INNOVATION & RESEARCH CAUCUS

HOW DO NON-R&I FACTORS INFLUENCE INNOVATION?

A subnational place-based perspective

IRC Report No: 101

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CONTENTS

EXECUTIVE SUMMARY 4
1. Context and Study Objectives 7
1.1 Policy context and rationale 7
1.2 Study objectives and research questions 8
1.3 Scope of the study 9
2. Analytical Framework: Context, Characteristics and Connectivity 10
2.1 The Three Cs Framework 10
2.2 Context of place 11
2.3 Characteristics of place 12
2.4 Connectivity of place 14
2.5 Implications for the empirical analysis 15
3. Our approach 16
3.1 Data and Indicators 16
3.2 Descriptive spatial analysis 18
3.3 Multilevel Modelling 18
3.3.1 Within-local model 19
3.3.2 Between-local model 19
3.4 Interpretation and limitations 19
4. The Geography of Innovation in the UK 20
4.1 Innovation activity is highly concentrated 20
4.2 Innovation inequality is local, not just regional 21
4.3 Wider place conditions are also locally differentiated 24
4.4 Innovation does not align with a single place condition 25
5. Place Conditions and Innovation Outcomes 25
5.1 Overall findings 25
5.2 Public R&D business support - Innovate UK support 27
5.3 Place context 28
5.3.1 Crime and the wider urban environment 28
5.3.2. Local political and institutional context 32
5.4 Characteristics of place 32
5.4.1 Skills and absorptive capacity 32
5.4.2 Housing and place attractiveness 33

5.4.3 Health and workforce participation 33
5.5 Connectivity of place 35
5.5.1 Digital connectivity 35
5.5.2 Transport connectivity 35
5.6 Synthesis 37
6. Policy Implications, Investment Opportunities and Concluding Remarks 37
6.1 Policy Implications and Investment Opportunities 37
6.2 Concluding remarks 39
REFERENCES 40
APPENDIX A. Data and Supporting Descriptive Evidence 45
A.1 Data construction and coverage 45
A.1.1 Patents 45
A.1.2 Trademarks 46
A.1.3 Innovate UK Support 46
A.1.4 Geographical harmonisation 46
A.2 Descriptive statistics 47
A.3 Data Limitations 48
APPENDIX B. Econometric Methods and Full Results 49
B.1 Model specification and interpretation 49
B.2 Interaction and non-linear models 49
B2.1 Patent model 49
B2.2 Trademark model 52

EXECUTIVE SUMMARY

Context and study objectives

Places differ markedly in their ability to generate, absorb and commercialise new knowledge. While research and innovation investment remains central to these processes, innovation outcomes are also shaped by the wider local conditions in which firms, workers, public institutions and infrastructure systems operate. This report examines how selected non-R&I factors relate to local innovation outcomes in the UK, focusing on the context, characteristics and connectivity of places. The analysis considers two complementary innovation measures: patents, which mainly capture technological invention, and trademarks, which are more closely associated with the commercial introduction of products and services. In doing so, the report aims to provide an evidence-based account of whether, and how, wider local conditions may complement or constrain public support for business innovation.

Our approach

The report combines descriptive spatial analysis with multilevel modelling. The descriptive analysis maps the distribution of patents, trademarks and selected non-R&I indicators across UK regions and local areas, with particular attention to the extent to which differences arise between broad regions or within them. The econometric analysis then examines whether these place conditions are associated with innovation outcomes, while distinguishing changes within places over time from persistent differences between places. This distinction is important because many of the strongest patterns in the data reflect established differences in local innovation capacity rather than short-term responses to changes in individual indicators.

Key findings

Our analysis shows that innovation in the UK is highly spatially concentrated, but that this concentration is not adequately captured by a simple regional divide. In the patent analysis, most measured inequality arises from differences between local authority districts within the same ITL1 regions. In 2022, 82.4% of measured patent inequality was attributable to within-region differences. This implies that broad regional averages can conceal substantial variation in innovation capacity, infrastructure conditions, skills and local economic environments.

- **Innovate UK support is positively associated with innovation across places.** Places receiving more Innovate UK funding tend to record more patents and trademarks. The most consistent results are found across places rather than within the same place over time, indicating that public support is embedded in wider local innovation systems

- **No single non-R&I factor explains local innovation performance.** Pairwise relationships between innovation and individual place indicators are generally weak to moderate. This supports a systems interpretation in which local context, characteristics and connectivity operate jointly rather than independently.

- **Effective connectivity matters more than infrastructure presence alone.** Full-fibre availability and rail usage are more informative than basic broadband availability or the presence of a train station. This indicates that infrastructure quality, reliability and actual use are central to innovation outcomes.

- **Skills are a central component of absorptive capacity.** Higher-level qualifications distinguish places with stronger established patenting capacity and are also associated with within-place changes in trademark activity. This suggests that human capital matters for both knowledge generation and commercially oriented innovation.

- **Housing captures both attractiveness and constraint.** Higher house prices are associated with stronger patenting across places, probably reflecting agglomeration, access to skilled labour, local amenities and expectations about future economic performance. However, high housing costs can also restrict labour mobility and increase costs for innovative firms.

- **Contextual indicators require cautious interpretation.** Crime, health and local engagement variables are best understood as proxies for wider local environments rather than direct policy levers. In particular, crime should not be interpreted as an innovation input, even where it appears in significant interactions.

These findings should be interpreted as evidence of association rather than causality. Innovate UK funding is not allocated randomly, and places receiving more support may already have stronger firms, universities, networks, intermediaries and institutional capacity. Similarly, several non-R&I indicators capture broad local conditions rather than precisely defined mechanisms. A positive coefficient or interaction should therefore not be read as evidence that increasing a particular indicator would necessarily increase innovation. This is particularly important for indicators such as crime and house prices, where high values may reflect wider urban scale, market demand or agglomeration pressures, but may also have adverse social or economic consequences. The results are most useful for identifying robust spatial patterns, informing place diagnostics and highlighting the need for complementary policy packages.

Policy implications and investment opportunities

Based on these findings, the report proposes the following policy priorities:

- **Use subregional evidence to design and deliver innovation support.** The high share of patent inequality arising within ITL1 regions means that regional averages are insufficient for programme design. Local diagnostics should identify existing capabilities, constraints, links to neighbouring innovation centres and the complementary conditions needed to make innovation support effective.

- **Combine innovation funding with complementary local capacity-building.** Competitive funding should be accompanied by support that helps firms, universities, intermediaries and local partnerships identify opportunities, prepare applications, collaborate and use new knowledge effectively. This is particularly important in places where weaker institutional capacity may limit access to national innovation programmes.

