Out of sight? Revealing creativity-led innovation in rural regions

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Abstract

Economic geography has offered several insights to understand the role of geography in shaping creativity, innovation and the way they are connected. Unfortunately, most attention has been devoted to analyzing cities and urban regions as the ideal context where creativity and innovation come together. Emerging narratives are challenging this urban perspective and proposing that creativity-led innovation can also thrive in rural, more remote, regions. This counter-narrative builds upon fascinating case studies, yet systematic quantitative evidence is lacking.

To fill this gap, we offer original empirical evidence comparing urban and rural regions in Europe, for the period 2011-2019. We leverage large scale occupational data to capture regional shares of creative occupations and we combine patents and trademarks to allow a richer comparison of different regional innovation patterns. Our findings suggest that creativity-led innovation processes are at play in both urban and rural regions, but can only be uncovered in rural regions when broadening the innovation metrics used. These findings bear key policy implications, as they inform efforts towards formulating and monitoring regional innovation ambitions which are more sensitive to the characteristics of rural contexts.

Keywords: creativity, innovation, regions, urban, rural, creative occupations, patents, trademarks

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1.Introduction

The link between creativity and innovation is a strong one. The very Schumpeterian notion of innovation being 'creative destruction' suggests that innovation relies on unleashing human creativity to come up with novel ideas that can overturn existing economic, technological and social configurations. Firm-level theories and evidence have revealed mechanisms through which creativity gets spurred and turns into actual innovation. More aggregate perspectives have drawn attention to how geography matters, for creativity, for innovation and for the link between creativity and innovation (Feldman, 1994; Florida et al., 2017). A geographical perspective builds upon the basic intuition that innovation and creativity do not develop in isolation from the spaces and contexts where the individuals generating new ideas operate, live and socialize.

Within economic geography, most studies have stressed how cities and the related urban contexts appear the ideal hotbed for creativity-led innovation activities. On the one hand, creative talent is drawn to cities because of the infrastructures, amenities and cultural openness that they offer (Florida, 2004). On the other hand, cities offer excellent opportunities for connecting both diverse and specialized activities (Bettencourt et al., 2007; Balland et al., 2020). The two mechanisms appear to reinforce each other and point to creativity and innovation concentrating in cities, especially large ones.

This urban perspective has been challenged, both conceptually and empirically. Emerging narratives suggest that non-urban/rural regions and smaller cities have been neglected when it comes to both creativity and innovation. One strand of research has specifically criticized the idea that creative talent is only drawn to urban amenities: natural amenities typical of rural regions may also matter (McGranahan et al., 2011). In fact, some have talked about a 'creativity-led rural renaissance' (Argent et al., 2013). Another strand of research has suggested that innovation can thrive in disconnected and remote locations typical of peripheral, less urban contexts (Shearmur, 2012; Grabher, 2018). Unfortunately, these emerging narratives tend to rely on case studies and comparative empirical work is missing. Also, the two strands of research have not been linked to investigate whether and how rural regions benefit from creativity-led innovation.

Overall, we lack a clear picture of how creativity-led innovation might matter in urban vs rural contexts. In this study we aim at advancing our understanding with a focus on both the mechanisms at play and the measurement challenges. Our theoretical discussion integrates the insights from prior literature and shows how the dominant urban narratives and the alternative non-urban narratives focus on specific benefits of each geographical context. Methodologically, we build upon recent advances in measuring creative activities and innovation at the regional level.

Our empirical focus is on Europe and we investigate the relationship between regional shares of employment in creative occupations and innovation for the period 2011-2019. We leverage large scale occupational data to capture regional shares of creative occupations and we combine patents and trademarks to allow a richer comparison of different regional innovation patterns. The intuition is that the two intellectual property rights capture different types of innovation and different phases of the innovation process, with trademarks being closely related to those phases where creative workers and their symbolic knowledge come into play. Our findings suggest that creativity-led innovation processes are at play in both urban and rural regions, but with specific properties.

Our results can inform policy: it remains difficult to reveal the contribution of creativity beyond urban contexts, yet smart specialization strategies for these regions could benefit from insights on whether innovation trajectories can exploit the presence of creative activities (Castaldi & Drivas, 2023). For many rural regions such local strengths are clearly not residing in the technological or scientific domain but can be found in a broader set of territorial assets and small firm capabilities (Radosevic, 2018). Hence, mobilizing metrics of creativity and innovation that span a broader range of activities than those focused on high-tech specializations is bound to do more justice to what happens in rural and peripheral regions.

2.Research background

2.1 Cities as the place where creativity and innovation come together?

The narrative of cities being the ideal place for creative activities has been established thanks to Florida's work on the creative class. According to Florida (2004) cities provide essential elements to the creative class: firstly, the infrastructure and networks necessary for technological development to take place; secondly, talent, as a critical mass of highly skilled individuals who can potentially collaborate and interact with other professionals who support creative activities, such as business, law or physical and engineering science professionals; thirdly, the tolerance and open-minded spirit that attract people from different cultural and ethnic backgrounds. At the same time the creative class idea has been criticized, both on conceptual and empirical grounds. Asheim & Hansen (2009) proposed a focus on differentiated knowledge bases as a better way to understand the distribution of different types of creative activities across places. In their analysis, only activities strongly relying on symbolic knowledge bases would show a tendency to concentrate in urban environments. Overall, the evidence on whether creative activities concentrate in cities is mixed and focused on a few countries, like the UK and the US (Huggins & Clifton, 2011; Kemeny et al., 2020).

When it comes to innovation, cities have also been portrayed as the ideal environment for innovative firms. The arguments are many, partly related to the general advantages of agglomeration (Carlino & Kerr, 2014; Duranton & Puga, 2001), partly aligning to specific properties of modern innovation activities. Cities offer diverse environments already praised in the seminal work of Jane Jacobs (Jacobs, 1969). Such environments appear to particularly facilitate the emergence of new firms and radical forms of innovation (Florida et al., 2017). Instead, the advantages of cities can turn into burdens once firms grow and move to more incremental forms of innovation (Henderson et al., 1995; Duranton & Puga, 2001). Empirical work has mostly focused on comparing large and small cities, often in the US (Bettencourt et al., 2007; Balland et al., 2020; Castaldi, 2023). For Europe, several authors have warned that the innovation landscape might be different, with fewer large cities and less urbanized regions also scoring high on innovation (Fritsch & Wyrwich, 2021a; Iammarino et al., 2019).

If both creative activities and innovation concentrate in cities, then one would expect the relationship between creativity and innovation to be strongest in cities. Specific mechanisms pointing in this direction have been suggested in work that follows communities of creative talent (Grabher, 2004; Vinodrai, 2006). Cities offer opportunities for job hopping, allowing creative workers to learn from different contexts and cross-pollinate ideas (Vinodrai, 2006). In this sense creative workers can build bridges and help the recombination of ideas (Rodríguez-Pose & Lee, 2020; Wojan, 2022). The concentration of specialized creative professionals in cities also allows to develop communities of practice, where new creative ideas are socially constructed (Grabher, 2004, Cohendet et al., 2014). Moreover, creative workers often work in project-based settings where their input complements that coming from other specialized professionals (Rahman & Barley, 2017). Urban settings facilitate matching talent to opportunities to exploit synergies. Finally, cities are also preferred locations for corporate headquarters, which might speed up the journey from idea to market and spur product innovation (Nasirov et al., 2021).

2.2 Beyond the city: creativity and innovation in rural regions

As a response to Florida's work, a few scholars suggested that creative talent is not only attracted to cities but may also turn to rural areas for natural amenities like outdoor activities and clean air (McGranahan et al., 2011). A few studies documented the existence of 'rural artistic havens' (Wojan et al., 2007) and suggested a 'creativity-led rural renaissance' (Argent et al., 2013). This line of research has stressed how rural communities offer a cultural environment where artists and creative talent can thrive (Sorensen, 2009). These authors challenge the view of rural regions as being characterized by closed cultures and traditional values. A complementary strand of research has focused on small cities as places where creative talent might also migrate too, thanks to more affordable housing and better quality of life than large cities (Waitt & Gibson, 2009). Some have even argued that rural regions might expose workers to diversity even more than cities. The intuition is that workers would escape operating in specialized communities of practice and instead be more likely to engage in social interactions across worker types (Meili and Shearmur, 2019).

