Where Cities Fail to Triumph:

The Impact of Urban Location and Local Collaboration on Innovation in Norway

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Abstract:

The role of cities in fostering innovation has for long been taken for granted. Agglomeration and the knowledge spillovers generated in dense urban environments have been considered fundamental drivers of innovation. This view has, however, become challenged by research questioning the returns to physical agglomeration and local networking, placing instead more emphasis on the importance of inter-regional and international collaboration, and on innovation in peripheral regions. This paper delves into the debate on the role of cities for innovation by examining the interplay between urban location and local collaboration in Norway. It uses data from the Community Innovation Survey for 2006 to 2010 to map out the geographical dimension of R&D collaboration in Norwegian firms with a view to assessing whether different types of R&D collaboration in urban and rural locations affect firms' propensity to innovate. The results show that local collaboration is associated with increased process and organisational innovation, while it does not produce higher levels of product or marketing innovation. Conversely, international collaboration is connected with higher probabilities of product, new-to-market and marketing innovations. Furthermore, location in urban or rural areas makes no difference for most innovation outcomes in Norway when other characteristics are controlled for. Location in cities also does not shape the returns to local R&D collaboration. Hence, the role of cities for innovation in Norway, whether in themselves or as sites for dense local interaction, is less relevant than the urban innovation literature would predict.

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1. INTRODUCTION

Cities are widely regarded as the best locations for the brewing of innovation. "Cities, the dense agglomerations that dot the globe, have been engines of innovation since Plato and Socrates bickered in an Athenian marketplace" (Glaeser, 2011, p. 1). Cities bring together innovative actors in dense environments, facilitating the connectivity that some have called 'buzz' (Storper & Venables, 2004). Cities also produce positive externalities through their concentration of skills, entrepreneurship and creativity, through the related and diverse firms they contain, and through the trade and cultural exchanges they generate. Proximity to other innovative actors in cities "provides valuable information that can be a wellspring of innovation" (Glaeser, 2011: p. 21). Hence, the general perception is that if firms want to innovate, they have to locate in cities. Firms in cities are more innovative, and the bigger the city, the bigger the potential for a firm to become innovative.

However, this tenet has been increasingly challenged by empirical research looking at where firms get the information that makes them more innovative (e.g. Doloreux & Dionne, 2008; Fitjar & Rodríguez-Pose, 2011; Tödtling, Grillitsch, & Höglinger, 2012; Rodríguez-Pose & Fitjar, 2013; Grillitsch & Nilsson, 2015; Meili 2018). This research has emphasized that innovation is more a consequence of internal developments within the firm and of the development of purpose-built networks than of the positive externalities afforded by dense urban environments. Firms in relatively remote environments often compensate for the lack of local externalities by developing more pipelines that bypass the local environment and reach out to other innovative environments, often in distant parts of the world (Grillitsch & Nilsson 2015; Mayer, Habersetzer, & Meili, 2016; Haberzetzer, Grèzes-Bürcher, Boschma, & Mayer, 2019). Besides, peripheral regions may offer other advantages, such as quietness or opportunities for secrecy, which can attract some types of innovative firms (Shearmur, 2012; Mayer & Baumgartner, 2014; Shearmur & Doloreux, 2016; Eder, 2019).

Consequently, there is a growing debate about whether local linkages, in general, and local linkages within cities, in particular, actually influence firms' capacity for innovation. This paper delves into this question by means of a rich dataset containing a large sample of Norwegian firms. Norway is an interesting case because of its status as one of the most innovative economies in the world. The presence of highly innovative and productive firms in such a small and remote (albeit rich) country, lacking large urban agglomerations, represents a puzzle in light of the theories that posit that innovation mainly happens in big cities. In addressing how local collaboration in cities shape innovation, this paper provides new empirical evidence, using more extensive and reliable data than most previous research on this topic. The analysis uses three waves of the Norwegian Community Innovation Survey (CIS) between 2006 and 2010 to build an unbalanced panel of more than 6000 observations. The paper examines the extent to which local R&D collaboration matters more or less for innovation than R&D collaboration at greater geographical distance (both within and outside Norway) and whether the impact of local collaboration on innovation is greater in larger urban areas than in small cities, towns, and rural regions.

The results challenge the prevailing view that innovation benefits from frequent interaction in close geographical proximity. Local collaboration is only associated with greater levels of process and organisational innovation, while it seems to be mostly irrelevant for other types of innovation. Product, new-to-market, and marketing innovation rely on other forms of networking and mainly on connections to agents located outside Norway. Moreover, the benefits from collaborating locally, nationally, or internationally in innovation projects are unrelated to the urban or rural location of the firm.

The paper proceeds by reviewing the debate on whether local collaboration and its facilitation in urban environments leads to greater innovation. The methods and data are presented in

section 3, while section 4 focuses on the empirical analysis. The paper concludes with a summary of the results and some implications for further analysis and policy.

2. DOES COLLABORATION IN CITIES LEAD TO GREATER INNOVATION?

Recent developments in urban economics have put cities at the heart of the innovative process. Technological change and globalisation, rather than leading to the "death of distance" (Cairncross, 2001) or a "flat world" (Friedman, 2005), have been intrinsically associated with an increasing concentration of economic and innovative activities (Florida, 2005; Scott & Storper, 2007). In particular, ever more innovative processes take place in urban areas (McCann, 2008). Agglomeration in cities facilitate mechanisms that drive such concentration by enticing formal and informal interaction and knowledge exchange between innovative actors (Storper & Venables, 2003; Glaeser, 2011). The bigger the city, the greater the capacity for different types of local interactions, and the greater the innovation and productivity increases (Combes, Duranton, Gobillon, Puga, & Roux, 2012). Hence, to be innovative, firms supposedly need to be in cities, i.e. they need to 'be there' where new knowledge is generated and diffused through intensive local exchanges (Gertler, 2003). Cities, in general, and city size, in particular, thus matter for innovativeness, productivity and economic growth (Glaeser & Kerr, 2009; Puga, 2010; De la Roca & Puga, 2017; Soo, 2018). From this perspective, location in cities – and the bigger city, the better – becomes a must for innovation, productivity and competitiveness. By contrast, location in more isolated rural areas is deemed to represent a huge handicap for innovation (Soto & Paredes, 2016). Cities are regarded as sites of creativity, innovation and economic growth; smaller cities and rural areas are not.

Why are cities associated with higher levels of innovation? Several mechanisms can account for this (Accetturo, Di Giacinto, Micucci, & Pagnini, 2018). Firstly, the density linked to cities

create positive externalities, which rise with city size. Cities put innovative actors in close geographical proximity and facilitate the development of dense input-output links as well as access to top-level skills and physical infrastructure (e.g., Duranton & Puga, 2001; Ellison, Glaeser, & Kerr, 2010). Knowledge sharing is more efficient among co-located actors as the transmission of tacit knowledge relies on regular face-to-face communication (Storper & Venables, 2004; McCann, 2007). Secondly, sorting effects mean that innovative workers and firms are drawn to cities, where they are more likely to maximise the use of their skills (Baldwin & Okubo, 2006; Storper, Kemeny, Makarem, & Osman, 2015; Ahlin, Andersson, & Thulin, 2018). Inter-regional mobility of labor is associated with increases in firm-level innovation and productivity (e.g. Timmermans & Boschma, 2014; Eriksson & Rodríguez-Pose, 2017). Third, cities can facilitate the emergence of complex systems of interpersonal and interfirm interaction that foster innovation systems (e.g. Cooke & Morgan, 1994; Cooke, Gómez-Uranga, & Etxebarría, 1998; Iammarino, 2005). Finally, tacit knowledge travels with difficulty, meaning that new knowledge is geographically constrained and its expansion beyond cities complicated. There is a strong distance-decay effect in the diffusion of knowledge and innovation, with limited knowledge spillovers at play beyond 80 kms from the center cities in the US and beyond 200 kms for the EU (Crescenzi, Rodríguez-Pose, & Storper, 2007). Cities are thus at the heart of the sharing, matching and learning processes that drive innovation (Duranton & Puga, 2004).

The analysis presented in this paper focuses exclusively on the third and fourth mechanisms that supposedly facilitate firm-level innovation in cities: extra-firm collaborations and the opportunities cities offer for firms to engage in innovation collaboration and form networks. How the geography of the location of firms and of the collaborative networks they generate affects firm-level innovation, in general, and different types of innovation – product, new-to-market, process, organisational, and marketing innovation – in particular, is discussed on the basis of existing literature for Norway and elsewhere. Three research questions will be tackled:

i) whether local collaboration is associated with more innovation than collaboration at a distance, ii) whether collaboration at different geographical distances affects different types of innovation differently, and iii) whether the association between local collaboration and innovation is larger in urban than in rural regions and in bigger cities than in smaller ones.

The importance of local interaction in cities for innovation and economic growth is at the center of various approaches to regional development. From new economic geography and urban economics to the industrial districts, regional innovation systems, clusters, and innovative *milieux* literature, it is emphasised that interaction happens most easily in dense and highly institutionalised environments, where trusting relationships resulting from geographic proximity sustain collaboration. In such environments, geographical proximity is considered to produce proximity also in other dimensions, such as social or cognitive proximity (Boschma, 2005).

However, the assumption that innovation is fundamentally an urban phenomenon "sits uncomfortably with empirical work showing that innovation occurs in peripheral regions […], that openness – at least when measured by the variety and type of external contacts – is not necessarily higher in cities […], and that firm-level innovativeness is only weakly associated with location across the metropolitan to peripheral small town spectrum" (Shearmur, 2015: p. 424). A growing body of research has tended to stress, first, that inter-firm cooperation differs between regions, independent of regional firm characteristics (Fritsch, 2003); second, that geographic proximity between cooperation partners may be less important for innovation than hitherto assumed (Fitjar & Rodríguez-Pose, 2011); and, third, that innovation can happen – and often happens – outside large cities (Shearmur, 2017; Eder, 2019; Frick & Rodríguez-Pose, 2018).

First, even in densely agglomerated areas, innovative actors may depend more on connections to actors in distant places than on local contacts (Huber, 2012). Firms in larger, urban regions

have greater access to extra-regional knowledge. Research on the world-city network emphasizes the growing linkages between the world's largest cities (Beaverstock, Smith, & Taylor, 2000; Taylor, 2001). Indeed, firms located in the Norwegian capital region have more international partners than those located in smaller towns and regions, leading Herstad and Ebersberger (2015) to conclude that place-specific resources also support the development of international linkages (see also Fitjar & Rodríguez-Pose, 2014). Excessive physical proximity may even be harmful. The 'proximity paradox' (Boschma & Frenken, 2010) or 'Goldilocks principle' (Fitjar, Huber, & Rodríguez-Pose, 2016) notes that while some proximity is necessary for successful knowledge sharing, excessive proximity reduces the scope for learning. Indeed, various contributions have indicated that if the preoccupation with local collaboration becomes too dominant, this may lead to myopic knowledge search and lock-in to established ways of thinking (Amin & Cohendet, 2004; Giuliani & Bell, 2005). As Solesvik and Gulbrandsen (2014: p. 24) underline, "many forms of collaboration seem to have little impact on innovation".

