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Imitate, or innovate and collaborate? On innovation strategy choices in the urban economy

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Abstract

This paper explores how the innovation strategies of firms reflect the density, diversity and connectivity of their urban locations. Firms located outside the four large-city regions of Norway are generally more committed to development work than are their urban counterparts. Still, once engaged, firms in certain large-city locations exhibit unique preferences towards geographically dispersed collaboration that are most pronounced within the Western business district of the Capital. This shows that firm-level decisions along interconnected activity dimensions must be considered in order for different strategy choices, and the interdependencies between them that are an essential feature of urban economies, are to be revealed. The study provides new insights into the large-city region knowledge dynamics that are increasingly important to human capital formation, employment and growth.

JEL codes: R11, O31, O33

Keywords: Urbanization, innovation, collaboration, knowledge dynamics, Norway

Introduction

The density, diversity and international connectivity of large-city regions is reflected in the human resources that organizations can recruit; in the partners that are available for them to collaborate with and in the contact points that people and partners provide to global information flows (Herstad & Ebersberger, 2013; Simmie, 2003). This raises the question of whether unique urban economy resource conditions translate into stronger or weaker commitments of local firms to development work (E Glaeser, 2000; E. Glaeser, Kallal, Scheinkman, & Shleifer, 1992). This question is of high relevance, because innovation policies that are tailor-made to the knowledge dynamics of large-city regions are growing in importance as urbanization itself progresses.

Prior empirical research has focused on whether firms in various types of locations 'on average' differ along certain activity or output dimensions (Doloreux & Shearmur, 2012; Fitjar & Rodríguez-Pose, 2013; Solesvik & Gulbrandsen, 2014; Teirlinck & Spithoven, 2008). Some have found positive associations between the density of related economic activity in an area, and patterns of collaboration (Bennett, Robson, & Bratton, 2001). In the context of services, it has been suggested that this relationship is particularly strong in sub-clusters of capital regions (Herstad & Ebersberger, 2013; Wood, 2002). Others claim that a direct relationship between locations and behavior is far from apparent (Amin & Thrift, 2002; Doloreux, Amara, & Landry, 2008; Doloreux & Shearmur, 2012; Shearmur, 2012). Some have even found that firms located outside high-density agglomerations are more committed to R&D and innovation (Herstad & Ebersberger, 2014; Suarez-Villa & Walrod, 1997), more network-oriented in their innovation processes (Fritsch, 2003; Herstad, Pålshaugen, & Ebersberger, 2011; Teirlinck & Spithoven, 2008; Tödtling & Trippl, 2005), and better connected to non-local markets than are their urban counterparts (O'Farrell, Zheng, & Wood, 1996).

Arguably, conceptual and empirical approaches that allow firms to respond differently to the same local resource conditions are needed to reflect the defining characteristics of the larger territorial economies that their strategies are expected to express; that is, diversity of ideas, human resources and network configurations, and the different, yet potentially interdependent, business strategies that this diversity allow firms to pursue. Acknowledging this, Herstad and Ebersberger (2013, 2014) found that services firms in the Central and Western business districts of the Norwegian capital are less inclined than their rural counterparts to engage actively in development work; yet, once engaged, also more strongly connected to a broader range of partners domestically and abroad. They conclude that the complexity of counteracting influences is effectively concealed if the different strategic decisions and processes that combined mediate between external incentives and firms-specific strategy responses are collapsed into one (Herstad & Ebersberger, 2014).

The following seeks to explore these ideas beyond the realm of the knowledge intensive business services sector (Herstad & Ebersberger, 2013, 2014; Shearmur, 2012). Conceptually, the paper identifies and discusses a set of basic innovation strategy choices that firms are forced to make. Using representative sample Community Innovation Survey data from Norway, a categorical innovation strategy variable is constructed that translate these choices into strategies that at the outset are assumed to reflect different degrees of commitment to innovation. Ordered logistic regressions are therefore estimated that consider whether this degree vary with the locations of firms within and outside the Norwegian urban hierarchy. Multinomial logistic regression techniques are then used to investigate whether certain urban locations are associated with stronger or weaker preferences for certain strategies over others.

The results of the two estimation techniques are compared and interpretations are provided that reflect on the data, methodologies and findings of prior research.

Innovation strategy decisions

In the current economic landscape, the competitiveness of industrial organizations depend on their ability to identify, access and assimilate knowledge developed outside their own value chains, sector domains and immediate geographical surroundings (Hargadon & Sutton, 1997; Herstad, Aslesen, & Ebersberger, 2014; Katila, 2002). As a result, firms must allow a wide range of internal competences, business processes and external network configurations to operate in tandem and complement each other in their impacts on competitiveness and growth (Grant, 1996; Herstad, Sandven, & Ebersberger, 2015; Jensen, Johnson, Lorenz, & Lundvall, 2007; Østergaard, Timmermans, & Kristinsson, 2011).

As the boundaries of firms in this way becomes more 'permeable' (Jacobides & Billinger, 2006; Rothaermel, Hitt, & Jobe, 2006), their receptiveness to various types of external influences increases. Locations are of interest in this respect, because they represent physical spaces that exposes firms to impulses which reflect specific industrial configurations and legacies (Fernhaber, Gilbert, & McDougall, 2008). 'Localisation economies', a term originally coined by Alfred Marshall (Marshall, 1920), describe the benefits of locating in specialised regions. These include exposure to sector-specific information, access to common supplier infrastructures and pools of labour with competences and work practices shaped by the industry in question.

The contrasting concept of 'urbanization economies' stem from the work of Jane Jacobs (1969) on the benefits of diversity and density (E. Glaeser et al., 1992; Jacobs, 1969). Recently, it has been suggested that advantages such as better infrastructures and broader local markets should be distinguished from the 'urban knowledge dynamics' (Shearmur,

2012) that arises from cross-fertilization between firms that engage in different businesses but concentrate within a geographically confined area. An essential driver of these dynamics is high inter-firm mobility in local labour markets that also serve as points of gravitation in larger domestic and international mobility flows (Almeida & Kogut, 1999; Aslesen, Isaksen, & Stambøl, 2008; Herstad & Ebersberger, 2014). These allow different collocated firms to tap into each other's knowledge bases and networks (Agrawal, Cockburn, & McHale, 2006; Bouty, 2000; G Dokko & Rosenkopf, 2010; G. Dokko, Wilk, & Rothbard, 2009), and draw inspiration from different organizational practices and business strategies (Madsen, Mosakowski, & Zaheer, 2003). On the one hand, this may strengthen the capacity of firms to successfully innovate. On the other, it may also reduce their propensity to engage in development work (Herstad & Ebersberger, 2014) due to the real option of allowing 'learning-by-hiring' and other forms of imitation to substitute for it (E Glaeser, 2000; E. Glaeser et al., 1992). The mirror image of this seen from the perspective of employees is the wider range of employment opportunities that are available to them in urban locations. This may weaken their commitment to given employers, and translate into appropriability problems that may further raise the threshold for firms to engage (Combes & Duranton, 2006; Shearmur, 2012; Suarez-Villa & Walrod, 1997).

Firms outside large-city regions, by contrast, may experience that their development work is constrained by weaker local supply of human resources, and less diverse, if not weaker, local partner bases. However, they may also be more inclined to engage in such work at the outset because they need to 'internalize' some of the benefits that are external to firms in more dense and diverse regions (Doloreux & Shearmur, 2012; O'Farrell et al., 1996). This means that the question of whether or not firms have engaged in development work is of fundamental importance to the understanding of how they relate to their external contexts:

Decision #1: Whether to engage in systematic development work, of stay passive.

An important aspect of innovation strategy is the implementation of different open innovation practices (Ebersberger, Bloch, Herstad, & van de Velde, 2012; Spithoven, Vanhaverbeke, & Roijakkers, 2012). Among these, collaborative ties are of particular interest because they reflect choices made to 'open up' organizational knowledge bases to other firms and institutions. Direct, two-way communication involving proprietary knowledge distinguishes collaboration from search, i.e. unilateral scanning of the environment for inspiration and ideas (Ebersberger & Herstad, 2011; Laursen & Salter, 2006), and from the transfer of knowledge embodied in products, machinery and documents that occurs through technology trade and contractual R&D purchases (Dachs, Ebersberger, & Pyka, 2008; de Jong & Freel, 2009; Fey & Birkinshaw, 2005; Tether, 2002).

