itself – or, as Bathelt and Glückler (2003: 124) contend, “we use space as a basis for asking particular questions about economic phenomena but space is not our primary object of

knowledge.” This approach allowed us to present a contingent and path-dependent understanding of (temporary) space and innovation, and consider economic action (i.e., innovation) *across* space and time. The insights generated through this actor-centered approach may yield new understanding of innovation differences among firms located in the same cluster (Hervas-Oliver and Albers-Garrigos, 2009).

Overall, the findings of this study carry implications for spatial perspectives of innovation and knowledge. Where literature on clusters and knowledge tends to describe knowledge as an externality that is (a) local in nature, and (b) equally available to all firms (Breschi and Malerba, 2001; Rychen and Zimmermann, 2008), the current study suggests rather that firms may purposefully engage in knowledge creation by actively participating in knowledge exchange networks. However, the question that remains open is, what are the implications of the above-presented firm-level consequences for the level of the cluster. In essence, cluster structures are the result of individual agents’ responses to both local and global developments. Thus, cluster-based firms can contribute significantly to the competitiveness of the cluster as a whole by engaging in intra-cluster ties and building local networks, and by seeking interaction with extra-cluster entities (Arikan, 2009; Rosenkopf and Almeida, 2003). Both aspects enhance a cluster’s knowledge creation capability (Arikan, 2009), which should provide an advantage to all firms comprising a given cluster. As such, the present study suggests that TCs could play an important role in local knowledge rejuvenation by allowing cluster-based firms to engage in non-local interactions, thereby enhancing firm-level innovation performance.

Of course, the current study also carries some limitations. First, it focuses on one particular industry that is inclined to producing technology-based, well-documented innovations. Our focus on the electronics industry not only limits the

extent to which our findings can be generalized to other industries; it also implies a focus on “articulated knowledge” (Tallman and Phene, 2007) due to our focus on patents. Second, we considered primarily conferences oriented to scientific-communities; future studies should consider other types of events, such as international trade shows. Finally, our method for event participation measurement is based only on proceedings data. This approach allowed us to make a legitimate comparison between firms, but we did not capture participants that have no proceedings published afterwards. Despite these limitations, our study represents an important contribution to the emerging literature on TCs and to the spatial organization of innovation in general.

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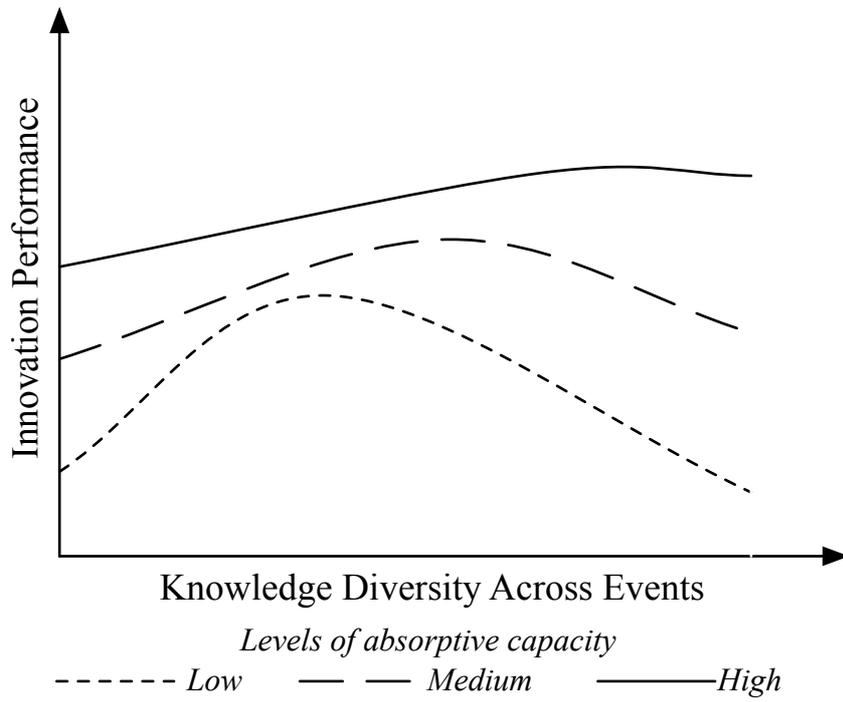