Second, innovative actors outside big cities do not stand still. Lower density makes long-distance interaction a must for firms outside big cities. This implies that knowledge sharing at arm's length is frequently more common than what the geography of innovation literature has acknowledged (e.g. Andersson, Quigley, & Wilhelmsson, 2005; Doloreux & Dionne, 2008; Fitjar & Rodríguez-Pose, 2011; Tödtling et al. 2012; Rodríguez-Pose & Fitjar, 2013; Fitjar & Huber, 2015; Grillitsch & Nilsson, 2015). While knowledge gain at close quarters is relatively easy in large urban areas, it becomes much more difficult in more remote or less densely populated regions, where the limited number of actors represents an important handicap for innovation. To cope with this, firms in peripheral regions must compensate by investing more in developing external and, in particular, extra-regional, long-distance linkages and collaborations (Grillitsch & Nilsson, 2015; Jakobsen & Lorentzen, 2015). Through links to

urban actors, peripheral firms can access urban knowledge, while retaining potential other benefits of their peripheral location (Mayer et al. 2016). Furthermore, sorting effects may imply that highly productive firms stay in peripheral regions as transportation costs are relatively less important to them (Forslid & Okubo, 2015).

Peripheral location has seemingly not held back Norwegian firms (e.g. Fitjar & Rodríguez-Pose, 2011, 2015; Solesvik & Gulbrandsen, 2014), which are much more innovative than the size of its cities would suggest. The roots of Norwegian innovation lie fundamentally in the capacity of its firms to overcome geographical peripherality and establish long-distance partnerships with innovative firms, research centers, consultancies, and universities, often located beyond the national borders. Firms establishing international connections tend to be more innovative than those relying on domestic linkages (Fitjar & Rodríguez-Pose, 2011: p. 1264). Similar mechanisms to compensate for peripherality have been found in Sweden (Grillitsch & Nilsson, 2015). Swedish firms in more remote environments are more likely than firms in large cities to establish networks – both national and international – outside their local geographical area. Similar results have been reported for Canada (Doloreux, 2003; Doloreux & Dionne, 2008), Belgium (Teirlinck & Spithoven, 2008), and Austria (Tödtling et al., 2012).

Furthermore, the partnerships behind firm-level innovation are mostly purpose-built rather than the result of chance encounters. Purpose-built partnerships are more often associated with long-distance collaborations (Fitjar & Rodríguez-Pose, 2017). 'Global pipelines' are relationships in which firms invest considerable time and effort to interact with a partner from which it can gain valuable and non-superfluous knowledge (Bathelt, Malmberg, & Maskell, 2004). This is a more costly strategy, but one that may carry greater rewards. However, due to the costs of long-distance knowledge search, global pipelines may be more viable for larger than for smaller firms (Ebersberger & Herstad, 2013; Grillitsch & Nilsson, 2015).

The jury is, in any case, still out on the mechanisms through which cities sustain learning processes conducive to innovation (Shearmur, 2012). While some highlight the importance of local collaboration, others suggest that long-distance collaboration may be more beneficial. Some research also stresses that different types of innovation may require different geographical settings and different types of collaboration (Teirlinck & Spithoven, 2008; Doloreux & Shearmur, 2012; Lee & Rodríguez-Pose, 2013; Shearmur, 2015; Eder, 2019). As indicated by Fitjar and Rodríguez-Pose (2011) and Shearmur (2015), more radical innovation can happen anywhere, with firms relying either on their own internal capacities or on targeted, often long-distance, connections. Such linkages can be the source of innovations that set firms apart in their markets by providing new knowledge and ideas from outside the local market. By contrast, the adoption and commercialisation of innovation benefits more from local labor, finance and marketing expertise and, therefore, from local interaction, information exchange and feedback (Shearmur, 2015: p. 428). In particular, changes within the firm, e.g. in process or organisational forms, may be more contingent on cultural context and therefore require a local approach. In these cases, being located in cities and clusters can facilitate firm-level learning (Lee & Rodríguez-Pose, 2013: p. 1756).

Overall, this suggests that there is a need for more empirical research on the relationship between firms' location in urban or rural regions, the spatial scales of their collaboration patterns, and different types of innovation outcomes. This paper makes several contributions to this debate. First, previous studies have not analyzed the interaction between local collaboration and urban location, and hence the view that local collaboration is more beneficial in urban contexts remains essentially an assumption. Second, using panel data from Norway allows for greater control of unobserved firm heterogeneity than the mostly cross-sectional research that approached this question in the past. The richness of the dataset also permits us to dodge the problems of non-response bias. Finally, the analysis examines several different innovation

outcomes, enabling a more nuanced understanding of how collaboration and location may have different implications for different types of innovation.

3. METHODS AND DATA

We use three waves of the Community Innovation Survey (CIS) for Norway to create an unbalanced panel of firms [1] and match the firm-level data with Statistics Norway linked employer-employee data – from official employment registers used for tax purposes and from official education registers. This enables us to obtain detailed information on the composition of each firm's workforce.

The Norwegian CIS offers, relative to most other innovation surveys, several benefits which are helpful in tackling our research questions. Firstly, it includes information on whether domestic partners are intra-regional or extra-regional, permitting an analysis of local collaboration. The harmonised CIS does not include this information, although some other countries do. Secondly, it asks all firms about their collaboration partners in joint R&D and other innovation activities, not just the innovative ones. This is essential for assessing the relationship between collaboration and innovation outcomes. Thirdly, unlike most other countries, participation is mandatory for sampled firms. Non-respondents are fined. This results in a response rate of 94-97 percent of sampled firms, almost ruling out the risk of non-response bias. Fourthly, the sample is designed to be regionally representative at the level of economic regions.

The sample includes the full population of large firms and of R&D intensive firms, as well as a sample of small firms. [2] The final sample contains between 5980 and 6532 firms in the three waves considered in this paper: 18924 observations in total. These represent around a third of

firms and two-thirds of all employees in the overall population of Norwegian firms with more than 5 employees.

The analysis comprises firms which participated in two concurrent waves. The very high response rate and the inclusion of the full population of the largest firms mean that many firms are present in consecutive waves. Of course, this is more often the case for firms with more than 50 employees or smaller firms with R&D activities, where the full population is included. However, around half of all firms in each survey also participate in the next wave. We can therefore exploit the longitudinal structure of the data to measure independent variables two years before dependent variables, allowing for better control of possible reverse causality. Consequently, independent variables and controls in 2006 are used to predict innovation levels in 2008, and independent variables and controls in 2008 to predict innovation in 2010. While this does not rule out the potential for endogeneity related to the effects of innovation on collaboration patterns or on firm location decisions, it does at least mean that the outcome is observed after the collaboration project or location decision. From Model 2, we also add a lagged dependent variable that further controls for past innovation. The final data set consists of 6382 observations. This includes 1893 firms that were present throughout the period and were measured twice for independent as well as for dependent variables, and 2596 firms that were only present in two consecutive surveys. Appendix Table A.1 shows descriptive statistics on the sample.

3.1 Dependent variables

In line with the Oslo Manual, we define innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD and Eurostat 2005:46). Building on this definition, the CIS includes measures of four dimensions of innovation – product, process, organisational, and marketing – all used as

dependent variables in the analysis. In addition, the product innovation dimension contains an indicator of the novelty of innovation – whether product innovations were new to the market – also considered in the analysis. The total number of dependent variables is thus five[3]. All innovation measures are dichotomous variables with a value of 1 if the firm has introduced an innovation in the preceding three years (i.e. during 2004-06 for the 2006 survey) and 0 otherwise. Figure 1 shows the share of firms reporting innovation of each type in the three waves included in the analysis.

--------- Figure 1 about here ---------

Product innovation is registered if the firm introduced new or significantly improved goods and/or services into the market. *New-to-market product innovation* is a sub-category of the above, including only innovations that were new to the firm's market and excluding innovations that were new to the firm, but which already existed in the market. *Process innovation* refers to the introduction of new or significantly improved methods for production of goods or services; for storage, delivery, or distribution of goods or services; or new support functions, such as systems for maintenance, procurement, accounting, or IT. *Organisational innovation* is the introduction of organisational changes, such as new business practices for organisation of work or procedures; new methods for organisation of work responsibilities or decision-making within the firm; or new methods for organising external relations to other firms or public institutions. *Marketing innovation* refers to any significant changes in design or packaging of goods or services; the use of new media or methods for promoting products; the use of new methods for product placement or new sales channels; or the use of new methods for pricing goods or services.

3.2 Independent and control variables

There are two main independent variables in the analysis. Our first independent variable of interest – **partners** – measures the breadth of the firm's collaboration with different types of external partners in innovation processes. The CIS asks about collaboration linkages[4] in the preceding three years with eight different types of external partners: within the enterprise/enterprise group, with suppliers, clients/customers, competitors, consultants/consultancy firms, commercial laboratories/R&D enterprises, universities/higher education institutions, and public or private research institutes. For each partner used, the firm is further asked to identify the location of the partner. The index is a simple count of the number of different types of partners used at each geographical scale, indicating the breadth of the firm's network at each scale. Three geographical scales are taken into account: *regional partners* refers to the number of partner types used within the region; *national partners* depicts the number of partner types located elsewhere in Norway; while *foreign partners* is the number of partner types located outside Norway. Figure 2 shows the average number of partner types at each geographical scale in the three periods.

--------- Figure 2 about here ---------

The second variable of interest – **location** – indicates the firm's location in one of four types of regions: *Big city regions* are regions with an urban center which has a population of 500,000 or above and a high level of services. There is only one such region in Norway: the capital Oslo. *Medium city regions* are regions with an urban center which has a population of between 150,000 and 500,000 and a high level of services. Three Norwegian regions belong in this

category: Bergen, Stavanger, and Trondheim. *Small city regions* are regions with an urban center with a population of between 19,000 and 150,000 and a medium or high level of services. This category includes a total of 16 regions: Fredrikstad, Drammen, Tønsberg, Skien, Kristiansand, Ålesund, Bodø, Tromsø, Moss, Hamar, Lillehammer, Gjøvik, Sandefjord, Arendal, Haugesund, and Molde. Figure 3 shows a map of the urban regions of Norway. Finally, *rural regions* are regions without any urban center or with an urban center of less than 19,000 inhabitants or with a lower level of services. Firms located in rural regions are, according to the theories discussed, less likely to benefit from local agglomeration and density and therefore have less potential to innovate. This is therefore the baseline category for comparison with other locations. Table 1 shows the definition of each location category and the number of firms in each category in the three periods. The number of firms is relatively similar across geographical categories (Table 1).