Collaboration exposes the firm to partner opportunism and increases the risk of uncontrolled knowledge leakages (Ritala, Olander, Michailova, & Husted, 2015). Thus, firms may be particularly reluctant to open their development work up to partners if located in environments where this risk is high at the outset, i.e. in large-city regions (E Glaeser, 2000). Moreover, the benefits that accrue to each partner is contingent on their respective capacities to understand, assimilate and transform what is communicated. This need for 'absorptive capacity' (Cohen & Levinthal, 1989, 1990) translate into a risk of asymmetric benefits that become apparent only once the work has started (Lam, 2000; Lane & Lubatkin, 1998; Schmidt, 2010). Thus, collaboration is a selective activity in which firms can be assumed to engage only when expected costs and inherent uncertainties are outweighed by expected benefits. The second fundamental decision to be considered is therefore:

Decision #2: Whether to contain development work within the boundaries of the firm, or actively involve partners.

On the one hand, firms located in knowledge-rich regional environments may be less inclined to collaborate locally due the option of instead tapping each other's labour market spillovers (Balsvik, 2011; Møen, 2005) and the added risk of knowledge leakages that collaboration involve (Henttonen, Hurmelinna-Laukkanen, & Ritala, 2015; Herstad & Ebersberger, 2013). On the other, search and absorptive capacity constraints associated with collaboration are reduced by proximity. Nearby partners are easier to identify and monitor than those outside the local environment, and are often easier to trust (Laursen, Masciarelli, & Prencipe, 2012a). Proximity also tend to nurture similarity in organizational structures and routines, and continuous experimentation, adaption and adjustments is easier when face-to-face interaction is possible. This suggest that firms, given the option, tend to prefer local partners over non-local.

At the same time, collaborative linkages have the capacity to transfer knowledge over long distances (Adams, 2002; Herstad et al., 2014; Torre, 2008). This means that they can be used by firms to overcome local resource constraints (Cotic-Svetina, Jaklic, & Prodan, 2008; Herstad & Brekke, 2012). Distant collaboration requires more management attention and organizational resources to be allocated to the task. This particularly applies at the international level, i.e. when partners are 'distant' not only in physical terms but also in terms of the institutional conditions, industrial specialisation paths and business cultures that they represent, and often reflect in their organizational structures and routines (Asheim, Ebersberger, & Herstad, 2012; Asheim & Herstad, 2005; Boschma, 2005; Lam, 2000). Organizational capacity and management attention are scarce resources. For some firms, the decision to involve collaboration partners therefore translates into a trade-off between the advantages of proximity that domestic partners provide, and the advantages of diversity and connectivity that are often unique to international collaboration (Fitjar & Rodríguez-Pose, 2012):

Decision #3: Whether to involve domestic partners and benefit from proximity, or foreign partners and benefit from diversity

Still, many firms are linked to partners domestically as well as abroad. In these cases, domestic linkages expresses the existence of place-specific resources that are particularly valuable because they reflect the history, industry composition and position of the home region in the international landscape of technology (Benito, Larimo, Narula, & Pedersen, 2002; Ebersberger, Herstad, & Koller, 2014; Fernhaber et al., 2008), and may actively serve in support of international involvement (Laursen, Masciarelli, & Prencipe, 2012b). They do so by means of the privileged information and contact points to global networks that local partners provide (Graf, 2010; Herstad & Ebersberger, 2013), and by way of local supply of managers and employees that have international experiences and therefore maintain informal networks to actors and locations abroad (Deprey, 2011; Oettl & Agrawal, 2008). Thus, the decision to engage internationally while remaining linked at home is not only a particularly strong firm-level expression of commitment to innovation. It is also a strong indicator of place-specific resources supportive thereof. Consequently, it must be considered an innovation strategy decision in its own right:

Decision #4: Whether to maintain domestic collaborative linkages while actively involving partners abroad in development work

These four decision are used as the point of departure for exploring empirically the different ways in which firms may reflect the knowledge dynamics of their urban locations. Keeping this objective in mind, the use of micro-level innovation survey data for the purpose necessitate a brief overview of the economy from which this data is drawn. The following section provides this overview.

The Norwegian urban system

Norway is a small, open economy that is specialized in advanced deep-water oil and gas extraction technologies, seafood, maritime equipment, ammunition and weapons systems, and metallurgical industries (e.g. Benito et al., 2002; Fagerberg, Mowery, & Verspagen, 2009). These are largely engineering-based; characterized by cumulative knowledge development aimed at problem-solving in specific contexts of technology application. Compared to other European countries, Norway was only marginally influenced by the ICT bubble burst of the early 2000s and the advent of the financial crisis in late 2007 (Herstad, 2011). This resilience has been due to the demand for offshore oil and gas extraction technology in the wake of high international energy prices; to strong export markets for seafood; and to growth in the exports of advanced weapons systems and ammunition (Castellacci & Fevolden, 2014).

The capital region of Greater Oslo dominates the landscape of research, higher education and employment (Aslesen et al., 2008; Herstad et al., 2011; K Onsager, Gundersen, & Sørlie, 2010). Therefore, it warrants special attention. In 2010, the region accounted for 27.5 per cent of Norwegian employment; compared to only 8 per cent, 7 per cent and 5 per cent in the other major cities of Bergen, Stavanger and Trondheim (cf. Table 1). It houses the largest Norwegian university, in addition to several university colleges, business schools and research institutes. Moreover, corporate group headquarters and other strategic functions tend to locate in this region (Aslesen & Isaksen, 2007; Aslesen & Jakobsen, 2007) even though business activities are often conducted elsewhere. As a result, it is estimated to represent one third of all Norwegian R&D personnel, and account for over 40 per cent of industry expenditures on research, development and innovation (Foyn et al., 2011).

Large-city regions are known to be polycentric and differentiated, i.e. composed of multiple, heterogeneous business clusters (Brezzi & Veneri, 2014; Niu, Ding, & Knaap, 2014; Suarez-

Villa & Walrod, 1997) that do not necessarily overlap with administrative boundaries (Shearmur, 2012). Therefore, the work of Jukvam (2002) on functional housing and labour market regions is used as the point of departure for delineating business locations that belong to the four large-city labour market regions in Norway from those that do not. Moreover, Greater Oslo is split into the Central Capital City (CAPITAL C), the Western business cluster that extends well into neighbouring municipalities (CAPITAL W) and the outer dwelling municipalities (CAPITAL O).

From the location quotients displayed in Table 1, it can be seen that the Western business district of the Capital is characterised by over-representation of employment in the offshore oil & gas sector, and in industries such as low-tech manufacturing, ICTs and technical services (Table 1). In the inner City itself, offshore oil & gas employment and manufacturing employment is under-represented and the specialisation in ICTs, scientific and technical services is less strong. The Capital is known to exert a strong gravitational pull in domestic labour markets (Aslesen et al., 2008; Herstad et al., 2011; Stambøl, 2005), and services firm in this region to maintain broader collaborative locally and abroad than do services firms in other regions (Herstad & Ebersberger, 2013).

Table 1 approximately here

The second, third and fourth largest cities are different from the Capital both in terms of share size, and in terms of industry composition. Generally, business services are less over-represented, and the role of Stavanger as operational stronghold for the Norwegian offshore oil and gas industry is apparent not only from the exceptionally strong location quotient for the sector itself, but also from the over-representation of employment in medium-tech manufacturing and technical services industries known to supply the sector with equipment, technology and support services. Moreover, the smaller large-city labour market region of

Trondheim exhibit particularly strong employment performance in scientific and technical services, and in public administration and teaching; both reflecting that it hosts the dominant technical university and one of Europe's largest applied industrial research institutes. These two institutions are densely linked to the dominant Norwegian industries (Narula, 2002).