Figure 1. Stylized representation of Hypothesis 3

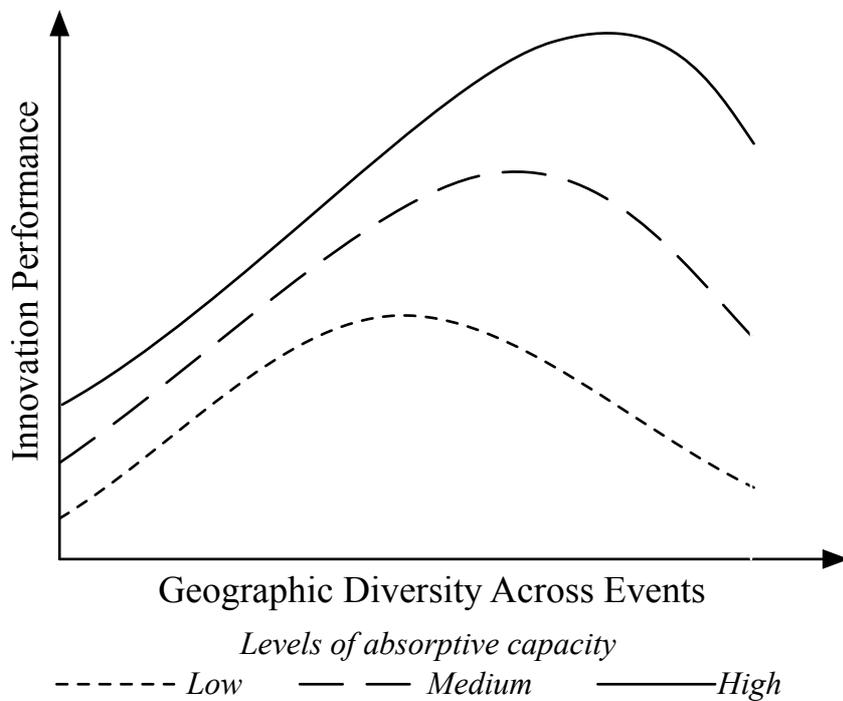


Figure 2. Stylized representation of Hypothesis 4

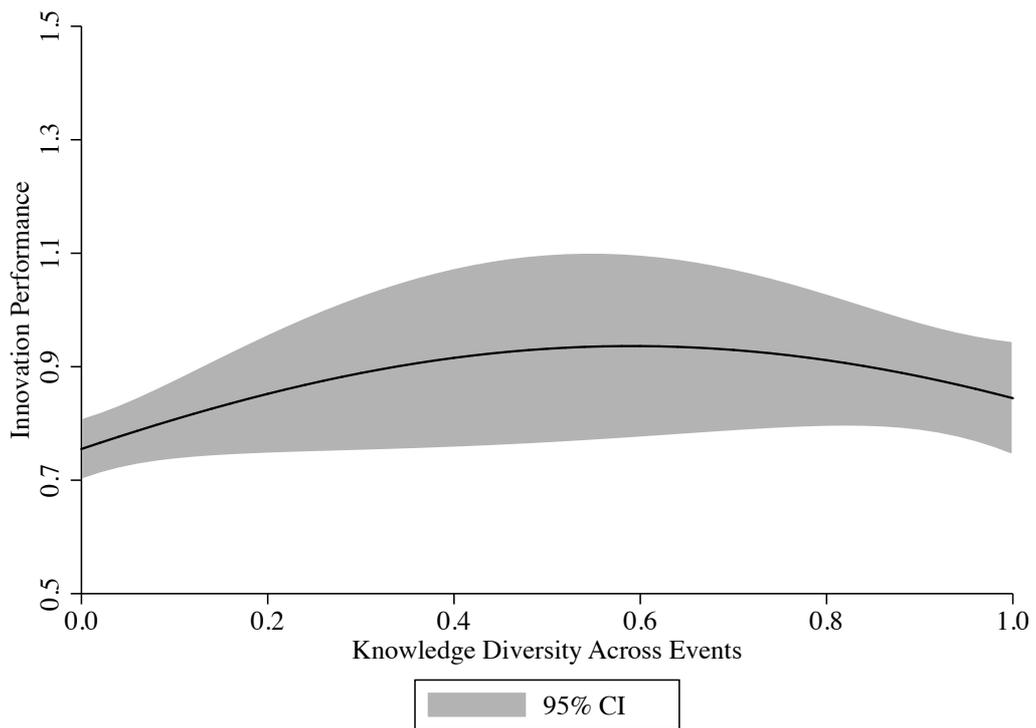


Figure 3. Impact of knowledge diversity across events on innovation performance

