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Related variety, unrelated variety and the novelty content of firm innovation in urban and non-urban locations

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ABSTRACT

In this paper, we investigate whether the composition of experience-based knowledge accumulated by firms in urban and rural locations is reflected in the novelty content of their innovations. Looking at the manufacturing industry, and using Norwegian Linked Employer-Employee register data (LEED) merged with Community Innovation Survey (CIS) data, we find that *unrelated experience variety* within firms increases the probability of radical innovation, independently of firms' location, whereas *related variety* increases the probability of incremental innovation in large-city regions. These results demonstrate that innovation capacity cannot be understood from the single perspective of R&D efforts and strategy as it also depends on experiences accumulated in 'entire organizations' and the locations in which accumulation occurs. Moreover, they suggest that for manufacturing firms, urban locations are not hot spot for radical change. Instead, they support incremental innovative activities by facilitating effective sharing of knowledge between related sectors.

Key words: Diversity, Innovation, Related Variety, Unrelated Variety, Urban, Rural

JEL: O31, P25, O15, O14, J24

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1. Introduction

Classic contributions in innovation studies (Arrow 1962, Lundvall and Johnson 1994, Nelson and Winter 1982) emphasize that knowledge is ultimately the product of experience, and resides within individuals (Nonaka 1994) whose interactions in organizational and spatial contexts shape the innovativeness of firms and the development paths of regions and countries (Lundvall et al. 2002, Nelson and Winter 1982). It is also well established that industrial development work depend on a broader range of knowledge than what resides within star scientists or can be contained within dedicated research and development (R&D) units (Castellacci et al. 2018, Grant 1996, Jensen et al. 2007, Parrilli and Alcalde Heras 2016). In spite of this, it remains common practice in the field of innovation studies to focus explicitly on patenting, R&D activities and university-industry linkages when investigating empirically the dynamics of learning and innovation.

Representing a clear departure from this, evolutionary economic geography (EEG; cf. Boschma and Martin 2010) uses the composition of entire economies in terms of, for instance, employment (Aarstad, Kvitastein, and Jakobsen 2016, Frenken, Van Oort, and Verburg 2007) or exports (Hidalgo et al. 2007, Saviotti and Frenken 2008) to proxy what regions or countries do, and what they learn from doing it. Beyond providing essential insights into the causes of path-dependency in territorial development (Neffke, Henning, and Boschma 2011, Xiao, Boschma, and Andersson 2018), research in this tradition has demonstrated how the knowledge bases of individuals firms evolve as new employees enter with skills and insights acquired at prior places of employment (Boschma, Eriksson, and Lindgren 2009, Herstad, Sandven, and Ebersberger 2015, Herstad 2018b, Timmermans and Boschma 2014). Still, firm-level research has yet to consider how the composition of experiences accumulated ‘in entire organizations’ (Bell et al. 2011, Solheim and Herstad 2018) influence the performances of firms as innovators. This is because the literature dedicated to the study of organizational diversity (Horwitz 2005, Horwitz and Horwitz 2007, Østergaard, Timmermans, and Kristinsson 2011) insofar has focused on dimensions such as gender, ethnicity, age and education. As these characteristics are either given at birth (demographics) or acquired early (education), they not capture the past *learning* of employees through career paths that may extend well beyond the current employer firm and sector.

In response, we study nearly 1500 Norwegian firms and explicitly focus on whether the composition of experiences accumulated by employees through their recent career paths is reflected in the novelty content of their employers' innovations. To do so, we build on the distinction between 'related variety' (RV) and 'unrelated variety' (URV) introduced in recent evolutionary theorizing (Frenken, Van Oort, and Verburg 2007, Timmermans and Boschma 2014) to capture the extent to which experiences have been gained in similar or dissimilar domains of the surrounding economy. By doing so, we obtain the baseline result that related variety (RV) of work-life experiences increases the probability of incremental ('new to firms market but not to the world') product innovation, while unrelated variety (URV) facilitates radical product innovations ('new to world market'). Moreover, we consider influences on innovation from urban location, and whether location moderate the effect of internal experiences. This is due to large-city regions providing particularly favourable contexts for ongoing matching of employee skills with employer knowledge bases (Helsley and Strange 1990, Herstad 2018a), and because internal experiences may interact with external impulses from the urban economy such as local 'information buzz'(Storper and Venables 2004). The results demonstrate that RV is particularly beneficial for incremental innovation when firms are located, and thus accumulate their human resources, in an urban environment. Finally, we find indications, albeit weak and inconclusive due to data limitations, that urban RV is particularly important for incremental innovation in firms without own R&D activity.

2. Related and unrelated variety, innovations and location

Innovations depend on interactions between people with complementary knowledge and insights (Østergaard, Timmermans, and Kristinsson 2011). The 'cognitive resource diversity perspective'in research on human resources (cf. Horwitz 2005) proposes that firms benefit from a diverse workforce because it represents a range of knowledge and ideas, networks and perspectives. A diverse workforce promotes the production of knowledge and innovation, since it provides a large pool of diverse resources that trigger learning and facilities new combinations (Van Engen and Van Woerkom 2010, 133). Moreover, it equals broader 'prior related knowledge' that increases firms' absorptive capacity, i.e. the ability to identify, assimilate and exploit external knowledge (Cohen and Levinthal 1990). A diverse workforce also brings in different social and professional networks (Agrawal, Cockburn, and McHale 2006, Bouty 2000). This variety may be beneficial for original and boundary-crossing recombination of knowledge (Carlile 2004). It might also challenge group-think and avoid lock-in (Phillips, Liljenquist, and Neale 2009, Schuetz 1944). Exposure to diverging perspectives could lead to innovative ideas (Bantel and Jackson 1989, van Knippenberg, De Dreu, and Homan 2004). Diversity is therefore considered to be beneficial for innovation, especially radical innovations (Nooteboom 2000).

On the other hand, the 'similarity attraction perspective' argues that people prefer to work with others that they consider to be similar to themselves, meaning that similarity enhances interactive learning and innovation. Very diverse attributes could lead to distrust, a lack of shared understanding, miscommunication, and high risks of conflicts that may reinforce the focus of firms on retaining rather than adjusting established practices (Dokko, Wilk, and Rothbard 2009, Horwitz 2005, Jehn, Northcraft, and Neale 1999, Madsen, Mosakowski, and Zaheer 2003). Workforce diversity could lead to difficulty in performing tasks, as team members do not share a common language and are less likely to develop a clear strategy. This would imply that similarity in the workforce would ease communication, promote common understanding, stimulate collaboration, and enhance interactive learning. Similarity is therefore considered to generate innovations, but more of an incremental nature (Nooteboom 2000).

Hence, firms are faced with a trade-off: They may build and try to take advantage of a diverse workforce, but this same diversity could also lead to a higher risk of conflict and negatively affect work group dynamics (Basset-Jones 2005). Therefore, the benefits of diversity has been depicted as a 'mixed blessing' (Williams and O'Reilly 1998) or a 'two-edged-sword' (Milliken and Martins 1996). This has led to a substantial volume of research that is concerned with how diversity affects firm performance (Horwitz and Horwitz 2007, Kearney, Gebert, and Voelpel 2009, van Knippenberg, De Dreu, and Homan 2004) and innovation conceptualized and measured in different ways (Bogers, Foss, and Lyngsie 2018, Mohammadi, Broström, and Franzoni 2017, Solheim and Herstad 2018, Østergaard, Timmermans, and Kristinsson 2011). Here, we consider explicitly the question of whether different types of diversity influences the novelty content of innovation (Nooteboom 2000, Solheim and Herstad 2018) and formulate a first set of hypothesis:

H1a. Intra-firm variety has a positive effect on radical product innovations

H1b. Intra-firm variety has a negative effect on incremental product innovations

However, it might be argued that that it is not diversity *per se* that matters for innovation, but what kind of diversity. Concepts such as 'cognitive complementarity' (Nooteboom et al.