Against this background, it is notable that Trondheim exhibit the same under-representation of employment in high-tech manufacturing that is found in the other urban labour market regions. It is mirrored by an over-representation of manufacturing employment in general, and high-tech manufacturing specifically, in locations outside the large-city labour market regions. This may indicate that industrial activities characterized by a particularly strong dependence on complex and cumulative knowledge development thrive in locations wherein they are sheltered from the disturbances of vibrant labour markets and overall urban economy information 'buzz' (Shearmur, 2012; Suarez-Villa & Walrod, 1997). Moreover, it suggests that the benefits of proximity to research institutions and knowledge-intensive business services firms that urban locations provide are outweighed by the diseconomies of urbanization that are specific to manufacturing firms (Herstad & Sandven, 2014).

Data, variables and methodological approach

The empirical analysis is based on Norwegian micro-data from the Seventh Community Innovation Survey (CIS2010), collected by Statistics Norway in 2010 as an extended version of the harmonized European survey (Eurostat, 2010). The questionnaire is based on the definitions of innovation input, behaviour and output laid out in the third edition of OECDs Oslo Manual (OECD, 2005), and covers the three-year reference period 2008-2010. In contrast to many other European countries, participation in the CIS2010 was compulsory for sampled Norwegian firms. This resulted in comparatively large dataset, which is not plagued by non-response biases. Data were thoroughly reviewed and validated by Statistics Norway prior to release for research purposes. Previous national waves of the Community Innovation Survey has been used extensively for analysis in economics (Cassiman & Veugelers, 2006; Cassiman & Veuglers, 2002; Czarnitzki, Ebersberger, & Fier, 2007), in management studies (Ebersberger & Herstad, 2011; Frenz & Ietto-Gillies, 2009; Grimpe & Sofka, 2009; Laursen & Salter, 2004, 2006; Sofka & Grimpe, 2010) and in economic geography (Ebersberger & Herstad, 2012; Herstad et al., 2014; Laursen, Reichstein, & Salter, 2011).

The CIS2010 data provided by Statistics Norway are supplied with identifiers that allow supplementary information on each sampled enterprise to be drawn from publicly maintained registers covering all business enterprises and individuals above the age of 16. This is commonly referred to as 'linked employer-employee' (LEED) data (Boschma, Eriksson, & Lindgren, 2009; Timmermans & Boschma, 2014). The use herein of CIS linked to LEED mirror that of Herstad & Ebersberger (2014) and Herstad, Sandven & Ebersberger (2015), using previous rounds of the survey.

Locations

The CIS states the municipality in which the sampled enterprises are legally registered. Based on this, observations can be assigned to either one of the six large-city locations presented in the descriptive section above (equal to Centrality Levels 5 (the Capital) and 4 (Bergen, Stavanger, Trondheim) in the classification of labour market regions provided by Jukvam, 2002), or to the reference group consisting of labour market regions classified at lower levels of centrality (CENTRALITY 1-3).

However, CIS is sampled at the enterprise level, and enterprises can consist of several establishments that are located in different regions. This means that enterprises do not necessarily conduct their businesses in the regions where they are registered. Specifically, a substantial proportion of employment in firms registered in the capital occurs in establishments located outside it. Information on the distribution of enterprise-level employment on different establishments, and thus on different regions, has therefore been gathered from linked employer-employee registers for 2010. Based on this, the location of enterprises sampled in the CIS, i.e. the unit of analysis, has been recoded so that it refers to the regions in which the largest proportion of employment occurs. This procedure relocated approximately 8 per cent of the CIS sample, predominantly by moving large enterprises legally registered in the Capital region into the CENTRALITY 1-3 reference group.

Dependent variables and estimation strategy

The dependent COMMITMENT is designed to reflect the four innovation strategy decisions that where identified in the conceptual section. It takes on the value 0 if the firm was not active; i.e. did not report positive innovation expenditures (R&D or non-R&D), on-going or abandoned development projects (including but not limited to R&D projects), the successful launch of a new or significantly improved service onto the market, or the implementation of improved production processes or support functions during the reference period of 2008-2010. This definition is in accordance with the routing structure of the CIS questionnaire (Herstad & Ebersberger, 2014; Herstad et al., 2015). Note that it does not refer to whether the firm *has* innovated, but to whether it works actively on trying to do so.

For active firms, COMMITMENT takes on the value 1 if, in the dedicated questions on this topic, no collaborative interaction is reported by the firm[1]. This corresponds to a decision to engage in CLOSED innovation. If the firm reported innovation collaboration with a domestic or with a foreign partner[2], but not with both, the dependent variable is assigned the value 2. This corresponds to a geographically CONSTRAINED network strategy. Last, the value 3 is assigned to capture the preferences towards geographically EXTENSIVE networking that are signaled when firms report collaboration both domestically and abroad.

At the outset, higher values on the dependent variable are assumed to reflect higher degrees of underlying commitment by the firm to development work. Thus, COMMITMENT is treated as an ordered categorical variable bound between 0 (no commitment) and 3 (high commitment), and estimated using ordered logistic regressions. This estimator assumes parallel regression lines, i.e. that the coefficients of the independent variables do not vary across the modalities of the dependent variable (Williams, 2006). To acknowledge this, the results of a Brant's tests for this assumption are reported (Brant, 1990; Long & Freese, 2006).

In the second stage of the analysis, and reflecting the results of the Brant's test, the dependent variable is treated as a nominal categorical variable that capture innovation strategies that are distinct yet cannot be reasonably ordered. Thus, different values of the dependent variable are

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[1] The types of collaborative relationships that the questionnaire allow firms state are with other units in own corporate group, clients, suppliers, competitors, consultancy firms, private R&D laboratories, public research institutes, universities and other higher education institutions.

[2] Foreign collaboration is defined as at least one relationship stated in Nordic Countries other than Norway, EU countries except the Nordic countries, North America, Asia or 'other' world regions.

estimated using a multinomial logistic regression. Two sets of results are reported: First, the discrete probabilities that firms exhibit either one of the four different innovation strategies, i.e. changes in the probability that a given strategy is chosen over all other optional strategies. Second, relative risk ratios that expresses changes in the odds that firms are PASSIVE, engaged in CLOSED innovation or engaged in EXTENSIVE networking, relative to the odds that firms are engaged in CONSTRAINED networking.

Control variables

Firm-level characteristics that influence innovation activity and behavior may be unevenly distributed on regions. Thus, if not controlled for, they may bias the estimates for influences associated with regional characteristics per se. First, the size of the firm is known to positively influence the innovation activity decision (COMMITMENT > 0). Therefore, the log of firm size in 2010 is included (SIZE). Similarly, the age of the firm may negatively influence the initial innovation activity decision (Herstad et al., 2015), yet also, due to network positing effects associated with age, positively influence the collaborative ties of firms that are engaged (ibid). The log of firm age is therefore included (AGE). Market presences determine potential market size and the diversity of market information to which the firm is exposed, and may therefore influence innovation (Crepon, Duguet, & Mairesse, 1998; Ebersberger & Herstad, 2011). MARBREADTH captures the number of geographical levels specified in the CIS questionnaire on which the firm states it is present[3].

The location quotients in Table 1 revealed clear urban-rural and inter-urban dividing lines in employment composition. Since different industrial sectors are characterized by different incentives to engage in innovation activities and collaborate at various spatial scales, controls

[3] The world regions for which market presences can be stated are Norway, other Nordic Countries, other European Countries, North America, Asia and other

for sector influences on innovation strategy are included. The first (agriculture, fisheries and forestry) and three last (public administration, health and culture & sports) sector groups given in Table 1 are not sampled by the Community Innovation Surveys. Consequently, differences in innovation activity and collaboration propensities among the remaining 15 sector are in the estimations captured by the inclusion of 14 sector dummies.

LEED contains information on the educational backgrounds of employees, summarized on a scale that span from 1 (primary school) to 8 (PhD). Based on this information, the average education level of the firms' staff can be computed and included as a control (EDUCATION). Generally, this is because human resources influences the capacity to engage in innovation activity, and the propensity of active firms to collaborate. Specifically, education may condition career paths, which in turn determine the experience-based knowledge and interpersonal network ties that new employees bring with them from prior places of employment (Herstad, Sandven, & Solberg, 2013).

Results

Table 2 below displays the results of the ordered logistic regression in which COMMITMENT is treated as a matter of degree. In the baseline regressions that include only sector controls, the only estimate that is significant compared to the CENTRALITY 1-3 reference is for the Outer dwelling municipalities of the Capital region. Still, the positive estimates for CAPITAL W and TRONDHEIM are jointly significant compared to the reference (Walds Chi2 = 4.89*), as are the negative estimates obtained for the other four urban locations (Walds Chi2 = 8.97*). This indicate that the types of firms that are most committed to innovation tend to operate in the technical research strongholds of the Western capital region districts and Trondheim.

