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# Territorial drivers of social innovations

Filippo Berti Mecocci [a], Roberto Dellisanti [b] and Amir Maghssudipour [c]

[a]Department of Economics and Management, University of Parma, Parma, Italy; [b]ABC Department, Politecnico di Milano, Milan, Italy; [c]Department of Economics and Management 'Marco Fanno' (DSEA), University of Padua, Padua, Italy

**ABSTRACT**
What territorial conditions enable social innovation? This paper examines whether accumulated technological knowledge, density externalities and public funding help explain social innovation intensity across European regions. Relying on a regional dataset originally assembled from multiple sources and adopting different econometric specifications, findings suggest no significant role for accumulated technological knowledge, while population density is positively associated with social innovation intensity. Public funding also matters, but only in low-density areas.

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## 1. Introduction

Persistent socio-economic inequalities are among the most significant challenges facing contemporary societies. Territorial imbalances expose the limitations of markets and conventional public services in efficiently allocating resources to meet evolving social needs. These mechanisms often fail to internalise negative externalities, adapt to shifting norms or absorb systemic shocks: failures that disproportionately affect disadvantaged populations and are themselves spatially uneven (Harper, 2014; Ramos-Toro, 2023). Social innovation has emerged as a place-based response to these failures, generating new ways to address unmet social needs through collaborative and inclusive approaches (Calderini et al., 2023; Moulaert et al., 2013; Pel et al., 2020; Sedita, 2024; Wittmayer et al., 2024) capable of enhancing societal well-being (Murray et al., 2010; Wegner et al., 2023).

Although economic concentration typically promotes growth through agglomeration economies, this approach generates tensions between efficiency and equity, fuelling scholarly debate over optimal policies (Austin et al., 2018; Boldrin & Canova, 2001). Consequently, European policy agendas have emphasised spatially balanced development, promoting social innovation as a community-driven alternative to conventional growth models (European Commission, 2011). These initiatives not only complement public and market mechanisms but can also reshape welfare service delivery and stimulate new forms of social entrepreneurship (Gasparin et al., 2021), since the territorial imbalances they aim at reducing are not only economic but also social in nature (Rodríguez-Pose, 2025). It becomes therefore important to answer the question: to what extent do local factors influence and facilitate the development of social innovation?

Previous literature has emphasised the social, institutional and entrepreneurial conditions that shape both the emergence of social innovation and its subsequent development. In particular, social innovation projects often face limited access to finance (Audretsch et al., 2022; Austin et al., 2006), while their development also depends on institutional arrangements (Vasin et al., 2017) that shape resource mobilisation (Desa, 2012; Moore et al., 2012; Phillips et al., 2015; Rogge et al., 2023), as well as on networks and coordination mechanisms that sustain collective action (Ozdemir & Gupta, 2021; Wegner et al., 2023; Wittmayer et al., 2020). However, this literature says relatively little about whether specific territorial characteristics can systematically shape the intensity of social innovation across places.

**CONTACT** Roberto Dellisanti roberto.dellisanti@polimi.it
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This paper addresses this gap by adopting a territorial perspective. First, it tests whether a mechanism that is central in regional innovation studies – accumulated domain-specific technological knowledge – also helps explain the geography of social innovation. We find that it does not. Social innovation follows a distinct logic from technological innovation, one that is not structured by path-dependent technological specialisation (Crescenzi & Rodríguez-Pose, 2011; Neffke et al., 2011). Second, we show that density externalities, proxied by population density, are positively associated with social innovation intensity, extending the economic agglomeration literature (Duranton & Puga, 2004; Rosenthal & Strange, 2004) to a domain where relational and place-based mechanisms appear to be the primary enabling conditions. Third, we find that public funding is more consequential in low-density contexts, suggesting a substitution pattern between population density and external financial support. This finding contributes to the place-based policy literature (Barca et al., 2012; Iammarino et al., 2019) by providing empirical evidence that the effectiveness of public investment in social innovation is itself territorially conditioned.

The paper is structured as follows. Section 2 reviews the literature on social innovation, develops a territorial reading of the concept and, on this basis, proposes a definition of social innovation from a territorial perspective. It also proposes a set of hypotheses on the possible mechanism through which accumulated technological knowledge, density externalities, and the interaction between density and public funding may affect social innovation intensity. Section 3 describes the large-scale dataset adopted in the study and related methodological challenges. Section 4 outlines the empirical models and identification strategy. Section 5 presents the main results. Section 6 concludes.

## 2. A territorial approach to social innovation

### *2.1. Embracing a territorial perspective on social innovation*

Social innovation is a multifaceted concept with definitions emerging across disciplines such as management (Drucker, 1987), entrepreneurship (Phills et al., 2008), governance (Lévesque, 2013), policy studies (Borzaga & Bodini, 2014) and creativity research (García et al., 2015). It is broadly understood as the development of novel solutions to social problems that are more effective, inclusive or sustainable than existing alternatives, with benefits accruing primarily to society (Baker & Mehmood, 2015; MacCallum et al., 2009; Moulaert et al., 2013; Pol & Ville, 2009). Van der Have and Rubalcaba (2016) report that the social innovation field is grounded in four distinct intellectual communities: community psychology (systemic change), creativity research (social arrangements and intrapreneurship), social and societal challenges (issues such as climate change and health), and local development (participation and institutional transformation). Therefore, social innovation represents a distinctive form of value creation that requires organisations to develop new organisational models, governance structures and performance measurements that can effectively balance social impact with economic sustainability (Yunus et al., 2010).

Ayob et al. (2016) trace the concept's evolution, highlighting three themes: technological innovation, social relations and societal impact. Comeau (2004) and Moulaert and Nussbaumer (2008) stress its links to technological change and its capacity to reshape human relations. Suitner et al. (2023) further describe social innovation as a multilevel, iterative process deeply embedded in socio-political, economic and cultural contexts (Howaldt & Kopp, 2012; Marques et al., 2018).