2007) and 'relatedness' (Boschma 2017) are used in the literature to underline that agents must have something in common in order for the learning potential associated with difference of perspectives to be captured. If the experience-based knowledge of employees is too different, this could hamper innovation because they are not able to communicate, yet, if they are instead too similar, this could lead to cognitive lock-in (Boschma 2005, Fitjar, Huber, and Rodríguez-Pose 2016, Nooteboom et al. 2007). In economic geography, Frenken, Van Oort, and Verburg (2007) argue that for variety to support innovation, it must be related, that is, cognitively close, yet not similar. As Frenken, Van Oort, and Verburg (2007) put it, related variety *"... improves the opportunities to interact, copy, modify, and recombine ideas, practices and technologies ..."* (p. 687). Recent studies suggest that related variety enhances incremental innovations in regions, while unrelated variety would be conducive to radical combinations (Castaldi, Frenken, and Los 2015, Miguelez and Moreno 2018). The impact on related and unrelated variety has been extensively researched at the regional scale. However, to our knowledge, the concept has not yet been extended to the level of the firm beyond explorative work underscoring the relevance of investigating further whether the latter is particularly important as trigger and facilitator of efforts leading to radical innovation (Solheim and Herstad 2018) . Therefore, we test the following hypotheses:

H2a: Intra-firm unrelated variety has a positive effect on radical product innovations

H2b: Intra-firm related variety has a positive effect on incremental product innovations

To do so, we need to consider influences from firms' locations. Since long, scholars have proposed that urban locations are hotspots of innovation (Duranton and Puga 2001, Glaeser 2011, Pred 1977, Shearmur 2011) because they are nuclei of information with a high connectivity to the outside world (Herstad 2018a, Pred 1966) and contain a large and diverse labour pool that triggers new ideas and innovations (Almeida and Kogut 1999, Knudsen et al. 2008, Lee and Rodríguez-Pose 2013). As Jacobs (1969, 59) put it, *"the greater the sheer numbers and varieties of divisions of labor already achieved in an economy, the greater the economy`s inherent capacity for adding still more kinds of goods and services. Also the possibilities increase for combining the existing divisions of labor in new ways"* (p. 59). This is not to say that innovations do not take place in peripheral regions; they do (Shearmur 2015, Shearmur 2017). But the innovation strategies of firms tend to be different in peripheral regions, where they draw on firm-internal capabilities and non-local linkages, given the lack of support from external resources locally (e.g. Fitjar and Rodríguez-Pose 2011, Grillitsch 2015, Iammarino et al. 2012, Isaksen 2015, Lo Turco and Maggioni 2016, Vaessen 1993).

The literature on the geography of innovation is less clear on the relationship between the local context and the type of innovation. Some argue that firms in urban regions are more likely to introduce radical product innovations, due to the amount and diversity of local knowledge and the connectivity to other regions that such urban environments offer (Duranton and Puga 2001, Harris 1988). Yet, Lee and Rodríguez-Pose (2013) found no effect of urban location on radical innovation and a positive effect on incremental change suggesting that urban spillovers foster imitation more so than innovation (cf. also Herstad 2018a). Moreover, in peripheral regions, the stronger reliance of firms on their internal capabilities may work towards promoting incremental innovations, however, their strong focus on non-local linkages may also enhance radical product innovations (Fitjar and Rodríguez-Pose 2011). So, from a theoretical point of view, it is not straightforward what type of innovation will prevail in urban regions, as compared to non-urban regions. Accordingly, we test the following hypotheses:

H3a: Urban location has a positive effect on radical product innovations

H3b: Non-urban location has a positive effect on incremental product innovations

Urban economics proposes that the density and diversity of large-city regions stimulates the matching of employee skills and employer demands (Andini et al. 2013, Helsley and Strange 1990). This is notable, as the limited spatial mobility of labour entail that firms accumulate human resources in places, the characteristics of which also shape individual career paths and thus their learning. Accordingly, internal and external variety may interact: As we expect intra-firm unrelated variety *and* urban locations to enhance radical innovations (H2a and H3a respectively), one might expect that intra-firm URV *in* urban locations favour radical product innovations even more as well-matched internal experience variety provide the network contact points (Agrawal, Cockburn, and McHale 2006) and prior related knowledge (Cohen and Levinthal 1990, Zahra and George 2002) required to take full advantage of diverse external information and resources. This is opposite for non-urban firms with related variety which we expect to be more conducive to incremental product innovations, as intra-firm related variety and non-urban regions (H2b and H3b respectively) both are expected to generate incremental innovations. Therefore, we develop and test two additional hypotheses:

H4a: Intra-firm unrelated variety in urban regions has a positive effect on radical product innovations

H4b: Intra-firm related variety in non-urban regions has a positive effect on incremental product innovations

Finally, we need to briefly acknowledge that the relationship between human resource diversity and innovation might depend on firms' commitment to development work, as commonly captured by their expenditures on R&D. On the one hand, R&D efforts may reflect emphasis on mobilization and integration of knowledge, thus potentially increasing the capacity to integrate diverse internal and external resources. On the other, internal variety and location might be more important when investments in R&D are limited or firms organize their development work as an integral part of their daily business operations (Jensen et al. 2007). Consequently, a final hypothesis is tested:

H5: The effect of internal experience variety on innovation depend on firms' R&D efforts

3. Data, variables and estimation strategy

Data

We use innovation data sampled by Statistics Norway in the Seventh round of the Pan-European Community Innovation Survey (CIS2010) that build on the definitions and guidelines of the Oslo Manual (OECD 2005). In contrast to many other European countries, participation in the Norwegian survey is compulsory for sampled firms. The result is comparatively large data sets, which are not plagued by non-response bias. The 2010 survey provides information on innovation activities and outcomes during the reference period 2008-2010, for firms with 5-9 employees (restricted survey with limited information) and 10 employees or more (full survey). Prior to release for research purposes, the data were thoroughly reviewed and validated by Statistics Norway. To provide the information needed to describe the experiences of firms' employees, the data have been merged with Linked Employer-Employee Data (LEED) covering the years 2004-2008 (Solheim and Herstad 2018).

The linked CIS-LEED dataset consists of 6,595 enterprises in manufacturing (including offshore oil & gas) and various services industries, of which 5,402 had 10 employees or more in 2010. Only these firms responded to the full CIS2010 questionnaire and provided the required information on the novelty content of innovations. Of these, we excluded 3,750 enterprises belonging to wholesale trade and logistics, hotels, restaurants and catering, infrastructure and knowledge intensive services industries. This is due to the complete absence of radical product innovation (as defined here) in several sub-sector of services and extensive 'missing' information on the novelty content of innovation more generally. The latter is supportive of the argument that dedicated measurement instruments may be required to capture innovation outside the manufacturing context for which the CIS was originally developed (Nordli 2016, Toivonen and Tuominen 2009).

Of the remaining 1,652 enterprises in manufacturing industries, 81 were established after 2008, and therefore excluded due to missing information on the composition of their human resource bases at the beginning of the CIS reference period (cf. 'independent variables' below). Finally, 92 firms established in 2006-2008 were excluded because the required controls for labour replacement rates in this period could not be computed (cf. 'control variables' below). Consequently, the sample used consists of 1,479 enterprises.

Dependent variables

It is only for product and process innovations that the firm is asked to evaluate novelty content. As the transparency of production processes is limited and the novelty content therefore difficult to evaluate, we focus on the introduction of new products. The variable INCREMENTAL takes on the value 1 when product innovations are reported as new to the firms' market, but not to the world market, meaning that firms introduced onto their own market a product already offered on other (geographical or sectoral) markets. The variable RADICAL takes on the value 1 if the firm reported introducing a product that was new to the firm itself, its market and to the world.

Table 1: Description of sample.

Sample characteristics				Diversity				Innovation			
NACE	**Description**	**Share of sample**	**UR-BAN**	**Mean RV**		**Mean URV**		**INCREMENTAL**		**RADICAL**	
				URB=1	URB=0	URB=1	URB=0	URB =1	URB= 0	URB =1	URB = 0
10	Food products	0.15	0.38	0.158	0.156	0.591	0.648	0.24	0.18	0.06	0.05
11	Beverages	0.01	0.47	0.136	0.100	0.577	0.825	0.13	0.11	0.00	0.00
13	Textiles	0.03	0.28	0.063	0.090	0.511	0.777	0.00	0.10	0.08	0.19
14	Clothing	0.01	0.41	0.105	0.155	0.629	0.806	0.11	0.08	0.33	0.08
15	Leather	0.003	0.00	n.a	0.022	n.a	0.404	n.a.	0.00	n.a	0.20
16	Timber & wood	0.07	0.20	0.046	0.081	0.425	0.634	0.13	0.18	0.00	0.01
17	Pulp & Paper	0.02	0.31	0.078	0.067	0.717	0.466	0.00	0.08	0.00	0.13
18	Printing & reproduction	0.03	0.58	0.123	0.124	0.438	0.651	0.18	0.15	0.00	0.00
20	Chemicals	0.04	0.32	0.076	0.153	0.757	0.910	0.15	0.14	0.15	0.21
21	Pharma	0.01	0.71	0.150	0.150	0.485	0.813	0.00	0.00	0.20	0.25
22	Rubber & plastics	0.04	0.29	0.074	0.087	0.662	0.814	0.19	0.13	0.00	0.21
23	Non-metallic minerals	0.05	0.27	0.092	0.062	0.707	0.829	0.29	0.20	0.05	0.05
24	Metals	0.03	0.15	0.052	0.079	0.637	0.761	0.00	0.13	0.14	0.05
25	Metal goods	0.11	0.36	0.109	0.126	0.637	0.815	0.08	0.06	0.08	0.11
26	Electronics & computers	0.05	0.63	0.100	0.163	0.877	0.950	0.13	0.03	0.50	0.52
27	Electrical equipment	0.04	0.37	0.102	0.065	0.999	0.804	0.20	0.21	0.36	0.17
28	Machinery & equipment	0.08	0.32	0.127	0.129	0.961	0.972	0.19	0.16	0.29	0.30
29	Automotive	0.03	0.30	0.044	0.047	0.573	0.731	0.08	0.03	0.15	0.23
30	Other transportation equip.	0.06	0.35	0.137	0.144	0.897	0.947	0.09	0.08	0.15	0.13
31	Furniture	0.04	0.16	0.030	0.097	0.346	0.584	0.33	0.21	0.22	0.17
32	Manufacturing nec,	0.03	0.51	0.039	0.019	0.553	0.479	0.00	0.11	0.10	0.16
33	Installation & repair of machinery	0.06	0.36	0.083	0.089	0.697	0.896	0.03	0.10	0.06	0.07
	Total (N=1570)	0.992	0.35								