--------- Figure 3 about here ---------

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Regions are defined at the level of economic regions, as classified by Statistics Norway. These are regions at the NUTS4 level and correspond in most cases to functional economic regions. The categorisation of different regions is based on Gundersen and Juvkam (2013), who developed a hierarchy of region sizes based on urban population and the level of services in each region. We also merge regions that are functionally integrated into the same labor market based on Gundersen and Juvkam (2013). This division of economic regions is becoming well-established in Norway and has already been used in previous studies of how the geographical

location of firms affects innovation (e.g. Herstad & Ebersberger, 2015; Aarstad, Kvitastein, & Jakobsen, 2016; Fitjar & Timmermans, 2017).

The CIS itself uses firms' official corporate addresses to identify the firm's location. For multi-plant firms, this can be misleading, especially in a study of urban vs. rural location. Some firms have their corporate headquarters and official address in one place (often a large city), but most of the actual production and employment take place somewhere else (e.g. in more peripheral locations). In order to account for this, we draw on linked employer-employee data from tax registers to identify the location of each firm's main activities as measured by the size of the workforce. We use the municipality listed as the workplace of the largest number of employees as the actual location of each firm.

Four main control variables are included in the analysis. *R&D Expenditure* is the total amount spent on internal research and development activities by the firm in the year of the survey, and is drawn from the CIS. *Number of employees* is the number of full-time employees in the firm. This is a count of people employed in the firm in the year of the survey, based on linked employer-employee data from tax registers. *Share of educated employees* is the percentage of the firm's workers who have completed a tertiary education degree. This variable is again based on linked employer-employee data, with information on each employee's education level drawn from the Norwegian education database. This is an official register used by the universities and the student loan authorities. The database includes education at Norwegian universities only, which could underestimate education levels at some firms. As all these three variables are highly skewed, we log-transform them using the natural logarithm. For R&D expenditure and share of educated employees, a constant of 1 was added before log-transforming as several firms had values of 0 on these variables. Appendix Table A.2 shows means, standard deviations, and pairwise correlations between the variables. Finally, *industry* is a set of dummy variables for the two-digit NACE industry of the firm, included as fixed effects. In total, the data contains

58 different two-digit industries. Appendix Table A.3 shows the composition of the sample by location and industry category (one-digit).

4. RESULTS

In order to examine the relationship between collaboration, location and innovation, we fit a logit regression model to the data. The model takes the following form:

$$\text{logit(Innovation}_{i,t}) = \alpha + \beta_1\, \textbf{Partners}_{i,t-1} + \beta_2\, \textbf{Location}_{i,t-1} + \beta_3\, \textbf{Controls}_{i,t-1} + \beta_4\,(t\text{-}1) + \varepsilon_{it}\ (1)$$

The dependent variable, *innovation*, refers to the five dimensions of innovation outlined above. We run five models, one for each measure of innovation. The probability of innovation in firm *i* at time *t* is modelled as a function of the vectors **partners** (referring to the three geographical scales outlined above), **location** (the four categories of centrality outlined above), and **controls** (the four control variables presented above) at time *t-1*. In this analysis, *t* can be either 2008 or 2010, while *t-1* is correspondingly 2006 or 2008. In addition, we include the time of measurement of the independent variables as a fixed effect to account for any temporal trends. As some firms are observed twice (at t=2008 and t=2010), we use robust standard errors, clustered over firms.[5] Table 2 shows the results of estimating this model (which we refer to as Model 1).

--------- Table 2 about here ---------

Looking first at the odds ratios for the control variables, these go along with expectations and point to the robustness of the analysis. R&D expenditure is strongly and significantly associated with all types of innovation. Firms that invest more in R&D, innovate more, regardless of the

type of innovation considered. The share of educated workers is also strongly and significantly associated with innovation, with the exception of process and marketing innovation. Firm size mainly has a strong positive connection with organisational innovation, which will be more relevant in larger organisations. Employment size is significantly (at the 90 percent level) negatively associated with the likelihood of new-to-market product innovation. The sector in which a firm operates also matters, as expected, for its capacity to innovate.

The location of the firm in an urban environment is linked to a higher likelihood of product innovation (including new-to-market) only. At the 95 percent confidence level, the only significant odds ratio is for location in big city regions on product innovation in general. This is associated with a 28 percent increase in the odds of innovation compared to rural location. However, the difference with firms located in medium or small city regions is smaller and not statistically significant. Reducing the confidence level to 90 percent, location in medium-sized city regions is also associated with a higher likelihood of product innovation in general, and location in big or medium-sized city regions with a higher likelihood of new-to-market product innovation specifically. For the latter category, the difference between the big, medium-sized and small city regions is even smaller, but firms in rural regions are less innovative. For other types of innovation, location in urban or rural regions makes no difference for the likelihood of innovation. For process and organisational innovation, firms in big city regions even tend to be less innovative than rural firms, although these differences are not statistically significant.

It is worth noting that this does not imply that there are no differences in innovation levels between urban and rural areas in Norway. If we fit model (1) following a stepwise approach, location in cities is associated with a higher likelihood of all innovation outcomes except process innovation, and with stronger odds ratios for location in larger cities. However, for organisational innovation, the differences disappear when controlling for R&D expenditure and firm size, and for marketing innovation, the difference disappears when also controlling for

industry. Hence, the higher levels of innovation in urban areas is mostly a function of firms in these areas being larger, more R&D intensive, and with better access to well-educated employees (see also Herstad, Sandven, & Solberg, 2013; Herstad, 2018), as well as of the industry composition of urban areas. When controlling for these characteristics, urban firms perform significantly better only when it comes to product innovation.

The breadth of collaboration with regional partners is associated with a higher likelihood of two types of innovation – process innovation and organisational innovation. The odds of process innovation increase by 8 percent for every additional regional partner used, while the odds of organisational innovation increase by 14 percent. However, collaboration with regional partners has no significant effect for product innovation in general, new-to-market product innovation in particular, or marketing innovation. More market-oriented innovation is independent of local collaboration. For these types of innovation, long-distance collaboration instead appears as the main factor behind innovation. Foreign collaboration is associated with a higher likelihood of product innovation, including new-to-market, as well as of marketing innovation. The odds of product innovation in general increase by 13 percent for every additional foreign partner used, while the odds of new-to-market product innovation increase by 7 percent and those of marketing innovation by 9 percent. Process and organisational innovation, in contrast, are not associated with the breadth of foreign collaboration.

Hence, two quite different collaboration patterns are connected with the different types of innovation, underlining the need for analyzing them separately: foreign collaboration is more closely related to market-oriented product (including new-to-market) and marketing innovations, while regional collaboration is associated with a higher likelihood of process and organisational innovations. A broader network scope seems required for more outward-,

market-oriented, and radical innovations, while an understanding of the local context is more important for innovations within the organisation.

4.1 Robustness checks

While the above analysis has employed the panel structure of the data to measure independent variables before dependent variables, this does not rule out the possibility of reverse causality. If the same firms innovate consistently over time, the level of collaboration of Norwegian firms or the places they source their information from could still be affected by the firm's level of innovation at an earlier time. In order to account for this, Model 2 includes a lagged dependent variable as a predictor, taking the following form:

$$\text{logit(Innovation}_{i,t}) = \alpha + \beta_1 \text{ Innovation}_{i,t-1} + \beta_2 \textbf{Partners}_{i,t-1} + \beta_3 \textbf{Location}_{i,t-1} + \beta_4 \textbf{Controls}_{i,t-1}$$
$$+ \beta_5 (t-1) + \varepsilon_{it} \tag{2}$$

In this model, innovation in one of the five dimensions considered is expected to closely follow innovation in the same dimension in the preceding period. All other independent variables are as in Model 1, including the use of robust standard errors clustered over firms. Variance inflation factors show no signs of severe multicollinearity in the model. Table 3 shows the results of fitting Model 2 to the data.

--------- Table 3 about here ---------

The results are mostly consistent with those from Model 1. However, and as expected with the introduction of the lagged innovation variable, some associations are weakened. The association between urban location and new-to-market product innovation disappears, while

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that with product innovation in general is now only significant at the 90 percent confidence level. For regional collaboration, the association with process innovation also vanishes, leaving organisational innovation as the only outcome significantly positively related to collaboration with regional partners. In addition, there is now a significant *negative* association at the 90 percent confidence level between regional collaboration and the likelihood of product innovation. For foreign collaboration, the association with product innovation in general remains, while the coefficient for new-to-market product innovation and marketing innovation is now only significant at the 90 percent confidence level. The lagged dependent variable itself is strongly and significantly associated with all types of innovation, indicating that firms that innovate in one period often remain innovative over time. For product innovation in general, having innovated in the preceding period is associated with 281 percent higher odds of innovation, controlling for other characteristics. The signs of control variables mostly stay the same, although the odds ratios for R&D expenditure in particular are weakened by the introduction of the lagged dependent variable.

Table 4 provides a further robustness check by restricting Model 2 only to firms that are innovation-active. Innovation-active firms are defined as those reporting positive innovation expenditure, collaboration in innovation processes, or any kind of innovation outcome (cf. e.g. Herstad et al. 2014). In total, 3861 of the original 6382 observations were classified as innovation-active and included in this section of the analysis.

-------- Table 4 about here ---------

The restriction of the analysis to innovation-active firms does not change the results in any major way. For regional partners, the results are largely the same as in Table 3: a significant

positive coefficient for organisational innovation and a negative coefficient for general product innovation, significant at 90 percent. For foreign partners, the results are stronger than in Table 3. The coefficients for new-to-market product innovation and marketing innovation are now significant at the 95 percent confidence level, and there is also a positive coefficient for process innovation, which is significant at 90 percent. The effects of location are stronger than in any of the preceding analyses, although still only in the area of product innovation, in general, as well as specifically for new-to-market product innovation. The dummies for big city regions and medium city regions are now significantly associated with a higher likelihood of product innovation in general and – for medium city regions – also of specifically new-to-market product innovation. Indeed, location in a medium city region now emerges with the highest odds ratio for all innovation outcomes, even if the differences are in most cases not statistically significant. For the control variables, the share of educated employees is not significantly associated with a higher likelihood of any kind of innovation when only innovation-active firms are considered. This factor is mainly associated with the decision to engage in innovation activities, rather than the outcome of such activities.

Several additional robustness checks have been conducted. Due to space limitations, not all of these are reported. One set of analyses limited the sample to the 4399 single-plant firms in the data, or, in another set of analyses, to the 5453 firms where the largest plant employs at least 50 percent of the firm's workforce. Even though this excludes many of the largest and most innovative firms, the results are broadly in line with the findings reported above, especially for the latter set of analyses. The results are also robust to the inclusion of firm age as an additional control variable. As firm age is not itself significantly associated with any of the innovation outcomes, it is not included in the analyses reported above.