This paper adopts a territorial perspective aligned with the 'local development' cluster and the relational focus of transformative social innovation (Pel et al., 2020). We frame it as a context-specific process shaped by spatial relations, collective agency and structural conditions. This place-sensitive approach addresses local challenges while empowering communities by enhancing their capacity to act, fostering a more inclusive and participatory model where disadvantaged groups can become active agents of change in shaping their own futures. In fact, social innovation activities are area-based programmes and collective actions (such as promoted by administrations at different levels or civil society) which 'valorize the knowledge and cultural assets of communities and which foregrounds the creative reconfiguration of social relations' (MacCallum et al., 2009, p. 2). Accordingly, a territorial definition of social innovation is proposed:

> *Social innovation refers to the development of locally embedded ideas, services, practices or organizational models that, driven by specific territorial contexts and needs, address unmet social needs, reconfigure social relations and collaborations, and enhance the capacity of communities to act.*

As framed above, social innovations are actions that unfold within the unique characteristics of a place, such as its social structures, economic conditions and cultural practices. Territory, understood as a community of people and thus in a relational sense (Perroux, 1955), actively shapes the possibilities and limitations of social innovation, influencing how interventions can either thrive or struggle based on local conditions and people's needs (Pel et al., 2020).

The need to study social innovation from a territorial perspective arises, as previously noted, from the fact that the needs addressed by such projects are territorially grounded. But this is not the sole motivation. In order to tackle these needs, social actors need to access project-specific resources that, differently from traditional businesses, are difficult to be mobilised and the local conditions may play a role in overcoming this limitation. In fact, on the entrepreneurial side, social innovation projects are often resource-constrained, facing lower remuneration and more limited access to capital than commercial ventures (Austin et al., 2006). Audretsch et al. (2022) identify 27 emerging needs of social innovators, highlighting how traditional entrepreneurial ecosystems may help address them. Among these needs, financing appears particularly crucial, as markets often fail to allocate resources to non-profit initiatives (Austin et al., 2006; Rogge et al., 2023).

Regulatory, political and technological institutions shape resource mobilisation (Desa, 2012; Phillips et al., 2015), while financial institutions and practices tend to marginalise social entrepreneurs (Moore et al., 2012). Vasin et al. (2017) further show that heterogeneous national and local institutional arrangements help explain differences in how populations respond to opportunities of social innovation, referring to this institutionalisation issue as a path-dependency problem. Moreover, Wittmayer et al. (2020) warn against a social 'innovation hero imaginary', while Ozdemir and Gupta (2021) advocate a network perspective. In line with this view, Wegner et al. (2023) stress the role of orchestrators in collaborative networks for social innovation projects.

Against this backdrop, local contexts play a critical role: local factors may either reinforce or mitigate these constraints, thereby shaping the intensity and emergence of social innovation across different contexts. This is the focus of the hypotheses developed in the following sections.

### 2.2. Accumulated technological knowledge and social innovation

Social innovation is often framed as distinct from technology-centred paradigms because it seeks solutions that move beyond conventional technology-oriented logics (Avelino et al., 2020; Howaldt et al., 2014; Moulaert et al., 2013). However, previous literature has also highlighted that technological institutions shape the emergence of social innovation (Desa, 2012; Phillips et al., 2015) and that path-dependent logics exist also in social innovation projects (Vasin et al., 2017). Without claiming that social innovation is a form of technological innovation, our first goal is to discuss whether technological knowledge accumulated in space – a mechanism that is central in regional innovation studies – can also play a role in the social innovation domain.

Regional economics has firmly established that technological specialisation follows path-dependent trajectories: capabilities, skills and knowledge infrastructures accumulated in specific domains and places create localised externalities – knowledge spillovers, skilled labour pools, specialised supplier networks – that shape the emergence of new activities (Capello & Lenzi, 2013; Kogan et al., 2017). There is therefore good reason to examine whether an analogous cumulative logic operates in the social innovation domain. Do territories with deep competencies in, say, digital platforms, biomedical devices or environmental engineering hold a latent comparative advantage in generating social innovations that recombine those competencies toward social goals? Or does social innovation production follow a different path, one less anchored in local technological knowledge and more dependent on institutional configurations or civic capacity?

This question finds indirect support also in parts of the social innovation literature. Several recent studies show that certain types of social innovation, particularly in energy transition (Rogge & Stadler, 2023; Suitner et al., 2023), healthcare (Desmarchelier et al., 2021) and digital inclusion (Ayob et al., 2016), draw explicitly on domain-specific technological knowledge and infrastructures embedded in local contexts. In these domains, territorial knowledge bases may enable innovators to repurpose existing competencies toward social goals. Even beyond technology-intensive domains, the mechanism retains theoretical plausibility. Even when social innovation originates from civic mobilisation, institutional experimentation or community organising, it does not emerge in a knowledge vacuum. Territories with deep accumulated technological knowledge offer broader pools of human capital, organisational capabilities and problem-solving expertise that can be repurposed toward socially oriented goals, regardless of whether the social innovation project is explicitly technology-driven. This is also related to the concept of technological relatedness and regional branching (Neffke et al., 2011): just as regions branch into technologically related industries, they may branch into socially innovative activities related to their accumulated knowledge domain generating novel solutions to social challenges (Howaldt et al., 2014).