- **Integrate skills and innovation policy.** The evidence on Level 4+ qualifications suggests that skills are central to both established innovation capacity and commercially oriented innovation activity. Innovation programmes should therefore be linked more systematically to higher education, technical education, workforce development and local employer needs.

- **Coordinate innovation policy with skills, housing and labour-market policy.** The positive association between house prices and patenting should not be interpreted as a case for higher housing costs. Rather, it suggests that innovative places are often high-demand locations. Policy should therefore seek to preserve access to skilled labour, affordable housing and suitable business space in established innovation centres, while strengthening the attractiveness and connectivity of emerging locations.

- **Prioritise the quality, reliability and use of connectivity.** Digital policy should move beyond basic coverage measures towards full-fibre availability, connection quality, affordability and firms' ability to use digital infrastructure productively. Transport policy should focus on effective access to labour markets, research organisations, suppliers and customers, rather than infrastructure presence alone.

- **Evaluate place-based innovation policy using multiple outcomes.** Patents and trademarks capture different types and stages of innovation. Evaluation should use both measures, alongside evidence on other inputs when available.

Concluding Remarks

Taken together, the evidence suggests that the challenge for place-based innovation policy is not simply to allocate more innovation funding geographically, but to understand and strengthen the local systems through which that funding is translated into innovation outcomes. Comparable investments can operate differently because places differ in skills, institutional capacity, housing markets, digital infrastructure and transport connectivity. The central implication is therefore to move from a funding-only model towards coordinated packages of innovation support and complementary interventions, tailored to local conditions while remaining connected to national priorities and neighbouring economic systems.

1. Context and Study Objectives

1.1 Policy context and rationale

Understanding why some places innovate more successfully than others is essential to designing effective innovation policy. Existing research offers a range of explanations, emphasising workforce skills (Caragliu, 2010; Nafizah and Roper, 2024), physical and digital connectivity (Agrawal et al., 2017; Koutroumpis, 2019), and institutional and macroeconomic conditions (Donges et al., 2023; Evers et al., 2020). However, this evidence spans different factors and geographical scales, making it difficult to translate into actionable insights about what supports or constrains innovation within and between places. Places also differ in their capacity to absorb and apply knowledge, meaning that an intervention that works in one area may not produce the same outcomes elsewhere.

Understanding these wider conditions matters for both the effectiveness and geographical reach of innovation policy. R&D is an important contributor to growth in post-industrial economies (Maguire et al., 2011), and public bodies contribute substantially to UK R&D expenditure (Rough et al., 2026). Total UK R&D spending represents 2.77% of GDP (Palladino, 2024). The scale of this investment makes it important to understand how complementary local conditions affect its returns and where coordination with other policy areas may improve outcomes.

Place is also central to the distribution of this investment. Around half of public R&D activity is concentrated in London, the South East and the East of England (Ma et al., 2026; Ortega-Argilés and Yuan, 2026). Yet substantial differences also exist among local authorities within the same region. This concentration raises questions about which places can access and benefit from innovation investment and whether wider local constraints limit participation in innovation-led growth (Pinheiro et al., 2025).

This report examines how selected non-R&I conditions are associated with local innovation outcomes and whether they shape the relationship between Innovate UK support and innovation. It considers patents and trademarks alongside measures of local context, characteristics and connectivity. The aim is to inform national, regional and local decision-making, including where innovation funding may need to be complemented by coordinated action on skills, housing, health, governance, transport or digital infrastructure.

Addressing these questions requires evidence that goes beyond mapping where innovation occurs. Policymakers also need to understand which wider place conditions are associated with innovation, whether these relationships reflect persistent differences between places or changes within them over time, and whether local conditions influence the relationship between public support and innovation outcomes. This report responds to that need by examining patents and trademarks alongside selected measures of place context, characteristics and connectivity. The analysis is guided by the following study objectives.

1.2 Study objectives and research questions

The overall objective of the study is to provide systematic evidence on how non-R&I conditions relate to innovation outcomes across UK places and whether these conditions shape the relationship between public innovation support and local innovation activity.

The study has four specific objectives:

- To map the geography of innovation, Innovate UK support and selected non-R&I conditions across UK regions and local areas.
- To assess how place conditions (local context, characteristics and connectivity) are associated with innovation outcomes, distinguishing changes within places over time from persistent differences between places.
- To examine whether these conditions strengthen or constrain the relationship between Innovate UK support and innovation outcomes.
- To identify implications for the design, coordination and evaluation of place-based innovation policy.

These objectives are addressed through the following research questions:

- How are patents, trademarks and Innovate UK support distributed across UK regions and local areas?
- To what extent do innovation inequalities arise between UK regions, and to what extent do they arise between local areas within the same region?
- How are selected indicators of place context, characteristics and connectivity associated with patents and trademarks?
- Do changes in these conditions within a place correspond to changes in innovation outcomes over time?
- How do persistent differences in place conditions relate to differences in innovation performance across places?
- Do non-R&I conditions strengthen or weaken the relationship between Innovate UK support and innovation outcomes?
- Do these relationships differ between patents and trademarks?
- What do the findings imply for the targeting, delivery and evaluation of place-based innovation support?

The distinction between changes within places over time and differences between places is central to the study. A factor may distinguish consistently high-innovation places without showing that a short-term change in that factor will produce an immediate increase in innovation. Separating these relationships helps avoid translating persistent spatial associations directly into causal policy claims.

1.3 Scope of the study

The analysis focuses on local innovation outcomes in the UK and uses two complementary indicators. **Patents** primarily capture technological invention and formalised knowledge creation. **Trademarks** provide a broader indicator of commercially oriented innovation, including the introduction and market positioning of new products and services. Neither measure captures innovation in its entirety, but their combined use provides a more complete picture than relying on patents alone.

Public support for research and innovation is measured using Innovate UK data. The main analysis considers the **value of Innovate UK awards** received in each place. The number of supported projects is also examined where relevant, although award value provides the clearer measure of the scale of public support. These indicators capture the geographical distribution of Innovate UK activity but do not constitute a causal evaluation of programme impact.

The non-R&I indicators are organised around the three dimensions of the analytical framework:

- ***Context:*** recorded crime and local election turnout;
- ***Characteristics:*** housing prices, healthy life expectancy and the proportion of the working-age population with Level 4 or higher qualifications; and
- ***Connectivity:*** full-fibre and other broadband measures, railway-station provision and passenger usage.

The selection reflects the original policy interest in transport, housing, broadband, crime, health and governance, together with the availability of sufficiently consistent subnational data. The indicators should be regarded as proxies for broader mechanisms. Election turnout, for example, does not measure institutional quality directly, while house prices reflect several overlapping features of local demand, attractiveness and affordability.

The empirical analysis uses different geographical units according to data availability. Patent analysis is primarily undertaken at local authority district level, whereas the trademark models use ITL3 areas. Regional comparisons use ITL1 geographies. The available time period also varies across indicators. These differences mean that the size of coefficients from patent and trademark models should not be compared directly.