A particular question concerns the role of R&D, as firms' R&D expenditure is potentially endogenous: Firms that expect to succeed in their R&D activities are likely to invest more.

Appendix Table A.4 shows the results for Model 1 when leaving out R&D investments as a control variable. In this model, **Partners** at all spatial scales are significantly positively related to nearly all innovation outcomes. Firm size and, in particular, education also have stronger positive coefficients. However, the effects of location in a big city region disappear (or turn negative, in the case of process innovation), while location in a medium city region has a somewhat stronger positive effect on product innovation and new-to-market innovation.

We have also added additional regional control variables, such as total regional R&D expenditure per worker, mean regional firm size, or regional population. Including these tends to reduce the effect of the **Location** variables, while not affecting any of the other variables in the model. We have also estimated the model including regional population size and population size squared instead of the dummy variables for city size. Regional population size has a positive and significant effect only on product innovation (at $p<0.05$) and new-to-market product innovation (at $p<0.10$), consistent with the findings reported in Table 2. The results for **Partners** and for the control variables are also consistent. We have also tried dividing Oslo into a central and a suburban part, following Herstad (2018), without finding significant differences between central and less central locations within Oslo.

In an additional analysis, we have estimated the models including county fixed effects (see Appendix Table A.5 for the results pertaining to Model 1, other results available on request).[6] In this case, all significant coefficients for location in a big city or medium city region disappear, while the results for **Partners** and for the control variables are consistent with those reported in the paper. Hence, there could be other spatial county effects, besides city size, that can account for the significant coefficient observed for the location variable. However, as the county fixed effect may also pick up some of the effect of location in a larger urban area – in particular for the largest urban agglomeration in Norway, the Oslo and Viken region – the

preferred option remains the model without county fixed effects. Finally, we have run the analyses using sampling weights, without any differences in the findings.

4.2 Local collaboration in cities and rural areas

The analyses so far have examined location and collaboration separately. However, we are also interested in the interaction between them, specifically in whether local collaboration is more beneficial in urban regions. In order to examine this, we extend the model to incorporate an interaction term between *Regional partners* and **Location**. Consequently, Model 3 is specified as follows:

$$\text{logit}(\text{Innovation}_{i,t}) = \alpha + \beta_1 \text{ Innovation}_{i,t-1} + \beta_2 \textbf{Partners}_{i,t-1} + \beta_3 \textbf{Location}_{i,t-1} + \beta_4 \text{ Regional partners}_{i,t-1} * \textbf{Location}_{i,t-1} + \beta_5 \textbf{Controls}_{i,t-1} + \beta_6 (t-1) + \varepsilon_{it} \tag{3}$$

The results of this analysis are shown in Table 5. Again, we use robust standard errors, clustered over firms. Multicollinearity diagnostics show variance inflation factors around 5.5 for *Regional partners* in all models and well below 3 for all other variables, including the interaction terms, indicating that multicollinearity is not severe.

-------- Table 5 about here ----------

The interaction terms between regional partners and location are mostly insignificant and indicate that the impact of regional collaboration is unaffected by the location of the firm. There are only two statistically significant odds ratios in the interaction terms – negative interactions between regional partners and location in small city regions for product and new-to-market product innovation. For location in big city regions, where the most beneficial effects of

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regional collaboration were expected, the interaction terms mostly have non-significant negative odds ratios compared to the baseline of rural regions. Table 6 furthermore shows the average marginal effects of *Regional partners* for different locations (Williams, 2012). In big cities, collaboration with regional partners is positively associated with organisational innovation only. Regional collaboration also has a positive coefficient for organisational and marketing innovation in medium-sized city regions. In small city regions, regional collaboration has a negative effect on product innovation, both in general and specifically for new-to-market product innovation. Overall, there are significant differences in the coefficients for regional collaboration between small and medium-sized city regions, but this does not extend to big city regions.

-------- Table 6 about here ----------

4.3 Intensity of innovation

The analyses conducted so far have examined the impact of collaboration and location on whether firms innovate or not. However, the influence of these factors may be seen not only in whether a firm innovates, but also in the intensity of innovation. In order to probe this, Table 7 shows the results of a Tobit regression analysis using the share of the firm's turnover from new products as the dependent variable. The right-hand sides of the models are identical to Models 1-3 above. We use two versions of the dependent variable. The first indicates the share of turnover from all products new to the firm (equivalent to product innovation in the analyses above), while the second indicates the share of turnover from products new to the market only (equivalent to new-to-market innovation in the analyses above).

-------- Table 7 about here ----------

The results are largely consistent with the findings in the logit regression analyses for product innovation and new-to-market product innovation. Firms that collaborate with foreign partners earn a significantly higher share of their income from new products (around 2.5 percentage points). For new-to-market product innovation, the coefficient is weaker and only significant at 90 percent in Models 1 and 3. It is not significant in Model 2, except when restricting the analysis to innovation-active firms. Regional and national collaboration are still not associated with product innovation. Firms located in big cities also earn a higher share of their income from new products, including products new to the market. However, there is no significant positive interaction between regional collaboration and location in a big city. On the contrary, the interaction term is negative and significant at 90 percent for new-to-market product innovation.

5. CONCLUSION

Agglomeration and density have been generally vaunted in the literature as the factors that make cities – and large cities in particular – much more innovative and productive (Duranton & Puga, 2001; Glaeser, 2011). Cities are considered the powerhouses of innovation. Firms that locate in big cities should benefit from various positive externalities, ranging from greater access to pools of talent to the diffusion of tacit knowledge, through countless formal and informal interactions afforded by large cities. Geographical proximity in dense and agglomerated environments supports the formation of networks that promote the picture of cities as the hubs of innovation in a more integrated world.

Yet, despite all the hype about the innovativeness of large agglomerations, many recent studies are paying attention to the capacity of some firms in smaller cities and rural areas to remain innovative (Andersson et al. 2005; Doloreux & Dionne, 2008; Fitjar & Rodríguez-Pose, 2011; Shearmur, 2015; Eder, 2019), notwithstanding being located in places that, according to the dominant views, are far from auspicious for innovation. Innovative firms in smaller cities and far-flung places overcome the disadvantages inherent to their location by superseding geographical distance and networking with other innovative actors beyond their immediate vicinity (Grillitsch & Nilsson, 2015).

This paper has delved into this debate by examining, using a large sample of Norwegian firms for the period between 2006 and 2010, whether local collaboration and urban location are indeed associated with greater levels of innovation, once other factors are controlled for, and, if this is the case, whether local collaboration is more likely to yield innovation in larger cities.

The results suggest that geographical distance matters, but only for certain types of innovation in Norway. Organisational innovation is robustly associated with the number of different types of partners a firm engages with in its immediate geographical milieu. Yet geographical proximity does not make a difference for the generation of more market-oriented types of innovation, such as product and new-to-market product innovation, or marketing innovation. Firms that engage with other economic actors in their immediate vicinity are not better off in terms of innovative capacity. For these types of innovation, long-distance collaboration instead seems to be the main driver of change. Norwegian firms capable of introducing product and marketing innovations in a more integrated economic environment are those that have reached out to the rest of the world in order to target the specific knowledge needed to make them more innovative

Moreover, although firms in urban locations tend to be more innovative in product and new-to-market product innovation, this is not due to any greater rewards from reaching out to local

partners in urban environments. The benefits of local collaboration in Norway are not related to whether the firm is located in Oslo, in a medium or small city-region, or in a rural area.

These results – robust to different specifications of the model – provide considerable food for thought about how geography, agglomeration, and density shape innovation. In Norway, there is virtually no evidence that its larger cities are drivers of innovation. Innovation is certainly linked to networking and reaching out to partners, but for a large number of innovations, these partners do not share the same regional innovation system. They are located at considerable geographical distance and mostly outside Norway. Hence, although it may be the case that agglomeration and density may facilitate interaction, this does not seem to be the type of interaction driving innovation.

This is, of course, a study that concerns only Norway, raising questions about external validity. Norway is in many ways an exceptional case: rich, innovative, remote, and with cities that, even in the case of Oslo, may be too small to benefit from the full range of externalities associated with agglomeration and densities. This makes it hard to assess the extent to which the results can be generalised to other contexts. Moreover, the Norwegian CIS survey concentrates on measuring formal collaborations. It does not register more informal linkages and knowledge sharing and flows that may play a non-negligible role in firm-level innovation. It also does not consider the role of labor mobility or other mechanisms of knowledge exchange in urban areas. However, if the literature on cities wants to establish the general point that innovation mostly takes place in urban areas, the innovation levels of Norwegian firms pose a puzzle in which this literature should be interested.

Furthermore, although we use panel data, endogeneity issues may remain. The choice of collaboration partners can be endogenous to the innovation process, as more innovative firms may be more willing to invest in external relationships and also have a larger choice of partners willing to work with them. Location could also be endogenous, due to firm sorting across

regions. The same goes for several of the control variables, and leaving out e.g. R&D investments or other controls has an impact on the results. Finally, the innovation outputs of firms are to some extent simultaneously determined, as product innovation may e.g. create a need for new processes or new marketing methods. Future research may want to consider these issues in greater depth.

The innovation patterns of firms in Norway challenge a series of well-established views about which are the main sources of firm-level innovation, about how innovation is generated, and about the capacity of cities to create highly favourable environments for the development and absorption of new innovations. The results thus send a request for more research into how connectivity at firm level is generated and which type of connectivity is more conducive to innovation. Cities have been too readily accepted as the right location for innovation. However, our results and an increasing number of others imply that this tenet may require a second look, as innovation does not always seem to be related to where firms locate, but more so to what firms do. Although cities may be more innovative because they contain more firms and more innovative firms, in the case of Norway there seems to be no evidence that the average firm in a large city innovates in a radically different way from those in smaller cities and rural areas.

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FOOTNOTES

[1] For detailed information on the three surveys, see Wilhelmsen and Foyn (2009), Wilhelmsen (2011), and Wilhemsen and Foyn (2012).

[2] Specifically, the sample includes all firms with 50 or more employees in the target industries of the survey (mining, manufacturing, services, oil and gas, and aquaculture). In addition, it includes all firms with 10-49 employees that reported significant R&D activities in previous survey waves. Finally, it includes a sample of all other firms with 5-49 employees in the target industries. These are sampled through a procedure which stratifies firms by size and industry. Larger firms within this segment have a higher likelihood of inclusion. There are slight variations in the sampling procedure across surveys (mainly pertaining to the stratification procedure), implying that sample averages and other descriptive statistics cannot be compared directly across years.