Variety of accumulated experience

Following our focus on the composition of knowledge created through 'learning-by-doing', the main independent variables used in the analysis capture the composition of 'experience years' accumulated within the firm at the start of the three-year period for which innovation output is reported. Based on LEED, matrixes have been generated for each firm that uses NACE industry codes to classify the workplaces of employees present in the firm in 2008 during the five-year period that ended this year (cf. Table 2). The NACE codes are hierarchically ordered and consist of two-digit main groups with three-digit sub-groups. We compute entropy measures that capture total variety of experience-years accumulated within the firm (VAR_TOT), variety within NACE 2-digit groups (i.e. related variety, denoted VAR_REL) and variety between 2-digit groups (i.e. unrelated variety, denoted VAR_UNREL) (Solheim and Herstad 2018). Compared to prior research on labour market mobility focusing on the degree of similarity between dispatching and receiving firms (Boschma, Eriksson, and Lindgren 2009, Herstad, Sandven, and Ebersberger 2015), this approach has the advantage of capturing whether the experiences accumulated by employees through their recent career paths are different *from each other*. Entropy measures are computed as described by Jacquemin and Berry (1979), and Table 1 gives average scores for each sector and location. The variety measures used in the regressions have been standardized, i.e. scaled as standard deviations from the mean of 0.

For illustrative purposes, we present in Table 2 an example of a firm that had 20 employees at the start of this period in 2008 and was engaged in the production of engines and turbines (NACE 28.110). Including 2008 and the four years prior to it gives 20 x 5 = 100 experience-years, of which 74 were associated with employment in the focal firms' sector (NACE 28.110) and a minimum of 20 in the firm itself. Due to unemployment, five person-years do not count as experience-years. The remaining 21 experience-years were generated in NACE 09.101 (oil & gas sector drilling services), NACE 24.421 (primary production of aluminum), NACE 24.422 (aluminum half-fabrics), NACE 26.110 (electronic components), NACE 26.200 (computers and equipment), NACE 26.300 (communication equipment) and NACE 62.020 (programming services).

Table 2: Example of experience diversity matrix. Firm with 20 employees.

Year of observation		**Sector of employment in prior years**			
Employee no.	**2008**	**2007**	**2006**	**2005**	**2004**
1	28.110	09.101	09.101	09.101	09.101
2	28.110	28.110	28.110	28.110	28.110
3	28.110	28.110	62.020	62.020	62.020
4	28.110	28.110	28.110	28.110	28.110
5	28.110	28.110	28.110	28.110	28.110
6	28.110	28.110	*unemployed*	*unemployed*	*Unemployed*
7	28.110	28.110	28.110	28.110	28.110
8	28.110	28.110	28.110	62.020	62.020
9	28.110	28.110	28.110	28.110	28.110
10	28.110	28.110	28.110	28.110	28.110
11	28.110	28.110	28.110	28.110	28.110
12	28.110	28.110	28.110	*unemployed*	*Unemployed*
13	28.110	28.110	28.110	28.110	28.110
14	28.110	28.110	28.110	28.110	28.110
15	28.110	28.110	24.421	24.421	24.421
16	28.110	24.422	24.422	24.422	24.422
17	28.110	28.110	28.110	26.110	26.200
18	28.110	28.110	28.110	28.110	28.110
19	28.110	28.110	26.300	26.300	26.300
20	28.110	28.110	28.110	28.110	28.110
Unrelated experience diversity (Entropy of distribution between 2-digit groups)					0.830069
+ Related experience diversity (Entropy of distribution within 2-digit groups)					0.100334
= Total experience diversity (Entropy of distribution between 5-digit groups					0.930403

Urban location

Prior research has used commuting patterns to develop (Jukvam 2002) and update (Gundersen and Jukvam 2013) a classification consisting of 161 Norwegian 'housing and labour market regions' that are ordered on a centrality scale from 5 (capital labour market region) through 4 (other large-city labour market regions) to 1 (peripheral regions). The variable URBAN takes on value 1 for firms located at centrality level 4 (Bergen, Stavanger, Trondheim) and 5 (Oslo). Because the CIS is sampled at the enterprise level and enterprises may consist of several establishments in different regions, multi-establishment enterprises have been assigned to the regions that accounted for the largest share of employment. This procedure did not structurally alter the results.

Control variables

Location choices, accumulated experiences and innovation propensities differ between industry groups (cf. Table 1). Therefore, 21 dummy variables are included in all regressions as controls for 22 NACE two-digit industry groups. Variety measured as entropy is inherently influenced by the size of the firm and may also be related to age. As both may influence innovation, the logs of firm age (AGE log) and size (SIZE log) are included as controls.

Variety in human resources is also related to the labour replace rates of a firm, as stability of staff inherently translates into low experience variety hypothesized to negatively influence innovation. At the same time, stability may in itself positively influence innovation through knowledge accumulation, and signal highly motivated employees (Herstad, Sandven, and Ebersberger 2015). This demands that the (assumed positive) effect of experience variety is isolated from the (assumed negative) effect of labour replacement. Therefore, the control variable CHURN is included that captures the proportion of employees present in the firm in 2006 that was replaced in the two-year period that ended at the start of the CIS reference period in 2008. A control for the average education level of firms' employees in 2008, described on the standard eight-level scale used in the registers, is also included (EDULEVEL). This is because the computation of experience variety measures for all employees independently of their education levels requires that effects (negative or positive) associated specifically with (low or high) education levels are accounted for separately.

Foreign market presence gives incentives to innovate due to competitive pressure and market size (Crepon, Duguet, and Mairesse 1998, Ebersberger and Herstad 2012). It also influences the ability of respondents to evaluate whether a product is new to the world market. Foreign market presence is therefore captured by the control variable FORMAR. Finally, innovation output reflects the innovation efforts of firms, and these efforts may also be associated with experience variety. The control variable 'R&D' is therefore included that takes on the value 1 for firms that stated in the CIS that they engaged in internal research and development activities during the reference period.

Estimation strategy

The two binary dependent variables are estimated separately using binomial probit regressions. To consider moderating effects of urban location on the effect of experience variety on innovation, interaction terms are included. As the explanatory variables are continuous, it is necessary to consider whether curvilinear effects are at play that may influence estimates for variety as well as the significance of their interactions with urban location (Ganzach 1997)[4]. Thus, interaction and squared terms are added step-wise. In line with Haans, Pieters, and He (2016), the full models include interaction involving the base variety terms and the squared variety terms. Supplementary Wald's tests of joint coefficient significance are used to decide what the appropriate model specifications are for each of the dependent variables.

In order to interpret the impact of exogenous variables in probit models it is necessary to calculate marginal effects (Hoetker 2007). This is not straightforward when polynomial terms and interaction effects are involved, as the sign, size and significance of marginal effects vary depending on the value of the dependent variables (Ai and Norton 2003, cf. also Ebersberger and Herstad 2011). Therefore, predicted probabilities and marginal effects of each variety variable have been computed at the mean effect of all other exogenous variables and are reported for a range that span from their approximate minimum values through the mean and up to the cut-point value for the 95th percentile of each variety distribution.

4. Main results

Incremental innovation

[4] Ganzach (1997) argues that failure to include squared terms when the underlying relationship is curvilinear may lead to 'false' interactions being detected, and vice versa.

Table 3 reports the results for incremental innovations[5]. This type of innovation is positively associated with R&D efforts, yet, not influenced by educational levels. No significant effect of total experience variety is detected. Therefore, we reject hypothesis 1b: intra-firm variety does not have a negative effect on incremental innovation. When the distinction between related and unrelated variety is introduced, we find a positive and significant effect of RV. This supports hypothesis 2b. Given the nature of this dependent variable, it is notable as experiences gained within other branches of the (NACE 2-digit) industry group of the focal firm may weigh heavily in RV. URBAN is not significant, which means we reject hypothesis 3b stating that non-urban location is positively associated with incremental innovation. The inclusion of polynomial terms yield insignificant baseline and squared term effects of related variety. Jointly, the two are strongly significant, and paralleled by joint significance also of the term capturing unrelated variety.