Therefore, we hypothesise that regions with specific accumulated technological knowledge can be more capable of mobilising those capabilities for socially innovative ends in the same knowledge domain. Thus, we propose a first hypothesis:

*Hypothesis 1: Regions with stronger accumulated technological knowledge in a given domain should display more social innovation projects in the same knowledge domain.*

### 2.3. Density externalities, public funding and social innovation

Social innovation is a mission-oriented initiative that requires several factors to be effectively generated and implemented. First, large networks formed by the aggregation of people can raise awareness about social issues. General awareness in a local community is then reached via knowledge spillovers. The greater the density of people, resources and networks, the greater the frequency of knowledge diffusion and related spillovers (Audretsch & Feldman, 1996; Black & Henderson, 1999; Jaffe et al., 1993). In the context of social innovation, density may matter because it facilitates information circulation and matching effects, and because dense territorial environments make unmet needs more visible, provide a critical mass for collective action and offer thicker social infrastructures through which collective responses can emerge. Dense places also create more opportunities for coalition-building among civil society actors, public bodies, socially oriented organisations and informal community networks. In this sense, density certainly captures agglomeration, but also the relational and organisational conditions under which social innovation projects are more likely to be recognised, coordinated and sustained. Following Moulaert et al. (2013) and Avelino et al. (2020), dense territories offer environments in which social needs become collectively salient, in which voluntary and civic actors can coordinate around shared problems, and in which the organisational ecology (e.g., associations, cooperatives, social enterprises, public agencies) reaches a sufficient mass to sustain socially innovative activity.

Second, social innovation projects aimed at creating innovative solutions to local problems require people and resources. This is arguably one of the most problematic factors in social entrepreneurship. The concentration of people in a place generates a variety of consumption products, and vice versa. This diversity attracts different types of people (Florida, 2002; Glaeser et al., 2001). The greater the diversity of people attracted, the higher the likelihood of attracting individuals involved in social action (Florida, 2002; Florida et al., 2008). If social innovators and individuals with talent and other human capital are attracted by consumption diversity, then highly dense places (e.g., urban areas) have a higher probability of attracting a pool of people willing to engage in social innovation. In summary, we hypothesise the following:

*Hypothesis 2: Regional density externalities are positively associated with social innovation intensity.*

As highlighted above, such highly concentrated places are typically cities. Urban areas, characterised by high levels of density and diversity (Jacobs, 1969), provide a fertile ground for a mix of ideas, perspectives and experiences. This diversity is key to identifying social challenges and fostering innovative solutions, as it naturally promotes interactions, collaboration and dialogue among different agents (various institutional actors, including non-governmental organisations (NGOs), universities, businesses, civil society, government agencies, etc.). Moreover, cities often face concentrated social issues (e.g., poverty, inequality and housing shortages) which create an urgent demand for innovative solutions (Buchholz, 2023; Lenzi & Perucca, 2023).

While local context, particularly through network externalities generated by the co-location of businesses, population and institutions, can shape the awareness of opportunities for social innovation, public actors also play a critical role by providing financial support. In recent years, the European Union has actively promoted social innovation as a means to drive social change and stimulate economic development in less-developed regions (European Commission, 2010). Where density externalities are already strong, the relational infrastructure, civic capacity and organisational density that characterise dense territories provide the absorptive conditions needed to translate financial resources into concrete social innovation outcomes. Public funding, in this context, tends not to substitute for what the territory already provides: it amplifies it, enabling initiatives that would otherwise lack only the financial trigger to emerge. This complementarity logic is consistent with the broader agglomeration literature, which shows that the returns to external resources tend to be higher where local capabilities are already developed (Crescenzi & Rodríguez-Pose, 2011). Therefore, we hypothesise the following:

*Hypothesis 3: Regional density externalities and public funding act as complements in the generation of social innovation.*

## 3. Data

To measure social innovation intensity across European regions, we rely on the European Social Innovation Database (ESID). It is constructed using sophisticated machine-learning and natural language-processing methods to collect data on social innovation projects and participants, extracting information from publicly available sources on the web (Gök et al., 2022). The dataset contains a large sample of social innovation projects. Each row represents a social innovation project and is coupled with its location (latitude and longitude) and topics referring to the technologies used in the project or the main goals. An additional file establishes the link between topics and key enabling technologies (KET) classes. There are six main KET classes: advanced manufacturing technology; advanced materials; industrial biotechnology; micro- and nano-electronics; nanoscience and technology; and optics and photonics. Using spatial data, we link each project to its corresponding NUTS-3 region, allowing for regional-level analysis of social innovation activity.

Because our objective is an aggregate territorial analysis rather than a case-based typology, we use ESID as a large-scale curated source on social innovation projects (Gok & Antai, 2021). Appendix A.4 in the supplemental data online provides a fuller description of the database construction, project examples and main coverage limitations. We then focus on the two main characteristics of each project included in the database: its geographical location and the KETs. KETs are not used here to define the nature of social innovation. They serve as a measurement device to construct a domain-specific indicator of accumulated technological knowledge and to test whether technological specialisation in a given domain is associated with social innovation projects tagged in the same domain. KET classes refer to European priority research and innovation projects. They are of strategic importance, potentially leading to improvements in health and environmental conditions and to leadership in industrial value chains. They are technological areas of particular interest to European institutions and are supported by Community funds such as Horizon Europe, the Digital Europe programme, and European Structural and Investment Funds.

We used multiple data sources to construct key variables included in the econometric specifications. Patent data from OECD REGPAT (1969–2023) provided spatially located patents, used to build the measure of accumulated technological knowledge at the regional and KET-class level, and to test whether technological capabilities foster social innovation (Hypothesis 1). The KOHESIO database (2014–20) identified funded social innovation projects via project categories, used to construct the measure of public funding targeted to social innovation and to assess its role in shaping social innovation intensity (Hypothesis 3). Soil-related variables came from the European Soil Database, used as instruments for population density to address endogeneity concerns in estimating density externalities (Hypotheses 2 and 3); while university locations were sourced from the European Tertiary Education Register (ETER), used as a control for local knowledge infrastructure and absorptive capacity. Population, gross domestic product (GDP), age demographics and manufacturing employment data were drawn from EUROSTAT and ARDECO. In particular, population data are used to construct population density, our main proxy for density externalities (Hypothesis 2); GDP and manufacturing employment are included as controls for long-run regional economic structure and development; and age demographics are used to control for demographic composition that may affect social innovation capacity. Additional variables such as electoral participation, crime rates and associations density are used to proxy civic engagement, social capital and institutional thickness, which may confound the relationship between territorial characteristics and social innovation (Punt et al., 2021).