The report combines descriptive spatial analysis with multilevel econometric modelling. The descriptive analysis examines trajectories, spatial concentration and the extent of inequality within and between regions. The multilevel models distinguish variation within places over time from persistent differences between places and test both the direct associations of place indicators and their interactions with Innovate UK support.

The study is designed to identify robust spatial patterns and policy-relevant relationships. It does not establish that changes in individual place conditions cause changes in innovation. Innovate UK support is not allocated randomly, and the indicators cannot capture every aspect of local industrial structure, institutional capacity or innovation activity. The findings should therefore inform local diagnostics and the design of complementary policy packages rather than provide a mechanical formula for allocating funding.

2. Analytical Framework: Context, Characteristics and Connectivity

2.1 The Three Cs Framework

This report uses the Three Cs—context, characteristics and connectivity—to organise complementary explanations of how place shapes innovation. Although interdependent (Baycan et al., 2017), each dimension highlights a distinct mechanism:

- **Context: What shapes incentives to innovate?** Institutional economics highlights the role of governance quality and policy credibility in shaping investment decisions (North, 1990; Acemoglu et al., 2001).

- **Characteristics: What shapes a place's capacity to generate and absorb innovation?** Endogenous growth and regional development theories emphasise human capital, industrial structure and territorial assets (Romer, 1986, 1990; Camagni, 2009; Buzard et al., 2020).

- **Connectivity: What shapes access to markets, labour and knowledge within and beyond a place?** Economic geography highlights how infrastructure and spatial interaction support knowledge spillovers and innovation diffusion (Audretsch and Feldman, 1996; Anselin et al., 1997; Beaudry et al., 2003; Broekel and Graf, 2006).

The framework reflects a multi-scalar systems understanding of innovation. Local innovation is shaped by regional and national conditions and by networks extending beyond administrative boundaries. Firms may be located in one local authority while recruiting workers, collaborating with research organisations and serving markets across a wider area. Innovation outcomes therefore depend not only on the assets located within a place, but also on the capacity to combine those assets and connect them to wider institutional and economic systems (Cooke et al., 1997; Crescenzi and Rodríguez-Pose, 2011; Rodríguez-Pose and Wilkie, 2019).

Within each dimension, we focus on *policy levers* through which BIST can influence innovation outcomes, either directly or in coordination with other government bodies. We distinguish these from *structural conditions*, which may change slowly or lie beyond BIST's immediate influence, while recognising that policy can reshape them over time.

2.2 Context of place

How do institutional and macroeconomic conditions shape incentives for innovation in different places?

The context of a place comprises the institutional, political and socioeconomic conditions that shape the risks, expected returns and coordination costs associated with innovation. Macroeconomic downturns and inflation can constrain investment differently across places because industrial structure and financial exposure vary (Roper and Turner, 2020; Schmitz, 2014; Evers et al., 2020). National policy therefore needs to consider how its incentives interact with regional institutions and local practices.

Place-specific incentives offer a means of encouraging local actors to engage in innovative activity. Institutional theory argues that incentives to innovate are shaped by the 'rules of the game' (North, 1990), with taxation and regulatory frameworks influencing expected returns and the costs of experimentation (Donges et al., 2023). In the UK, Investment Zones illustrate how national policy instruments can be combined around local priorities to encourage innovative investment and R&D spending. While there has been specific research on broader formal institutional change on growth (Raja & Larsson, 2024; Sweeney, 2026), the effects of Special Economic Zones on UK innovation are not yet well understood. Evidence from China, however, links Special Economic Zones to increased patenting activity (Wu et al., 2021), supporting the potential of place-specific incentives. The East Midlands Investment Zone illustrates this approach by combining economic incentives and support for research and industrial space with skills programmes and commercialisation support (Ministry of Housing, Communities and Local Government, 2026). However, transferring these lessons across contexts requires attention to local institutions and incentives that may often be overlooked. For instance, international evidence demonstrates a link between crime and lower innovation incentives, influencing firm productivity and limit business expansion (Saridakis et al., 2015). Not only that, in the broader environment, incentives may have limited effects where firms lack access to finance or skilled workers, suggesting a need for complementary measures. For BIST, the implication is to align national innovation support with the capabilities and constraints of particular places, coordinating complementary interventions with regional and local partners.

Spatially inclusive institutions, through formal rules and informal norms, shape innovation outcomes by influencing who participates in innovative activities and how organisations operate (Saka-Helmhout et al., 2020). Godlewska (2021), for example, finds that trust and attitudes towards traditional customs positively influence innovation outcomes in Central and Eastern European countries. The importance of informal institutions and an inventive environment is reinforced by combining two insights. First, Uzzi et al. (2013) underline that it is not just the 'amount' of innovation but also its quality and originality that is important in impactful research, linking this to combinations of established and unusual. Second, that multiple perspectives can encourage this environment, with a 'diversity dividend' in more inclusive environments, attributed to more creative solutions to problems (AlShebli et al., 2018, Celestin

& Vanthina, 2020). For policymakers, this brings a focus on how workers and the wider population engage with their own innovation futures, and the barriers that may prevent this. Liverpool City Region's Apprentice Travelcard offers a practical example of addressing a local barrier to participation in the local economy, providing half-price bus and rail travel for eligible young apprentices to reduce transport costs as a barrier to vocational training (Liverpool City Region Combined Authority, 2019). This illustrates coordinated support for access to training, rather than evidence of increased innovation. For BIST, institutional inclusivity brings into focus potential assumptions in policy design that may lead to exclusion, and how dialogue with diverse actors can help identify and reduce these barriers between and within places.

Subnational institutional credibility and coordination can strengthen incentives to innovate by reducing uncertainty about future support and the costs of collaboration, which is particularly important because innovation can involve sunk costs and delayed returns (Manso, 2011). From a place perspective, firms' willingness to invest depends on both national policy stability—as evidenced by Liang and Fiorino's (2013) study of innovation in the US energy industry—and confidence in regional and local delivery, which is shaped by regional government quality (Rodríguez-Pose and Di Cataldo, 2015). Regarding confidence in delivery, a way to proxy these attitudes on government credibility is turnouts in subnational elections, indicating a general perception of the importance of government in shaping meaningful policy, which is becoming especially important in the UK as powers to drive regional innovation futures are being expanded under devolved arrangements (Packel, 2008). Regarding differences in regional governance quality, these are difficult to measure directly, but a key point to underline in the UK context is that the baseline capacities of these institutions can differ substantially: for example, Greater Manchester Combined Authority employs around 1.22 staff per 1,000 residents, compared with 0.2 in Cambridgeshire and Peterborough Combined Authority (Sweeney, 2026). National support therefore needs to consider subnational authorities' capacity to absorb new responsibilities. In addition to internal capacities, regarding subnational collaboration around existing strengths, the UK Strength in Places Fund illustrates how policy can tailor incentives to place, as initiatives 'focus on a self-defined area anywhere in the UK, not limited by nations or regions' (UK Research and Innovation, 2023). This allows partnerships to reflect relevant economic relationships. For BSIT, this flexibility requires clear responsibilities and sustained coordination so participants can have confidence in delivery. It also raises a separate evaluation question: how to assess additional activity and spillovers where programme areas cross administrative boundaries.