Table 3: Baseline regression results, product innovation new to the firm's market but not the world

	Dependent variable: INCREMENTAL					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
	Coeff *(se)*	*Coeff* *(se)*	*Coeff* *(se)*	*Coeff* *(se)*	*Coeff* *(se)*	*Coeff* *(se)*
AGE (log)	-0.097	-0.091	-0.093	-0.096	-0.103	-0.095
	(0.082)	(0.082)	(0.083)	(0.083)	(0.083)	(0.083)
SIZE (log)	-0.039	-0.050	-0.063	-0.052	-0.063	-0.063
	(0.046)	(0.046)	(0.048)	(0.046)	(0.048)	(0.048)
R&D	1.145***	1.155***	1.160***	1.156***	1.161***	1.156***
	(0.105)	(0.105)	(0.106)	(0.105)	(0.106)	(0.131)
FORMAR	-0.821***	-0.837***	-0.827***	-0.828***	-0.823***	-0.825***
	(0.138)	(0.139)	(0.140)	(0.139)	(0.140)	(0.140)
EDULEVEL	-0.065	-0.051	-0.046	-0.057	-0.052	-0.043
	(0.084)	(0.084)	(0.085)	(0.085)	(0.086)	(0.086)
CHURN	0.519	0.686*	0.470	0.629	0.449	0.482
	(0.408)	(0.415)	(0.430)	(0.419)	(0.435)	(0.434)
URBAN	0.065	0.054	0.062	0.021	0.142	0.070
	(0.102)	(0.102)	(0.103)	(0.105)	(0.132)	(0.104)

[5] We also calculated another dependent variable called IMITATION. It takes on the value 1 if the firm states that it introduced a product that was new to the firm itself, but not new to its market, meaning that the firm imitated other firms in the same market. We found no effect of variety whatsoever on the probability of IMITATION. Findings of these estimates are available upon request.

TV	0.006					
	(0.053)					
RV		0.145***	0.085	0.073	0.009	0.045
		(0.048)	(0.077)	(0.060)	(0.093)	(0.109)
RV^2			0.021		0.024	0.024
			(0.022)		(0.026)	(0.032)
URV		-0.095*	-0.019	-0.105	-0.055	0.164*
		(0.057)	(0.066)	(0.067)	(0.075)	(0.095)
URV^2			-0.098**		-0.058	-0.082
			(0.041)		(0.048)	(0.063)
URBAN*RV				0.193**	0.204	
				(0.095)	(0.153)	
URBAN*RV^2					-0.010	
					(0.046)	
URBAN*URV				0.044	0.143	
				(0.105)	(0.129)	
URBAN*URV^2					-0.127	
					(0.090)	
R&D*RV						0.048
						(0.147)
R&D*RV^2						-0.001
						(0.044)
R&D*URV						-0.316***
						(0.118)
R&D*URV^2						0.000
Constant	-0.669	-0.829*	-0.660	-0.775*	-0.644	-0.667
	(0.421)	(0.429)	(0.444)	(0.431)	(0.448)	(0.448)
Wald Chi2 tests of joint coefficient significance						
All terms involving RELATED			9.48***	12.98***	11.80**	8.21*
All terms involving UNRELATED			7.01**	2.68	8.33*	13.88***
Observations	1463	1463	1463	1463	1463	14663
LR Chi2 (df)	207.71(27)***	217.71(28)***	224.97(30)***	222.87(30)***	232.08(34)***	233.36(34)***
R2	0.1768	0.1853	0.1915	0.1897	0.1976	0.1987

Note: Probit regressions. ***, ** and * indicate significance at the 1 per cent, 5 per cent and 10 per cent levels respectively.

The inclusion of interaction effects without polynomial terms yield jointly significant estimates for related variety, and the interaction itself is also significant. This suggests the capacity of firms to transform intra-firm related variety into incremental innovation depends on resources and influences from urban locations. This rejects hypothesis 4b: intra-firm related variety in non-urban locations does not promote incremental innovation. For unrelated variety, neither the interaction itself nor the joint effect of the base and interaction term are significant. Model 5 includes interaction with location and polynomial terms, the joint effect of all terms involving related variety is strongly significant while the joint effect of all terms involving unrelated variety is weakly significant. In Model 6, interaction with location is replaced with interaction involving R&D that yield strongly significant estimates for URV. This is supportive of Hypothesis H5. Thus, to consider the actual effects at play and their substantive importance, we need to consider in detail predicted probabilities and marginal effects.

First, we consider in Table 4 predicted probabilities and marginal effects computed based on Model 5, i.e. accounting for interaction between location and diversity but not between location, diversity and R&D. INCREMENTAL does not respond to related variety in firms located outside the large urban agglomerations. By contrast, in urban regions, marginal effect estimates are significant from 0.2 standard deviations above the mean and upwards. In this range, the predicted probability of incremental innovation doubles, meaning that the effect is of substantial size. The right-hand column demonstrates that firms in urban regions, as a result of this effect, have a significantly higher probability of incremental innovation than firms in non-urban locations when employees exhibit the same high level of related experience variety. As the marginal effect of urban location is insignificant through most of the range considered, this implies the urban economy effects on innovation cannot be understood independently of the internal knowledge base of firms.

Table 4: Predicted probabilities (PP) and marginal effects (ME) of variety and location on INCREMENTAL, full sample (N=1463). Computed from Model 5. 0 = mean diversity

Predicted probabilities and marginal effects of RV and URV							**Marginal effects of URBAN**	
	URBAN = 1 (N = 462)			URBAN = 0 (N = 1001)				
RV	**PP**	**ME**	**SE**	**PP**	**ME**	**SE**	**ME**	**SE**

-0.8	0.094	0.032	0.026	0.101	-0.005	0.023	-0.005	0.031
-0.6	0.100	0.035	0.027	0.100	-0.003	0.021	0.003	0.027
-0.4	0.108	0.038	0.027	0.099	-0.002	0.019	0.011	0.025
-0.2	0.115	0.041	0.027	0.099	0.000	0.018	0.019	0.025
0.0	0.124	0.044	0.027	0.099	0.002	0.016	0.027	0.026
0.2	0.133	0.047	0.027*	0.100	0.003	0.015	0.036	0.028
0.4	0.143	0.051	0.027*	0.101	0.005	0.014	0.045	0.031
0.6	0.153	0.054	0.027**	0.102	0.007	0.014	0.054	0.035
0.8	0.164	0.058	0.027**	0.103	0.009	0.013	0.064	0.039
1.0	0.177	0.062	0.027**	0.105	0.010	0.013	0.074	0.044*
1.2	0.189	0.067	0.028**	0.107	0.012	0.013	0.085	0.048*
1.4	0.203	0.071	0.029**	0.110	0.014	0.013	0.096	0.052*
1.6	0.218	0.076	0.031**	0.113	0.016	0.014	0.108	0.057*
1.8	0.233	0.080	0.033**	0.117	0.019	0.015	0.120	0.061*
2.0	0.250	0.085	0.037**	0.121	0.021	0.016	0.133	0.066**

URV	**PP**	**ME**	**SE**	**PP**	**ME**	**SE**	**ME**	**SE**
-1.6	0.039	0.058	0.014***	0.089	0.021	0.026	-0.049	0.037
-1.4	0.051	0.064	0.016***	0.093	0.018	0.026	-0.041	0.034
-1.2	0.065	0.067	0.021***	0.096	0.014	0.025	-0.031	0.032
-1.0	0.078	0.067	0.025***	0.099	0.011	0.023	-0.020	0.029
-0.8	0.091	0.063	0.028**	0.100	0.007	0.021	-0.009	0.026
-0.6	0.103	0.055	0.029*	0.101	0.003	0.019	0.002	0.025
-0.4	0.113	0.045	0.029	0.101	-0.002	0.017	0.012	0.025
-0.2	0.121	0.032	0.027	0.101	-0.006	0.015	0.020	0.025
0.0	0.126	0.018	0.024	0.099	-0.010	0.013	0.027	0.026
0.2	0.128	0.003	0.022	0.097	-0.013	0.012	0.031	0.027
0.4	0.127	-0.013	0.022	0.094	-0.017	0.012	0.033	0.027
0.6	0.123	-0.027	0.023	0.090	-0.020	0.013	0.033	0.027
0.8	0.116	-0.041	0.024*	0.086	-0.023	0.014*	0.031	0.027
1.0	0.107	-0.052	0.026**	0.081	-0.026	0.014*	0.026	0.027

1.2	0.095	-0.060	0.026**	0.075	-0.028	0.015*	0.020	0.027
1.4	0.083	-0.066	0.025***	0.070	-0.029	0.015*	0.013	0.028
1.6	0.069	-0.067	0.022***	0.064	-0.030	0.015**	0.006	0.029
1.8	0.056	-0.065	0.019***	0.058	-0.031	0.014**	-0.001	0.030

Note: Predicted probabilities and marginal effects of diversity and location computed at the mean effect of all other variables.