The urban narrative on innovation has also been challenged (Glückler et al., 2023; Shearmur, 2012). Some studies have claimed that rural innovation has been systematically neglected (Wojan & Nichols, 2018). Other studies have focused on the notion of 'peripheral regions', which are often less urbanized regions (Pugh and Dubois, 2021). The emerging innovation in the periphery literature (Eder, 2019) suggests that innovation can take place beyond urban cores. In fact, peripheral regions lacking agglomeration might benefit from their very distance when it comes to innovation potential. Eder & Trippl (2019) have proposed several properties that can constitute strengths of these regions. For instance, the institutional voids and distance to political centers might be a reason to deviate from usual patterns and develop unconventional alternatives. Interestingly, this might be particularly the case for creative and cultural activities where experimentation and opposition to dominant paradigms can be key (Grabher, 2018; Power & Collins, 2021; Kesidou et al., 2024). At the same time, rural regions can also provide the physical and social space for the 'slow innovation' that characterizes mature industries and mature firms (Shearmur, 2015). The related innovation is less about being at the global technological frontier and more about optimizing processes and products with incremental innovation thanks to internal capabilities accumulated over time (Shrolec et al., 2021).

When analyzing peripheral regions in Northern Canada, Petrov (2012) also found accumulated creative capacities and innovative hotspots in the Canadian periphery. Creativity and innovation emerged as even more fundamental to creating new paths in peripheral regions than urban areas. In this case, social capital and community efforts favored successful innovation. Local innovators in remote areas often operate beyond the spillovers of innovation centers, also making use of local ties and collaborations. In peripheral regions, according to Petrov (2012), the 'weakness of strong ties' can become a strength if an innovative activity builds appropriate networks and involves the community. Moreover, the type of innovation that prevails in peripheral regions tends to be more non-technological or soft innovation, often building on territorial assets that represent local culture, history and nature (Eder, 2019; Pires et al., 2014; Shearmur, 2017; Galetti et al., 2021). It can also be about turning creativity into innovation that expands symbolic knowledge bases, with the potential for regional path creation (Kesidou et al., 2024).

Table 1: Key arguments on the benefits of urban vs rural contexts for creativity, innovation and creativity-led innovation (source: own elaboration).

	Urban narrative	**Beyond the city narrative**
Benefits for creativity	Cities come with density and social interactions Infrastructure and networks facilitate operations Urban amenities, cultural openness, diversity	Rural regions as artistic havens and places of cultural heritage Less competition in the periphery Natural amenities, tight-knit communities, diverse social interactions
Benefits for innovation	High-tech innovation favored by agglomeration opportunities Particularly beneficial for startups	Slow innovation modes thrive in periphery rather than core Mature firms move out of city
Benefits for creativity-led innovation	Job hopping and cross-overs allow tapping into specialized creative talent Matching of talent to opportunities and organization of specialized teams	Institutional leeway and distance favor truly radical new creative activity Creative and cultural assets feeding into soft innovation

To conclude, Table 1 summarizes the key arguments put forward by these emerging, 'beyond the city' narratives, as opposed to the key arguments that characterize the urban narrative instead. When it comes to considering the evidence supporting the different arguments, one has to conclude that that the evidence for the emerging narratives has often been based on case studies and systematic comparative evidence is scattered (Argent et al., 2013, Eder, 2019). Hence, we turn to the methodological challenges that have stood in the way of producing evidence to inform the ongoing debate.

2.3 Methodological issues

The theories discussed above have by no doubt spurred a rich strand of empirical research in economic geography and related fields. Unfortunately, the evidence is mixed at best and often hard to compare. Empirical studies have had to deal with the double challenge of properly measuring creativity and innovation at a regional level.

As for measuring creative activities, early studies focused on identifying creative industries. Seminal methodological work was done at DCIM and OECD, to come up with shared and comparable classification of creative industries starting from industrial codes. Those early endeavors have been instrumental for exploring the role of creative industries and putting them on the agenda of policymakers (Cunningham, 2013). At the same time, it has become clear that an industry approach understates the actual contribution of creative activities. Creative talent is also employed in non-creative industries, hence a focus on creative occupations helps to systematically map creative activities in firms across all sectors (Higgs & Cunningham, 2008; Lee & Rodríguez-Pose, 2014). Interestingly, Lee & Rodríguez-Pose (2014) implemented both an industry and an occupational approach and concluded that the latter allows to better reveal the contribution of creative activities to innovation.

At the same time, measuring regional innovation also presents methodological challenges. Innovation surveys offer key advantages for capturing actual innovation and a few relevant studies exist that have relied on surveys (Grillitsch et al., 2017; Lee & Rodríguez-Pose, 2014; Wojan & Nichols, 2018). At the same time, relying on surveys has limitations, especially when it comes to timely and consistent monitoring. Moreover, many surveys have focused on one country at a time, hence comparative empirical work is missing.

Using intellectual property rights data to measure innovation overcomes the above limitations. It allows timely and consistent analysis and enables comparative work between countries and regions (Mendonça et al., 2004). Of course, this data also comes with its own limitations, which are well-known. Some of the limitations particularly apply to instances when only one IPR is used and patents have by far been the favorite innovation proxy (Fritsch & Wyrwich, 2021b; Rodríguez-Pose & Lee, 2020). Wojan & Nichols (2018) and others have suggested that patents might have a urban bias hence might fail to reveal innovation in non-urban regions. There is an emerging understanding that combining IPRs can allow a broader take on regional innovation (Castaldi & Mendonça, 2022; Ribeiro et al., 2022) and help to capture innovation across more types of regions (Castaldi, 2024; Pinate et al., 2021; Roper & Jibril, 2023).

Table 2: Key features of patents vs trademarks as innovation metrics

	Patents	**Trademarks**
Subject matter	Novel technological inventions	Distinctive symbols
Main legal requirements for registration	Novelty Industrial applicability	Distinctiveness (Intention to) Use in market
Phase of the innovation process	Research Development	Product Development Marketing
Type of innovation	New-to-the-world technical invention	Product/service innovation, non-technological innovation, also new-to-the-firm innovation
Knowledge base	Analytical	Symbolic
Occupations	Technical/engineering	Creative/design
Type of firms	Mostly large firms	All firm sizes
Sectoral context	Mostly high-tech sectors	All sectors

Source: own elaboration.

Firm-level studies can in principle better reveal mechanisms at play, yet they fail to account for the notion that creative and innovation activities are shaped by local conditions. Moreover, a regional perspective allows capturing more ways in which creativity shapes innovation, beyond corporate boundaries and through knowledge exchange, labour mobility and other geography-shaped interactions (Lee & Rodríguez-Pose, 2014). Sleuwaegen & Boiardi (2017) also provided evidence that regional innovative performance is affected directly and indirectly by creative workers, in addition to the contribution of so-called STEM professionals linked to science and technology.

In this study, we propose that the relationship between creativity and innovation at the regional level can be studied by capturing the regional share of employment in creative occupations and by combining patents and trademarks as innovation indicators (see Table 2 for an overview of the complementarities of the two indicators). We expect the role of creative occupations to emerge more clearly in relation to regional trademark counts than regional patent counts. The reason lies in how trademarks better capture those phases of the innovation processes where creative occupations dominate, namely the design, marketing and commercialization phases (Gatrell and Ceh, 2003; Mendonça et al., 2004). An additional reason is that trademarks are often preferred indicator for innovation in industries relying on creativity and symbolic knowledge production, like fashion, video games (Stoneman, 2010, Ribeiro et al., 2022) Herein, designers are an interesting group of creative workers that might play a role in both technological and market development (Castaldi & Drivas, 2023). Finally, trademarks also appear to complement patents when it comes to capturing incremental, new-to-the-firm innovation and innovation in mature industries focused on slow innovation (Morales et al., 2024).