2.3 Characteristics of place

How do a place's assets shape the capacity to generate and absorb innovation?

Alongside broader demographic trends and relatively fixed geographical characteristics, policy-relevant attributes of places can be grouped into production and consumption attributes. Human capital and the concentration of firms shape productive capabilities, while housing, amenities and place reputation influence the attraction and retention of people and investment.

Human capital and workforce capacity, including the skills and health of the workforce, is crucial to innovation in places. Education and skills enable firms to generate, adopt and apply knowledge, while workforce health influences whether people can participate in these activities. The relationship also works in the other direction: Liverpool City Region's Growth Plan links ambitions for health and biopharmaceutical innovation with improving local health outcomes (Liverpool City Region Combined Authority, 2025). This illustrates the potential alignment of innovation and health priorities, rather than evidence that sectoral investment has improved workforce health. The University of Sheffield's AMRC Training Centre provides a more direct example of developing capabilities alongside innovation investment, combining apprenticeship training with manufacturing research expertise and employer-informed provision (University of Sheffield AMRC Training Centre, n.d.). This underscores the importance of aligning innovation support with skills development and measures that support workforce participation, in coordination with education, health, and employment partners. This requires attention to the wider labour market, not just the locality receiving investment: firms may recruit across administrative boundaries, while residents living close to innovation activity may still face barriers to participation.

Scale, or the geographical concentration of firms and workers (agglomeration), influences how productive capabilities are brought together. Larger, denser cities tend to concentrate firms and skilled workers, supporting knowledge exchange and innovation (Carlino et al., 2007; Bettencourt et al., 2007). These advantages arise through sharing specialised infrastructure, improving matching between firms and workers, and learning through frequent interaction (Audretsch and Feldman, 1996; Duranton and Puga, 2004). Roper and Jibril (2024), for example, find a positive association between population density and innovation intensity across approximately 32,000 UK neighbourhoods, demonstrating the importance of local interaction and knowledge exchange in fostering innovative activity. Further, the UK Battery Industrialisation Centre (UKBIC) in Coventry illustrates how policy can strengthen these capabilities by providing shared facilities and expertise to help firms move from battery research towards industrial production (UK Battery Industrialisation Centre, 2026). These opportunities also exist in rural and island economies: the European Marine Energy Centre in Orkney combines specialist testing infrastructure with local wave and tidal resources to support technology development (Highlands and Islands Enterprise, 2026). Together, these examples raise an underlying question: how can public spending maximise complementarities with existing strengths and achieve economies of scale through shared facilities, while ensuring access for firms across a wider geography?

Place attractiveness further influences innovation outcomes because it influences whether workers are willing and able to locate near innovation opportunities, with implications for firms' recruitment and investment decisions. This recognises that innovative actors also engage in leisure activities and underscores that housing, amenities and quality of life affect location decisions alongside employment prospects (Glaeser et al., 2001; Florida, 2005; Couture, 2016). Housing and housing costs illustrate a potential tension between a place's success and

living conditions. Where supply is constrained, rising costs can restrict labour mobility and increase recruitment and premises costs for firms, restricting innovation (Hilber and Schöni, 2022; Maclennan and Long, 2023). Chu et al. (2024), for example, find that higher house prices reduced innovation in China, suggesting that the conditions accompanying concentration can also constrain its benefits. Furthermore, place reputation is not necessarily limited to worker decisions: Massey and Wield (1992), discussing UK science parks, highlight how narratives attached to places can influence how firms and investors assess locations, with negative perceptions discouraging investment or recruitment. These may be at the street or neighbourhood level, explaining why regional averages are insufficient in explaining innovative outcomes, with a multiscale perspective allowing investigation of substantial differences in affordability and attractiveness within areas.

2.4 Connectivity of place

How does infrastructure shape access to markets, labour and knowledge networks in a place?

A place's physical geography and inherited infrastructure shape its connectivity to surrounding places and may be difficult, costly or impossible to change. Within these structural conditions, transport and digital policy can change the effective geography of innovation by expanding market access, strengthening learning through interaction and enabling the diffusion of knowledge across places.

Market access enabled by better transport links influences innovation by expanding access to inputs and opportunities to commercialise new ideas beyond the local economy. For example, Andersson et al. (2023) find that connection to Sweden's historical railway network increased local patenting through greater inventor entry and productivity. Lower transport and communication costs also enabled inventors to sell ideas to firms along the network, creating wider markets for innovation. Within places, however, an important consideration is how changes in market access affect different firms: Aghion et al. (2024) find that increased export demand stimulated patenting primarily among initially more productive French businesses. This reinforces the principle that innovative actors relate to other areas and that connectivity can reshape the geographical inputs and markets of innovation. In England, the London–Stansted–Cambridge Innovation Corridor illustrates this relationship, connecting Cambridge's innovation economy with London, research centres in Hertfordshire and Essex, and international access through Stansted Airport (HM Government, 2019). A key task remains, however, in identifying connectivity improvements that extend market opportunities to firms outside areas already benefiting from strong regional and international connections.

Knowledge exchange facilitated by efficient and reliable public transport offers another mechanism through which innovative actors can combine expertise and use facilities unavailable within their own organisations. For example, Ioramashvili and Sweeney (2026) examine 2,599 UKRI-funded collaborative research projects involving two partner organisations connected by mainline rail. In their controlled regression, a ten-percentage-

point increase in the share of trains arriving on time is associated with approximately 15 per cent more publications. Further analysis highlights the importance of persistently poor connections. The role of transport in facilitating knowledge exchange is supported by Agrawal et al. (2017), who find that a 10 per cent increase in regional highway stock in the United States increases regional patenting by 1.7 per cent over five years. These findings are particularly relevant given ambitions to connect clusters across cities, such as the biotech industries of Liverpool and Manchester into a wider Industrial Biotechnology cluster between universities and firms across the North West (UK Research and Innovation, n.d.). In combination, these studies underscore the importance of both connectivity between places and the reliability needed to fully exploit the expertise and facilities distributed across the cluster.