Throughout the range of unrelated variety considered in Table 4, and holding related variety constant at the mean, the marginal effects of urban location are insignificant. This is consistent with the insignificant interaction between unrelated variety and urban location reported in Table 3. Urban firms exhibit significant and positive marginal effects at levels of unrelated variety that are well below the sample mean of 0, yet, align with non-urban firms in exhibiting significantly negative marginal effects from moderate levels of unrelated variety and upward.

To further investigate we need to account for the significant interaction between URV and R&D detected in Model 6. To do so, we have estimated Model 5 separately for firms with and without R&D. This approach account for the potential role of R&D in moderating all the factors considered, including the baseline effect of urban location, the baseline effects of diversity *and* the interactions between location and diversity considered. The downside is that standard errors increase and significance is reduced due to low N particularly in the two URBAN sub-groups (with or without R&D).

Table 5: Predicted probabilities (PP) and marginal effects (ME) of variety and location on INCREMENTAL. Computed based on Model 5 estimated separately for firms with and without R&D

	Predicted probabilities and marginal effects URV						**Marginal effect of URBAN**	
	URBAN = 1 (N = 269)			URBAN = 0 (N = 570)				
URV if R&D = 0	**PP**	**ME**	**SE**	**PP**	**ME**	**SE**	**ME**	**SE**
-1.6	0.005	0.021	0.022	0.031	0.013	0.014	-0.026	0.021
-1.4	0.011	0.035	0.023	0.034	0.014	0.015	-0.024	0.021
-1.2	0.020	0.051	0.022**	0.037	0.014	0.015	-0.018	0.022
-1.0	0.031	0.064	0.025**	0.040	0.015	0.015	-0.010	0.023

-0.8	0.045	0.071	0.032**	0.043	0.015	0.015	0.000	0.023
-0.6	0.059	0.070	0.039*	0.046	0.015	0.015	0.010	0.024
-0.4	0.072	0.060	0.040	0.049	0.015	0.015	0.020	0.026
-0.2	0.082	0.042	0.037	0.052	0.015	0.014	0.027	0.029
0	0.089	0.019	0.032	0.055	0.015	0.014	0.030	0.031
0.2	0.090	-0.006	0.030	0.058	0.015	0.014	0.028	0.032
0.4	0.086	-0.031	0.033	0.061	0.015	0.015	0.021	0.032
0.6	0.078	-0.051	0.038	0.064	0.015	0.017	0.010	0.031
0.8	0.066	-0.066	0.039*	0.067	0.015	0.019	-0.004	0.030
1.0	0.052	-0.071	0.036**	0.070	0.014	0.022	-0.020	0.029
1.2	0.038	-0.068	0.030**	0.072	0.014	0.026	-0.037	0.030
1.4	0.025	-0.058	0.025**	0.075	0.013	0.030	-0.051	0.031*
1.6	0.015	-0.043	0.024*	0.078	0.013	0.034	-0.064	0.034*
1.8	0.008	-0.028	0.024	0.080	0.012	0.039	-0.073	0.038*

	URBAN = 1 (N = 171)			URBAN = 0 (N = 386)				
URV if R&D = 1	**PP**	**ME**	**SE**	**PP**	**ME**	**SE**	**ME**	**SE**
-1.6	0.153	0.114	0.056**	0.278	0.007	0.095	-0.123	0.132
-1.4	0.176	0.111	0.067*	0.278	-0.003	0.087	-0.100	0.116
-1.2	0.197	0.104	0.074	0.277	-0.012	0.079	-0.077	0.101
-1.0	0.217	0.094	0.077	0.274	-0.022	0.070	-0.054	0.088
-0.8	0.235	0.082	0.077	0.268	-0.031	0.061	-0.031	0.076
-0.6	0.250	0.068	0.074	0.261	-0.039	0.052	-0.009	0.068
-0.4	0.262	0.052	0.068	0.253	-0.048	0.044	0.012	0.063
-0.2	0.271	0.035	0.061	0.242	-0.055	0.037	0.031	0.061
0	0.276	0.018	0.055	0.230	-0.062	0.032*	0.048	0.060
0.2	0.278	0.000	0.049	0.217	-0.069	0.029**	0.063	0.061
0.4	0.276	-0.018	0.045	0.203	-0.074	0.029***	0.075	0.061
0.6	0.271	-0.036	0.044	0.188	-0.078	0.030***	0.085	0.061
0.8	0.262	-0.053	0.046	0.172	-0.081	0.032**	0.092	0.061
1.0	0.250	-0.068	0.050	0.156	-0.083	0.034**	0.096	0.062

1.2	0.235	-0.083	0.054	0.139	-0.083	0.034**	0.097	0.063
1.4	0.217	-0.095	0.058	0.122	-0.082	0.033**	0.096	0.066
1.6	0.197	-0.104	0.059*	0.106	-0.079	0.031***	0.092	0.069
1.8	0.175	-0.111	0.058*	0.091	-0.075	0.027***	0.086	0.073

Table 5 indicate that the inverted U-shape relationship between incremental innovation and URV is particularly pronounced for urban firms that do not engage actively in R&D, meaning that for such firms, diverse experiences accumulated in large-city regions provide unique support for innovation by means of imitation as long as it stays below the threshold were diversity might become a disturbance. However, the evidence is weak and thus only indicative. The evidence suggesting that non-urban firms with R&D respond to URV by reducing emphasis on incremental innovation is stronger.

Radical innovation

Table 5 reports the baseline results. Radial innovation is positively associated with foreign market presence, R&D efforts and the education level of the firm. Notably, the effect of CHURN is negative, and significant in two out of five model specifications. This is notable in light of largely insignificant effects in estimations of INCREMENTAL. Intra-firm variety per se has no effect on radical innovation. As result, hypothesis 1 is rejected. By contrast, positive baseline and curvilinear effects in all models, and significant joint effects, is clear-cut evidence that unrelated variety increases the probability of radical innovation. This supports hypothesis 2a. Yet, it depends on labour churn that, in itself, reduces this probability. Labour replacement is an opportunity to maintain or increase the variety of knowledge available to the firm, but this must be balanced with stability conducive to knowledge accumulation and supportive organizational routines.

URBAN is not significant in any of the specifications, meaning we reject hypothesis 3a: urban location *per se* does not favor radical innovations. This lends to support critical remarks concerning an urban bias to innovation in the literature (Shearmur 2017). Moreover, we have to reject hypothesis 4a: the coefficient or URBAN*URV is negative though not significant, while we expected a positive effect on radical innovation. Finally, when moderating effects of

R&D are considered in Model, only a weakly significant estimate specifically for the interaction with the polynomial term for URV is detected. Yet, all terms capturing RV and all terms capturing URV are in this regression insignificant, meaning that no support for Hypothesis 5 is detected here and the effect of R&D is independent of internal experiences.

Table 6: Baseline regression results, product innovation new to the world market

Dependent variable: RADICAL

	Model 7	**Model 8**	**Model 9**	**Model 10**	**Model 11**	**Model 12**
	Coeff *(se)*	*Coeff* *(se)*	*Coeff* *(se)*	*Coeff* *(se)*	*Coeff* *(se)*	
AGE (log)	0.017	0.015	0.010	0.021	0.016	0.019
	(0.090)	(0.090)	(0.090)	(0.090)	(0.091)	(0.091)
SIZE (log)	0.088*	0.100**	0.084	0.099**	0.081	0.078
	(0.049)	(0.050)	(0.051)	(0.050)	(0.052)	(0.052)
R&D	1.314***	1.314***	1.312***	1.320***	1.318***	1.174***
	(0.128)	(0.128)	(0.129)	(0.129)	(0.130)	(0.173)
FORMAR	0.511***	0.512***	0.524***	0.516***	0.529***	0.526***
	(0.116)	(0.117)	(0.117)	(0.117)	(0.118)	(0.118)
EDULEVEL	0.188**	0.180**	0.183**	0.182**	0.182**	0.191**
	(0.079)	(0.080)	(0.080)	(0.080)	(0.080)	(0.081)
CHURN	-0.661	-0.758	-0.970*	-0.695	-0.920*	-0.990*
	(0.503)	(0.508)	(0.522)	(0.513)	(0.527)	(0.527)
URBAN	0.106	0.108	0.110	0.131	0.122	0.121
	(0.116)	(0.116)	(0.116)	(0.120)	(0.148)	(0.117)
TV	0.063					
	(0.057)					
RV		-0.065	-0.021	-0.021	0.042	-0.051
		(0.062)	(0.102)	(0.073)	(0.119)	(0.182)
RV^2			-0.017		-0.020	0.016
			(0.036)		(0.038)	(0.061)
URV		0.104*	0.179**	0.120*	0.205**	0.344*