[3] In a separate analysis, we also use the firm's share of income from new products, and from products new to the market, as measures of firm innovation, bringing the total number of dependent variables used in the paper to seven. These variables are further defined below.

[4] The questionnaire defines collaboration as active participation in joint R&D or other innovation activities with other organisations, excluding pure subcontracting.

[5] We have also estimated the models with standard errors clustered over counties, with no difference in the results.

[6] For Oslo and Akershus counties, the county fixed effects are perfectly collinear with the dummy variable for location in a big city region. To avoid this problem, we merge these

counties with the counties of Østfold and Buskerud – which will become part of the Viken

county together with Akershus from 2020 – for this analysis.

REFERENCES

Aarstad, J., Kvitastein, O.A., & Jakobsen, S.E. (2016). Related and unrelated variety as regional drivers of enterprise productivity and innovation: A multilevel study. *Research Policy*, *45*(4), 844–856.

Accetturo, A., Di Giacinto, V., Micucci, G., & Pagnini, M. (2018). Geography, productivity, and trade: Does selection explain why some locations are more productive than others? *Journal of Regional Science*, *58*(5), 949–979.

Ahlin, L., Andersson, M., & Thulin, P. (2018). Human capital sorting: The "when" and "who" of the sorting of educated workers to urban regions. *Journal of Regional Science*, *58*(3), 581–610.

Amin, A., & Cohendet, P. (2004). *Architectures of Knowledge: Firms, Capabilities, and Communities*. Oxford: Oxford University Press.

Andersson, R., Quigley, J. M., & Wilhelmsson, M. (2005). Agglomeration and the spatial distribution of creativity. *Papers in Regional Science*, *84*(3), 445–464.

Baldwin, R.E., & Okubo, T. (2006). Heterogeneous firms, agglomeration and economic geography: Spatial selection and sorting. *Journal of Economic Geography*, *6*(3), 323–346.

Bathelt, H., Malmberg, A., & Maskell, P. (2004). Clusters and knowledge: Local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography*, *28*(1), 31–56.

Beaverstock, J.V., Smith, R.G., & Taylor, P.J. (2000). World-city network: A new metageography? *Annals of the Association of American Geographers*, *90*(1), 123–134.

Boschma, R. (2005). Proximity and innovation: A critical assessment. *Regional Studies*, *39*(1), 61–74.

Boschma, R., & Frenken, K. (2010). The spatial evolution of innovation networks: A proximity perspective. In R. Boschma & R. Martin (Eds.), *The Handbook of Evolutionary Economic Geography* (pp. 120–135). Cheltenham: Edward Elgar.

Cairncross, F. (2001). *The Death of Distance: How the Communications Revolution is Changing Our Lives*. Boston, MA: Harvard Business School Press.

Combes P-P., Duranton, G., Gobillon, L., Puga, D., & Roux, S. (2012). The Productivity Advantages of Large Cities: Distinguishing Agglomeration From Firm Selection. *Econometrica*, *80*(6), 2543–2594.

Cooke, P., Gómez Uranga, M., & Etxebarría, G. (1998). Regional innovation systems: an evolutionary perspective. E*nvironment and Planning A*, *30*(9), 1563–1584

Cooke, P., & Morgan, K. (1994). Growth regions under duress: renewal strategies in Baden-Württemberg and Emilia Romagna. In A. Amin & N. Thrift (Eds.), *Globalization, institutions, and regional development in Europe* (pp. 91–117). Oxford: Oxford University Press.

Crescenzi, R., Rodríguez-Pose, A., & Storper, M. (2007). The territorial dynamics of innovation: a Europe-United States comparative analysis. *Journal of Economic Geography*, *7*(6), 673–709.

De la Roca, J., & Puga; D. (2017). Learning by working in big cities. *Review of Economic Studies*, *84*(1), 106–142.

Doloreux, D. (2003). Regional innovation systems in the periphery: The case of the Beauce in Québec (Canada). *International Journal of Innovation Management*, *7*(1), 67–94.

Doloreux, D., & Dionne, S. (2008). Is regional innovation system development possible in peripheral regions? Some evidence from the case of La Pocatière, Canada. *Entrepreneurship & Regional Development*, *20*(3), 259–283.

Doloreux, D., & Shearmur R. (2012). Collaboration, information and the geography of innovation in knowledge intensive business services. *Journal of Economic Geography*, *12*(1), 79–105.

Duranton G., & Puga, D. (2001). Nursery cities: urban diversity, process innovation, and the life cycle of products. *American Economic Review*, *91*(5), 1454–1477.

Duranton, G., & Puga, D. (2004). Micro-foundations of urban agglomeration economies. In G. Duranton, J.V. Henderson, & W.C. Strange (Eds.) *Handbook of Regional and Urban Economics*, vol. 4, (pp. 2063–2117). Amsterdam: North Holland.

Ebersberger, B., & Herstad, S.J. (2013). The relationship between international innovation collaboration, intramural R&D and SMEs' innovation performance: A quantile regression approach. *Applied Economics Letters*, *20*(7), 626–630.

Eder, J. (2019). Innovation in the periphery: A critical survey and research agenda. *International Regional Science Review*, *42*(2), 119-146.

Eriksson, R., & Rodríguez-Pose, A. (2017). Job-related mobility and plant performance in Sweden, *Geoforum*, *83*(1), 39–49.

Ellison, G., Glaeser, E.L., & Kerr, W.R. (2010). What causes industry agglomeration? Evidence from coagglomeration patterns. *American Economic Review*, *100*(3), 1195–1213.

Fitjar, R.D., & Huber, F. (2015). Global pipelines for innovation: Insights from the case of Norway. *Journal of Economic Geography*, *15*(3), 561–583.

Fitjar, R.D., Huber, F., & Rodríguez-Pose, A. (2016). Not too close, not too far: Testing the Goldilocks principle of 'optimal' distance in innovation networks. *Industry and Innovation*, *23*(6), 465–487.

Fitjar, R.D., & Rodríguez-Pose, A. (2011). When local interaction does not suffice: Sources of firm innovation in urban Norway. *Environment & Planning A*, *43*(6), 1248–1267.

Fitjar, R.D., & Rodríguez-Pose, A. (2014). The geographical dimension of innovation collaboration: Networking and innovation in Norway. *Urban Studies*, *51*(12), 2572–2595.

Fitjar, R.D., & Rodríguez-Pose, A. (2015). Networking, context and firm-level innovation: Cooperation through the regional filter in Norway. *Geoforum*, *63*(1), 25–35.

Fitjar, R.D., & Rodríguez-Pose, A. (2017). Nothing is in the air. *Growth and Change*, *48*(1), 22–39.

Fitjar, R.D., & Timmermans, B. (2017). Regional skill relatedness: Towards a new measure of regional related diversification. *European Planning Studies*, *25*(3), 516–538.

Florida, R. (2005). The world is spiky. *Atlantic Monthly*, *296*(3), 48–51.

Forslid, R., & Okubo, T. (2015). Which firms are left in the periphery? Spatial sorting of heterogeneous firms with scale economies in transportation. *Journal of Regional Science*, *55*(1), 51–65.

Frick, S.A., & Rodríguez-Pose, A. (2018). Big or small cities? On city size and economic growth. *Growth and Change*, *49*(1), 4–32.

Friedman, T. (2005). *The World is Flat*. New York, NY: Farrar, Straus and Giroux.

Fritsch, M. (2003). Does R&D-cooperation behavior differ between regions? *Industry and Innovation*, *10*(1), 25–39.

Gertler, M.S. (2003). Tacit knowledge and the economic geography of context, or the undefinable tacitness of being (there). *Journal of Economic Geography*, *3*(1), 75–99.

Giuliani, E., & Bell, M. (2005). The micro-determinants of meso-level learning and innovation: Evidence from a Chilean wine cluster. *Research Policy*, *34*(1), 47–68.

Glaeser E. (2011). *The Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier*. Harmondsworth: Penguin.

Glaeser, E.L., & Kerr, W.R. (2009). Local Industrial Conditions and Entrepreneurship: How Much of the Spatial Distribution Can We Explain? *Journal of Economics & Management Strategy*, *18*(3), 623–663.

Grillitsch, M., & Nilsson, M. (2015). Innovation in peripheral regions: Do collaborations compensate for a lack of local knowledge spillovers? *Annals of Regional Science*, *54*(1), 299–321.

Gundersen, F., & Juvkam, D. (2013). Inndelinger i senterstruktur, sentralitet og BA-regioner (NIBR report 2013:1). Oslo: Norwegian Institute for Urban and Rural Research.

Habersetzer, A., Grèzes-Bürcher, S., Boschma, R., & Mayer, H. (2019). Enterprise-related social capital as a driver of firm growth in the periphery? *Journal of Rural Studies*, *65*(1), 143-151.

Herstad, S.J. (2018). Innovation strategy choices in the urban economy. *Urban Studies*, *55*(6), 1185–1202.

Herstad, S.J., Aslesen, H.W., & Ebersberger, B. (2014). On industrial knowledge bases, commercial opportunities and global innovation network linkages. *Research Policy*, *43*(3), 495–504.

Herstad, S.J., & Ebersberger, B. (2015). On the link between urban location and the involvement of knowledge-intensive business services firms in collaboration networks. *Regional Studies*, *49*(7), 1160–1175.

Herstad, S.J., Sandven. T. & Solberg, E. (2013). Location, education and enterprise growth. *Applied Economics Letters*, 20(10): 1019–1022.

Huber, F. (2012). Do clusters really matter for innovation practices in information technology? Questioning the significance of technological knowledge spillovers. *Journal of Economic Geography*, *12*(1), 107–126.

Iammarino, S. (2005). An evolutionary integrated view of regional systems of innovation. Concepts, measures and historical perspectives. *European Planning Studies*, *13*(4), 495–517.

Jakobsen, S.E., & Lorentzen, T. (2015). Between bonding and bridging: Regional differences in innovative collaboration in Norway. *Norwegian Journal of Geography*, *69*(2), 80–89.

Lee, N., & Rodríguez-Pose A. (2013). Original innovation, learnt innovation and cities: Evidence from UK SMEs. *Urban Studies*, *50*(9), 1742–1759.

Mayer, H., & Baumgartner, D. (2014). The role of entrepreneurship and innovation in peripheral regions. *disP – The Planning Review*, *50*(1), 16–23.

Mayer, H., Habersetzer, A., & Meili, R. (2016). Rural-urban linkages and sustainable regional development: The role of entrepreneurs in linking peripheries and centers. *Sustainability*, *8*(8), 745.

McCann P. (2007). Sketching out a model of innovation, Face-to-face interaction and economic geography. *Spatial Economic Analysis*, *2*(2), 117–134.

McCann, P. (2008). Globalization and economic geography: the world is curved, not flat. *Cambridge Journal of Regions, Economy and Society*, *1*(3), 351–370.