Our analysis focuses on eight Western European countries (Italy, Germany, Spain, France, Portugal, Austria, Belgium and the Netherlands) to ensure comparability and capture territorial differences. All data were aggregated at the NUTS-3 regional level. Table 1 details variable names, definitions and sources. For descriptive statistics and correlation tables, see Tables A9–A11 in Appendix A.3 in the supplemental data online.

## 4. Models and identification strategies

To test our hypotheses, we implemented different regression techniques and addressed possible sources of endogeneity that could bias the coefficients of interest. In general, our three main hypotheses use the number of social innovation projects as the main dependent variable.

### 4.1. Model 1: The effect of accumulated knowledge on social innovation intensity

In the first hypothesis, we investigate whether the presence of regionally embedded knowledge fosters social innovation. We built a proper regional dataset by summing over social innovation projects within NUTS-3 regions. This gives the number of social innovation projects that each NUTS-3 region developed. Next, we consider that social innovation projects also have a KET-specific breakdown using the topics provided by ESID and the linking table according to which each topic refers to specific KET classes. These keywords are not mutually exclusive, so a project may belong to multiple KET classes. Our final measure of social innovation is the sum of the projects available in the ESID dataset within the same KET classes and regions used for patents. The same routine made for social innovation has been developed for patents; in this way, we

**Table 1.** Description of the variables and related classifications.

| Variable | Operationalisation | Source |
|---|---|---|
| Social Innovation Projects (Y) | Count of social innovation projects per NUTS-3 region (and by key enabling technologies (KET) class in multilevel models) | European Social Innovation Database (ESID) |
| Accumulated Technological Knowledge | Density (/km$^2$) of recent patents (1981–2023) by NUTS-3 region and KET class; instrumental variable: historical patents (1969–80) | OECD REGPAT |
| Residual Patents | Density (/km$^2$) of patents not linked to KETs, per NUTS-3 region | OECD REGPAT |
| Density Externalities | Population/km$^2$ as of 2010 | EUROSTAT, ARDECO |
| Public Funding | Total European Union funds received – European Regional Development Fund (ERDF), Cohesion Fund (CF) and European Social Fund (ESF) – per km$^2$ between 2014 and 2020, filtered for projects involving social innovation, aggregated at the NUTS-3 level | KOHESIO database |
| GDP (1991) | Gross domestic product in 1991, by NUTS-3 region | EUROSTAT, ARDECO |
| Manufacturing Employment (1991) | Share of employment in manufacturing sector in 1991 | EUROSTAT, ARDECO |
| University | Dummy variable = 1 if a university is located in the region | European Tertiary Education Register (ETER) |
| Soil Productivity (Instrument) | Geological characteristics (e.g., soil fertility) used as an instrument for population density | European Soil Database |
| Young and Old Dependency Ratio | Youth (< 15 years) and elderly (> 64 years) dependency ratios | EUROSTAT, ARDECO |
| Electoral participation | Participation rate (voters/electors), average 1999–2023, by NUTS-3 region, in European Parliament Elections | EU-NED: The European NUTS-Level Election Dataset |
| Crime rate | Number of reported thefts over the total population, average 2008–23 (ln) | EUROSTAT |
| Associations density | Share of firms belonging to NACE code 94.9 – Activities of other membership organisations[a] – over total firms, by NUTS-3 region | Orbis |
| *Other useful classifications* | | |
| KET classification | Classification of projects and patents into six KET classes: advanced manufacturing, advanced materials, industrial biotech, micro/nanoelectronics, nanotech, and optics/photonics | ESID Topics–KET Linking table; OECD REGPAT (IPC classes) |
| Urban/rural classification | Based on EUROSTAT metropolitan area classifications at the NUTS-3 level | EUROSTAT Metropolitan Area Classification |

Note: [a]This group includes the activities of units (except business and employers' membership organisations, professional membership organisations, and trade unions) that promote the interests of their members.
Source: Authors' elaboration.

were able to link each International Patent Classification (IPC) class to the large set of KET classes. Our regression approach is:

$$Y_{r,ket} = \mu_r + \theta_{ket} + \beta \cdot \text{Acc.Knowledge}_{r,ket} + \gamma' \cdot X_{r,ket} + \epsilon_{r,ket} \tag{1}$$

Our model leverages two-way fixed effects to estimate the impact of accumulated technological knowledge proxied by patents in each KET class and NUTS-3 region on social innovation projects. Here, $\mu_r$ are regional fixed effects and $\theta_{ket}$ are KET class fixed effects. Since our variable for social innovation is a natural count, we leverage a Poisson estimator including fixed effects.[1] Concerning Acc.Knowledge$_{r,ket}$ we implemented the same procedure used for social innovation on patents, but split the overall sample of patents into 'historical' and 'recent'. Historical patents, which are those registered before 1981, are then used as an instrumental variable for recent patents. We calculated the cumulative sum of patents within regions and KET classes (*ket*) from 1969 to 1980 and from 1981 to 2023. Specifically, the variable Acc.Knowledge$_{r,ket}$ refers to the last 40 years of patenting activity. Besides the variable proxying for accumulated technological knowledge, we also include in all specifications the variable for the residual patents (those not belonging to KET classes). This is a relevant control for the innovative capacity of a region. Both our variables are density (divided by the regional surface in km$^2$).

Such estimation is unbiased when the variable for accumulated technological knowledge is orthogonal to the error term ($\epsilon_{r,ket}$). This might not occur for several reasons. A first source of endogeneity is the *reverse causality*. The presence of local capabilities related to specific technological classes generates both social innovation and patents, so they are simultaneously determined. Also, in other terms, when looking at the measure employed to gauge accumulated technological knowledge, the number of patents might be a consequence of the presence of a strong activity of social innovation in the same KET class. To deal with this source of endogeneity, we use as an instrumental variable the 'historical' number of patents (the sum of patents in each KET class for each region from 1969 to 1980) to predict the number of patents today.