		(0.061)	(0.079)	(0.072)	(0.094)	(0.182)
URV^2			-0.071*		-0.083*	-0.334**
			(0.037)		(0.045)	(0.154)
URBAN*RV				-0.141	-0.143	
				(0.129)	(0.203)	
URBAN*RV^2					-0.016	
					(0.089)	
URBAN*URV				-0.049	-0.088	
				(0.114)	(0.152)	
URBAN*URV^2					0.033	
					(0.077)	
URBAN*RV						0.050
						(0.212)
URBAN*RV^2						-0.043
						(0.073)
URBAN*URV						-0.208
						(0.197)
URBAN*URV^2						0.292*
						(0.158)
Constant	-3.493***	-3.447***	-3.253***	-3.487***	-3.264***	-3.170***
	(0.469)	(0.471)	(0.483)	(0.473)	(0.485)	(0.495)
Wald Chi2 tests of joint coefficient significance						
All terms involving RELATED			1.06	2.24	2.46	1.14
All terms involving UNRELATED			5.74*	3.06	5.98	7.65
Observations	1418	1418	1418	1418	1418	1418
LR Chi2 (df)	401.00(27)***	403.01(28)***	407.50(30)***	404.99(30)***	410.22(34)***	412.30(34)***
R2	0.3381	0.3398	0.3436	0.3415	0.3459	0.3477

Note: Probit regressions. ***, ** and * indicate significance at the 1 per cent, 5 per cent and 10 per cent levels respectively.

Predicted probabilities and marginal effects are therefore computed and analyzed on the basis of Model 10 that include polynomial terms but no interactions. Table 6 demonstrate that the probability of radical innovation does not respond at all to the related variety of experiences in firms. Marginal effect estimates for unrelated variety, by contrast, are strongly significant at low levels and remain positive and significant up to 0.4 standard deviations above the mean before the predicted probability stabilizes. In this range, the predicted probability increases from 2.4 per cent at the minimum level of URV, to 7.5 per cent at 0.4 standard deviations above the mean, i.e. it more than triples.

Table 7: Predicted probabilities (PP) and marginal effects (ME) of diversity on RADICAL. Computed from Model 10. N = 1418. 0 = mean diversity.

RV	PP	ME	SE
-0.8	0.068	0.001	0.020
-0.6	0.068	0.000	0.018
-0.4	0.068	-0.001	0.017
-0.2	0.068	-0.002	0.015
0.0	0.068	-0.003	0.013
0.2	0.067	-0.004	0.012
0.4	0.066	-0.004	0.010
0.6	0.065	-0.005	0.009
0.8	0.064	-0.006	0.008
1.0	0.063	-0.007	0.007
1.2	0.061	-0.008	0.007
1.4	0.060	-0.008	0.007
1.6	0.058	-0.009	0.008
1.8	0.056	-0.009	0.009
2.0	0.054	-0.010	0.009

URV	PP	ME	SE
-1.6	0.025	0.024	0.005***
-1.4	0.030	0.025	0.006***
-1.2	0.035	0.027	0.007***
-1	0.040	0.028	0.009***
-0.8	0.046	0.028	0.010***

-0.6	0.052	0.028	0.010***
-0.4	0.057	0.027	0.011**
-0.2	0.062	0.025	0.011**
0	0.067	0.023	0.011**
0.2	0.072	0.021	0.010**
0.4	0.075	0.017	0.010*
0.6	0.079	0.014	0.010
0.8	0.081	0.010	0.010
1	0.082	0.006	0.011
1.2	0.083	0.001	0.012
1.4	0.083	-0.003	0.013
1.6	0.082	-0.007	0.014
1.8	0.080	-0.011	0.015

Note: Predicted probabilities and marginal effects of diversity computed at the mean effect of all other variables.

5. Concluding remarks

We use a unique Norwegian dataset to address the question of whether the novelty content of innovation reflect the composition of experiences accumulated in 'entire organizations'. When doing so, we introduced the distinction between related and unrelated experience variety to delineate between broad experiences from within (RV) versus between (URV) employment domains, i.e. sectors. We took great care to isolate effects associated with the composition of internal experiences from effects associated with location in diverse and dense urban environments, and acknowledged, conceptually as well as empirically, that influences from the internal knowledge base may depend on the type of locations in which human resources where accumulated as well as the overall emphasis of firms on development work expressed by R&D.

Based on this we demonstrate, first, that diverse experiences *per se* does not matter: Making the distinction between related and unrelated variety is essential. Second, our analyses reveal that (urban/non-urban) location *per se* does not matter: One needs to take the internal knowledge bases that connects firms to their locations into account to detect which firms benefit (cf. Lo Turco and Maggioni 2016, Rigby and Brown 2015). Conversely, while we found no direct effect of intra-firm variety on product innovation, we found a strong, positive effect of intra-firm related variety on incremental product innovation specifically in urban regions and indications that this effect is particularly strong for firms that do not engage themselves in R&D; i.e. firms that in this way signal a strategy of imitation. Thus, by accumulating human resources characterized by broad experiences from within related fields, urban firms are able to introduce onto their own markets what other firms, in related sectors, have already introduced onto theirs. By contrast, unrelated experience variety increases generally, i.e. independently of urban location and R&D, the probability of radical innovations. Accordingly, divergent experiences stimulate out-of-the-box thinking and avoid lock-in.

At the same time, and third, we also found that too much unrelated variety may hamper the overall innovativeness of firms: From low to moderate levels, increases in unrelated variety are strongly associated with an upsurge in the probability of radical product innovation but this concomitance occurrence flattens out at levels above the mean where it is paralleled by *decreasing* probabilities for incremental innovation that is most distinct among R&D-active firms outside the large-city regions. This is consistent with the idea that firms may perceive such exposure as an environmental disturbance to which they respond by retaining rather than adjusting practices (Madsen, Mosakowski, and Zaheer 2003), the outcome of which is reduced overall innovation propensity.

Finally, it must be emphasized that our results provide no support for the idea that urban locations are hot-spots for radical innovation. Instead, they are consistent with the work of Lee and Rodríguez-Pose (2013) finding location in UK large-city regions associated with learning that facilitates incremental innovation. However, in our study this is not a general urban economy effect that stem from simply 'being there' and accessing 'the urban buzz' (Fitjar and Rodríguez-Pose 2016, Storper and Venables 2004): Instead, firms need to actively use the labour markets or large-city regions to accumulate internally the related experiences that the capacity to transform external resources into incremental innovation depends on.

Beyond our use of Norwegian data only and the open question of whether specific economy characteristics have left imprints on the results, there are notable limitations to the study. By considering only manufacturing firms due to the related data and sector specificity reasons discussed in the technical section, we do not observe interactions between internal experiences and urban location in the service industries that are strongly agglomerated in large-city regions. Moreover, we do not capture whether regions are hotspots for innovation in the form of new firm formation, nor the role of experiences in this respect. A more general limitation that mirror our overall objective is that we have not considered composition along other dimensions that might be important for innovation, in themselves or in interaction with experiences. This applies, for instance, to age, ethnicity and education. Finally, we only considered the binary location characteristic 'urban'. While well-founded in extant literature and attractive for econometric reasons, future studies could move beyond this and consider how internal variety is shaped by, and interact with, the variety of employment in different labour market regions (Aarstad, Kvitastein, and Jakobsen 2016).

These limitations simply underscore that the approach developed and applied here is complementary to traditional ones focusing on the innovation strategies and activities of firms: It captures, albeit crudely, elementary cognitive and social characteristics of organizations that insofar have been hidden under a blanket of technological indicators. By doing so, it points to the need for future studies to use data from other countries and consider in more detail how dedicated innovation activities such as R&D, external innovation search and collaboration interact with the larger knowledge bases of firms that are the skills and experiences accumulated by employees through their career paths.

References

Aarstad, Jarle, Olav A. Kvitastein, and Stig-Erik Jakobsen. 2016. "Related and unrelated variety as regional drivers of enterprise productivity and innovation: A multilevel study." *Research Policy* 45 (4):844-856. doi: http://dx.doi.org/10.1016/j.respol.2016.01.013.

Agrawal, A., I. Cockburn, and J. McHale. 2006. "Gone but not forgotten: knowledge flows, labor mobility, and enduring social relationships." *Journal of Economic Geography* 6 (5):571-591. doi: 10.1093/jeg/lbl016.

Ai, C, and E.C Norton. 2003. "Interaction terms in logit and probit models." *Economics Letters* 80:123-129.