Meili, R. (2018). *The Charms of Smallness: Economic Dynamics and Innovation Mechanisms in Small and Medium-sized Towns* (Doctoral dissertation). Retrieved from the Institute of Geography, University of Bern.

OECD & Eurostat (2005). *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data.* Third edition. Paris: OECD and the European Commission.

Puga, D. (2010). The magnitude and causes of agglomeration economies. *Journal of Regional Science*, *50*(1), 203–219.

Rodríguez-Pose, A., & Fitjar, R.D. (2013). Buzz, archipelago economies and the future of intermediate and peripheral areas in a spiky world. *European Planning Studies*, *21*(3), 355–372.

Scott, A.J., & Storper, M. (2007). Regions, globalization, development. *Regional Studies*, *41*(S1), S191–S205.

Shearmur, R. (2012). Are cities the font of innovation? A critical review of the literature on cities and innovation. *Cities*, *29*(S2), S9–S18.

Shearmur, R. (2015). Far from the madding crowd: Slow innovators, information value, and the geography of innovation. *Growth & Change*, *46*(3), 424–442.

Shearmur, R. (2017). Urban bias in innovation studies. In H. Bathelt, P. Cohendet, S. Henn, & L. Simon (Eds.), *The Elgar Companion to Innovation and Knowledge Creation* (pp. 440–456). Cheltenham: Edward Elgar.

Shearmur, R., & Doloreux, D. (2016). How open innovation processes vary between urban and remote environments: Slow innovators, market-sourced information and frequency of interaction. *Entrepreneurship and Regional Development*, *28*(5-6), 337–357.

Solesvik, M. & Gulbrandsen, M. (2014). Interactions for innovation: Comparing Norwegian regions. *Journal of Entrepreneurship Management and Innovation*, *10*(3), 7–28.

Soo, K.W. (2018). Innovation across cities. *Journal of Regional Science*, *58*(2), 295–314.

Soto, J., & Paredes, D. (2016). Cities, wages, and the urban hierarchy. *Journal of Regional Science*, *56*(4), 596–614.

Storper, M., Kemeny, T., Makarem, N.P., & Osman, T. (2015). *The Rise and Fall of Urban Economies: Lessons from San Francisco and Los Angeles*. Stanford, CA: Stanford Business Books.

Storper, M., & Venables, A.J. (2005). Buzz: Face-to-face contact and the urban economy. *Journal of Economic Geography*, *4*(4), 351–370.

Taylor, P.J. (2001). Specification of the world city network. *Geographical Analysis*, *33*(2), 181–194.

Teirlinck, P., & Spithoven, A. (2008). The spatial organization of innovation: Open innovation, external knowledge relations and urban structure. *Regional Studies*, *42*(5), 689–704.

Timmermans, B., & Boschma, R. (2014). The effect of intra- and inter-regional labour mobility on plant performance in Denmark: the significance of related labour inflows. *Journal of Economic Geography*, *14*(2), 289–311.

Tödtling, F., Grillitsch, M., & Höglinger, C. (2012). Knowledge Sourcing and Innovation in Austrian ICT Companies—How Does Geography Matter? *Industry & Innovation*, *19*(4), 327–348.

Wilhelmsen, L. (2011). Innovasjon i norsk næringsliv 2006-2008 (Report 32/2011). Oslo: Statistics Norway.

Wilhelmsen, L., & Foyn, F. (2009). Innovasjon i norsk næringsliv 2004-2006 (Report 46/2009). Oslo: Statistics Norway.

Wilhelmsen, L., & Foyn, F. (2012). Innovasjon i norsk næringsliv 2008-2010 (Report 46/2012). Oslo: Statistics Norway.

Williams, R. (2012). Using the Margins Command to Estimate and Interpret Adjusted Predictions and Marginal Effects. *Stata Journal*, *12*(2), 308–331.

TABLE 1: Location of firms and number of observations

Type	Definition	Regions	Sampled firms		
			2006	**2008**	**2010**
Big city regions	Centers with >500,000 pop.	Oslo	1624	1732	1854
Medium city regions	Centers with 150,000 – 500,000 pop.	Bergen, Stavanger, Trondheim	1160	1169	1253
Small city regions	Centers with pop. 19,000 – 150,000 pop.	Fredrikstad, Drammen, Tønsberg, Grenland, Kristiansand, Ålesund, Bodø, Tromsø, Moss, Hamar, Lillehammer, Gjøvik, Sandefjord, Arendal, Haugesund, Molde	1874	1688	1872
Non-urban regions		Rest of country	1754	1391	1553
Total			6412	5980	6532

TABLE 2: Logit regression results, Model 1

VARIABLES	(1) Product innovation	(2) New-to-market innovation	(3) Process innovation	(4) Organisational innovation	(5) Marketing innovation
Regional partners	0.99	1.00	1.08*	1.14***	1.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
National partners	1.01	1.02	0.99	1.03	0.97
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Foreign partners	1.13***	1.07*	1.04	1.03	1.09*
	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)
Small city	1.13	1.19	0.91	1.03	1.01
	(0.12)	(0.13)	(0.09)	(0.10)	(0.10)
Medium city	1.22+	1.23+	1.00	1.08	1.09
	(0.14)	(0.15)	(0.11)	(0.12)	(0.12)
Big city	1.28*	1.24+	0.88	0.94	1.05
	(0.15)	(0.16)	(0.10)	(0.10)	(0.12)
Log R&D expenditure	1.29***	1.28***	1.20***	1.10***	1.14***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Log no. of employees	0.97	0.94+	1.04	1.20***	1.01
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
Log % of educated employees	2.56**	2.25*	1.34	2.10*	1.60
	(0.81)	(0.75)	(0.42)	(0.62)	(0.48)
Industry FE	Included	Included	Included	Included	Included
Time FE	Included	Included	Included	Included	Included
Constant	0.05***	0.03***	0.14***	0.08***	0.07***
	(0.02)	(0.01)	(0.04)	(0.03)	(0.02)
N	6,363	6,341	6,378	5,650	6,061
Pseudo R^2	0.26	0.24	0.13	0.08	0.11

Odds ratios. Robust standard errors (clustered over firms) in parentheses.
*** p<.001, ** p<.01, * p<.05, + p<.10

TABLE 3: Logit regression results, Model 2

VARIABLES	(1) Product innovation	(2) New-to-market innovation	(3) Process innovation	(4) Organisational innovation	(5) Marketing innovation
Innovation t-1	3.81***	3.09***	2.56***	2.02***	3.19***
	(0.30)	(0.28)	(0.19)	(0.15)	(0.24)
Regional partners	0.95+	0.96	1.04	1.14***	1.01
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
National partners	0.97	1.00	0.96	1.04	0.96
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Foreign partners	1.12**	1.06+	1.04	1.00	1.06+
	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
Small city	1.09	1.13	0.92	1.01	0.95
	(0.11)	(0.12)	(0.09)	(0.10)	(0.09)
Medium city	1.21+	1.20	1.00	1.10	1.04
	(0.13)	(0.14)	(0.11)	(0.12)	(0.11)
Big city	1.23+	1.22	0.88	0.93	1.00
	(0.14)	(0.15)	(0.10)	(0.11)	(0.11)
Log R&D expenditure	1.21***	1.23***	1.16***	1.09***	1.11***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Log no. of employees	0.99	0.97	1.04	1.22***	1.04
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
Log % of educated employees	2.44**	2.35**	1.58	1.61	1.58
	(0.75)	(0.77)	(0.48)	(0.52)	(0.49)
Industry FE	Included	Included	Included	Included	Included
Time FE	Included	Included	Included	Included	Included
Constant	0.05***	0.03***	0.11***	0.04***	0.07***
	(0.02)	(0.01)	(0.03)	(0.02)	(0.02)
N	6,363	6,341	6,378	4,907	5,667
Pseudo R^2	0.30	0.27	0.15	0.10	0.15

Odds ratios. Robust standard errors (clustered over firms) in parentheses.
*** $p<.001$, ** $p<.01$, * $p<.05$, + $p<.10$

TABLE 4: Logit regression results for innovation-active firms, Model 2

VARIABLES	(1) Product innovation	(2) New-to-market innovation	(3) Process innovation	(4) Organisational innovation	(5) Marketing innovation
Innovation t-1	3.26***	2.80***	2.25***	1.68***	2.78***
	(0.28)	(0.25)	(0.18)	(0.14)	(0.23)
Regional partners	0.95+	0.96	1.04	1.13***	1.01
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
National partners	0.98	1.01	0.97	1.04	0.97
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Foreign partners	1.14***	1.08*	1.05+	1.02	1.08*
	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
Small city	1.11	1.08	0.89	0.94	1.02
	(0.13)	(0.13)	(0.10)	(0.11)	(0.12)
Medium city	1.34*	1.31*	1.06	1.01	1.16
	(0.17)	(0.17)	(0.13)	(0.13)	(0.15)
Big city	1.31*	1.24	0.88	0.83	1.05
	(0.17)	(0.17)	(0.11)	(0.11)	(0.14)
Log R&D expenditure	1.20***	1.19***	1.14***	1.07***	1.09***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Log no. of employees	0.91**	0.91**	0.99	1.16***	0.98
	(0.03)	(0.03)	(0.03)	(0.05)	(0.04)
Log % of educated employees	1.19	1.57	1.03	1.20	0.93
	(0.40)	(0.54)	(0.35)	(0.44)	(0.32)
Industry FE	Included	Included	Included	Included	Included
Time FE	Included	Included	Included	Included	Included
Constant	0.08***	0.05***	0.16***	0.08***	0.10***
	(0.03)	(0.02)	(0.05)	(0.03)	(0.04)
N	3,842	3,834	3,839	3,084	3,506
Pseudo R^2	0.23	0.21	0.10	0.06	0.12

Odds ratios. Robust standard errors (clustered over firms) in parentheses.
*** $p<.001$, ** $p<.01$, * $p<.05$, + $p<.10$