3. Empirical research design

3.1 Data sources

We compiled an original panel dataset of European regions to empirically investigate the relationship between creative occupations and regional innovation, with a focus on differences between urban and rural regions.

To start with, we obtained data from Eurostat on occupations from the Labour Force Survey (LFS), a collection of national household surveys conducted across Europe. This database includes information on individuals indicating occupation (by ISCO-08, 3-digit level) and place of work (by NUTS level 2), among many other variables.

In our work, we take a regional perspective, conducting the analysis at the NUTS-2 regional level (the most disaggregated level at which occupational data are available at the 3-digit level) in the period between 2011 and 2019. The start of the period comes from data availability, as occupational data following the latest ISCO classification (2008 version) is only available from 2011. The end of the period is chosen to both avoid the pandemic years and to take into account grant lags for patent and trademark filings.

In the database development process, we dropped Bulgaria, Malta, Poland and Slovenia since they did not have 3-digit occupation data, and the Netherlands because it only had information at the country level, making it impossible to identify rural and urban regions. The United Kingdom is included in the analysis, but it only provides regions at the 1-digit NUTS level, which means 12 NUTS regions. We also removed observations without occupational or regional identification and workers from regions outside European Union countries (such as candidate countries like Türkiye or other countries where workers commute to work, as for these cases not all variables we are using are available). These actions resulted in removing only 4% of the workers. The final dataset covers 15.7 million workers for the period 2011 to 2019.

We obtained patent applications at the European patent office from the OECD REGPAT Database (August 2022 edition) and trademark applications at the European Union Intellectual Property Office from the ISI-Trademark Data Collection (ISI-TM) (Neuhäusler, Frietsch & Rothengatter, 2021). To assign patents to regions, we use the information of the location of the inventors, which is closest to the location where the invention was developed. For trademarks we can only rely on the location of the owner. Patent data from REGPAT is already regionalized, instead we had to regionalize trademark data starting from the owner address. We dropped 5.5% of the data because of missing information in the owner address field. For both patents and trademarks, we counted only applications that made it to registration, using the application year as reference since it is closest to the actual moment that the innovation was developed. In case patents or trademarks had inventors or owners in different regions we opted for whole counting, hence counted that patent or trademark for all regions.

In total, our data covers 27 European countries (22 EU countries, 4 EFTA and the UK) accounting for 217 NUTS-2 regions, plus 12 UK NUTS-1 regions.

3.2 Definition of key variables

We used yearly counts of new filings of patents and trademarks to measure regional innovation. Ó hUallacháin & Douma (2021) suggested that a fair comparison of cities or regions of different size should rely on using relative instead of absolute counts of innovations. Hence our dependent variables capture patent and trademark intensities, defined as the number of patents or trademark per thousand employed persons. Using employment instead of population aligns with the idea that we are mostly capturing corporate creativity (Gatrell & Ceh, 2003).

We followed previous studies to define creative occupations as those classified as creative and cultural by Eurostat and based on 4-digit ISCO codes (Eurostat, 2018) for instance, (Markusen et al., 2008; Boschma & Fritsch, 2009; Bakhshi, Freeman & Higgs, 2013; Rodríguez-Pose & Lee, 2020; OECD, 2022). Not all 4-digit occupations within a given 3-digit ISCO code might count as creative, but the LFS data is only at the 3-digit level. Table A.1 lists all 3-digit ISCO codes that we count as creative. We indicate with an asterisk (*) those 4-digit occupations that Eurostat would not classify as creative or cultural (Eurostat, 2018; OECD, 2022). It is worth noting that national statistical offices do not always align in terms of classifications, hence some extra codes are added in specific countries (OECD, 2022). However, due to the scarcity of data on 4-digit occupations, most studies follow the same strategy and adopt the complete composition of 3-digit ISCO codes to define cultural and creative occupations (Higgs & Cunningham, 2008; Boschma & Fritsch, 2009; Sleuwaegen & Boiardi, 2014). Overall, the chosen 3-digit occupation codes represented in 2019 5.22% of the total occupations in the 27 European countries considered.

Another crucial step for the analysis consisted in classifying regions by levels of urbanization. We follow Eurostat, which classifies NUTS-3 regions based upon criteria of geographical contiguity and minimum population in an area (Eurostat, 2021). Since our data is at the NUTS-2 level, we had to aggregate NUTS 3 areas to the NUTS 2 regional level. We used the distribution of employed persons in each NUTS-3 to classify NUTS 2 regions as predominantly urban, intermediate or rural. In other words, a region is "predominantly urban" when the majority of employed people work in an area classified as urban; "predominantly intermediate" when the majority portion of employed persons work in an area classified as intermediate; and finally, "predominantly rural" when the majority portion of employed people work in an area that is considered rural. Table A.2 displays the final regional allocation by urbanization degree based on this methodology.

3.3 Methods of analysis

We estimated a two-way fixed-effect model by year and region. The dependent variable represents regional innovation measured either by patent or trademark intensity – both in logarithmic scale since the distribution across regions is highly skewed and also weighted by the size of regional labour market. Our main independent variable of theoretical interest is the share of creative occupations ($Creative\_sh_{rt}$) as a percentage of all occupations.

The baseline specification is as follows:

$$Innovation_{rt} = \beta_1 + \beta_2\ Creative\_sh_{rt} + \beta_3\ Tert\_educ\_sh_{rt} + \beta_4\ Smallsize\_sh_{rt} + \beta_5\ High\_tech\_service\_sh_{rt} + \beta_6\ High\_tech\_manuf\_sh_{rt} + \varphi_r + \sigma_t + \varepsilon_{rt}$$

The model includes several independent variables to control for factors that are often found to affect regional innovation. We control for human capital as the share of population (from 25 to 64 years) with tertiary education (tert_educ_sh). Earlier studies have questioned whether the effect of creative activities is not simply driven by human capital intensity (Boschma & Fritsch, 2009; Marrocu & Paci, 2012). We also control for the firm size composition of the region, taking the percentage of workers employed in firms with less than ten employees (smallsize_sh). Finally, to control for productive structure we use the regional shares of employment in high and medium-high tech manufacturing (high_tech_manuf_sh) and in knowledge-intensive high-tech services (high_tech_service_sh).

Given the contemporaneous relationships, we are only assessing the association between cultural and creative occupations and regional innovation. After estimating the baseline models, we explore if the role of cultural and creative occupations differs between urban and rural or non-urban regions.