Almeida, Paul, and Bruce Kogut. 1999. "Localization of Knowledge and the Mobility of Engineers in Regional Networks." *Management Science* 45 (7):905-917. doi: 10.1287/mnsc.45.7.905.

Andini, Monica, Guido de Blasio, Gilles Duranton, and William C. Strange. 2013. "Marshallian labour market pooling: Evidence from Italy." *Regional Science and Urban Economics* 43 (6):1008-1022. doi: https://doi.org/10.1016/j.regsciurbeco.2013.04.003.

Arrow, K. J. 1962. "The Economic Implications of Learning by Doing." *The Review of Economic Studies Ltd.* 29 (3):155-173.

Bantel, K.A, and S.E Jackson. 1989. "Top management and innovations in banking: Does the composition of the top team make a difference?" *Strategic Management Journal* 10:107-124.

Basset-Jones, N. 2005. "The Paradox of Diversity Management, Creativity and Innovation." *Creativity and Innovation Management* 14:169-175. doi: 10.1111/j.1467-8691.00337.x.

Bell, S.T, A.T Villado, M.A Lukasik, L Belau, and A.L Briggs. 2011. "Getting specific about demographic diversity and team performance: A meta-analysis." *Journal of Management* 37 (3):709-743.

Bogers, M, N. J Foss, and J Lyngsie. 2018. "The "human side" of open innovation: The role of employee diversity in firm-level openness." *Research Policy* 47 (1):218-231. doi: https://doi.org/10.1016/j.respol.2017.10.012.

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

Boschma, R, R Eriksson, and U Lindgren. 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, and R Martin. 2010. "The aims aims and scope of evolutionary economic geography." In *The handbook of evolutionary economic geography*, edited by R Boschma and R Martin, 3-39. Cheltenham: Edward Elgar.

Boschma, Ron. 2017. "Relatedness as driver of regional diversification: a research agenda." *Regional Studies* 51 (3):351-364. doi: 10.1080/00343404.2016.1254767.

Bouty, Isabelle. 2000. "Interpersonal and interaction influences on informal resource exchanges between R&D researchers across organizational boundaries." *The Academy of Management Journal* 43 (1):50-65.

Carlile, P.R. 2004. "Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge Across Boundaries." *Organization Science* 15 (5):555-568. doi: https://doi.org/10.1287/orsc.1040.0094.

Castaldi, C, K Frenken, and B Los. 2015. "Related Variety, Unrelated Variety and Technological Breakthroughs: An analysis of US State-Level Patenting." *Regional Studies* 49 (5):767-781. doi: 10.1080/00343404.2014.940305.

Castellacci, Fulvio, Magnus Gulbrandsen, Jarle Hildrum, Ieva Martinkenaite, and Erlend Simensen. 2018. "Functional centrality and innovation intensity: Employee-level analysis of the Telenor group." *Research Policy*. doi: https://doi.org/10.1016/j.respol.2018.06.004.

Cohen, W. M., and D. A. Levinthal. 1990. "Absorptive capacity - a new perspective on learning and innovation." *Administrative Science Quarterly* 35 (1):128-152.

Crepon, B, E Duguet, and J Mairesse. 1998. "RESEARCH, INNOVATION AND PRODUCTIVITY: AN ECONOMETRIC ANALYSIS AT THE FIRM LEVEL." *Economics of Innovation & New Technology* 7 (2):115.

Dokko, G., S. L. Wilk, and N. P. Rothbard. 2009. "Unpacking Prior Experience: How Career History Affects Job Performance." *Organization Science* 20 (1):51-68. doi: 10.1287/orsc.1080.0357.

Duranton, G, and D Puga. 2001. "Nursery Cities: Urban Diversity, Process Innovation, and the Life Cycle of Products." *American Economic Review* 91 (5):1454-1477. doi: doi: 10.1257/aer.91.5.1454.

Ebersberger, B, and S Herstad. 2011. "Product innovation and the complementarities of external interfaces." *European Management Review* 8 (3):117-135.

Ebersberger, B, and S Herstad. 2012. "Go abroad or have strangers visit? On organizational search spaces and local linkages " *Journal or Economic Geography* 12 (1):273-295.

Fitjar, R.D, F Huber, and A Rodríguez-Pose. 2016. "Not too close, not too far: testing the Goldilocks principle of "optimal" distance in innovation networks." *Industry and Innovation: published online 25.05.2016*.

Fitjar, R.D, and A Rodríguez-Pose. 2011. "Innovating in the Periphery: Firms, Values and Innovation in Southwest Norway." *European Planning Studies* 19 (4):555-574. doi: 10.1080/09654313.2011.548467.

Fitjar, Rune Dahl, and Andrés Rodríguez-Pose. 2016. "Nothing is in the Air." *Growth and Change*:n/a-n/a. doi: 10.1111/grow.12161.

Frenken, K, F Van Oort, and T Verburg. 2007. "Related Variety, Unrelated Variety and Regional Economic Growth " *Regional Studies* 41 (5):685-697. doi: doi: 10.1080/00343400601120296.

Ganzach, Y. 1997. "Misleading interaction and curvililnear terms." *Psychological Methods* 2 (3):235-247.

Glaeser, E. 2011. *The Triumph of the City*. London: Pan Macmillan.

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

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

Gundersen, F, and D Jukvam. 2013. "Inndelinger i senterstruktur, sentralitet og BA-regioner (Categorizations of centrality and labor market regions)." *NIBR Report* 2013 (1).

Haans, Richard F. J., Constant Pieters, and Zi-Lin He. 2016. "Thinking about U: Theorizing and testing U- and inverted U-shaped relationships in strategy research." *Strategic Management Journal* 37 (7):1177-1195. doi: 10.1002/smj.2399.

Harris, R.I.D. 1988. "Technological Change and Regional Development in the UK: Evidence from the SPRU Database on Innovations." *Regional Studies* 22 (5):361-374. doi: 10.1080/00343408812331345050.

Helsley, Robert W., and William C. Strange. 1990. "Matching and agglomeration economies in a system of cities." *Regional Science and Urban Economics* 20 (2):189-212. doi: https://doi.org/10.1016/0166-0462(90)90004-M.

Herstad, S, T Sandven, and B Ebersberger. 2015. "Recruitment, knowledge integration and modes of innovation." *Research Policy* 44 (1):138-153. doi: http://dx.doi.org/10.1016/j.respol.2014.06.007.

Herstad, Sverre J. 2018a. "Innovation strategy choices in the urban economy." *Urban Studies* 55 (6):1185-1202. doi: 10.1177/0042098017692941.

Herstad, Sverre J. 2018b. "Beyond 'related variety': how inflows of skills shape innovativeness in different industries." *European Planning Studies* 26 (2):396-420. doi: 10.1080/09654313.2017.1392490.

Hidalgo, C.A, B Klinger, A.L Barbasi, and R Hausmann. 2007. "The product space conditions the development of nations." *Science* 317:482-487.

Hoetker, G. 2007. "The use of logit and probit models in strategic management research: Critical issues." *Strategic Management Journal* 28 (4):331-343. doi: 10.1002/smj.582.

Horwitz, S.K. 2005. "The compositional impact of team diversity on performance: Theoretical considerations." *Human Resource Development Review* 4 (2):219-245.

Horwitz, S.K, and I.B Horwitz. 2007. "The Effects of Team Diversity on Team Outcomes: A Meta-Analytic Review of Team Demography." *Journal of Management* 33:987-1015.

Iammarino, S, M Piva, M Vivarelli, and N Von Tunzelmann. 2012. "Technological Capabilities and Patterns of Innovative Cooperation of Firms in the UK Regions." *Regional Studies* 46 (10):1283-1301. doi: 10.1080/00343404.2012.679259.

Isaksen, A. 2015. "Industrial development in thin regions: trapped in path extension?" *Journal of Economic Geography* 15 (3):585-600. doi: 10.1093/jeg/lbu026.

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

Jacquemin, A.P, and C.H Berry. 1979. "ENTROPY MEASURE OF DIVERSIFICATION AND CORPORATE GROWTH." *Journal of Industrial Economics* 27:359-369.

Jehn, K.A, G.B Northcraft, and M.A Neale. 1999. "Why some differences make a difference: A field study of diversity, conflict, and performance in workgroups." *Administrative Science Quarterly* 44:741-763. doi: 10.2307/2667054

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

Jukvam, D. 2002. *Defining labour market regions*. Oslo: Norwegian Institute for Urban and Regional Research.

Kearney, Eric, Diether Gebert, and Sven C. Voelpel. 2009. "When And How Diversity Benefits Teams: The Importance Of Team Members' Need For Cognition." *Academy of Management Journal* 52 (3):581-598. doi: 10.5465/amj.2009.41331431.

Knudsen, B, R Florida, K Stolarick, and G Gates. 2008. "Density and Creativity in U.S. Regions." *Annals of the Association of American Geographers* 98 (2):461-478. doi: 10.1080/00045600701851150.