TABLE 5: Logit regression results, Model 3

VARIABLES	(1) Product innovation	(2) New-to-market innovation	(3) Process innovation	(4) Organisational innovation	(5) Marketing innovation
Innovation t-1	3.81***	3.10***	2.56***	2.03***	3.18***
	(0.30)	(0.28)	(0.19)	(0.15)	(0.24)
Regional partners	0.96	1.05	1.10	1.10	1.06
	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)
National partners	0.98	1.01	0.97	1.05	0.97
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Foreign partners	1.12***	1.07*	1.04	0.99	1.07*
	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
Small city	1.13	1.20+	0.94	1.01	0.97
	(0.11)	(0.13)	(0.09)	(0.10)	(0.10)
Medium city	1.17	1.20	1.03	1.06	1.01
	(0.13)	(0.15)	(0.11)	(0.12)	(0.11)
Big city	1.22+	1.27+	0.89	0.92	1.02
	(0.14)	(0.16)	(0.10)	(0.11)	(0.11)
Reg.partners*Small city	0.85*	0.82*	0.91	0.98	0.90
	(0.07)	(0.07)	(0.07)	(0.08)	(0.07)
Reg.partners*Medium city	1.11	1.00	0.92	1.14	1.08
	(0.09)	(0.09)	(0.08)	(0.10)	(0.09)
Reg.partners*Big city	1.00	0.88	0.97	1.05	0.89
	(0.08)	(0.08)	(0.07)	(0.09)	(0.07)
Log R&D expenditure	1.21***	1.22***	1.16***	1.09***	1.11***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Log no. of employees	0.99	0.97	1.04	1.22***	1.04
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
Log % of educated employees	2.43**	2.39**	1.58	1.61	1.59
	(0.76)	(0.79)	(0.48)	(0.52)	(0.49)
Industry FE	Included	Included	Included	Included	Included
Time FE	Included	Included	Included	Included	Included
Constant	0.04***	0.03***	0.11***	0.04***	0.06***
	(0.01)	(0.01)	(0.03)	(0.02)	(0.02)
N	6,363	6,341	6,378	4,907	5,667
Pseudo R^2	0.30	0.27	0.15	0.10	0.15

Odds ratios. Robust standard errors (clustered over firms) in parentheses.
*** p<.001, ** p<.01, * p<.05, + p<.10

TABLE 6: Average marginal effects of *Regional partners* in different regions

	Product innovation	**New-to-market innovation**	**Process innovation**	**Organisational innovation**	**Marketing innovation**
Big city	-.005	-.009	.009	.024**	-.009
	(.007)	(.007)	(.007)	(.009)	(.008)
Medium city	.010	.006	.003	.039***	.021*
	(.008)	(.007)	(.009)	(.010)	(.009)
Small city	-.026***	-.017*	-.000	.012	-.007
	(.007)	(.007)	(.008)	(.010)	(.008)
Peripheral region	-.005	.005	.014†	.017	.009
	(.008)	(.007)	(.009)	(.011)	(.010)

Note: † = P < .10 * = P < .05 ** = P < .01 *** = P < .001

TABLE 7: Tobit regression results

VARIABLES	Share of income from product innovation				Share of income from new-to-market innovation			
	Model 1	Model 2	Model 2, innovation-active	Model 3	Model 1	Model 2	Model 2, innovation-active	Model 3
Innovation t-1		0.49***	0.44***	0.49***		0.51***	0.47***	0.50***
		(0.04)	(0.04)	(0.04)		(0.06)	(0.06)	(0.06)
Regional partners	1.07	0.46	0.34	0.78	0.70	0.13	0.01	1.83
	(0.70)	(0.65)	(0.63)	(1.31)	(0.70)	(0.68)	(0.65)	(1.33)
National partners	-0.48	-0.76	-0.58	-0.65	0.17	0.06	0.19	0.17
	(0.65)	(0.62)	(0.59)	(0.62)	(0.65)	(0.63)	(0.60)	(0.62)
Foreign partners	2.58***	2.41***	2.83***	2.45***	1.14+	1.00	1.34*	1.08+
	(0.64)	(0.60)	(0.58)	(0.60)	(0.66)	(0.64)	(0.62)	(0.63)
Small city	1.66	0.76	1.52	1.22	2.85	3.03	2.63	4.06+
	(2.44)	(2.26)	(2.48)	(2.28)	(2.45)	(2.32)	(2.54)	(2.39)
Medium city	4.41	3.86	6.74*	2.91	4.94+	4.64+	7.52**	4.26
	(2.68)	(2.49)	(2.72)	(2.59)	(2.69)	(2.53)	(2.77)	(2.63)
Big city	5.01+	4.41+	6.15*	4.65+	5.29+	5.45*	7.05*	6.35*
	(2.78)	(2.57)	(2.78)	(2.61)	(2.85)	(2.69)	(2.93)	(2.74)
Reg.partners*Small city				-2.00				-3.53*
				(1.79)				(1.70)
Reg.partners*Medium city				2.47				0.62
				(1.85)				(1.95)
Reg.partners*Big city				-1.22				-3.05+
				(1.59)				(1.66)
Log R&D expenditure	6.29***	5.09***	4.22***	5.08***	5.61***	5.00***	4.16***	4.98***
	(0.29)	(0.29)	(0.29)	(0.29)	(0.32)	(0.31)	(0.32)	(0.31)
Log no. of employees	-4.11***	-2.48***	-4.78***	-2.45***	-3.39***	-2.44***	-3.87***	-2.44***
	(0.74)	(0.69)	(0.78)	(0.69)	(0.76)	(0.71)	(0.79)	(0.71)
Log % of educated employees	20.14**	17.48*	-1.22	17.67*	19.24*	18.11*	6.68	18.35*
	(7.60)	(7.21)	(7.56)	(7.21)	(7.89)	(7.50)	(7.77)	(7.50)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Industry FE	Included	Included	Included	Included	Included	Included	Included	Included
Time FE	Included	Included	Included	Included	Included	Included	Included	Included
Constant	-64.47***	-68.23***	-49.30***	-69.52***	-71.30***	-73.06***	-60.60***	-75.02***
	(9.26)	(8.20)	(8.90)	(8.38)	(9.92)	(8.60)	(9.43)	(8.75)
N	6,382	6,382	3,861	6,382	6,382	6,382	3,861	6,382
Pseudo-R^2	0.08	0.09	0.06	0.09	0.09	0.10	0.07	0.10

Coefficients. Robust standard errors (clustered over firms) in parentheses. Left-censored at 0, right-censored at 100.

*** $p<.001$, ** $p<.01$, * $p<.05$, + $p<.10$

Appendix Table A.1: Descriptive statistics on the sample

	2006-2008		2008-2010	
No. of employees	*N*	*Percent*	*N*	*Percent*
<19	912	28.4	655	20.7
20-49	707	22.0	788	24.9
50-99	706	22.0	710	22.4
100-499	732	22.8	842	26.6
>500	159	4.9	171	5.4
R&D expenditure	*N*	*Percent*	*N*	*Percent*
None	2092	65.1	2016	63.7
Less than NOK 1 million	244	7.6	217	6.9
NOK 1 – 10 million	678	21.1	701	22.1
More than NOK 10 million	202	6.3	232	7.33
% of educated employees	*N*	*Percent*	*N*	*Percent*
<5%	564	17.5	438	13.8
5-10 %	584	18.2	527	16.7
10-25 %	862	26.8	898	28.4
25-50 %	505	15.7	572	18.1
>50%	701	21.8	731	23.1
Industry	*N*	*Percent*	*N*	*Percent*
Seafood	42	1.3	41	1.3
Mining and quarrying	98	3.0	127	4.0
High-tech/medium high-tech manufacturing	381	11.8	398	12.6
Low-tech/medium low-tech manufacturing	1054	32.8	823	26.0
El., gas and water supply	110	3.4	157	5.0
Construction	206	6.4	251	7.9
Trade	233	7.2	268	8.5
Transport and storage	220	6.8	218	6.9
Information and communications	438	13.6	422	13.3
Financial services	163	5.1	169	5.3
Other services	271	8.4	292	9.2
Total N	3216		3166	

Appendix Table A.2: Correlation matrix

	Mean	SD	Reg. partners	National partners	Foreign partners	Big city	Medium city	Small city	Log R&D exp	Log no. empl
Regional partners	.25	.90								
National partners	.25	.95	.41							
Foreign partners	.21	.87	.38	.48						
Big city	.28	.45	-.00	-.02	.02					
Medium city	.19	.39	.01	.00	-.01	-.30				
Small city	.29	.45	.01	.03	.01	-.39	-.31			
Log R&D exp.	1.87	3.44	.36	.39	.41	.03	.03	.00		
Log no. empl.	3.38	1.28	.13	.18	.19	.08	.02	-.02	.24	
Log % educated empl.	.21	.20	.13	.11	.14	.35	.02	-.14	.32	.00

Appendix Table A.3: Sampled firms in region by industry

Industry	Big city	Medium city	Small city	Peripheral
Seafood	0.0	1.3	0.6	3.9
Mining and quarrying	1.8	7.4	1.4	5.0
High-tech/medium high-tech manufacturing	8.6	11.0	17.6	10.9
Low-tech/medium low-tech manufacturing	11.2	28.6	37.7	42.3
El., gas and water supply	1.9	3.9	4.9	6.4
Construction	6.5	7.1	7.7	7.4
Trade	15.3	6.2	6.1	2.2
Transport and storage	7.2	7.2	6.3	6.8
Information and communications	25.7	11.8	8.0	6.7
Financial services	8.5	4.2	3.3	4.3
Other services	13.2	11.4	6.5	4.1
N	1814	1261	1827	1480

Appendix Table A.4: Logit regression results, Model 1, excluding R&D expenditure

VARIABLES	(1) Product innovation	(2) New-to-market innovation	(3) Process innovation	(4) Organisational innovation	(5) Marketing innovation
Regional partners	1.13***	1.12***	1.17***	1.20***	1.11***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)
National partners	1.15***	1.14***	1.08**	1.08**	1.04
	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
Foreign partners	1.31***	1.22***	1.15***	1.10**	1.17***
	(0.05)	(0.04)	(0.03)	(0.03)	(0.04)
Small city	1.12	1.18	0.91	1.02	1.02
	(0.11)	(0.13)	(0.09)	(0.10)	(0.10)
Medium city	1.28*	1.31*	1.05	1.09	1.12
	(0.14)	(0.16)	(0.11)	(0.12)	(0.12)
Big city	1.11	1.09	0.81+	0.89	0.98
	(0.13)	(0.14)	(0.09)	(0.10)	(0.11)
Log no. of employees	1.10***	1.09**	1.15***	1.25***	1.07*
	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)
Log % of educated employees	16.31***	15.66***	5.38***	4.55***	4.46***
	(4.80)	(4.91)	(1.58)	(1.29)	(1.27)
Industry FE	Included	Included	Included	Included	Included
Time FE	Included	Included	Included	Included	Included
Constant	0.06***	0.04***	0.15***	0.09***	0.08***
	(0.02)	(0.01)	(0.04)	(0.03)	(0.03)
Observations	6,363	6,341	6,378	5,650	6,061
Pseudo R^2	0.171	0.157	0.0761	0.0622	0.0860