However, there might be the case that some *unobservable* local conditions that were able to attract 'talent' producing inventions in the past, today still affect the flow of such talents in the regions determining simultaneously patents and social innovations. This source of endogeneity stems from the omitted variable bias. We exploit the multilevel form of the dataset to include regional fixed effects ($\mu_r$). The inclusion of such fixed effects partial-out unobservable sources of talent inflows. However, we also include a specification in which we include some region-varying control variables such as: GDP in 1991; manufacturing concentration in 1991; the total amount of public funds provided via the European Regional Development Fund (ERDF), the Cohesion Fund (CF) and the European Social Fund (ESF) between 2014 and 2020; the young and old dependency ratio; and a dummy for the presence of universities. A last possible bias derives from the fact that some KET classes are more likely to be included in projects of social innovation than others. Regions with high levels of patents in a specific KET class might have higher levels of social innovation just because they specialised in the 'right' KET domain. We deal with this by introducing KET fixed effects in the regression ($\theta_{ket}$).

### 4.2. Model 2: The effect of density externalities on social innovation intensity

Second, since density externalities do not vary within KET classes, we deal with this estimation having no longer the multilevel form for our dataset. The variable $Y_{r,ket}$ can be further aggregated at the regional level, ignoring the KET breakdown, to address the second hypothesis regarding the role of density externalities (Ahlfeldt et al., 2015; Ahlfeldt & Pietrostefani, 2019). Our cross-section regression is the following:

$$Y_r = \beta \cdot \text{Dens.Externalities}_r + \rho' \cdot X_r + \epsilon_r \tag{2}$$

where $Y_r$ is the count of social innovation projects in each NUTS-3 region; accordingly, as for the previous model, we employ a Poisson estimator. Here, $\beta$ is the elasticity of social innovation with respect to density externalities proxied by population density in 2010; $X_r$ is a vector of control variables as described in model 1. We use population density as a measure of density externalities, as commonly interpreted in the literature on regional agglomerations. Population density serves as a relevant indicator of the concentration of people in each area, which often correlates with agglomerative activity. Higher population densities typically signify a clustering of resources, businesses and workers: key components of agglomeration economies such as knowledge spillovers, shared resources and labour market pooling. This measure allows us to identify regional differences in concentration and provides insights into the relative intensity of agglomeration effects. Our choice to study population density in this context is specifically motivated by the social dimension of social innovation. While agglomeration effects could also be assessed through other measures, such as economic specialisation, infrastructure or firm networks, we focus on population density because it directly reflects the social aspects that are central to our analysis.

Several sources of endogeneity may bias our estimates. Most importantly, reverse causality may arise if regions with a stronger social innovation environment become more attractive places to live and work, thereby increasing employment, population and, ultimately, regional density. In addition, omitted regional characteristics may simultaneously affect both density and the propensity to generate social innovation.

We address these concerns in two steps. First, we include a rich set of predetermined controls capturing long-run differences in regional development and demographic structure: the total amount of public funds received through the ERDF, CF and ESF over the period 2014–20; the young- and old-age dependency ratios; GDP in 1991; manufacturing concentration in 1991; and a dummy for the presence of a university. Second, following the agglomeration literature, we instrument current regional density with geological characteristics related to soil productivity and terrain conditions (Combes & Gobillon, 2015; Gaigné & Sanch-Maritan, 2019). The identifying assumption is that geological characteristics are strong predictors of the historical spatial distribution of population and economic activity, while being plausibly orthogonal to contemporary social innovation capacity except through their effect on present-day density. This logic is standard in the literature: soil and geological conditions helped shape past settlement patterns, whereas in contemporary, largely non-agricultural economies they are far less likely to directly determine the location of economic and social activities once basic controls are included. To strengthen this argument, we focus on geological characteristics that are unlikely to have been recently altered by human activity.

### 4.3. Model 3: The effect of the interaction between public funding and density externalities on social innovation intensity

Third, we include public funding as a source of financial resources able to foster social innovation projects.

$$Y_r = \alpha + \beta\cdot(\text{Den.Externalities}\cdot\text{Pub.Funding})_r + \gamma\cdot X_r^{'} + \epsilon_r \tag{3}$$

where $Y_r$ still represents the number of social innovation projects in each NUTS-3 region. The variable *Pub. funding* represents the density of total financing (in euros) provided to each NUTS-3 region through the ERDF, CF and ESF (divided by the regional surface in km$^2$). Data are available on the KOHESIO website. We used data from 2014 to 2020 and aggregated them through projects at the NUTS-3 level to identify those involving only social innovation. Here, since interaction terms in non-linear models do not help interpretation, we estimate our model using an ordinary least squares (OLS) and treating $Y_r$ as a continuous variable. However, Appendix A4 in the supplemental data online provides a table of results using a Poisson estimator designed for count data.

An important source of bias here comes from the eligibility criteria of each fund. Eligible regions are those with less than 75% of the European average per capita GDP, which introduces potential endogeneity. To address this issue, we include a vector of control variables ($X_r'$) able to expunge concerns regarding observable characteristics of regions that are used as eligible criteria. Control variables are GDP in 1991; the total amount of funds less those for social innovations; manufacturing concentration in 1991; young and old dependency ratio; and a dummy for the presence of universities. Density externalities are still proxied by population density. It is instrumented, as in the previous model, by soil productivity. If the coefficient $\beta$ is positive, that means that density and public funding act as a complement, while if it is negative, it means they are substitutes.

**Table 2.** Effect of density externalities and accumulated technological knowledge on social innovation intensity, Poisson.