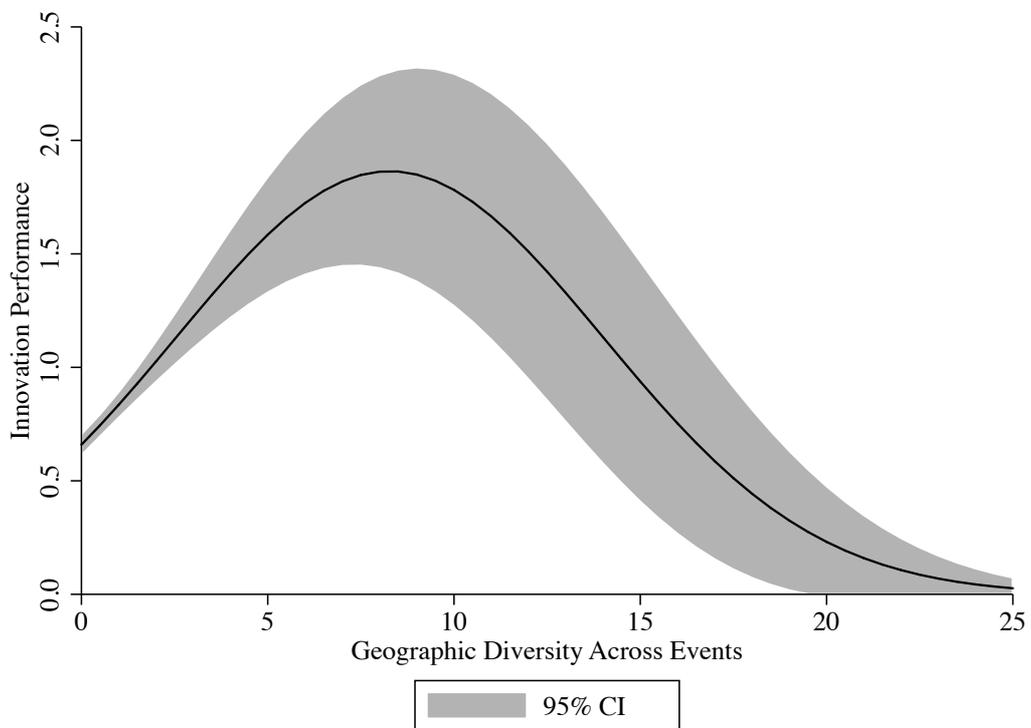


Figure 4. Impact of geographic diversity across events on innovation performance

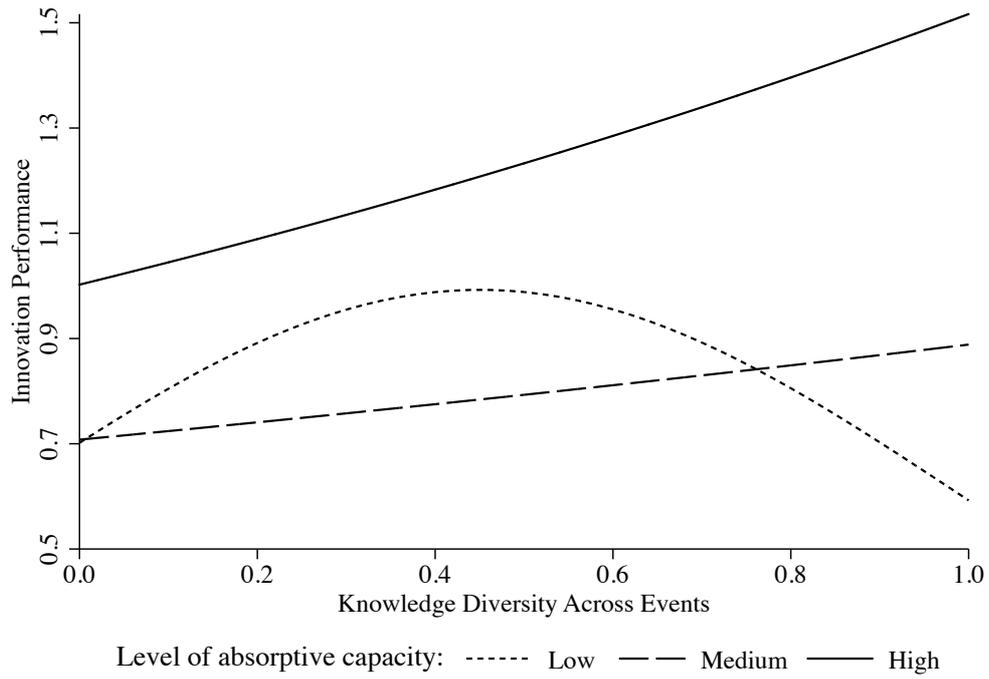


Figure 5. Impact of knowledge diversity across events on innovation performance at varying levels of absorptive capacity