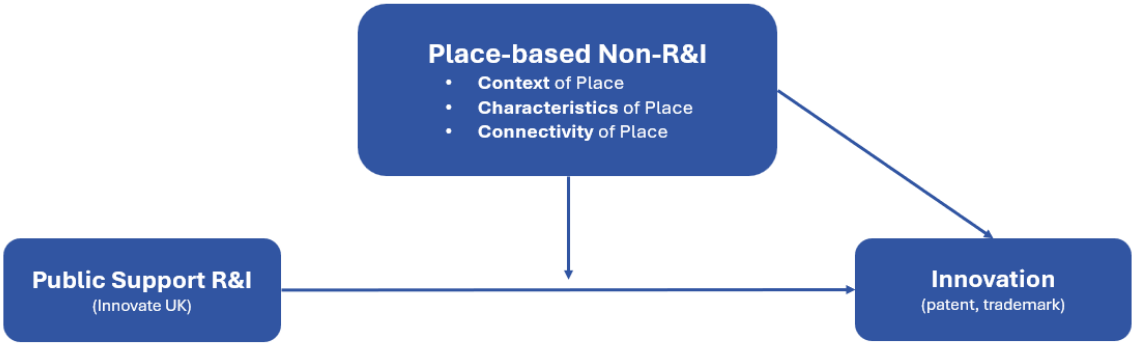
Digital connectivity complements physical infrastructure by reducing communication costs and expanding access to information. In the UK, broadband expansion increases employment but has limited short-term productivity effects (DeStefano et al., 2023), with similar findings in Ireland and Germany (Haller and Lyons, 2015; Bertschek et al., 2013). Geographic inequalities in the intensity of digital use can also persist even where access gaps narrow (Blank et al., 2019, 2020). Connection quality, including broadband speed, matters alongside coverage (Joshi, 2024; Chen and Wang, 2023). Equally important are the complementary capabilities that enable firms to adopt digital technologies and translate adoption into productivity and innovation gains (Department for Science, Innovation and Technology, 2024; Rampersad and Troshani, 2020; Lee et al., 2016). Regional coverage figures may therefore conceal local differences in effective participation. For BIST, small-area data can help distinguish gaps in infrastructure from barriers to adoption, identifying where connectivity investment requires complementary support for skills and organisational capabilities (Singleton et al., 2020; Office for National Statistics, 2023).

2.5 Implications for the empirical analysis

Across the three C's, innovation is shaped by interacting mechanisms: *context* determines the incentives and credibility of the policy environment; *characteristics* determine workforce capability, agglomeration, and the spatial sorting of skilled labour; and *connectivity* determines market access, interaction intensity and the diffusion of knowledge.

The next stage of this report turns to the data. We examine the empirical evidence on how these three mechanisms operate across places, and assess the extent to which variation in context, characteristics and connectivity is associated with differences in subnational innovation performance.

Figure 1. Conceptual framework



3. Our approach

This report combines descriptive spatial analysis with multilevel econometric modelling to examine how innovation and wider place conditions vary across the UK. The descriptive analysis maps patents, trademarks, Innovate UK support and selected non-R&I indicators, while the econometric analysis examines whether place conditions are associated with innovation outcomes and whether they influence the relationship between public R&I support and innovation.

Our data work and analysis bring together two main groups of indicators:

- *Place-based innovation indicators:* patents and trademarks as innovation outcomes and Innovate UK project funding as a measure of public R&I support.
- *Place-based Non-R&I indicators:* different variables organised under the c*ontext, characteristics and connectivity* of places**.**

3.1 Data and Indicators

Place-based innovation indicators are grouped into innovation outcomes and innovation inputs. Among innovation outcomes, our analysis incorporates information on patents and trademarks. Public R&I support is measured through the number of Innovate UK-funded projects and the total amount of Innovate UK funding awarded in the local area.

Patents primarily capture technological invention, while trademarks provide a broader measure of commercially oriented innovation. Innovate UK support is measured principally through the value of awards received in each local area. The non-R&I indicators include crime and election turnout; housing prices, healthy life expectancy and Level 4+ qualifications; and digital and rail connectivity.

The dataset consists of UK local-level information—LAD for patents and ITL3 for trademarks—covering the period 2006–2024. For every local area, we have data on projects and funds across 19 years, providing multiple observations for the same local area.

Patents and trademarks capture different dimensions of innovation. Patents primarily capture technological invention, while trademarks provide a broader measure of commercially oriented innovation. The patent and trademark models use different geographical units, samples and periods, and direct comparisons of the magnitude of coefficients should therefore be avoided.

Table 1. Indicators used in the analysis

Dimension/Variable	Description	Source	Period
Innovation Performance			
Patents	Number of patent applications in the local area.	Orbis IP	2009 - 2024
Trademarks	Number of trademark applications in the local area.	EUIPO	1996 - 2024
R&I Support			
InnovateUK projects	Number of Innovate UK-funded projects in the local area.	InnovateUK	2004 - 2024
InnovateUK funding	Total amount of Innovate UK funding awarded in the local area.	InnovateUK	2004 – 2024
Non-R&I Place Feature: Place Context			
Recorded crime	Number of recorded crimes Number of recorded crime offences relative to the local population.	Home Office Crime & CSP Open Data	2009 - 2024
Election turnout	Voter turnout in local elections, measured as the percentage of the electorate casting a vote.	The Elections Centre	2018 - 2023
Non-R&I Place Feature: Place Characteristics			
Housing	Average residential property price in the local area.	HM Land Registry	2009 - 2023
Health	Healthy life expectancy at birth, averaged across males and females.	ONS	2013 - 2024
Level 4+ qualifications	Percentage of the working-age population with Level 4 or higher qualifications.	Nomis	2006 - 2024
Non-R&I Place Feature: Place Connectivity			
Digital	Digital connectivity measured by broadband availability (full fibre) and broadband speed (below 30 Mbit/s) in the local area.	Ofcom	2018 - 2024
Transport	Rail connectivity measured using railway station provision and passenger usage relative to the local population.	Office of Rail and Road	2006 - 2024
Control Variables			
Local development	Gross domestic product (GDP) per head at the ITL1 level.	ONS	1998 - 2023
Population density	Number of residents per square kilometre in the local area.	ONS	1991 - 2024

The non-R&I indicators should be understood as indicators of wider place conditions rather than direct policy levers. Crime may reflect urban scale, deprivation, economic activity and reporting practices. House prices may capture both the attractiveness of economically dynamic areas and affordability constraints. Election turnout provides only a partial indication of local institutional context. Broadband coverage and station provision also do not necessarily capture infrastructure quality, reliability or use.

Further information on the construction, geographical harmonisation and limitations of the indicators is provided in Appendix A.

3.2 Descriptive spatial analysis

The descriptive spatial analysis examines the geographical distribution of patents, trademarks, Innovate UK support and the selected non-R&I indicators. Regional trajectories, maps and the Theil inequality index are used to distinguish differences between ITL1 regions from differences between local areas within them.