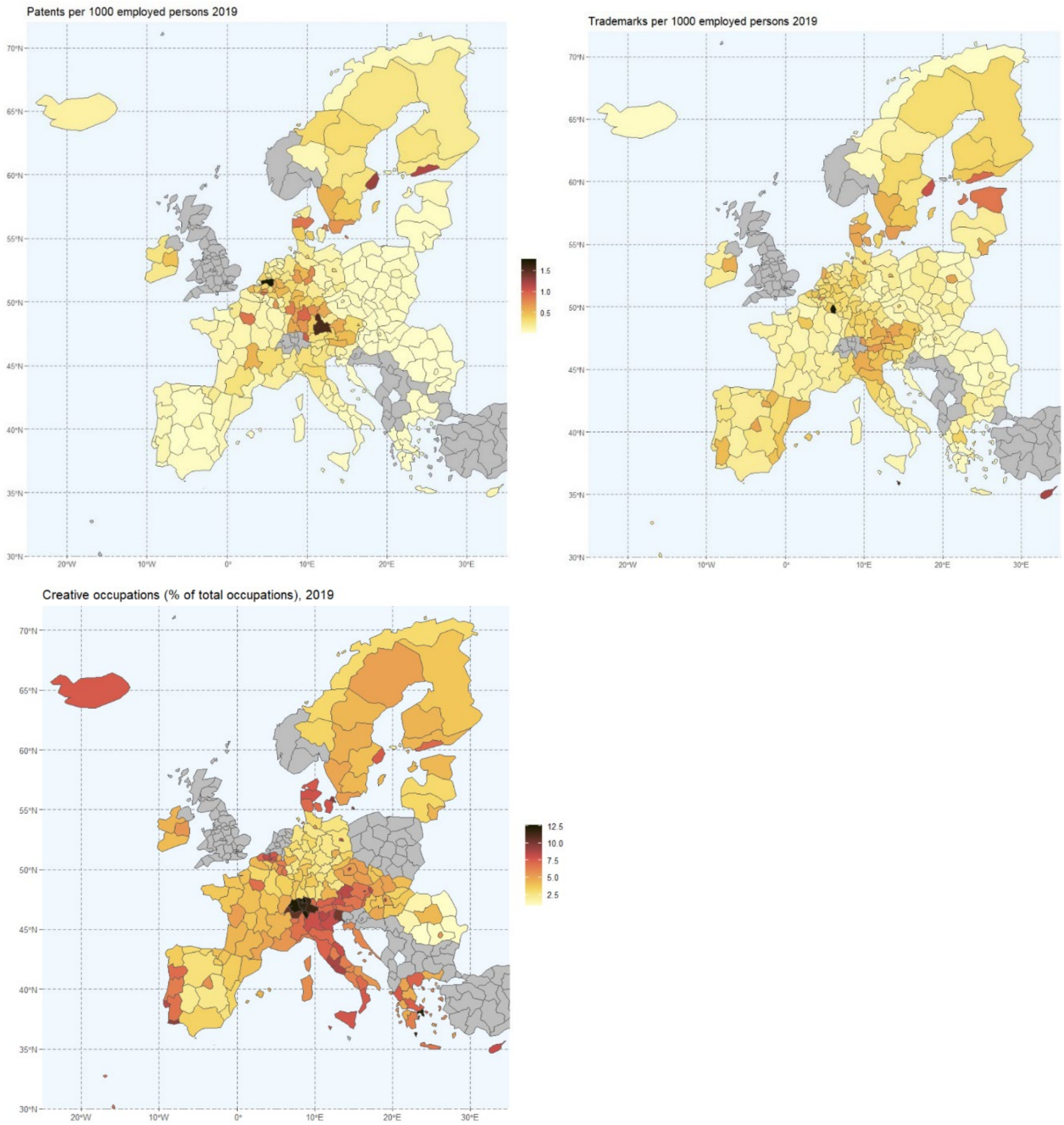
4. Results

4.1 Descriptive results

Figure 1 shows maps for the distribution of our key variables of theoretical interest for all 229 NUTS 2 regions. The first and second map show patent and trademark intensity; the third map illustrates the share of CCOs relative to total employment.

Patent activity appears much more concentrated spatially than trademark activity. This result aligns with other studies that have found different regional distributions of these two measures of innovation in Europe (Pinate et al., 2021, Castaldi & Drivas, 2023). The maps clearly indicate that the two measures of regional innovation clearly help to capture innovation activities happening in different places.

Figure 1: Patent and trademark intensities and share of creative occupations across EU regions, in 2019.



Source: Own elaboration, based on data from LFS, REGPAT and EUIPO.

The map displaying the shares of creative occupations shows that some regions clearly specialize in these activities. Practically all regions of Switzerland, Italy and Portugal stand out among those with the highest shares. One can recognize several regions that have been characterized as pursuing 'creative application' innovation patterns (Capello & Lenzi, 2013).

Table 3 reports the descriptive statistics of the main variables, while the correlation tables can be found in the appendix (Table A.3). In Table 4 we compare average values for the key variables of theoretical interest. Urban regions score higher both on IPR intensities and share of creative occupations, as expected from prior literature.

Table 3: Overview of variables, including definition, data sources and descriptive statistics

Variables	Definition	n	mean	stdev	median	min	max	Data source
ln_patents_employed	Ln of patents per 1,000 employed persons	1780	0.18032	0.19919	0.11012	0.00017	1.06651	OECD REGPAT and Eurostat
ln_trademarks_ employed	Ln of trademarks per 1,000 employed persons	1838	0.19176	0.15068	0.16054	0.00093	1.20166	EUIPO and Eurostat
creative_sh	Share of creative occupations (%)	2038	5.06765	2.36884	4.52990	0.54604	14.44444	LFS
tert_educ_sh	Share of population aged 25-64 with tertiary education (%)	2009	29.05540	9.65740	28.30000	9.90000	59.60000	Eurostat
smallsize_sh	Share of occupations in companies with less than 10 employees (%)	2038	35.95074	12.65161	33.20590	6.17796	83.60458	LFS
high_tech_service_sh	Knowledge-intensive high-technology services (% of employment)	1806	2.62957	1.57617	2.20000	0.50000	9.60000	Eurostat
high_tech_manuf_sh	High and medium-high tech manufacturing (% of employment)	1834	5.99411	3.88872	5.00000	0.20000	22.00000	Eurostat

Table 4: Descriptives of key variables for urban and rural regions.

		Patent intensity	Trademark intensity	Share of creative occupations (%)
Urban	average	0.19790	0.23819	5.38693
	stdev	0.22384	0.15197	2.44601
Rural	average	0.10846	0.13382	4.49646
	stdev	0.13339	0.13848	1.74068

4.2 Regression results

Table 4 reports results for the baseline model estimated using all regional observations. The findings point to a significant positive relationship between the share of creative occupations and regional innovation, for both indicators. This confirms the general idea that there is a link between creativity and innovation at the regional level. The main effect is there also after inserting the control variables. In particular, regional human capital also plays a significant role, but it does not take away the significance of creative occupations as specific human capital.

Table 4: Baseline results – all regions

	patents_employ(ln)		trademarks_employ(ln)	
	(1)	(2)	(3)	(4)
creative_sh	0.34114***	0.38162***	0.60073***	0.51258***
	(0.08391)	(0.09568)	(0.09661)	(0.10372)
tert_educ_sh		0.12633**		0.22693***
		(0.05222)		(0.05675)
smallsize_sh		-0.03630		0.09571***
		(0.02979)		(0.03221)
high_tech_service_sh		0.10383		0.28971
		(0.24705)		(0.26843)
high_tech_manuf_sh		-0.12913		-0.36409**
		(0.13587)		(0.14589)
Region FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,763	1,569	1,818	1,577
R^2	0.98049	0.98081	0.95258	0.96039
Adjusted R^2	0.97778	0.97802	0.94618	0.95467
Residual Std. Error	0.02975	0.02968	0.03497	0.03224

Note: Coefficients are significant at *p < 0.10; **p < 0.05; ***p < 0.01 level. Standard error in parentheses.

Table 5 reports the results for urban regions only. These results confirm those for the baseline model and align with the expectations from urban theories. In line with the ideas the cities provide the ideal environment for creativity and innovation to flourish, we find a significant relationship between of creative occupation shares and both patent and trademark activity.

When we estimate the same models for rural regions, different patterns emerge (see Table 6). For these regions findings indicate no statistically significant association between creative occupations and innovation when innovation is measured with patents. Instead, a significant positive association is there when regional innovation is measured with trademarks. These results suggest that creativity-led innovation processes in rural context might indeed be better captured with innovation indicators with more potential for measuring other types of innovation than those concentrating in cities. These may include incremental innovations, non-technological innovations and soft innovation supported by territorial assets.

Table 5: Model results for urban regions.

	patents_employ(ln)		trademarks_employ(ln)	
	(1)	(2)	(3)	(4)
creative_sh	0.33255**	0.42209**	0.38441*	0.45602**
	(0.15685)	(0.17416)	(0.20235)	(0.19596)
tert_educ_sh		0.07059		0.43371***
		(0.11536)		(0.12981)
smallsize_sh		-0.14999**		0.22541***
		(0.06206)		(0.06983)
high_tech_service_sh		-0.10521		-0.41165
		(0.38628)		(0.43464)
high_tech_manuf_sh		-0.16294		0.20323
		(0.38219)		(0.43005)
Region FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	470	443	481	444
R^2	0.98737	0.98759	0.94894	0.96276
Adjusted R^2	0.98454	0.98468	0.93748	0.95392
Residual Std. Error	0.02874	0.02874	0.03791	0.03234

Note: Coefficients are significant at *p < 0.10; **p < 0.05; ***p < 0.01 level. Standard error in parentheses.