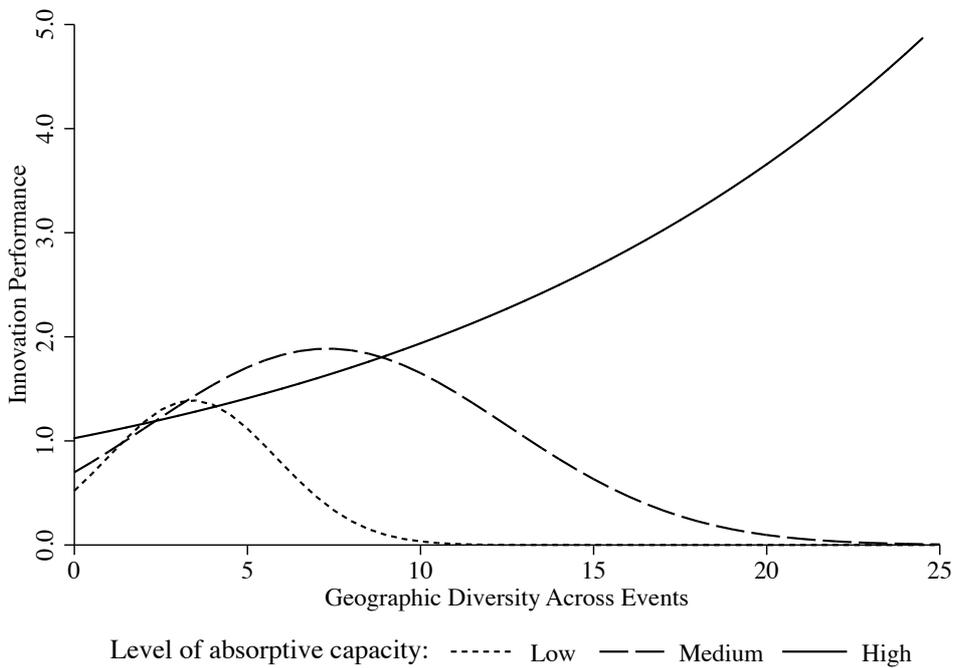


Figure 6. Impact of geographic diversity across events on innovation performance at varying levels of absorptive capacity

Table 1. Means, standard deviations, and correlations

	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9
1. Number of patents granted	2.29	6.21	0	149									
2. Knowledge div. across events	0.04	0.20	0	1	0.091*								
3. Geographic div. across events	0.61	1.49	0	25	0.115*	0.558*							
4. Number of publications	0.72	5.14	0	139	0.041*	0.354*	0.691*						
5. Absorptive Capacity	0.50	0.47	0	1	0.275*	0.111*	0.167*	0.084*					
6. Firm size (logged)	4.44	0.86	0	6.18	0.058*	-0.009	-0.049*	-0.072*	0.075*				
7. Annual revenue (logged)	16.08	1.67	9.59	18.41	-0.011	-0.034*	-0.093*	-0.017	0.010*	0.436*			
8. City size (logged)	11.36	1.86	6.91	16.50	0.000	0.053*	0.068*	-0.018	-0.009	0.034*	-0.313*		
9. GDP per capita (logged)	10.61	0.45	6.96	11.33	-0.009	-0.097*	-0.153*	0.004	0.004	-0.064*	0.447*	-0.323*	
10. Number of secondary NAICS codes	1.46	1.53	0	9	-0.035*	0.117*	0.147*	0.150*	0.047*	0.072*	0.023	0.039*	-0.119*