Patent activity inequality is analysed at Local Authority District level using the Theil inequality index, which considers not only inequality across ITL1 regions but also patent-activity dispersion across their respective LADs. The index is decomposed into differences between the twelve UK ITL1 regions and differences between LADs within those regions.

The preliminary analysis of relationships between non-innovation indicators and patents uses pairwise correlations and scatterplots. These relationships are descriptive and provide an initial assessment of how housing, crime, broadband connectivity, healthy life expectancy and transport relate to patenting. They do not account for other local characteristics and should not be interpreted as causal.

The full regional trajectories, Theil decompositions, correlation matrix and exploratory figures are presented in section 5 and Appendix A.

3.3 Multilevel Modelling

To analyse whether Non-R&I place determinants impact place-based innovation outcomes, considering the role of public support for R&I, while accounting for the hierarchical structure of the data, we followed the general multilevel econometric estimation approach. Multilevel Structural Equation Modelling (MSEM) allows us to capture both the direct effects of Innovate UK support and non-R&I place determinants, as well as their interaction effects on local innovation activity, measured as patents and trademarks.

The multilevel panel data models estimate two regression models at the *within*-local and *between*-local levels.

3.3.1 Within-local model

We analyse how within-local effects of non-R&I place determinants and public R&I impact local innovation performance, including their interaction effects. More precisely, we used local innovation performance at time t and regressed it on local support for R&I and non-R&I place determinants at time t-2. This method is used to analyse the within-local lagged association of both non-R&I determinants and public support for R&I and their interactions on local innovation activity.

3.3.2 Between-local model

We analyse a comparable model considering the between-local differences in each variable. At this between-local level, we estimate the relationship between average levels of local allocation of R&I public support and average levels of non-R&I place determinants and average levels of local performance.

The dataset of the innovation model consists of information from the UK at the local level (LAD for patents and ITL3 for trademarks), covering the period 2006 - 2024. For every local area, we have data on projects and funds across 19 years, providing multiple observations for the same local area. Non-R&I determinants are presented in the table below. Within-regional variability refers to fluctuations or deviations that occur within a single local area, focusing on variations from its average performance. In contrast, local variability highlights differences among local areas, comparing characteristics of one local area with those of another.

3.4 Interpretation and limitations

Our econometric analysis provides systematic evidence on how innovation outcomes vary with the context, characteristics and connectivity of places. The multilevel framework is valuable because it distinguishes changes within local areas over time from persistent differences between areas. However, several limitations have to be considered, as they may affect the interpretation of our results and, therefore, the conclusions and policy implications derived from them.

Our results identify associations, not causal effects. The models cannot fully address issues of reverse causality, omitted local characteristics or the non-random allocation of Innovate UK support. Places receiving more support may already have stronger firms, research capacity and innovation ecosystems. The estimates should therefore not be interpreted as evidence of programme additionality.

The strongest findings concern differences between places. Significant coefficients in our models capture persistent differences between high- and low-innovation places, while the within-place results are often weaker. Between-place estimates may reflect established differences in industrial structure, institutional capacity and economic development. They do not predict what would happen if support increased in a particular location.

Data coverage, geography and measurement vary across models. Our patent models mainly use LADs, while trademark models use ITL3 areas, and the available samples and time periods differ by indicator. Direct comparisons of the magnitude of coefficients should be avoided.

Complex relationships require cautious interpretation. Non-linear and interaction effects show that some associations vary across local contexts and are not constant. Greater weight should be placed on results that remain consistent across specifications.

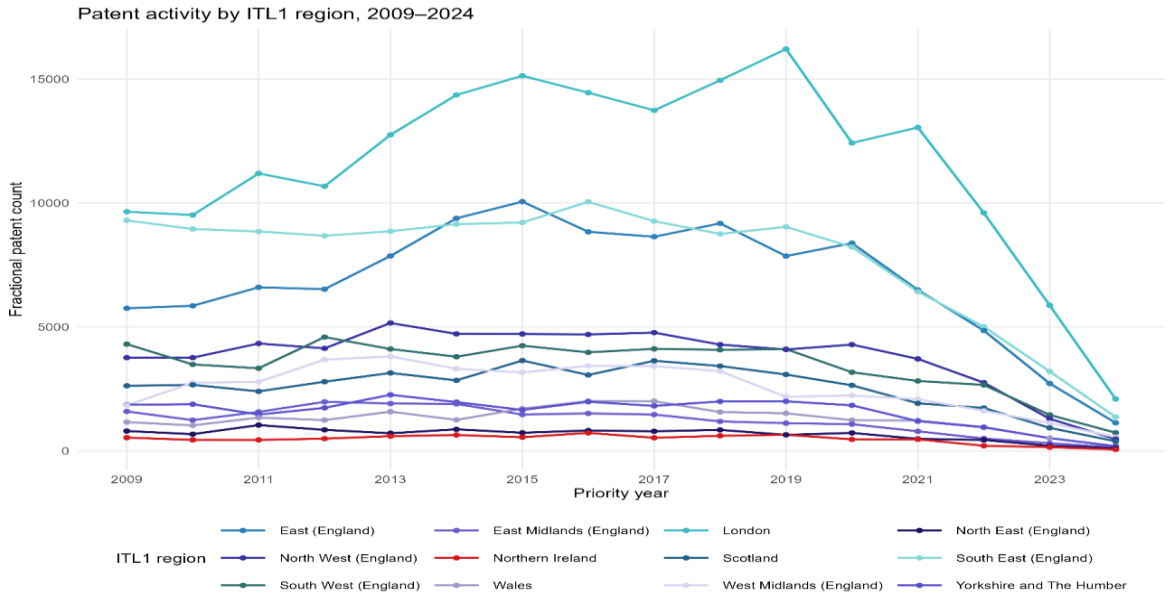
4. The Geography of Innovation in the UK

This section presents the descriptive analysis of the geography of innovation in the UK. It examines the regional and local distribution of patents and trademarks, the degree of innovation inequality and the extent to which the same spatial pattern is observed across the non-R&I indicators.

4.1 Innovation activity is highly concentrated

For the regional descriptive analysis, patents are attributed to regions based on the location of the applicant, using the applicant's mapped UK geography. The regional measure captures patent participation by region and year: a patent is attributed to a region when one of its applicants is located there.