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Panel A** | | | | | |
| Density externalities | 0.81*** | 0.88*** | 0.25*** | 1.03*** | 0.61** |
| | (0.09) | (0.09) | (0.09) | (0.19) | (0.28) |
| Country FE | No | Yes | Yes | No | Yes |
| Controls | No | No | Yes | No | Yes |
| Geological IV | No | No | No | Yes | Yes |
| Observations | 816 | 816 | 727 | 800 | 722 |
| First-stage *F*-statistic | | | | 132.65 | 12.74 |
| Hansen *J* *p*-value | | | | [0.00] | [0.21] |
| **Panel B** | | | | | |
| Accumulated technological knowledge | 0.10 | −0.07 | −0.08*** | 0.04 | −0.02 |
| | (0.07) | (0.06) | (0.02) | (0.05) | (0.08) |
| KET FE | No | No | No | Yes | Yes |
| NUTS-3 FE | No | No | Yes | Yes | Yes |
| Controls | No | Yes | No | No | No |
| Historical IV | No | No | No | No | Yes |
| Observations | 4896 | 4656 | 822 | 822 | 822 |

Note: Panel A tests the hypothesis about density externalities. Panel B tests the hypothesis about accumulated technological knowledge. The dependent variable is the number of social innovation projects. All independent variables are log-transformed. The estimated coefficients come from Poisson regressions for count data. Control variables are: a dummy variable for the presence of universities; gross domestic product (GDP) in 1991; manufacturing concentration in 1991; the ratio of young-to-old dependency in 2006; and the total amount of funds given by European social cohesion projects, a proxy for crime, European electoral participation and associations density. The instrumental variable (IV) is an indicator variable for soil profile differentiation where 1 means 'high differentiation', 2 means 'low differentiation' and 3 means 'no differentiation' in panel A. Panel B's column (5) is estimated using a control function approach. In the first stage, we ran an ordinary least squares (OLS), saving the error term, which we included in the second stage. Standard errors are clustered at the NUTS-3 level in panel A, and robust in panel B. In panel B, the number of observations decreases from 4896 in column (1) to 4656 in column (2) – a simple Poisson model – to 822 in the subsequent columns using the panel estimator of the Poisson model, since it uses only observations that vary within the panel. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. FE, fixed effects; KET, key enabling technologies.

## 5. Results

Table 2 presents our estimation of a Poisson model, which quantifies the impact of density externalities and accumulated technological knowledge on the occurrence of social innovations. Social innovation is defined as the natural count of social innovation projects. Panel A presents the results for density externalities (proxied by population density). Panel B presents the results for accumulated technological knowledge (proxied by regional*KET density of accumulated patents). Across all models, population density has a positive and statistically significant effect on the number of social innovation projects, while the effect of accumulated technological knowledge is never statistically significant, suggesting that it has no effect. Specifically, column (1) of panel A shows that a 10-percentage point increase in density externalities raises the expected number of social innovation projects by approximately 8.1%. After adding country fixed effects and a rich set of covariates in column (3), the estimate decreases to 2.5%, though it remains significant at the 1% level. Columns (4) and (5) address concerns about endogeneity by instrumenting population density with a geological IV, obtaining an elasticity of about 0.61. These results consistently underscore the positive and robust role of density externalities. This finding is consistent with the theoretical mechanisms outlined in Section 2.3: dense territorial environments make unmet needs more visible, provide a critical mass for collective action and offer thicker social infrastructures through which collective responses can be organised and sustained (Lenzi & Perucca, 2023; Moulaert et al., 2013).

In Table 2, panel B, accumulated technological knowledge is not statistically significant. Overall, even when we instrument our proxy for accumulated technological knowledge using the historical number of patents in the same region and KET class, the result remains not statistically significant. Therefore, we conclude that there is no overall effect of accumulated technological knowledge on the expected number of social innovation projects. This null result is theoretically informative and speaks directly to the debate about whether social innovation follows the same territorial logic as technological innovation. The absence of a significant effect suggests that social innovation does not simply branch out of existing technological specialisations in the way that new industries tend to emerge from related knowledge bases (Boschma & Frenken, 2018; Frenken et al., 2007). This finding is consistent with a strand of the social innovation literature that positions social innovation as structurally distinct from technology-driven processes, rooted instead in relational, institutional and place-based conditions (Avelino et al., 2020; Moulaert et al., 2013).

Other territorial mechanisms, such as those operating through the density of interactions, the visibility of unmet needs and the organisational capacity of local communities, may therefore play a more decisive role, as we examine in the following sections.

Table 3 shows our estimation of the interaction term between density externalities (proxied by population density) and public funding (proxied by the density of social cohesion funds) on social innovation. Because interaction terms are not directly interpretable in non-linear models, we used a linear specification (OLS), treating social innovation projects as a standard continuous variable. We standardised all our variables to obtain comparable coefficients and to easily interpret interaction terms.

Table 3 again shows a positive effect of density externalities on social innovation projects. In columns (1) and (2), we found non-statistically significant coefficients for public funding, whereas negative and statistically significant coefficients emerged in columns (3) and (4), where we added control variables and country fixed effects. Density externalities remained positive and statistically significant. The coefficient in column (4) indicates that an increase of 1 SD (standard deviation) in density externalities results in a 0.55 SD increase in social innovation. Conversely, an increase of 1 SD in public funding generates a 0.10 SD reduction in the expected number of social innovation projects.

We included the interaction term between density and public funding in column (5). For this term, we conditioned our estimation on control variables and country fixed effects. The model suggested a negative interaction term (Figure 1 shows the marginal effects). Public funding has no statistically significant effect when density externalities are set at zero; however, as Figure 1 shows, the effect is positive and statistically significant when externalities are lower than zero.

Our findings suggest that density externalities and public funding act as substitutes in fostering social innovation, in contrast with Hypothesis 3. In urban areas, density externalities – as effects of knowledge spillovers, diverse social networks and a critical mass of skilled individuals – lower the barriers to initiating and scaling social innovation projects. These environments provide many of the resources and conditions necessary for innovation through market or informal mechanisms, reducing dependence on external financial support. In contrast, in less densely populated regions – where such endogenous support systems are weaker – public funding plays a more decisive role. Here, financial support from public sources compensates for the lack of spontaneous collaboration networks and institutional infrastructure, making it a critical driver of social innovation activity. This substitution mechanism is consistent with the place-based policy literature, which argues that the returns to public investment depend on the absorptive capacity of the territory (Barca et al., 2012; Iammarino et al., 2019). Our results suggest that absorptive capacity for social

**Table 3.** Effect of the interaction between public funding and density externalities on social innovation intensity, ordinary least squares (OLS).