Table 6: Model results for rural regions

	patents_employ(ln)		trademarks_employ(ln)	
	(1)	(2)	(3)	(4)
creative_sh	0.19973	0.21341	0.70666***	0.68528***
	(0.15113)	(0.18098)	(0.19954)	(0.22659)
tert_educ_sh		0.18584***		0.11796
		(0.06257)		(0.07858)
smallsize_sh		-0.05359		0.08670
		(0.04584)		(0.05695)
high_tech_service_sh		-0.05963		0.82767*
		(0.36477)		(0.45850)
high_tech_manuf_sh		-0.26676		-0.42578**
		(0.16390)		(0.20418)
Region FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	815	682	849	689
R^2	0.96889	0.97220	0.94835	0.96097
Adjusted R^2	0.96309	0.96637	0.93900	0.95288
Residual Std. Error	0.02656	0.02651	0.03597	0.03328

Note: Coefficients are significant at *p < 0.10; **p < 0.05; ***p < 0.01 level. Standard error in parentheses.

We also note that our human capital variable behaves differently in the models estimated for urban or rural regions. For urban regions, human capital is not associated to patenting: creative occupations, together with the presence of large companies, help to explain shares of patented innovation. For rural regions, human capital does instead play a significant role, next to creative occupations, and together with the presence of small companies. Overall, the two sets of regressions results sketch very specific models of creativity-led innovation in urban as opposed to rural regions.

4.3 Robustness checks

A first robustness test we did was to use an alternative method to classify NUTS-2 areas by level of urbanization. Instead of using shares of employment to aggregate NUTS 3 areas to the NUTS 2 regional level, we used GDP levels instead. Following the same methodological procedure as before, we now used the distribution of GDP in each NUTS-3 to classify NUTS 2 regions as predominantly urban, intermediate or rural. Iversen & Herstad (2022) pointed out that trademarking is particularly sensitive to GDP, hence this robustness check appeared to make sense to check the trademark models. Moreover, this alternative method allows to check for the effect of less populated but very wealthy regions, like Luxembourg. Tables B.1 and B.2 present the results for these additional estimations. They generally align with our baseline models.

A second robustness test followed the suggestion put forward by Dotzel & Wojan (2022), in response to Rodríguez-Pose & Lee (2020). According to the authors, there is a bias when considering patents per capita as a measure of innovation and assuming that science, technology, engineering and mathematics (STEM) workers are the only ones responsible for patenting. Creative workers can also contribute to generating new ideas and patents (Wojan, 2022). We calculated an 'inventive class' as suggested by Dotzel & Wojan (2022) to weigh the innovation measures instead of overall employment. The inventive class encompasses Science, Engineering, and Technical workforce categories and other 11 occupations that demonstrated a consistent association with patenting in randomised tests (Dotzel & Wojan, 2022; Wojan, 2022). This robustness check might be particularly relevant for rural regions, which may suffer most from employment composition bias. Tables B.4 to B.6 report the results. For urban regions the results are quite different: the positive association between creative occupations and innovation is only there for patents and not for trademarks. For rural regions the results reveal instead the expected significant association with trademarks, and a weak association with patents too. The latter result is clearly the effect of accounting for the actual share of STEM occupations in rural regions.

Additionally, we also analyzed whether our results were robust to slightly different lists of creative occupations. For instance, we tried a more restrictive definition and selected only the ISCO 3-digits codes where the majority of occupations at 4-digits are classified as creative. To do so, we excluded two leftover categories, namely codes 235 (Other teaching professionals) and 411 (Other clerical support workers). The results align with our baseline models (results not shown here).

5. Discussion and conclusion

This study had the ambition to better understand how creativity-led innovation processes might be at play at the regional level. Our interest was in gauging whether such processes would be different in urban as opposed to rural contexts. Next to reviewing the main theoretical arguments put forward to understand the role of geography in linking creativity and innovation, we called for the need of quantitative comparative analysis. Such empirical evidence could then inform ongoing debates within research on the geography of innovation on the relative benefits of specific geographical contexts. Specifically, the claim that urban contexts are the ideal hotbed for creativity and innovation has been challenged by research pushing a 'beyond the city' narrative. This counter-narrative, combining insights from studies on innovation in the periphery and rural innovation has proposed intriguing arguments supported by fascinating cases, but systematic evidence on the key expectations has been lacking.

Our study's findings suggest three main insights.

First, when focusing on urban regions, our results confirmed the expected role played by creative workers in innovation processes. It should be noted that many empirical studies on the geography of creativity and innovation only include urban regions. The problem does not lie with the findings themselves: indeed cities work well at bringing together creative workers and at offering a fruitful environment for innovation activities. What is instead problematic is then rushing to the conclusion that cities are the only geographical context for creativity-led innovation.

Indeed our second sets of results, those specific to rural regions, reveal that creativity-led innovation processes can also thrive in those regions. Yet, they remain hidden when using measures of innovation that have a urban and invention focus, such as patents. Our findings reveal that a positive association between creative occupations and innovation in rural regions is only there when innovation is measured with trademarks. This result can be explained by two considerations. Trademarks better capture downstream innovation phases where creative occupations play a key role. Moreover, trademarks better capture non-technological innovation and innovation from small firms which are likely to be more common characterizations of innovation in rural areas.

Finally, our findings reveal that urban and rural regions offer different but potentially equally effective contexts for creativity-led innovation. Innovation in urban regions appears associated with the concentration of creative occupations and the presence of large firms, irrespective of overall human capital available. Instead innovation in rural regions seems to thrive from the combination of creative occupations and human capital, with the presence of small firms playing a significant role.

Our study has a number of limitations of which we are aware. First, our geographical level of analysis captures relatively large regions which are likely to include places with different degrees of accessibility and population density. This is a common shortcoming of standard classifications of regions into urban or rural categories. Future research could offer micro-geographical perspectives like those in Roper and Jibril (2023). That would require matching innovation data to firm-level data and occupational data. Those efforts could be done for single countries and could reveal underlying mechanisms that studies at the regional level cannot uncover. Second, IPR-based indicators of innovation have known limitations and do not capture all innovation activities. It would be interesting to replicate our analysis with data generated with novel techniques, like those used in Rammer et al. (2020) or Nathan and Rosso (2022).

Despite these limitations, our study's findings provide original insights that bear relevance for researchers and policymakers alike.

We have contributed novel quantitative comparative evidence on factors associated to urban and rural innovation, thereby complementing the qualitative evidence from case studies of specific regions and specific cases of innovation in the periphery. The latter evidence remains important to understand the underlying mechanisms (like in the recent study of Kesidou et al., 2024).

A key insight for policy is that monitoring regional innovation and smart specialization efforts cannot be done solely relying on patent metrics (see also Castaldi & Drivas, 2023, Castaldi and Mendonça, 2022). Such metrics work well at revealing creativity-led innovation efforts in urban contexts, but are clearly problematic in case of rural contexts. The very spirit behind smart specialization policies is to promote investment in activities that represent local strengths and have potential for deployment in innovation and entrepreneurial activities (Foray et al., 2018). For many rural regions such local strengths are clearly not residing in the technological or scientific domain but can be found in a broader set of territorial assets and small firm capabilities (Radosevic, 2018). Hence, mobilizing metrics of creativity and innovation that span a broader range of activities than those focused on high-tech specialization is bound to do more justice to what happens in rural and peripheral regions. In this sense, such efforts can inform place-based approaches aiming at tapping into hidden potential of regions that often feel 'left behind' (Rodríguez-Pose, 2018).

References

Argent, N., Tonts, M., Jones, R., & Holmes, J. (2013). A creativity-led rural renaissance? Amenity-led migration, the creative turn and the uneven development of rural Australia. *Applied Geography*, *44*, 88–98.