When the controls for firm-level characteristics are included in Model 2, a clearer and more consistent picture emerges in that all urban locations except the smallest region of TRONDHEIM yield negative coefficient estimates that are jointly significant (Walds Chi2 = 22.59***) compared to the reference. In addition, the individual estimate for the Central and Western business districts of the capital are negative, and the former strongly significant. This suggests that once inter-regional differences in the size and age composition of firms, and in their market presences, are accounted firms, firm located in urban regions are less committed to development work than are firms in non-urban locations.

Table 2 approximately here

The supplementary Brant's test are reported to the right in Table 2. The insignificance of the Chi2 test statistics for five out of the six region dummies suggest that the effects of these dummies - that draw in the same direction - are of comparable size irrespective of the specific level of commitment considered. Thus, the parallel regression line assumption is not violated and firms in these urban labor market regions are simply less committed to innovation than firms assigned to the CENTRALITY 1-3 reference. The exception is the significant Chi2 test statistic for CAPITAL W. From the binary logistic regressions on which the Brant's test is based, it is evident that the coefficient for CAPITAL W changes sign from negative to positive when a high level of commitment is estimated (COMMITMENT > 2). Moreover, both SIZE and EDUCATION appear to matter more for explaining high levels of commitment, than they matter for explaining lower levels. The latter is consistent with prior research suggesting that education levels matter most for explaining international collaboration (Fitjar & Rodríguez-Pose, 2013)

Table 3 approximately here

To investigate this further, a multinomial logistic estimation of the dependent variable has been conducted. The ML estimator is a generalization of the binomial logistic regression to multiple outcome problems. Instead of assuming that the categories of the dependent variable reflect more or less of the same underlying quantitative construct, i.e. herein the degree of commitment, it estimates the odds of given outcomes compared to the odds that the outcome is a chosen base. In the analysis herein, CONSTRAINED networking is the base outcome. This reflects the level (COMMITMENT > 2) at which the Brant's test found the estimate for CAPITAL W to change sign.

Table 3 above displays two types of output that can be obtained from the baseline ML regression reported in Table 1 the Appendix. The upper part of the table reports the discrete marginal effects, i.e. percentage-point changes in the probability that firm's fall into the category in question, compared to the probability that firms fall into any one of the other categories. From this, it is evident that firms located in the central and western business districts of the capital region are significantly more likely than firms located outside the large-city regions to be PASSIVE. Moreover, they are significantly less likely than firms in the reference to be amongst those that engage in CONSTRAINED networking. Firms in Trondheim, by contrast, exhibit higher average probabilities EXTENSIVE networking, compared to any of the other possible strategies. Overall, this is consistent the ordered logit results in that firms located in all other urban labor market regions but Trondheim are significantly less involved in innovation than firms located outside the large-city regions.

Once focus is turned away from the ‘average’ firm response, it is evident that inter-regional differences in the probabilities of given discrete outcome, over all other outcomes, are of less interest than inter-regional differences in the probabilities that firms choose certain strategies over others, here the base CONSTRAINED. This can be expressed in terms of relative risk ratios, i.e. differences between regions in their respective ratios between the odds for outcome x and the odds for outcome y, where y is the base strategy CONSTRAINED and x can be any of the other possible outcomes estimated in the ML regression. Relative risk ratios are always above 0 and expresses how many times *as* likely a firm in a given region is of exhibiting y rather than x, compared to firms in the reference region.

The relative risk ratios displayed in the bottom part of Table 3 show that firms located in the Western engineering, ICT and business services cluster of the Capital region are more than three times *as* likely as firms in non-urban regions of being PASSIVE rather than engaged in CONSTRAINED networking. At the same time, they are also 2.5 times and 2.8 times as likely as are firms in the reference locations of engaging in CLOSED innovation or EXTENSIVE networking respectively, rather than engaging in CONSTRAINED networking.

It is notable that the relative risk ratios for CLOSED innovation are above 1 for all urban regions except TRONDHEIM. Supplementary Walds tests of the coefficients reported in Table A1 in the Appendix find these estimates to be jointly significant (Walds Chi2 9.87*).

This means that firms in all urban regions but Trondheim, the smallest, exhibit a likelihood of choosing closed collaboration over selective networking that is significantly higher than the likelihood of this choice in non-urban agglomerations. Substantially, it means that the very same vibrant local knowledge conditions that increases the probability that urban firms remain passive, also provide those that do choose to engage with incentives to protect proprietary knowledge by containing this work within their own organizations instead of selectively involving collaboration partners.

Moreover, relative risk ratios for the choice of EXTENSIVE networking over CONSTRAINED are also above 1 for all urban regions except BERGEN, yet insignificant when all positive estimates (i.e. relative risk ratios above 1) are tested jointly. However, the positive estimates for the capital specifically (CAPITAL C, CAPITAL W and CAPITAL O) are jointly significant at Walds Chi2 = 8.62**. Substantially, this suggests that firms in the Capital that have overcome the initial disincentive towards proprietary knowledge exposure through collaboration use the local resources and knowledge dynamics that initially provided this disincentive to support the establishment of far-reaching collaborative ties.

Conclusion

This paper has investigated whether the innovation strategies of individual firms reflect the density, diversity and connectivity of their urban locations. From research on knowledge-intensive business services (Herstad & Ebersberger, 2013, 2014), it adopted the idea that certain high-density urban agglomerations are characterized by place-specific knowledge dynamics expressed as comparatively higher probabilities that firms are either strongly committed to innovation, or passive and building their business strategies on localized knowledge spillovers from universities, higher order public sector institutions, and, most importantly, the active innovators with whom they are also collocated.

Firms located outside the four large-city regions of Norway are generally more inclined to engage in development work than are their urban counterparts. This is consistent with the notions that firms in less endowed locations engage to 'internalize' benefits that are external to firms in other locations; or choose to operate outside the larger cities to shelter their cumulative development work from the environmental disturbances that more vibrant labor markets and weaker overall appropriability regimes represent. In urban locations, by contrast, firms are less inclined to engage due to the existence of external resources that reduces their need to do so; and their ability to internalize and appropriate returns from such work (E Glaeser, 2000; Shearmur, 2012; Suarez-Villa & Walrod, 1997). This is not the complete picture, though: Once firms in the Capital region have decided to open up their development work to partner participation, they also exhibit preferences for choosing geographically dispersed collaboration over more selective collaborative linkages that are stronger than in non-urban regions and most pronounced within the Western engineering, ICTs and services stronghold. This is clearly consistent with the idea that initially inspired the analysis.

To the author’s knowledge, no prior empirical contributions on this topic have used official innovation data to acknowledge that the decision to engage in development work is different from the subsequent choices of whether to collaborate, and what collaboration strategies to implement. Instead, firms have been surveyed under the implicit assumption that questions on innovation strategies and output are relevant for all to respond on (Doloreux & Shearmur, 2012; Fitjar & Rodríguez-Pose, 2013; Fritsch, 2003). Whether or not they are is ultimately a question of perspective; still, it is in these cases difficult to determine whether firms respond negatively e.g. on collaborative linkages because they have decided not to involve partners in their development work, or because they have decided not to engage in development work at all. Obviously, when actual innovation output is studied, the distinction between not trying to innovate and not managing to do so with success becomes even more important to make.

In several other studies, estimations have been based only on the sub-samples of firms that have decided to engage in development work and thus self-selected into the sample. This underlying process of self-selection (Cassiman & Veugelers, 2006; Heckman, 1979; Puhani, 2000) is rarely accounted for in substantive terms, or methodologically (Herstad & Ebersberger, 2014; Herstad et al., 2015; Solesvik & Gulbrandsen, 2014). As should be evident from the above, firms in certain locations may be less inclined to engage in innovation, and thus of having self-selected into the study; yet, at the same time, they may also be more inclined than firms in other locations to collaborate once they are engaged. Obviously, different substantive implications are warranted when both choices are observed, compared to when only the latter is. Less obvious is the methodological point that estimations only of the latter are at risk of being biased by unobserved determinants of the innovation activity decision that are correlated with the dependent and explanatory variables (Heckman, 1979). When the dependent variable is also a choice variable, this risk is particularly high.