* - $p < 0.001$

Table 2. Negative binomial models for innovation performance †

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
<i>Independent variables</i>												
Knowledge diversity across events			0.523***	(0.047)	2.016***	(0.344)					0.729*	(0.370)
Knowledge diversity across events ²					-1.588***	(0.364)					-0.617	(0.380)
Geographic diversity across events							0.155***	(0.013)	0.294***	(0.019)	0.251***	(0.025)
Geographic diversity across events ²									-0.017***	(0.002)	-0.015***	(0.002)
<i>Control variables</i>												
Number of publications	0.001	(0.001)	-0.001	(0.001)	-0.001	(0.001)	-0.007***	(0.002)	-0.001	(0.001)	-0.001	(0.001)
Absorptive Capacity	1.520***	(0.046)	1.459***	(0.047)	1.454***	(0.047)	1.456***	(0.047)	1.408***	(0.047)	1.405***	(0.047)
Number of secondary NAICS codes	0.105***	(0.025)	0.092***	(0.025)	0.089***	(0.025)	0.095***	(0.025)	0.097***	(0.026)	0.093***	(0.026)
Firm size (logged)	0.023	(0.044)	0.053	(0.045)	0.051	(0.045)	0.045	(0.045)	0.059	(0.045)	0.062	(0.045)
Annual revenue (logged)	-0.033	(0.026)	-0.054*	(0.026)	-0.054*	(0.026)	-0.039	(0.026)	-0.051	(0.026)	-0.055*	(0.027)
City size (logged)	-0.010	(0.018)	-0.018	(0.018)	-0.019	(0.018)	-0.015	(0.018)	-0.019	(0.018)	-0.020	(0.018)
GDP per capita (logged)	0.061	(0.088)	0.139	(0.088)	0.138	(0.088)	0.139	(0.090)	0.173	(0.091)	0.178*	(0.091)
Industry codes (dummy)	Yes		Yes		Yes		Yes		Yes		Yes	
Constant	-1.934	(1.298)	-2.723*	(1.228)	-2.692*	(1.226)	-2.825*	(1.272)	-3.259**	(1.250)	-3.268**	(1.238)
N (firm-years)	9680		9680		9680		9680		9680		9680	
<i>df</i>	11		12		13		12		13		15	
Wald χ^2	1167***		1303***		1325***		1345***		1426***		1437***	
Log-likelihood	-11704		-11646		-11637		-11636		-11589		-11586	

† The dependent variable is innovation performance measured as number of patents granted in following year after explanation period t . The overall time period is 20 years.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3. Negative binomial models on subsamples

	Model 7a		Model 8a		Model 7b		Model 8b		Model 7c		Model 8c	
<i>Independent variables</i>												
Knowledge diversity across events	0.037	(0.100)	1.540*	(0.602)	0.227*	(0.101)	0.467	(0.713)	0.414***	(0.086)	0.183	(0.620)
Knowledge diversity across events ²			-1.709**	(0.625)			-0.554	(0.743)			0.168	(0.627)
Geographic diversity across events	0.279***	(0.034)	0.578***	(0.068)	0.103***	(0.026)	0.271***	(0.042)	0.064**	(0.021)	0.121**	(0.042)
Geographic diversity across events ²			-0.085***	(0.017)			-0.019***	(0.003)			-0.005	(0.004)
<i>Control variables</i>												
Number of publications	0.024*	(0.011)	0.026*	(0.011)	-0.009**	(0.003)	0.006	(0.004)	-0.003	(0.002)	-0.002	(0.002)
Absorptive Capacity	1.479***	(0.083)	1.430***	(0.085)	1.582***	(0.086)	1.536***	(0.086)	1.175***	(0.079)	1.163***	(0.080)
Number of secondary NAICS codes	0.048	(0.051)	0.066	(0.052)	0.172**	(0.055)	0.176**	(0.056)	0.130**	(0.044)	0.128**	(0.044)
Firm size (logged)	-0.122	(0.074)	-0.129	(0.074)	0.091	(0.093)	0.118	(0.095)	0.274***	(0.079)	0.271***	(0.079)
Annual revenue (logged)	-0.045	(0.049)	-0.041	(0.049)	-0.008	(0.051)	-0.029	(0.053)	-0.128**	(0.041)	-0.126**	(0.041)
City size (logged)	0.088**	(0.033)	0.087*	(0.034)	0.023	(0.034)	0.017	(0.035)	-0.142***	(0.035)	-0.141***	(0.035)
GDP per capita (logged)	0.220	(0.217)	0.202	(0.217)	-0.044	(0.407)	-0.049	(0.427)	0.221	(0.116)	0.222	(0.116)
Industry codes (dummy)	Yes		Yes		Yes		Yes		Yes		Yes	
Constant	-3.437	(2.326)	-3.273	(2.342)	-2.126	(4.220)	-1.806	(4.424)	-2.290	(1.477)	-2.357	(1.482)
N (firm-years)	3200		3200		2820		2820		3660		3660	
<i>df</i>	11		13		12		14		13		15	
Wald χ^2	600		617		482		514		372		374	
Log-likelihood	-3792		-3775		-3669		-3653		-4088		-4086	