Asheim, B. & Hansen, H.K. (2009). Knowledge bases, talents, and contexts: On the usefulness of the creative class approach in Sweden. *Economic Geography*, 85(4), 425–442.

Bakhshi, H., Freeman, A. & Higgs, P. (2013). *A dynamic mapping of the UK'S creative industries*. London: NESTA Working Paper, January.

Balland, P. A., Jara-Figueroa, C., Petralia, S. G., Steijn, M. P. A., Rigby, D. L., & Hidalgo, C. A. (2020). Complex economic activities concentrate in large cities. *Nature Human Behaviour*, *4*(3), 248–254.

Bettencourt, L. M., Lobo, J., Helbing, D., Kühnert, C., & West, G. B. (2007). *Growth, innovation, scaling, and the pace of life in cities*. *Proceedings of the National Academy of Sciences*, 104 (17), 7301-7306.

Boschma, R. A., & Fritsch, M. (2009). Creative class and regional growth: Empirical evidence from seven european countries. *Economic Geography*, *85*(4), 391–423.

Capello, R., & Lenzi, C. (2013). Territorial patterns of innovation: a taxonomy of innovative regions in Europe. *The Annals of regional science*, 51, 119-154.

Carlino, G., & Kerr, W. R. (2014). Agglomeration and Innovation. Handbook of Regional and Urban Economics, in: Gilles Duranton & J. V. Henderson & William C. Strange (ed.), *Handbook of Regional and Urban Economics*, Edition 1, Volume 5, pages 349-404, Elsevier.

Castaldi, C. (2023). The geography of urban innovation beyond patents only: New evidence on large and secondary cities in the United States. *Urban Studies*, 61(7), 1248-1272.

Castaldi, C., & Drivas, K. (2023). Relatedness, Cross-relatedness and Regional Innovation Specializations: An Analysis of Technology, Design, and Market Activities in Europe and the US. *Economic Geography*, 99(3), 253–284.

Castaldi, C., & Mendonça, S. (2022). Regions and trademarks: research opportunities and policy insights from leveraging trademarks in regional innovation studies. *Regional Studies* 56(2), 177–189.

Cohendet, P., Grandadam, D., Simon, L., & Capdevila, I. (2014). Epistemic communities, localization and the dynamics of knowledge creation. *Journal of Economic Geography*, 14(5), 929-954.

Cunningham, S. (2013). *Hidden innovation: Policy, industry and the creative sector*. University of Queensland Press (Australia).

Dotzel, K. & Wojan, T. (2022). *An Occupational Approach to Analyzing Regional Invention*. National Center for Science and Engineering Statistics. Working Papers NCSES 22-202.

Duranton, G., & Puga, D. (2001). Nursery Cities: Urban Diversity, Process Innovation, and the Life Cycle of Products. *American Economic Review*, *91*(5), 1454–1477.

Eder, J. (2019). Innovation in the Periphery: A Critical Survey and Research Agenda. *International Regional Science Review,* 42(2), 119–146.

Eder, J., & Trippl, M. (2019). Innovation in the periphery: Compensation and exploitation strategies. *Growth and Change*, *50*(4), 1511–1531.

Eurostat. (2018). *Guide to Eurostat culture statistics - 2018 edition*. Luxembourg: Publications Office of the European Union. Retrieved from https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/KS-GQ-18-011

Eurostat. (2021). Applying the Degree of Urbanisation. Edition 2021. Applying the Degree of Urbanisation. Brussels.

Feldman, M. P. (1994). *The Geography of Innovation*. Springer Science & Business Media.

Florida, R. (2004). *Cities and the creative class*. Psychology Press.

Florida, R., Adler, P., & Mellander, C. (2017). The city as innovation machine. *Regional Studies*, *51*(1), 86–96.

Foray, D., Morgan, K., & Radosevic, S.. (2018). The role of smart specialisation in the EU research and innovation policy landscape. European Commission.

Fritsch, M., & Wyrwich, M. (2021a). Does Successful Innovation Require Large Urban Areas? Germany as a Counterexample. *Economic Geography*, *97*(3), 284–308.

Fritsch, M., & Wyrwich, M. (2021b). Is innovation (increasingly) concentrated in large cities? An international comparison. *Research Policy*, *50*(6), 104237.

Galetti, J.R.B., Tessarin, M.S. & Morceiro, P.C. 2021. Skill relatedness, structural change and heterogeneous regions: evidence from a developing country. *Papers in Regional Science*, 100(6), 1355–1376.

Gatrell, J. D., & Ceh, S. L. B. (2003). Trademark data as economic indicator: The United States, 1996-2000. *The Great Lakes Geographer*, 10(1), 46-56.

Glückler, J., Shearmur, R., & Martinus, K. (2023). Liability or opportunity? Reconceptualizing the periphery and its role in innovation. *Journal of Economic Geography*, 23(1), 231–249.

Grabher, G. (2004). Learning in projects, remembering in networks? Communality, sociality, and connectivity in project ecologies. *European Urban and Regional Studies*, 11(2), 103–123.

Grabher, G. (2018). Marginality as strategy: Leveraging peripherality for creativity. *Environment and Planning A: Economy and Space*, *50*(8), 1785–1794.

Grillitsch, M., Martin, R., & Srholec, M. (2017). Knowledge Base Combinations and Innovation Performance in Swedish Regions. *Economic Geography*, *93*(5), 458–479.

Henderson, V., Kuncoro, A., & Turner, M. (1995). Industrial Development in Cities. *Journal of Political Economy*, 103(5), 1067–1090.

Higgs, P., & Cunningham, S. (2008). Creative Industries Mapping: Where have we come from and where are we going? *Creative Industries Journal*, *1*(1), 7–30.

Huggins, R., & Clifton, N. (2011). Competitiveness, creativity, and place-based development. *Environment and Planning A*, *43*(6), 1341–1362.

Iammarino, S., Rodriguez-Pose, A., & Storper, M. (2019). Regional inequality in Europe: Evidence, theory and policy implications. *Journal of Economic Geography*, *19*(2), 273–298.

Iversen, E.J. & Herstad, S.J. (2022). Dynamics of regional diversification: a new approach using trademark data. *Regional Studies,* 56(2), 276–289.

Jacobs, J. (1969). *The economy of cities*. Random house.

Kemeny, T., Nathan, M., & O'Brien, D. (2020). Creative differences? Measuring creative economy employment in the United States and the UK. *Regional Studies*, *54*(3), 377–387.

Kesidou, E., Plakoyiannaki, E., & Tardios, J. A. (2024). Symbolic knowledge innovation through bricolage in the periphery: the Bauhaus movement. *Journal of Economic Geography*, lbae010.

Lee, N., & Rodríguez-Pose, A. (2014). Creativity, cities, and innovation. *Environment and Planning A*, *46*(5), 1139–1159.

Markusen, A., Wassall, G.H., DeNatale, D. & Cohen, R. (2008). Defining the creative economy: Industry and occupational approaches. *Economic Development Quarterly,* 22(1), 24–45.

Marrocu, E., & Paci, R. (2012). Education or Creativity: What Matters Most for Economic Performance? *Economic Geography*, *88*(4), 369–401.

McGranahan, D. A., Wojan, T. R., & Lambert, D. M. (2011). The rural growth trifecta: Outdoor amenities, creative class and entrepreneurial context. *Journal of Economic Geography*, *11*(3), 529–557.

Meili, R., & Shearmur, R. (2019). Diverse diversities - Open innovation in small towns and rural areas. *Growth and Change*, 50(2), 492-514.

Mendonça, S., Pereira, T. S., & Godinho, M. M. (2004). Trademarks as an indicator of innovation and industrial change. *Research Policy*, 33(9), 1385-1404.

Morales, P., Flikkema, M.J., Castaldi, C. & de Man, A.P. (2024). When do trademarks improve the measurement of innovation? An analysis of innovations from Dutch SMEs. *Science and Public Policy*, (forthcoming).

Nasirov, S., Li, Q. C., & Kor, Y. Y. (2021). Converting technological inventions into new products: The role of CEO human capital. *Journal of Product Innovation Management*, *38*(5), 522–547.