Lee, N, and A Rodríguez-Pose. 2013. "Original Innovation, Learnt Innovation and Cities: Evidence from UK SMEs." *Urban Studies* 50 (9):1742-1759. doi: 10.1177/0042098012470395.

Lo Turco, A, and D Maggioni. 2016. "On firms' product space evolution: the role of firm and local product relatedness." *Journal of Economic Geography* 16 (5):975-1006. doi: 10.1093/jeg/lbv024.

Lundvall, B. A., B. Johnson, E. S. Andersen, and B. Dalum. 2002. "National systems of production, innovation and competence building." *Research Policy* 31 (2):213-231.

Lundvall, Bengt-äke, and Björn Johnson. 1994. "The Learning Economy." *Journal of Industry Studies* 1 (2):23-42. doi: 10.1080/13662719400000002.

Madsen, T, E Mosakowski, and S Zaheer. 2003. "Knowledge retention and personnel mobility: The nondisruptive effects of inflows of experience." *Organization Science* 14 (2):173-191.

Miguelez, E, and R Moreno. 2018. "Relatedness, external linkages and regional innovation in Europe." *Regional Studies* 52 (5):688-701. doi: 10.1080/00343404.2017.1360478.

Milliken, F.J, and L.L Martins. 1996. "Searching for Common Threads: Understanding the Multiple Effects of Diversity in Organizational Groups." *The Academy of Management Review* 21 (2):402-433. doi: 10.2307/258667.

Mohammadi, A, A Broström, and C Franzoni. 2017. "Workforce Composition and Innovation: How Diversity in Employees' Ethnic and Educational Backgrounds Facilitates Firm- Level Innovativeness." *Journal of Product Innovation Management* 34 (4):406-426. doi: doi:10.1111/jpim.12388.

Neffke, F, M Henning, and R Boschma. 2011. "How do regions diversity over time? Industry relatedness and the development of new growth paths in regions." *Economic Geography* 87 (3):237-265.

Nelson, R, and S Winter. 1982. *An evolutionary theory of economic change*. Cambridge, MA: Harvard University Press.

Nonaka, I. 1994. "A dynamic theory of organizational knowledge creation." *Organization Science* 5:14-37.

Nooteboom, B. 2000. *Learning and innovation in organizations and economies*. New York: Oxford University Press.

Nooteboom, B, W Van Haverbeke, G Duysters, V Gilsing, and A van den Oord. 2007. "Optimal cognitive distance and absorptive capacity." *Research Policy* 36 (7):1016-1034. doi: 10.1016/j.respol.2007.04.003.

Nordli, A.J. 2016. "Measuring innovation in tourism with Community Innovation Survey: a first step towards a more valid innovation instruments." *Scandinavian Journal of Hospitality and Tourism* 17 (4):423-440. doi: 10.1080/15022250.2016.1247382.

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

Parrilli, Mario Davide, and Henar Alcalde Heras. 2016. "STI and DUI innovation modes: Scientific-technological and context-specific nuances." *Research Policy* 45 (4):747-756. doi: http://dx.doi.org/10.1016/j.respol.2016.01.001.

Phillips, K.W, K.A Liljenquist, and M.A. Neale. 2009. "Is the Pain Worth the Gain? The Advantages and Liabilities of Agreeing With Socially Distinct Newcomers." *Personality and Social Psychology Bulletin* 35 (3):336-350. doi: 10.1177/0146167208328062.

Pred, A.R. 1966. *The spatial dynamics of urban-industrial growth 1800-1914. Interpretative and theoretical essays*. Cambridge: MIT Press.

Pred, A.R. 1977. *City-systems in advanced economies: past growth, present processes and future development options*. London: Hutchinson.

Rigby, D.L, and W.M Brown. 2015. "Who Benefits from Agglomeration?" *Regional Studies* 49 (1):28-43. doi: 10.1080/00343404.2012.753141.

Saviotti, P.P, and K Frenken. 2008. "Export variety and the economic performance of countries." *Journal of Evolutionary Economics* 18 (2):201–218

Schuetz, A. 1944. "The Stranger: An Essay in Social psychology." *American Journal of Sociology* 49 (6):499-507.

Shearmur, R. 2011. "Innovation, Regions and Proximity: From Neo-Regionalism to Spatial Analysis." *Regional Studies* 45 (9):1225-1243. doi: 10.1080/00343404.2010.484416.

Shearmur, R. 2017. "Urban Bias in Innovation Studies." In *The Elgar Companion to Innovation and Knowledge Creation: A Multi-Disciplinary Approach*, edited by H Bathelt, P Cohendet, S Henn and L Simon, 440-456. Cheltenham: Edward Elgar.

Shearmur, Richard. 2015. "Far from the Madding Crowd: Slow Innovators, Information Value, and the Geography of Innovation." *Growth and Change* 46 (3):424-442. doi: 10.1111/grow.12097.

Solheim, Marte C. W., and Sverre J. Herstad. 2018. "The Differentiated Effects of Human Resource Diversity on Corporate Innovation." *International Journal of Innovation and Technology Management* 15 (5):25. doi: 10.1142/s0219877018500463.

Storper, M, and A.J Venables. 2004. "Buzz: face-to-face contact and the urban economy." *Journal of Economic Geography* 4 (4):351-370.

Timmermans, Bram, and Ron Boschma. 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. doi: 10.1093/jeg/lbs059.

Toivonen, M, and T Tuominen. 2009. "Emergence of innovations in services." *The Service Industries Journal* 29 (7):887-902. doi: 10.1080/02642060902749492.

Vaessen, P.M.M. 1993. Small business growth in contrasting environments. Department of Economic Geography, Faculty of Administrative Scinces, KU Nijmegen.

Van Engen, M, and M Van Woerkom. 2010. "Learning from Differences. The Relationships between Team Expertise Diversity, Team Learning, Team Performance, and Team Innovation." In *Workplace Learning. Concepts, Measurement, and Application*, edited by M Van Woerkom and R Poell. NY/Oxon: Routledge.

van Knippenberg, D, C. K.W De Dreu, and A.C Homan. 2004. "Work Group Diversity and Group Performance: An Integrative Model and Research Agenda." *Journal of Applied Psychology* 89 (6):1008-1022. doi: 10.1037/0021-9010.89.6.1008.

Williams, K.Y, and C.A O'Reilly. 1998. "Demography and diversity in organizations: A review of 40 years of research." *Research in Organizational Behavior, Vol 20, 1998* 20:77-140.

Xiao, Jing, Ron Boschma, and Martin Andersson. 2018. "Industrial Diversification in Europe: The Differentiated Role of Relatedness." *Economic Geography*:1-36. doi: 10.1080/00130095.2018.1444989.

Zahra, S.A, and B George. 2002. "Absorptive capacity: A review, reconceptualization and extension." *Academy of Management Review* 27 (2):185-203.

Østergaard, Christian R., Bram Timmermans, and Kari Kristinsson. 2011. "Does a different view create something new? The effect of employee diversity on innovation." *Research Policy* 40 (3):500-509. doi: http://dx.doi.org/10.1016/j.respol.2010.11.004.

Table A1: Descriptive statistics and correlations. N=1479 (all observations included in estimations of INCREMENTAL)

		Mean	**SD**	**Min**	**Max**	1	2	3	4	5	6	7	8	9	10	
1	INCRE-MENTAL	0.137	0.344	0	1	1										
2	RADICAL	0.141	0.348	0	1	-0.161	1									
3	AGE (log)	2.912	0.579	1.609	4.718	-0.025	-0.011	1								
4	SIZE (log)	3.839	1.083	2.303	8.757	0.033	0.149	0.077	1							
5	R&D ACTIVE	0.396	0.489	0	1	0.262	0.421	0.004	0.282	1						
6	FORMAR	0.237	0.425	0	1	-0.115	0.322	-0.015	0.227	0.317	1					
7	EDU-LEVEL	3.645	0.714	1	7.125	-0.003	0.320	-0.064	0.136	0.352	0.336	1				
8	CHURN	0.209	0.118	0	0.875	0.038	-0.112	-0.015	-0.049	-0.120	-0.112	-0.144	1			
9	URBAN	0.317	0.466	0	1	0.013	0.041	0.007	-0.027	-0.011	-0.041	0.187	0.032	1		
10	VAR_TOT (std)	0	1	-1.928	4.465	0.022	0.145	-0.200	0.209	0.168	0.107	0.279	0.163	0.047	1	
11	VAR_REL (std)	0	1	-0.876	8.073	0.089	0.041	-0.144	0.210	0.089	0.079	0.125	0.066	0.050	0.587	
12	VAR_UNREL (std)	0	1	-1.944	4.120	-0.003	0.154	-0.185	0.173	0.165	0.099	0.282	0.167	0.037	0.965	0.3