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Public funding | 0.04 | −0.02 | −0.10** | −0.10** | 0.11 |
| | (0.03) | (0.02) | (0.05) | (0.05) | (0.09) |
| | | | | | [33.45] |
| Density externalities | | 0.68*** | 0.55** | 0.55** | 0.63*** |
| | | (0.19) | (0.22) | (0.23) | (0.21) |
| | | [12.48] | [9.44] | [7.37] | [8.38] |
| Density externalities*Social cohesion funds | | | | | −0.39** |
| | | | | | (0.16) |
| | | | | | [19.61] |
| Observations | 816 | 800 | 747 | 747 | 747 |
| Country FE | No | No | No | Yes | Yes |
| Controls | No | No | Yes | Yes | Yes |
| Geological IV | No | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | 0.00 | 0.65 | 0.65 | 0.65 | 0.68 |
| Hansen *J* *p*-value | | [0.05] | [0.02] | [0.02] | [0.03] |

Note: The table tests the hypothesis about the interaction term between density externalities and public funding using an OLS estimator. The dependent variable is the number of social innovation projects/km$^2$, treated as a standard continuous variable. All independent variables are standardised to ease the interpretation of the interaction term. Public funding refers to the standardised value of those public funding regarding social innovation only. Control variables are: a dummy variable for the presence of universities; gross domestic product (GDP) in 1991; manufacturing concentration in 1991; the ratio of young-to-old dependency in 2006; and the total amount of other (not addressed to social innovation) funds given by European social cohesion projects, associations density, a proxy for crime and electoral participation. Values in brackets are Sanderson–Windmeijer first-stage *F*-statistics for the corresponding endogenous regressor and Hansen *J* *p*-values. Standard errors are clustered at the NUTS-3 level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. FE, fixed effects; IV, instrumental variable.

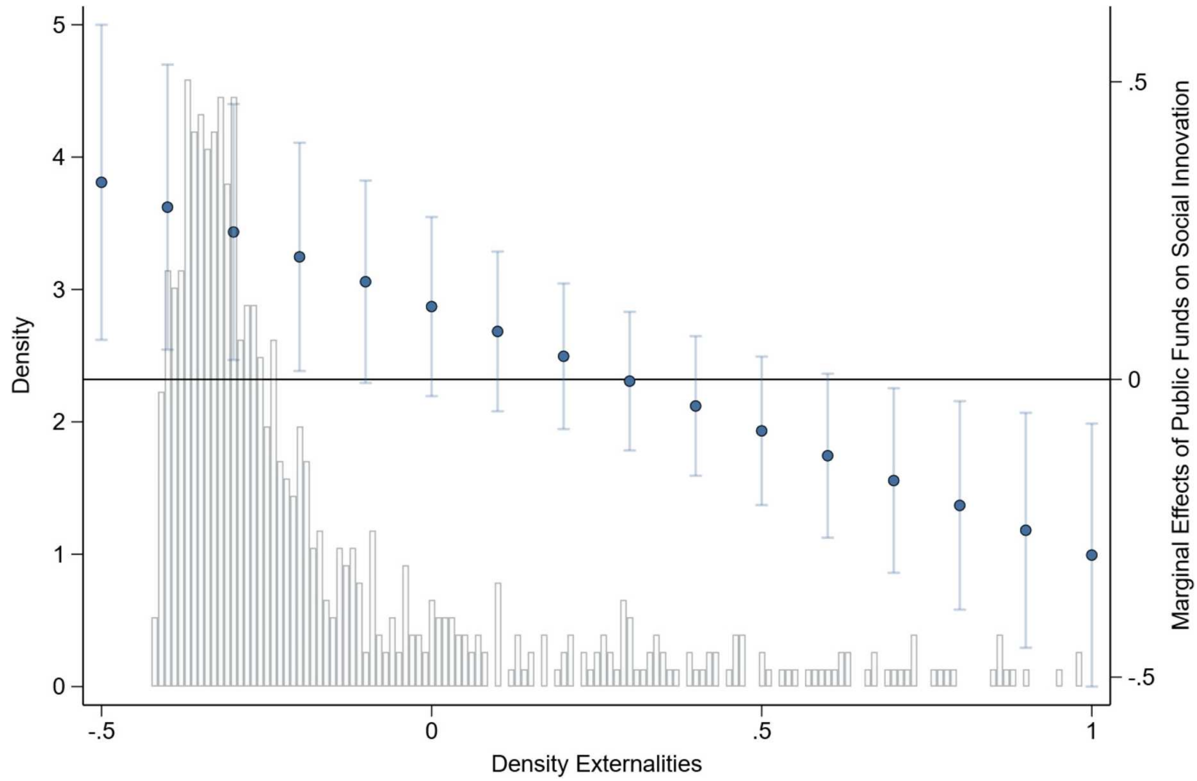


**Figure 1.** Marginal effect of public funding at different levels of density externalities, ordinary least squares (OLS).

innovation is not primarily a function of technological capabilities, but of the relational density and organisational thickness of the local environment: conditions that public funding can partially substitute for, but not fully replicate.

We report a set of robustness checks that corroborate our main findings. Table A1 in Appendix A.1 in the supplemental data online revisits Table 2 using OLS instead of Poisson, treating social innovation as a continuous outcome in logarithms; the positive association with density is confirmed, as it is the effect of accumulated technological knowledge. Table A2 in Appendix A.1 online estimates a linear probability model in which social innovation is coded as an indicator {0,1} equal to 1 when at least one initiative is observed in a given region (0 otherwise) and again yields consistent results under OLS. Table A3 in Appendix A.1 online replaces the Poisson specification with a Probit model and reaches the same qualitative conclusions. Table A4 in Appendix A.1 online re-estimates Table 3 using an alternative Poisson specification, confirming the baseline estimates. Table A5 in Appendix A.1 online adopts an alternative proxy for density externalities based on associations density; results remain stable under this measure as well. Table A6 in Appendix A.1 online estimates the same specification of density as in Table 2 using a negative binomial estimator. Results are consistent with previous findings.