The study herein has its own limitations. The classification of Norwegian labor market regions treats non-urban locations as one and does not do justice to what is a much more differentiated landscape of regional innovation (K. Onsager, Isaksen, Fraas, & Johnstad, 2007; Strand & Leydesdorff, 2013). Still, this simple classification was implemented to illustrate conceptual and methodological points and avoid that a more complex empirical approach with attention to the specificities of the Norwegian context would overshadow the overall objective: To show that firms may respond very differently to the same local resource conditions; that certain responses, e.g. extensive networking, by some firms opens up opportunities for many other firms to choose differently – i.e. to remain passive; and that these interdependencies are particularly pronounced in certain high-density, diverse and internationally connected urban agglomerations.

The results and limitations combined begs for future research to consider other, more fine-grained comparative dimensions. Questions that are of immediate interest relate to the possible existences, and types, of interdependent firm-level strategies that are nurtured by other types of locations, for instance, by specialized industrial clusters of the Marshallian type. Moreover, studies that link different innovation strategy decision directly to the actual industry composition of labor market regions, captured in terms of degrees of variety (Boschma & Iammarino, 2009; Ebersberger et al., 2014; Frenken, Oort, & Verburg, 2007), are clearly warranted. In-depth qualitative research is also needed to consider in detail the micro-level processes and mechanisms that link different innovation strategy decision to the external environment. Of course, this research must do what innovation scholars tend not to: Study, in a comparative perspective, also the firms that have decided not to engage in development work and consider what has led to this decision.

Large city regions are not dynamic venues for creativity, innovation and structural change by default. Rather, they are venues wherein spillovers from subsets of highly committed firms and knowledge institutions rapidly diffuse and are absorbed by other firms that, as a result of this, do not themselves see the same need to engage. Should the former drivers of urban economy knowledge dynamics choose to relocate or reduce their efforts, for instance in response to a general economic slowdown or to diseconomies of urbanization such as congestion and real estate prices, the urban economy can rapidly transform from a loci of creativity and entrepreneurship to a venue for high unemployment and social distress. Accordingly, the urban economy knowledge dynamic as identified herein does not immediately call for efforts aimed at increasing the general rate of knowledge diffusion or stimulate firms to collaborate more locally (Tödtling & Trippl, 2005). Rather, it calls for policy preparedness and initiatives to ensure the willingness of individual firms to remain present in the large-city regions where people prefer to live, and commit to development work in spite of local knowledge dynamics that work against this decision.

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References

Adams, J. D. (2002). Comparative localization of academic and industrial spillovers. *Journal of Economic Geography,* 2 253-278.

Agrawal, A., Cockburn, I., & McHale, J. (2006). Gone but not forgotten: knowledge flows, labor mobility, and enduring social relationships. *Journal of Economic Geography,* 6: 571-591. doi: 10.1093/jeg/lbl016

Almeida, P., & Kogut, B. (1999). Localization of Knowledge and the Mobility of Engineers in Regional Networks. *Management Science,* 45: 905-917.

Amin, A., & Thrift, N. (2002). *Cities. Reimagining the urban*. Cambridge: Polity Press.

Asheim, B. T., Ebersberger, B., & Herstad, S. (2012). MNCs between the global and the local: Knowledge bases, proximity and globally distributed knowledge networks. In M. Heidenreich (Ed.), *Innovation and Institutional Embeddedness of Multinational Companies*. Cheltenham: Edward Elgar (in print).

Asheim, B. T., & Herstad, S. (2005). Regional innovation systems, varieties of capitalisms and non-local relations: Challenges from the globalising economy. In R. A. Boschma & R. C. Kloosterman (Eds.), *Learning from Clusters: A critical Asessment for an Economic-Geographical Perspective*. Dordrecth: Springer.

Aslesen, H. W., & Isaksen, A. (2007). Knowledge intensive business services and urban industrial development. *Service Industries Journal,* 27: 321-338. doi: 10.1080/02642060701207239

Aslesen, H. W., Isaksen, A., & Stambøl, L. S. (2008). Knowledge intensive business services as innovation agent through client interaction and labour mobility. *International Journal of Services Technology and Management,* 9: 138-153.

Aslesen, H. W., & Jakobsen, S. E. (2007). The role proximity and knowledge interaction between head offices and KIBS. *Tijdschrift voor Economische en Sociale Geografie,* 98: 188-201.

Balsvik, R. (2011). Is labor mobility a channel for spillovers from multinationals? Evidence from Norwegian manufacturing. *Review of Economics and Statistics,* 93: 285-297.

Benito, G. R. G., Larimo, J., Narula, R., & Pedersen, T. (2002). Multinational enterprises from small economies: Internationalization patterns of large companies from Denmark, Finland and Norway. *International Studies of Management and Organization,* 32: 57-78.

Boschma, R. (2005). Proximity and Innovation: A Critical Assessment. *Regional Studies,* 39: 61-74.

Boschma, R., Eriksson, R., & Lindgren, U. (2009). How does labour mobility affect the performance of plants? The importance of relatedness and geographical proximity. *Journal of Economic Geography,* 9 (2): pp. 169–190.

Boschma, R., & Iammarino, S. (2009). Related Variety, Trade Linkages, and Regional Growth in Italy. *Economic Geography,* 85: 289-311. doi: 10.1111/j.1944-8287.2009.01034.x

Bouty, I. (2000). Interpersonal and interaction influences on informal resource exchanges between R&D researchers across organizational boundaries. *The Academy of Management Journal,* 43: 50-65.

Brant, R. (1990). Assessing Proportionality in the Proportional Odds Model for Ordinal Logistic Regression. *Biometrics,* 46: 1171-1178.

Brezzi, M., & Veneri, P. (2014). Assessing Polycentric Urban Systems in the OECD: Country, Regional and Metropolitan Perspectives. *European Planning Studies*1-18. doi: 10.1080/09654313.2014.905005

Cassiman, B., & Veugelers, R. (2006). In search of complementarity in innovation strategy: Internal R&D and external knowledge aquisition. *Management Science,* 52: 68-82.

Cassiman, B., & Veuglers, R. (2002). Cooperation and spillovers: Some empirical evidence from Belgium. *American Economic Review,* 9: 1169-1184.

Castellacci, F., & Fevolden, A. (2014). Capable Companies or Changing Markets? Explaining the Export Performance of Firms in the Defence Industry. *Defence and Peace Economics*1-27. doi: 10.1080/10242694.2013.857451

Cohen, W. M., & Levinthal, D. A. (1989). Innovation and learning: The two faces of R&D. *Economic Journal,* 99: 569-596.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity - a new perspective on learning and innovation. *Administrative Science Quarterly,* 35: 128-152.

Combes, P. P., & Duranton, G. (2006). Labour pooling, labour poaching, and spatial clustering. *Regional Science and Urban Economics,* 36: 1-28. doi: 10.1016/j.regsciurbeco.2005.06.003

Cotic-Svetina, A., Jaklic, M., & Prodan, I. (2008). Does collective learning in clusters contribute to innovation? *Science and Public Policy,* 35: 335-345

Crepon, B., Duguet, E., & Mairesse, J. (1998). Research, innovation, and productivity: An econometric analysis at the firm level. *Economics of Innovation and New Technology,* 7: 115–158.

Czarnitzki, D., Ebersberger, B., & Fier, A. (2007). The relationship between R&D collaboration, subsidies and R&D performance: Empirical evidence from Finland and Germany. *Journal of Applied Econometrics,* 22: 1347-1366.

Dachs, B., Ebersberger, B., & Pyka, A. (2008). Why do firms cooperate for innovation? A comparison of Austrian and Finnish CIS3 results. *International Journal of Forsight and Innovation Policy,* 4: 200-229.

de Jong, J. P. J., & Freel, M. (2009). Absorptive capacity and the reach of collaboration in high technology small firms. *Research Policy,* 39: 47-54.

Deprey, B. D. (2011). The internationalisation process of small and medium-sized management consultancies in the UK. *Doctor of Philosophy Thesis, Anglia Ruskin University*.