Nathan, M., & Rosso, A. (2022). Innovative events: product launches, innovation and firm performance. *Research Policy*, 51(1), 104373.

Neuhäusler, P., Frietsch, R. & Rothengatter, O. (2021). Documentation of RISIS datasets: ISI-Trademark data collection.

Ó hUallacháin, B., & Douma, J. (2021). Secondary city invention: internal resources versus agglomeration allures. *Regional Studies*, *55*(6), 1015–1031.

OECD (2022). Defining and measuring cultural and creative sectors. In The Culture Fix. Paris: OECD Publishing. 22–41.

Petrov, A.N. (2012). Beyond spillovers: Interrogating innovation and creativity in the peripheries. In *Beyond Territory: Dynamic Geographies of Knowledge Creation, Diffusion, and Innovation*. H. Bathelt, M. Feldman, & D.F. Kogler, Eds. Routledge. 168–190.

Pinate, A. C., Faggian, A., Di Berardino, C., & Castaldi, C. (2023). The heterogenous relationship between migration and innovation: Evidence from Italy. *Industry and Innovation*, 30(3), 336–360.

Pires, A. da R., Pertoldi, M., Edwards, J. & Hegyi, F.B. (2014). *Smart Specialisation and Innovation in Rural Areas*. Seville: JCR Technical Reports. S3 Policy Brief Series No. 09/2014.

Power, D., & Collins, P. (2021). Peripheral visions: the film and television industry in Galway, Ireland. *Industry and Innovation*, *28*(9), 1150–1174.

Radosevic, S. (2018). *Fostering innovation in less-developed and low institutional capacity regions*: Challenges and opportunities. Background paper for an OECD/EC Workshop on 22 June 2018.

Rahman, H. A., & Barley, S. R. (2017). Situated redesign in creative occupations–An ethnography of architects. *Academy of Management Discoveries*, 3(4), 404-424.

Rammer, C., Kinne, J., & Blind, K. (2020). Knowledge proximity and firm innovation: A microgeographic analysis for Berlin. *Urban Studies*, 57(5), 996-1014.

Ribeiro, L. C., dos Santos, U. P., & Muzaka, V. (2022). Trademarks as an indicator of innovation: towards a fuller picture. *Scientometrics*, *127*(1), 481–508.

Rodríguez-Pose, A. (2018). The revenge of the places that don't matter (and what to do about it). *Cambridge Journal of Regions, Economy and Society*, 11(1), 189-209.

Rodríguez-Pose, A., & Lee, N. (2020). Hipsters vs. geeks? Creative workers, STEM and innovation in US cities. *Cities*, *100*.

Roper, S., & Jibril, H. (2023). Understanding the geographical distribution of innovation in England: density, accessibility and spillover effects. *Regional Studies*, 58(6), 1320–1338.

Pugh, R., & Dubois, A. (2021). Peripheries within economic geography: Four "problems" and the road ahead of us. *Journal of Rural Studies*, 87(Oct), 267-275.

Shearmur, R. (2012). Are cities the font of innovation? A critical review of the literature on cities and innovation. *Cities*, *29*(SUPPL.2).

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

Shearmur, R. (2017). Urban bias in innovation studies. In *The Elgar companion to innovation and knowledge creation*. H. Bathelt, P. Cohendet, S. Henn, & L. Simon, Eds. Edward Elgar Publishing. 440–456.

Srholec, M., Žížalová, P., & Horák, P. (2021). Indigenous lead firms in rural regions: geography of global production networks revisited. *Economics of Innovation and New Technology*, 30(3), 221-238.

Sleuwaegen, L., & Boiardi, P. (2014). Creativity and regional innovation: Evidence from EU regions. *Research Policy*, 43(9), 1508–1522.

Sorensen, T. (2009). Creativity in rural development: an Australian response to Florida (or a view from the fringe). *International Journal of Foresight and Innovation Policy*, 5 (1-3), 24-43.

Stoneman, P. (2010). *Soft innovation: economics, product aesthetics, and the creative industries*. Oxford University Press, USA.

Vinodrai, T. (2006). Reproducing Toronto's Design Ecology: Career Paths, Intermediaries, and Local Labor Markets. *Economic Geography*, 82(3), 237–263.

Waitt, G., & Gibson, C. (2009). Creative Small Cities: Rethinking the Creative Economy in Place. *Urban Studies*, 46(5–6), 1223–1246.

Wojan, T.R. & Nichols, B. (2018). Design, innovation, and rural creative places: Are the arts the cherry on top, or the secret sauce? *PLoS ONE*, 13(2), 1–23.

Wojan, T.R. (2022). Viewpoint: 'Hipsters vs. Geeks?' and patenting productivity: A replication using an unbiased measure. *Cities*, 131(October), 6–10.

Wojan, T.R., Lambert, D.M. & Mcgranahan, D.A. (2007). Emoting with their feet: Bohemian attraction to creative milieu. *Journal of Economic Geography*, 7(6), 711–736.

Appendices

Table A.1: List of ISCO-08 codes (3 and 4-digit level) associated with cultural and creative occupation

ISCO-08	Cultural and creative occupations
216	Architects, planners, surveyors and designers
2161	Building architects
2162	Landscape architects
2163	Product and garment designers
2164	Town and traffic planners
2165	Cartographers and surveyors
2166	Graphic and multimedia designers
235	Other teaching professionals
2351*	Education methods specialists
2352*	Special needs teachers
2353	Other language teachers
2354	Other music teachers
2355	Other arts teachers
2356*	Information technology trainers
2359*	Teaching professionals n.e.c.
262	Librarians, archivists and curators
2621	Archivists and curators
2622	Librarians and related information professionals
264	Authors, journalists and linguists
2641	Authors and related writers
2642	Journalists
2643	Translators, interpreters and other linguists
265	Creative and performing artists
2651	Visual artists
2652	Musicians, singers and composers
2653	Dancers and choreographers
2654	Film, stage and related directors and producers
2655	Actors
2656	Announcers on radio, television and other media
2659	Creative and performing artists n.e.c.

ISCO-08	Cultural and creative occupations
343	Artistic, cultural and culinary associate professionals
3431	Photographers
3432	Interior designers and decorators
3433	Gallery, museum and library technicians
3434*	Chefs
3435	Other artistic and cultural associate professionals
352	Telecommunications and broadcasting technicians
3521	Broadcasting and audio-visual technicians
3522*	Telecommunications engineering technicians
441	Other clerical support workers
4411	Library clerks
4412*	Mail carriers and sorting clerks
4413*	Coding, proof-reading and related clerks
4414*	Scribes and related workers
4415*	Filing and copying clerks
4416*	Personnel clerks
4419*	Clerical support workers n.e.c.
731	Handicraft workers
7311	Precision-instrument makers and repairers
7312	Musical instrument makers and tuners
7313	Jewellery and precious-metal workers
7314	Potters and related workers
7315	Glassmakers, cutters, grinders and finishers
7316	Sign writers, decorative painters, engravers and etchers
7317	Handicraft workers in wood, basketry and related materials
7318	Handicraft workers in textile, leather and related materials
7319	Handicraft workers n.e.c.

Source: Authors, based on Eurostat. Note: n.e.c.: not elsewhere classified.

Table A.2: Countries and numbers of NUTS regions by degree of urbanisation

Country	Urban regions	Intermediate regions	Rural regions
AT	1	1	7
BE	1	8	2
CH	0	7	0
CY	1	0	0
CZ	1	2	5
DE	10	20	8
DK	1	0	4
EE	0	0	1
EL	1	0	12
ES	15	1	3
FI	1	1	3
FR	6	0	20
HR	0	0	2
HU	1	1	6
IE	1	0	2
IS	1	0	0
IT	4	9	8
LI	0	1	0
LT	1	0	1
LU	0	0	1
LV	0	0	1
NO	1	1	5
PT	3	1	3
RO	1	0	7
SE	2	4	2
SK	1	0	3
UK	8	3	1
Total	**62**	**60**	**107**

Source: Authors, based on Eurostat and LFS.