Figure 3. Patent trajectories by ITL1 region, 2009–2024

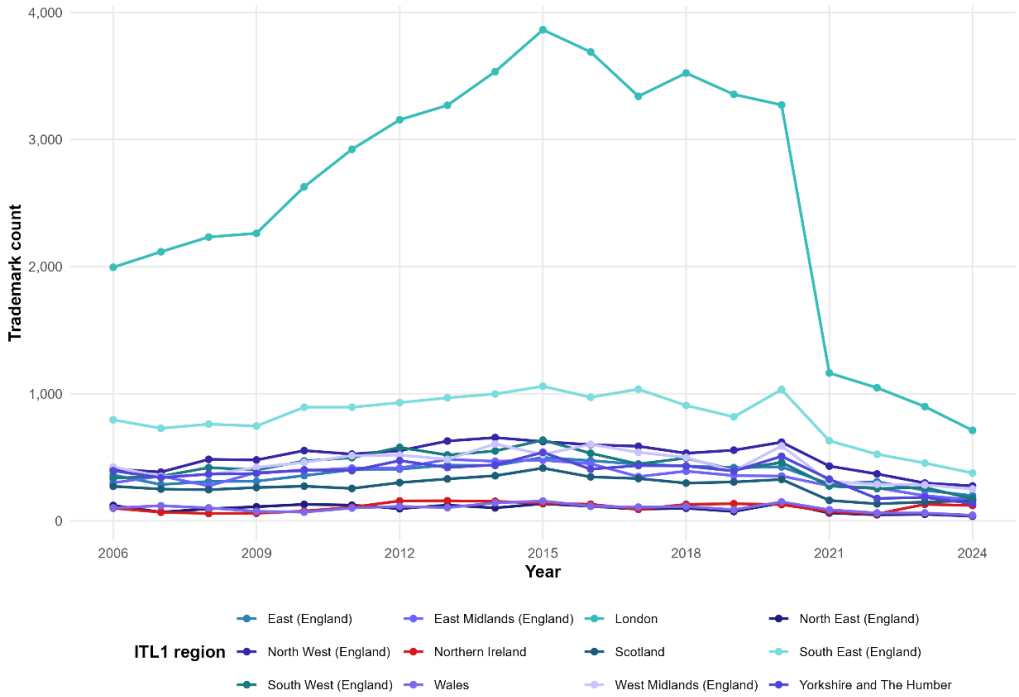


Patenting remains highly concentrated across the whole period, with the largest ITL1 trajectories—South East, London and East (England)—clearly decoupled from the rest of the UK distribution. The sharp decline in recent years may partly reflect patent publication and

reporting lags, as applications are typically published around 18 months after filing. Previous research has also excluded the final three years of patent data to account for delays between application and grant (Crescenzi et al., 2016).

Trademark activity is also geographically unequal. The sharp decline from 2021 coincides with post-Brexit changes in trademark filing routes and may partly reflect changes in data coverage rather than underlying activity. However, patents and trademarks capture different forms of innovation. Patents are more closely associated with technological invention, while trademarks capture commercially oriented activity. Places may therefore perform strongly on one measure without occupying the same position on the other.

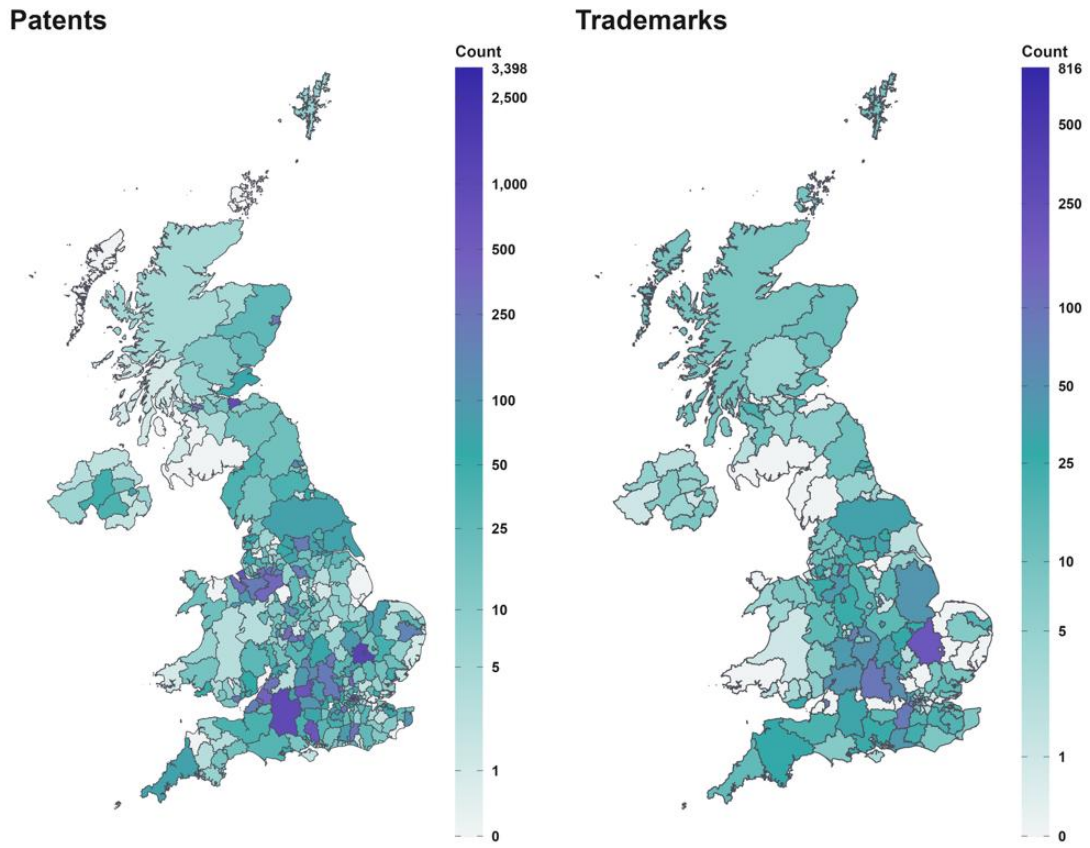
Figure 4. Trademark trajectories by ITL1 region, 2006–2024



4.2 Innovation inequality is local, not just regional

Figure 5 shows that patenting and trademark activity are concentrated in a relatively limited number of places, but the two outcomes do not have identical geographies. Patent activity displays pronounced local concentrations, while trademark activity is distributed across a somewhat broader set of areas.

Figure 5. Geographic distribution of patenting and trademarks in 2022



To understand this relationship in more detail, we analyse patent-activity inequality at the Local Authority District level with the Theil inequality index; we find that inequality in patent production has increased over time. LAD-level patent inequality is higher in 2022 than in 2009, with a 2022 patent Theil index of 1.48.

Patent activity has been persistently unequal across places in the UK. In 2022, patent inequality reached its highest point, with 17.6% attributable to differences between the twelve UK regions and 82.4% attributable to differences between LADs within the ITL1 regions.