Odds ratios. Robust standard errors (clustered over firms) in parentheses.
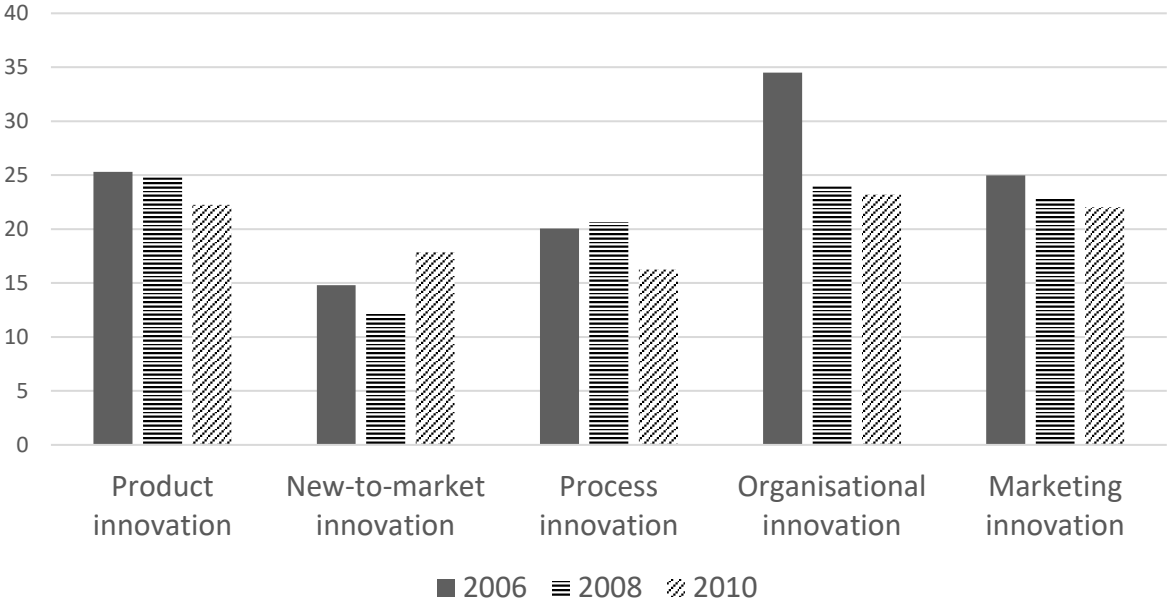*** $p<.001$, ** $p<.01$, * $p<.05$, + $p<.10$

Appendix Table A.5: Logit regression results, Model 1 with county fixed effects

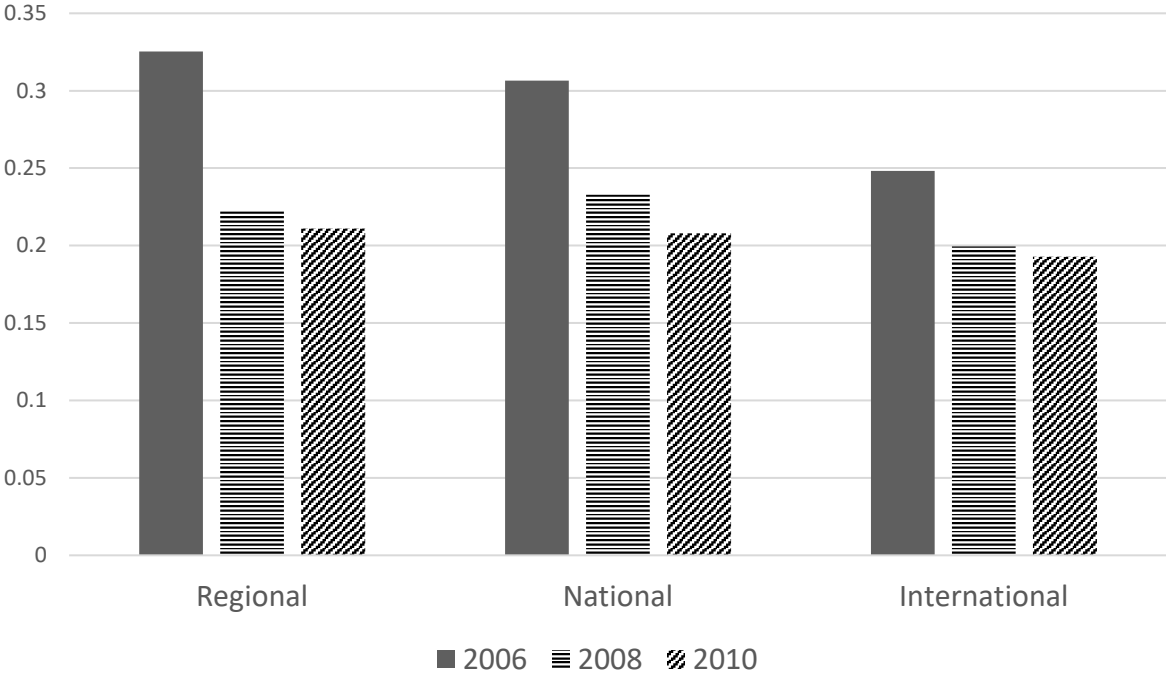| VARIABLES	(1) Product innovation	(2) New-to-market innovation	(3) Process innovation	(4) Organisational innovation	(5) Marketing innovation
Regional partners	0.99	1.00	1.07*	1.14***	1.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
National partners	1.01	1.03	0.99	1.03	0.98
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Foreign partners	1.14***	1.08*	1.05+	1.04	1.09*
	(0.04)	(0.04)	(0.03)	(0.03)	(0.04)
Small city	1.14	1.14	1.00	0.98	0.97
	(0.14)	(0.15)	(0.12)	(0.11)	(0.11)
Medium city	1.17	1.28	0.98	1.22	1.19
	(0.21)	(0.24)	(0.16)	(0.21)	(0.21)
Big city	1.05	1.02	0.82	0.76+	0.87
	(0.18)	(0.18)	(0.13)	(0.11)	(0.13)
Log R&D expenditure	1.29***	1.28***	1.20***	1.10***	1.14***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Log no. of employees	0.97	0.94+	1.05	1.21***	1.01
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
Log % of educated employees	2.51**	2.25*	1.34	1.98*	1.59
	(0.80)	(0.76)	(0.42)	(0.59)	(0.48)
Industry FE	Included	Included	Included	Included	Included
County FE	Included	Included	Included	Included	Included
Year FE	Included	Included	Included	Included	Included
Constant	0.06***	0.04***	0.14***	0.09***	0.09***
	(0.02)	(0.02)	(0.05)	(0.03)	(0.03)
Observations	6,351	6,329	6,366	5,640	6,050
Pseudo R^2	0.264	0.245	0.129	0.0793	0.116

Odds ratios. Robust standard errors (clustered over firms) in parentheses.
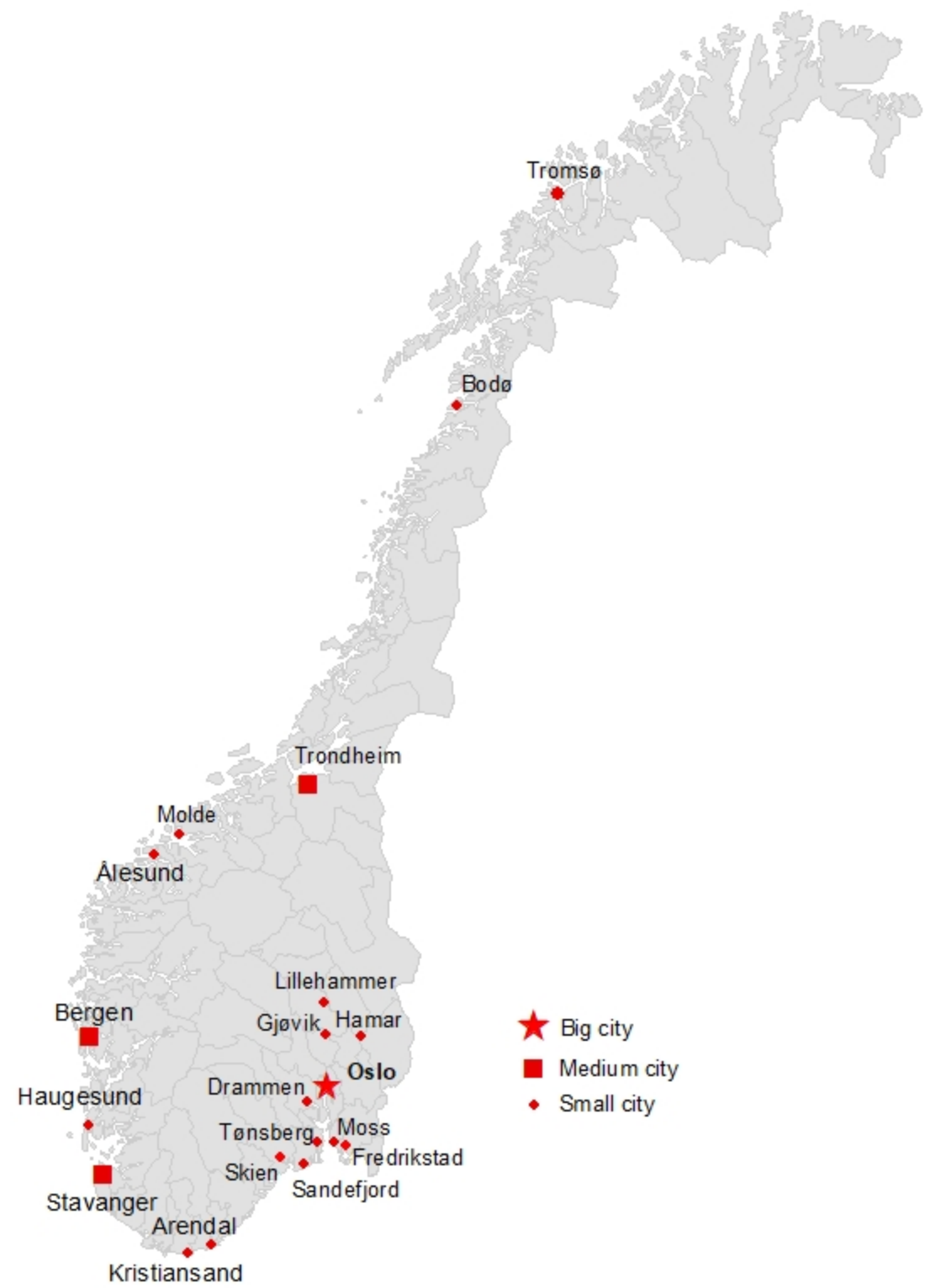*** p<.001, ** p<.01, * p<.05, + p<.10

Figure 1: Share of firms reporting innovation by type of innovation and survey period

Figure 2: Average types of partners used at each geographical scale by survey period

Tromsø

Bodø

Trondheim

Molde

Ålesund

Lillehammer

Bergen

Gjøvik   Hamar

Haugesund

Drammen   **Oslo**

Tønsberg   Moss

Skien   Fredrikstad

Stavanger

Sandefjord

Arendal

Kristiansand

★ Big city

■ Medium city

◆ Small city