Dokko, G., & Rosenkopf, L. (2010). Social Capital for Hire? Mobility of Technical Professionals and Firm Influence in Wireless Standard Committees. *Organization Science,* 21: 677-695.

Dokko, G., Wilk, S. L., & Rothbard, N. P. (2009). Unpacking Prior Experience: How Career History Affects Job Performance. *Organization Science,* 20: 51-68. doi: 10.1287/orsc.1080.0357

Doloreux, D., Amara, N., & Landry, R. (2008). Mapping regional and sectoral characteristics of knowledge-intensive business services: Evidence from the Province of Quebec (Canada). *Growth and Change,* 39: 464-496. doi: 10.1111/j.1468-2257.2008.00434.x

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

Ebersberger, B., Bloch, C., Herstad, S., & van de Velde, E. (2012). Open innovation practices and their effect on innovation performance. *International Journal of Innovation and Technology Management,* 9: 1-23.

Ebersberger, B., & Herstad, S. (2011). Product innovation and the complementarities of external interfaces. *European Management Review,* 8: 117-135.

Ebersberger, B., & Herstad, S. (2012). Go abroad or have strangers visit? On organizational search spaces and local linkages *Journal or Economic Geography,* 12: 273-295.

Ebersberger, B., Herstad, S., & Koller, C. (2014). Does the composition of regional knowledge bases influence extra-regional collaboration for innovation? *Applied Economic Letters,* 21: 201-204. doi: 10.1080/13504851.2013.848019

Eurostat. (2010). Community innovation survey - Reference Metadata in Euro SDMX Metadata Structure (ESMS). *http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/en/inn_esms.htm (last accessed 17 Aug 2010, 18:00)*.

Fagerberg, J., Mowery, D. C., & Verspagen, B. (2009). The evolution of Norway's national innovation system. *Science and Public Policy,* 36: 431-444. doi: 10.3152/030234209x460944

Fernhaber, S. A., Gilbert, B. A., & McDougall, P. P. (2008). International entrepreneurship and geographic location: An empirical examination of new venture internationalization. *Journal of international Business Studies,* 39: 267-290.

Fey, C. F., & Birkinshaw, J. (2005). External sources of knowledge, governance mode and R&D performance. *Journal of Management,* 31: 597-621.

Fitjar, R. D., & Rodríguez-Pose, A. (2012). Firm collaboration and modes of innovation in Norway. *Research Policy,* 42: 128–138. doi: http://dx.doi.org/10.1016/j.respol.2012.05.009

Fitjar, R. D., & Rodríguez-Pose, A. (2013). The geographical dimension of innovation collaboration: Networking and innovation in Norway. *Urban Studies*. doi: 10.1177/0042098013510567

Foyn, F., Gundersen, F., Gunnes, H., Langhoff, K., Nås, S. O., Onsager, K., . . . Wilhelmsen, L. (2011). Regionale sammenligninger av FoU og innovasjon (Regional comparisons of R&D and innovation). In K. Wendt (Ed.), *Det norske forskningssystemet 2011 (Science and technology indicators for Norway 2011)*. Oslo: The Research Council of Norway.

Frenken, K., Oort, F. V., & Verburg, T. (2007). Related Variety, Unrelated Variety and Regional Economic Growth. *Regional Studies,* 41: 685-697.

Frenz, M., & Ietto-Gillies, G. (2009). The impact on innovation performance of different sources of knowledge: Evidence from the UK Community Innovation Survey. *Research Policy,* 38: 1125-1135. doi: 10.1016/j.respol.2009.05.002

Fritsch, M. (2003). Does R&D Cooperation Behavior Differ between Regions? *Industry & Innovation,* 10: 25 - 39.

Glaeser, E. (2000). The New Economics of Urban and Regional Growth. In G. Clark, M. Feldman & M. Gertler (Eds.), *The Oxford Handbook of Economic Geography* (pp. 83-98). Oxford: Oxford University Press.

Glaeser, E., Kallal, H., Scheinkman, J., & Shleifer, A. (1992). Growth in Cities. *Journal of Political Economy,* 100: 1126-1152.

Graf, H. (2010). Gatekeepers in regional networks of innovators. *Camb. J. Econ.* doi: 10.1093/cje/beq001

Grant, R. (1996). Prospering in dynamically-competitive environments: organizational capability as knowledge integration. *Organization Science,* 7: 375-387.

Grimpe, C., & Sofka, W. (2009). Search patterns and absorptive capacity: Low- and high-technology sectors in European countries. *Research Policy,* 38: 495-506. doi: 10.1016/j.respol.2008.10.006

Hargadon, A., & Sutton, R. I. (1997). Technology brokering and innovation in a product development firm. *Administrative Science Quarterly,* 42: pp.716-749.

Heckman, J. J. (1979). Sample selection bias as a specifcation error. *Econometrica,* 47: 153-161.

Henttonen, K., Hurmelinna-Laukkanen, P., & Ritala, P. (2015). Managing the appropriability of R&D collaboration. *R&D Management*n/a-n/a. doi: 10.1111/radm.12121

Herstad, S. (2011). Paradigms, Regimes and the Shifting Notions of Institutional Best Practice. *Journal of the Knowledge Economy,* 2: 173-191. doi: 10.1007/s13132-010-0030-7

Herstad, S., Aslesen, H. W., & Ebersberger, B. (2014). On industrial knowledge bases, commercial opportunities and global innovation network linkages. *Research Policy,* 43: 495– 504. doi: 10.1016/j.respol.2013.08.003

Herstad, S., & Brekke, T. (2012). Globalization, modes of innovation and regional knowledge diffusion infrastructures. *European Planning Studies,* 20: 603-1625.

Herstad, S., & Ebersberger, B. (2013). On the link between urban location and the involvement of knowledge intensive business services in collaboration networks. *Regional Studies,* (in press) doi: DOI:10.1080/00343404.2013.816413

Herstad, S., & Ebersberger, B. (2014). Urban agglomerations, knowledge intensive services and innovation activity: Establishing the core connections. *Entrepreneurship & Regional Development,* 26: 211-233. doi: 10.1080/08985626.2014.888098

Herstad, S., Pålshaugen, Ø., & Ebersberger, B. (2011). Industrial innovation collaboration in a capital region context. *Journal of the Knowledge Economy,* 2: 507-532.

Herstad, S., & Sandven, T. (2014). When are recruited competences supportive of innovation? Inter-industry differences in the importance of diversity and similarity. *Paper under review*.

Herstad, S., Sandven, T., & Ebersberger, B. (2015). Recruitment, knowledge integration and modes of innovation. *Research Policy,* 44: 138-153. doi: http://dx.doi.org/10.1016/j.respol.2014.06.007

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

Jacobides, M. G., & Billinger, S. (2006). Designing the boundaries of the firm: From "make, buy, or ally" to the dynamic benefits of vertical architecture. *Organization Science,* 17: 249-261.

Jacobs, J. (1969). *The Economy of Cities*. New York: Vintage Books.

Jensen, M. B., Johnson, B., Lorenz, E., & Lundvall, B. A. (2007). Forms of knowledge and modes of innovation. *Research Policy,* 36: 680-693.

Katila, R. (2002). New Product Search over Time: Past Ideas in Their Prime? *The Academy of Management Journal,* 45: 995-1010.

Lam, A. (2000). Tacit knowledge, organizational learning and innovation: A societal perspective. *Organization Studies,* 21: 487-513.

Lane, P. J., & Lubatkin, M. (1998). Relative absorptive capacity and interorganizational learning. *Strategic Management Journal,* 19: 461-477.

Laursen, K., Masciarelli, F., & Prencipe, A. (2012a). Regions matter: How localized social capital affects innovation and external knowledge aquisition. *Organization Science,* 23: 177-193.

Laursen, K., Masciarelli, F., & Prencipe, A. (2012b). Trapped or spurred by the home region? The effects of potential social capital on involvement in foreign markets for goods and technology. *Journal of international Business Studies,* 43: 783-807.

Laursen, K., Reichstein, T., & Salter, A. (2011). Exploring the Effect of Geographical Proximity and University Quality on University-Industry Collaboration in the United Kingdom. *Regional Studies,* 45: 507-523. doi: 10.1080/00343400903401618

Laursen, K., & Salter, A. (2004). Searching high and low: What types of firms use universities as a source of innovation? *Research Policy,* 33: 1201-1215.