These alternative specifications suggest that the substantive findings are stable across different specifications and estimators. Appendix A.2 in the supplemental data online provides a heterogeneity analysis for different types of social innovations. We found a positive effect of density on social innovation only for those social innovation projects involving competition and cooperation. Rather, we found a negative interaction term between density and public funding across all kinds of social innovation projects. The latter supports the existence of a substitution effect between density and social innovation intensity.

## 6. Conclusions

This study advances understanding of the territorial determinants of social innovation, focusing on regional density, accumulated technological knowledge, and the interaction between density and public funding. Drawing on a territorial definition of social innovation and using a large-scale cross-regional dataset covering eight Western European countries at the NUTS-3 level, it applies a new angle to social innovation, testing whether mechanisms well-established in regional innovation studies such as accumulated technological knowledge and density externalities also help explain the geography of social innovation. The paper makes three distinct empirical contributions, linked to specific theoretical mechanisms, together reframing how we should think about the territorial conditions enabling social innovation.

The first contribution concerns accumulated technological knowledge. It does not significantly stimulate social innovation, and this is theoretically meaningful. It demonstrates that social innovation does not follow the same path-dependent, branching logic characterising technological diversification. Instead, its geography depends more on relational, institutional and place-based conditions than on historically accumulated technological competencies. For scholars working at the intersection of regional economics and (social) innovation studies, this result sets a clear boundary: mechanisms driving technological clusters do not directly extend to social innovation. This boundary is itself a contribution.

The second contribution concerns the role of density externalities. Dense territorial environments are more conducive to the emergence of social innovation projects: density facilitates coalition-building, makes unmet needs more visible and provides a critical mass for collective action. This result is robust to the inclusion of controls for civic engagement, institutional thickness and social fragility, and it holds when population density is instrumented with geological characteristics to address reverse causality. The finding positions density externalities as an important driver of social innovation, operating through mechanisms that are specific to the social innovation domain: not merely a transposition of agglomeration effects from the technological innovation literature.

The third contribution concerns the interaction between density and public funding. Public funding appears to be effective only in low-density territories, suggesting a substitution pattern between external financial resources and the relational advantages of dense local environments. Where relational ties stimulated by density are weaker, public support can partially fill the gap, though it cannot fully replicate the enabling conditions of dense environments. This substitution pattern is both empirically novel and policy-consequential: it implies that the effectiveness of place-based public investment in social innovation is itself conditioned by territorial structure, and that uniform funding strategies are likely to be inefficient.

These findings carry direct implications for the design of place-based policies. The substitution pattern between density and public funding calls for a place-sensitive funding strategy that goes beyond standard convergence criteria. Such a strategy must account not only for the intensity of social needs, but also for the relational capacity of the territory to translate external financial support into sustained socially innovative activity. Regions that combine high social fragility with low density may represent the highest priority targets for public intervention, as they face both greater needs and weaker endogenous enabling conditions. At the same time, the result on accumulated technological knowledge suggests that policymakers should not conflate innovation policy with social innovation policy: investing in technological capabilities does not automatically generate the conditions for social innovation to emerge.

Our results imply that policies diluting density externalities in already dense areas would mechanically depress the incidence of social innovation. The broader implication is that efficient place-based policies should be explicitly asymmetric across space: in low-density areas, social innovation warrants direct financial support because territorial frictions are binding; in high-density areas, by contrast, policy should focus on preserving and enhancing agglomeration economies, rather than subsidising social innovation directly, since density already performs much of that enabling function.

Beyond the policy sphere, these findings speak to organisations operating in the social innovation space. Being located in a high-technology cluster is not a prerequisite for developing impactful socially innovative activities. What matters more is access to dense relational environments that facilitate stakeholder mobilisation and the circulation of information about unmet social needs. For social enterprises, impact investors and intermediary organisations, territorial embeddedness in socially dense environments may represent a more valuable locational asset than proximity to technological knowledge hubs. In low-density settings, the substitution pattern between public funding and density suggests that place-based intermediary organisations and targeted capacity-building initiatives may be the more effective instrument in low-density contexts.

The work is not exempt from limitations. The ESID database is built from curated web-based sources and may under-represent informal, emergent or weakly digitalised initiatives. Moreover, the analysis is limited to eight Western European countries and does not explicitly model cross-regional spillovers. The heterogeneity analysis further suggests that different types of social innovation projects, particularly those oriented towards competition and cooperation, may respond differently to territorial conditions, pointing to the need for more fine-grained analyses in future work. Future research should therefore examine whether similar mechanisms operate in other institutional contexts and advocate for improved local-level statistics on social innovation projects. Finally, the identification strategy, while substantially strengthened by the geological instrument and the new social controls, cannot rule out all long-run channels through which historical settlement patterns may correlate with present-day institutional conditions.

## Note

1. We test the robustness of our results to different estimation strategies: (1) Table A1 in Appendix A.1 in the supplemental data online reports ordinary least squares (OLS) estimates treating social innovation as a continuous variable; (2) Table A2 in Appendix A.1 online presents OLS estimates treating social innovation as a binary variable {0, 1} (1 if present, 0 otherwise); and (3) we also estimate in Table A3 in Appendix A.1 online a Probit model using the same binary specification.

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## Disclosure statement

No potential conflict of interest was reported by the authors.

## ORCID

*Filippo Berti Mecocci* http://orcid.org/0009-0006-8134-4092
*Roberto Dellisanti* http://orcid.org/0000-0002-1362-5603
*Amir Maghssudipour* http://orcid.org/0000-0003-2012-3916

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