Table A3: Correlation table (Pearson-method), based on the observations for the three main models (all regions, urban regions, rural regions).

All regions	*ln_patents_employ*	*ln_trademarks_employ*	*creative_sh*	*tert_educ_sh*	*smallsize_sh*	*high_tech_service_sh*
trademarks_employ(ln)	0.626***					
creative_sh	0.255***	0.389***				
tert_educ_sh	0.415***	0.484***	0.260***			
smallsize_sh	-0.425***	-0.155***	0.026	-0.277***		
high_tech_service_sh	0.387***	0.424***	0.491***	0.677***	-0.269***	
high_tech_manuf_sh	0.226***	-0.097***	-0.252***	-0.258***	-0.408***	-0.201***

urban regions	*ln_patents_employ*	*ln_trademarks_employ*	*creative_sh*	*tert_educ_sh*	*smallsize_sh*	*high_tech_service_sh*
trademarks_employ(ln)	0.538***					
creative_sh	0.285***	0.237***				
tert_educ_sh	0.328***	0.482***	0.275***			
smallsize_sh	-0.463***	-0.062	-0.204***	-0.296***		
high_tech_service_sh	0.390***	0.322***	0.595***	0.638***	-0.461***	
high_tech_manuf_sh	0.274***	-0.071	-0.213***	-0.193***	-0.348***	-0.174***

rural regions	*ln_patents_employ*	*ln_trademarks_employ*	*creative_sh*	*tert_educ_sh*	*smallsize_sh*	*high_tech_service_sh*
trademarks_employ(ln)	0.724***					
creative_sh	0.417***	0.522***				
tert_educ_sh	0.480***	0.418***	0.223***			
smallsize_sh	-0.293***	-0.155***	0.02	-0.219***		
high_tech_service_sh	0.412***	0.438***	0.359***	0.640***	-0.125**	
high_tech_manuf_sh	-0.054	-0.178***	-0.201***	-0.311***	-0.403***	-0.200***

Appendix B: Robustness checks

Table B.1: Model results for urban regions, defined in terms of GDP

FE (year and region), PT and TM per thousand employed – Urban				
	Dependent variable:			
	patents_employ(ln)		trademarks_employ(ln)	
	(1)	(2)	(3)	(4)
creative_sh	0.51615***	0.56534***	0.49522***	0.37454**
	(0.14588)	(0.15462)	(0.16202)	(0.15967)
tert_educ_sh		0.17059*		0.27084**
		(0.10187)		(0.10519)
smallsize_sh		-0.02682		0.22183***
		(0.05018)		(0.05182)
high_tech_service_sh		0.08683		1.03315***
		(0.35897)		(0.37069)
high_tech_manuf_sh		-0.15007		-0.25682
		(0.32097)		(0.33145)
Region FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	610	580	617	580
R^2	0.98679	0.98755	0.94152	0.95502
Adjusted R^2	0.98482	0.98553	0.93279	0.94771
Residual Std. Error	0.03153	0.03019	0.03577	0.03118

Note: Coefficients are significant at *p < 0.10; **p < 0.05; ***p < 0.01 level. Standard error in parentheses.

Table B.2: Model results for rural regions, defined in terms of GDP

FE (year and region), PT and TM per thousand employed - Rural				
	Dependent variable:			
	patents_employ(ln)		trademarks_employ(ln)	
	(1)	(2)	(3)	(4)
creative_sh	0.28176*	0.08425	0.62588**	0.75163**
	(0.14999)	(0.21178)	(0.25353)	(0.34965)
tert_educ_sh		-0.06838		0.17912
		(0.08520)		(0.14128)
smallsize_sh		0.04384		0.03326
		(0.05777)		(0.09461)
high_tech_service_sh		-0.56457		-1.27813
		(0.54966)		(0.91761)
high_tech_manuf_sh		0.08376		-0.32974
		(0.20161)		(0.33173)
Region FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	340	254	365	257
R^2	0.96640	0.97373	0.91329	0.93609
Adjusted R^2	0.96017	0.96758	0.89852	0.92134
Residual Std. Error	0.02109	0.02022	0.03653	0.03338

Note: Coefficients are significant at *p < 0.10; **p < 0.05; ***p < 0.01 level. Standard error in parentheses.

Table B.3: Model results when using innovation counts relative to inventive class employment (all regions)

FE (year and region), baseline – PT and TM per inventive employment – Baseline				
	Dependent variable:			
	patents_inventive(ln)		trademarks_inventive(ln)	
	(1)	(2)	(3)	(4)
creative_sh	1.22906***	1.34368***	1.54175***	1.89246***
	(0.28764)	(0.30108)	(0.40805)	(0.36258)
tert_educ_sh		-0.09446		-0.06315
		(0.16334)		(0.19699)
smalllsize_sh		0.07147		0.48062***
		(0.09373)		(0.11247)
high_tech_service_sh		-0.59093		-0.47762
		(0.77270)		(0.93195)
high_tech_manuf_sh		-0.67169		-1.33810***
		(0.42373)		(0.50491)
Region FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,686	1,542	1,707	1,547
R^2	0.97278	0.97675	0.92482	0.95275
Adjusted R^2	0.96907	0.97341	0.91467	0.94597
Residual Std. Error	0.09986	0.09243	0.14313	0.11140

Note: Coefficients are significant at *p < 0.10; **p < 0.05; ***p < 0.01 level. Standard error in parentheses. Patents and trademarks are divided by persons employed in inventive class and are in Ln, and all control variables are stated as share in all regressions.

Table B.4: Model results when using innovation counts relative to inventive class employment (urban regions)

FE (year and region), PT and TM per inventive employment – Urban				
	Dependent variable:			
	patents_inventive(ln)		trademarks_inventive(ln)	
	(1)	(2)	(3)	(4)
creative_sh	1.82555***	1.22401*	-2.96187**	1.03838
	(0.68244)	(0.70243)	(1.50268)	(0.83172)
tert_educ_sh		0.20703		-0.03661
		(0.39711)		(0.47020)
smallsize_sh		-0.04842		1.03460***
		(0.25096)		(0.29716)
high_tech_service_sh		0.71650		1.34483
		(1.36593)		(1.61735)
high_tech_manuf_sh		-2.21339		0.76717
		(1.49214)		(1.76679)
Region FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	279	269	287	269
R^2	0.98452	0.98598	0.86495	0.96405
Adjusted R^2	0.98036	0.98185	0.82910	0.95346
Residual Std. Error	0.08741	0.08391	0.20079	0.09936

Note: Coefficients are significant at *p < 0.10; **p < 0.05; ***p < 0.01 level. Standard error in parentheses. Patents and trademarks are divided by persons employed in inventive class and are in Ln, and all control variables are stated as share in all regressions.

Table B.5: Model results when using innovation counts relative to inventive class employment (rural regions)

FE (year and region), PT and TM per inventive employment – Rural				
	Dependent variable:			
	patents_inventive(ln)		trademarks_inventive(ln)	
	(1)	(2)	(3)	(4)
creative_sh	1.02238*	1.00765*	1.79438**	1.92235**
	(0.60368)	(0.60086)	(0.80959)	(0.80229)
tert_educ_sh		0.09366		-0.35414
		(0.20837)		(0.27860)
smallsize_sh		0.08163		0.43387**
		(0.15285)		(0.20234)
high_tech_service_sh		-2.00926*		0.82811
		(1.21156)		(1.62308)
high_tech_manuf_sh		-0.51884		-1.27752*
		(0.54346)		(0.72078)
Region FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	756	668	767	673
R^2	0.96514	0.97567	0.93504	0.95229
Adjusted R^2	0.95875	0.97065	0.92322	0.94255
Residual Std. Error	0.10137	0.08771	0.13600	0.11721

Note: Coefficients are significant at *p < 0.10; **p < 0.05; ***p < 0.01 level. Standard error in parentheses. Patents and trademarks are divided by persons employed in inventive class and are in Ln, and all control variables are stated as share in all regressions.