Laursen, K., & Salter, A. (2006). Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal,* 27 (2) 131-150.

Long, J. S., & Freese, J. (2006). *Regression models for categorical dependent variables using Stata* (2 ed.). College Station, TX: Stata Press.

Madsen, T., Mosakowski, E., & Zaheer, S. (2003). Knowledge retention and personnel mobility: The nondisruptive effects of inflows of experience. *Organization Science,* 14: 173-191.

Marshall, A. (1920). Industrial Organization, Continued. The Concentration of Specialized Industries in particular Localities. In A. Marshall (Ed.), *Principles of Economics, Book IV, Chapter X* (Ninth ed.). London: Macmillan.

Møen, J. (2005). Is Mobility of Technical Personnel a Source of R&D Spillovers? *Journal of Labor Economics,* 23: 81-114. doi: doi:10.1086/425434

Narula, R. (2002). Innovation systems and 'intertia' in R&D location: Norwegian firms and the role of systemic lock-in. *Research Policy,* 31: 795-816.

Niu, Y., Ding, C., & Knaap, G.-J. (2014). Employment Centers and Agglomeration Economies: Foundations of a Spatial Economic Development Strategy. *Economic Development Quarterly*. doi: 10.1177/0891242414560813

O'Farrell, P. N., Zheng, J., & Wood, P. A. (1996). Internationalization of Business Services: An Interregional Analysis. *Regional Studies,* 30: 101 - 118.

OECD. (2005). *Oslo Manual: Guidelines for collecting and interpreting innovation data*. Paris: OECD & Eurostat.

Oettl, A., & Agrawal, A. (2008). International Labor Mobility and Knowledge Flow Externalities. *Journal of international Business Studies,* 39: 1242-1260.

Onsager, K., Gundersen, F., & Sørlie, K. (2010). Osloregionen - mangfold, innovasjon og utvikling. *NIBR Report,* 2010.

Onsager, K., Isaksen, A., Fraas, M., & Johnstad, T. (2007). Technology cities in Norway: Innovating in glocal networks. *European Planning Studies,* 15: 549-566. doi: 10.1080/09654310601134896

Puhani, P. A. (2000). The Heckman correction for sample selection and its critique. *Journal of Economic Surveys,* 14: 53-68.

Ritala, P., Olander, H., Michailova, S., & Husted, K. (2015). Knowledge sharing, knowledge leaking and relative innovation performance: An empirical study. *Technovation,* 35: 22-31. doi: http://dx.doi.org/10.1016/j.technovation.2014.07.011

Rothaermel, F. T., Hitt, M. A., & Jobe, L. A. (2006). Balancing vertical integration and strategic outsourcing: Effects on product portfolio, product success, and firm performance. *Strategic Management Journal,* 27 (11): 1033-1056.

Schmidt, T. (2010). Absorptive Capacity – One size fits all? *Managerial and Decision Economics,* 31: 1-18.

Shearmur, R. (2012). The geography of intrametropolitan KIBS innovation: Distinquishing agglomeration economies from innovation dynamics. *Urban Studies,* 49: 2331-2356.

Simmie, J. (2003). Innovation and urban regions as national and international nodes for the transfer and sharing of knowledge. *Regional Studies,* 37: 607-620. doi: 10.1080/0034340032000108714

Sofka, W., & Grimpe, C. (2010). Specialized search and innovation performance - evidence across Europe. *R & D Management,* 40: 310-323.

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

Spithoven, A., Vanhaverbeke, W., & Roijakkers, N. (2012). Open innovation practices in SMEs and large enterprises. *Small Business Economics*1-26. doi: 10.1007/s11187-012-9453-9

Stambøl, L. S. (2005). Urban and regional labour market mobility in Norway. *Statistics Norway Social and Economic Studies*.

Strand, Ø., & Leydesdorff, L. (2013). Where is synergy indicated in the Norwegian innovation system? Triple-Helix relations among technology, organization and geography. *Technological Forecasting and Social Change,* 80: 417-484.

Suarez-Villa, L., & Walrod, W. (1997). Operational strategy, R&D and intra-metropolitan clustering in a polycentric structure: The advanced electronics industries of the Los Angeles basin. *Urban Studies,* 34: 1343-1380.

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

Tether, B. S. (2002). Who co-operates for innovation and why? An empirical analysis. . *Research Policy,* 31: 947-967.

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: 289-311. doi: 10.1093/jeg/lbs059

Torre, A. (2008). On the role played by temporary geographical proximity in knowledge transmission. *Regional Studies,* 42: 869-889. doi: 10.1080/00343400801922814

Tödtling, F., & Trippl, M. (2005). One size fits all? Towards a differentiated regional innovation policy approach. *Research Policy,* 34 (8) 1203-1219.

Williams, R. (2006). Generalized ordered logit/partial proportional odds models for ordinal dependent variables. *The Stata Journal,* 6: 58–82.

Wood, P. (2002). Knowledge-intensive services and urban innovativeness. *Urban Studies,* 39: 993-1002.

Østergaard, C. R., Timmermans, B., & Kristinsson, K. (2011). Does a different view create something new? The effect of employee diversity on innovation. *Research Policy,* 40: 500-509. doi: http://dx.doi.org/10.1016/j.respol.2010.11.004

Table 1: Employment and location quotients in the Norwegian urban system. 2010.

	Capital labour market region			**Other urban labour market regions**			**Centrality 1 - 3**	**Employment**
	Central	*Western*	*Outer*	*Bergen*	*Stavanger*	*Trondheim*		
Agriculture, forestry and fisheries	0,04	0,18	0,56	0,40	0,99	0,58	**1,57**	57 830
Offshore oil & gas, mining	0,06	**1,45**	0,05	**1,34**	**5,42**	0,54	0,82	55 163
Low-tech manufacturing	0,85	**1,65**	0,27	0,78	0,64	**1,41**	**1,13**	11 855
Low medium-tech manufacturing	0,25	0,53	0,51	**1,11**	**1,03**	0,51	**1,37**	40 493
High medium-tech manufacturing	0,24	0,71	0,58	**1,14**	**1,19**	0,58	**1,32**	99 293
High-tech manufacturing	0,49	0,25	0,91	0,86	0,94	0,97	**1,27**	81 285
Infrastructure	0,80	0,36	0,68	1,05	0,61	0,85	**1,21**	28 023
Construction	0,74	0,77	0,96	0,99	0,94	0,99	**1,12**	199 500
Wholesale and retail trade	0,95	**1,18**	**1,56**	0,93	0,89	0,95	0,97	362 494
Transportation	**1,01**	0,63	**1,83**	**1,15**	0,91	0,86	0,93	146 769
Hotels & restaurants	**1,07**	0,79	1,00	1,00	**1,07**	**1,17**	0,96	81 848
Telecom, software and publishing	**2,36**	**3,17**	0,47	0,90	0,78	**1,01**	0,48	86 927
Financial & real estate services	**1,89**	**1,70**	0,47	**1,26**	0,75	**1,11**	0,69	72 740
Scientific and technical services	**1,50**	**2,41**	0,78	**1,08**	**1,19**	**1,51**	0,67	123 894
Business services, other	**1,42**	1,00	0,97	**1,08**	**1,15**	**1,11**	0,82	134 991
Public administration & teaching	**1,33**	0,59	0,90	0,92	0,74	**1,17**	0,96	345 531
Health services	0,72	0,88	**1,02**	**1,03**	0,82	0,99	**1,12**	499 430
Culture, sports & membership org.	**1,57**	0,78	0,85	**1,01**	0,87	0,98	0,86	87 924
Share of employment	17,9 %	3,7 %	5,9 %	8,1 %	6,8 %	5,3 %	52,3 %	2 515 990 (100 %)

Note: Computations based on business register data from 2010. Industry, employment and location is identified at the individual establishment level. Location quotients are computed as region share of Norwegian employment in sector over region share of all employment in Norway.

Table 2: Ordered logistic regressions on commitment to innovation

	Dependent variable: COMMITMENT				**Brant's test of parallel regression lines**			
					Estimated coefficients from binary regressions			
	Model 1		Model 2		COMMITMENT > X			Chi2
	Coeff	*SE*	*Coeff*	*SE*	*> 0*	*> 1*	*> 2*	
CAPITAL C	-0,040	0,073	-0,304	0,079***	-0,330	-0,375	-0,251	1,320
CAPITAL W	0,167	0,123	-0,257	0,132*	-0,305	-0,376	0,098	15,440***
CAPITAL O	-0,366	0,130***	-0,196	0,133	-0,220	-0,304	-0,107	1,150
BERGEN	-0,011	0,102	-0,014	0,107	0,055	-0,062	-0,122	0,730
STAVANGER	-0,065	0,102	-0,228	0,109**	-0,195	-0,175	-0,080	0,480
TRONDHEIM	0,195	0,118	0,197	0,125	0,121	0,410	0,338	3,210
CENTRALITY 1 - 3	*Reference*		*Reference*					
GROUP			-0,107	0,069	-0,114	-0,022	-0,244	5,120*
AGE			-0,085	0,045*	-0,074	-0,063	-0,132	1,080
SIZE			0,340	0,026***	0,313	0,362	0,488	16,960***
EDUCATION			0,598	0,039***	0,537	0,797	0,870	25,140***
MARBREADTH			0,489	0,029***	0,526	0,431	0,523	9,870***
N	6079		6079					
LR Chi2	798.02***		1715.44***					
Pseudo R2	0.068		0.146					

Note: Coefficient estimates and standard errors from ordered logistic regressions. ***, ** and * indicate significance at 1 per cent, 5 per cent and 10 per cent levels respectively. Model 1 and Model 2 include 14 jointly significant sector dummies.

Note: Coefficients from j – 1 binary logistic regressions. Significant Chi2 test statistics indicate that the parallel regression line assumption is violated

Table 3: Multinomial logistic regressions on innovation strategy decisions.

	Model 3							
	Strategy 1: PASSIVE (COMMITMENT = 0)		Strategy 2: CLOSED (COMMITMENT = 1)		Strategy 3: CONSTRAINED (COMMITMENT = 2)		Strategy 4: EXTENSIVE (COMMITMENT = 3)	
Marginal effects on discrete outcome probabilities								
	Marg. Eff	*SE*	*Marg. Eff*	*SE*	*Marg. Eff*	*SE*	*Marg. Eff*	*SE*
CAPITAL C	0,054	0,015***	-0,023	0,014	-0,020	0,009**	-0,012	0,008
CAPITAL W	0,060	0,026**	-0,015	0,024	-0,053	0,017***	0,008	0,011
CAPITAL O	0,038	0,024	-0,011	0,024	-0,024	0,017	-0,003	0,015
BERGEN	-0,009	0,020	0,017	0,019	0,000	0,011	-0,007	0,012
STAVANGER	0,049	0,020**	-0,019	0,020	-0,016	0,012	-0,014	0,011
TRONDHEIM	-0,018	0,025	-0,021	0,024	0,017	0,011	0,022	0,012*
CENTRALITY 1-3	*Reference*		*Reference*		*Reference*		*Reference*	
Risk ratios relative to base outcome								
	RRR	*SE*	*RRR*	*SE*	*Base outcome*		*RRR*	*SE*
CAPITAL C	1,712	0,303***	1,333	0,242	1		1,162	0,256
CAPITAL W	3,156	1,114***	2,524	0,895***	1		2,869	1,092***
CAPITAL N	1,752	0,595*	1,504	0,528	1		1,450	0,612
BERGEN	0,987	0,221	1,083	0,249	1		0,907	0,262
STAVANGER	1,579	0,385*	1,262	0,318	1		1,054	0,318
TRONDHEIM	0,677	0,162	0,658	0,163*	1		1,056	0,301
CENTRALITY 1-3	*Reference*		*Reference*				*Reference*	

Note: Average marginal effects (percentage-point changes in predicted probability) and relative risk ratios from multinomial logistic regression Model 3. Control variables are included as in Model 2. ***, ** and * indicate significance at 1 per cent, 5 per cent and 10 per cent levels respectively. Baseline coefficient estimates and model statistics are reported Table A1 in the Appendix.

Table A1: Baseline multinomial logistic regression results and model statistics

	Model 3						
	Strategy 1: PASSIVE		Strategy 2: CLOSED		Strategy 3: CONSTRAINED	Strategy 4: EXTENSIVE	
	Coeff	*SE*	*Coeff*	*SE*	*Base outcome*	*Coeff*	*SE*
CAPITAL C	0,537	0,177***	0,287	0,181	-	0,150	0,220
CAPITAL W	1,149	0,353***	0,926	0,354***	-	1,054	0,380***
CAPITAL O	0,561	0,340*	0,408	0,351	-	0,372	0,422
BERGEN	-0,013	0,224	0,080	0,230	-	-0,097	0,289
STAVANGER	0,457	0,244*	0,233	0,252	-	0,053	0,301
TRONDHEIM	-0,389	0,239	-0,418	0,248*	-	0,054	0,286
CENTRALITY 1 - 3	*Reference*		*Reference*		-	*Reference*	
GROUP	-0,135	0,148	-0,255	0,153*	-	-0,412	0,190**
AGE	0,023	0,095	-0,044	0,098	-	-0,147	0,120
SIZE	-0,282	0,053***	-0,032	0,054	-	0,328	0,064***
EDUCATION	-0,725	0,081***	-0,386	0,083***	-	0,303	0,100***
MARBREADTH	-0,502	0,059***	-0,017	0,060	-	0,286	0,074***
CONSTANT	8,902	0,883***	4,310	0,913***	-	-1,449	1,037
N	6097						
LR Chi2	1935.13***						
Pseudo R2	0.165						

Note: The regression include 14 sector dummies. ***, ** and * indicate significance at 1 per cent, 5 per cent and 10 per cent levels respectively

Table A2: Descriptive statistics and correlations, CIS2010 sample. N = 6097

		Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	INACTIVE	0,644	0,479	0	1	1														
2	CLOSED	0,232	0,422	0	1	-0,740	1													
3	SELECTIVE	0,055	0,228	0	1	-0,326	-0,133	1												
4	DISPERSED	0,069	0,253	0	1	-0,365	-0,149	-0,066	1											
5	CAPITAL C	0,199	0,399	0	1	-0,006	0,018	-0,012	-0,006	1										
6	CAPITAL W	0,051	0,220	0	1	-0,033	0,018	-0,024	0,055	-0,011	1									
7	CAPITAL O	0,059	0,235	0	1	0,046	-0,022	-0,030	-0,023	-0,024	0,123	1								
8	BERGEN	0,079	0,270	0	1	-0,002	0,007	0,001	-0,009	-0,060	0,087	0,073	1							
9	STAVANGER	0,084	0,278	0	1	0,020	-0,016	-0,014	0,002	-0,068	0,080	0,065	0,034	1						
10	TRONDHEIM	0,056	0,230	0	1	-0,015	-0,015	0,026	0,030	-0,019	0,126	0,110	0,077	0,070	1					
11	CENTRALITY 1-3	0,519	0,500	0	1	0,019	-0,022	0,021	-0,018	-0,517	-0,241	-0,259	-0,304	-0,316	-0,253	1				
12	GROUP	0,701	0,458	0	1	-0,050	0,018	0,032	0,036	0,019	0,031	0,004	-0,010	0,033	-0,023	-0,044	1			
13	AGE (log)	2,705	0,671	1,099	4,718	0,009	-0,005	-0,004	-0,006	-0,017	-0,030	0,013	-0,016	-0,032	-0,029	0,048	0,043	1		
14	SIZE (LOG)	3,518	1,238	1,609	9,771	-0,125	0,044	0,027	0,139	0,042	0,007	0,008	-0,005	0,039	-0,018	-0,074	0,343	0,156	1	
15	EDUCATION	4,041	1,027	1	7,667	-0,274	0,135	0,116	0,189	0,279	0,171	-0,077	-0,015	0,000	0,046	-0,300	0,027	-0,102	-0,015	1
16	MARBREADTH	2,025	1,056	0	4	-0,347	0,203	0,099	0,230	0,012	0,059	-0,017	-0,002	0,032	-0,007	-0,053	0,107	0,009	0,125	0,231