Figure 6. Patent Theil index, 2009–2024

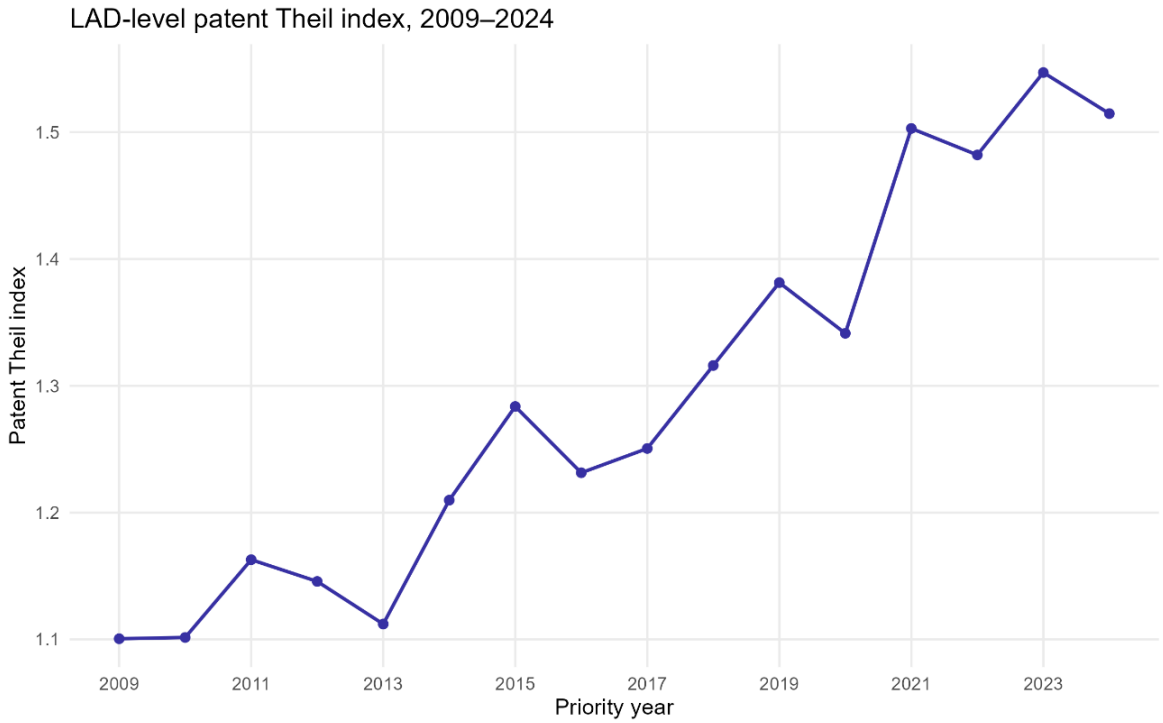


Table 2. Patent Theil decomposition, 2009 and 2022

Year	Total patent Theil	Between ITL1	Within ITL1	Between share	Within share
2009	1.10	0.14	0.96	12.7%	87.3%
2022	1.48	0.26	1.22	17.6%	82.4%

To further illustrate the geography of innovation in the UK, local-authority-district spatial mapping identifies the local authorities that contribute most to national patent concentration in 2022.

The same broad pattern is observed for trademarks: inequality is primarily local rather than regional. The total trademark Theil index declined from 1.46 in 2009 to 1.12 in 2022. In 2022, 16.5% of total inequality was attributable to differences between ITL1 regions, while 83.5% was attributable to differences between ITL3 regions within the same ITL1 region. This compares with 20.0% and 80.0%, respectively, in 2009.

Table 3. Trademark Theil decomposition, 2009 and 2022

Year	Total trademark Theil	Between ITL1	Within ITL1	Between share	Within share
2009	1.46	0.29	1.17	20.0%	80.0%
2022	1.12	0.185	0.94	16.5%	83.5%

These results confirm that UK regional inequality is local, not just regional. Within-region differences consistently outweigh between-region gaps. The geography of innovation is therefore not adequately represented by a simple regional or north–south divide.

4.3 Wider place conditions are also locally differentiated

Crime is highly uneven across local areas, with substantial variability both between regions and within regions. Crime landscapes are locally differentiated, echoing the strong spatial granularity observed in innovation. Changes in crime over time vary significantly across regions and local authorities, and no uniform national pattern emerges. Crime dynamics are locally contingent and shaped by place-specific economic, social and institutional factors.

Housing prices also exhibit strong spatial variation in the UK. There are clear differences between ITL1 regions—for example, London and the South East compared with other regions—but there are also significant variations within regions. Over the 2009–2023 period, housing shows long-run price growth following the post-financial-crisis recovery and considerable variation in growth rates across LADs. Regional averages mask wide variation across LADs, showing that local housing markets differ greatly even within the same ITL1 region.

Healthy life expectancy shows substantial variation across regional and local areas. Because it is measured in rolling windows, it changes more slowly than other non-R&I comparators such as housing prices or crime. Changes across the period reflect structural conditions, including long-term deprivation, health behaviours and public-service access. Healthy life expectancy is therefore a long-run proxy for local wellbeing rather than short-term adjustment.

Broadband connectivity has improved clearly over time. There has been a clear expansion of full-fibre and ultrafast infrastructure and a decline in areas below minimum service thresholds. However, progress is uneven across LADs. Some LADs have moved ahead through high-quality infrastructure, while others continue to experience persistent access constraints. Broadband spatial disparities are therefore increasingly about quality and last-mile gaps rather than basic access to digital infrastructure.

Across all indicators, there is strong variability both across and within regions at LAD level. This spatial pattern in innovation outcomes is similar to that observed for housing, crime, broadband and healthy life expectancy, although innovation appears more concentrated.

4.4 Innovation does not align with a single place condition

The pairwise relationships between patents and housing, crime, broadband connectivity and healthy life expectancy are generally weak to moderate in magnitude. No independent factor strongly influences the geography of innovation, supporting the interpretation that innovation reflects multidimensional, locally specific systems rather than simple direct one-to-one relationships.

The relationship between crime change and patent change across 258 matched LADs between 2009 and 2022 is very weak, with a Spearman rank correlation of 0.055 and a simple linear model adjusted R-squared of 0.1%. Crime change alone is associated with virtually none of the variation in patent change, even after excluding high-influence LADs. High-patent areas exist across widely varying crime levels.

Housing and healthy life expectancy vary with patent intensity, but the spread of LADs shows that neither characteristic alone consistently sorts innovation geography. High-patent areas often have higher house prices, but not all high-price areas are innovation leaders and not all innovative areas have uniformly high housing costs.

Broadband shows a limited direct relationship with innovation outcomes measured as patents. Because broadband coverage is high in many places by 2022, the clearest residual signal is often the remaining access gap rather than headline coverage. Broadband behaves more like a threshold variable than a linear driver of innovation.

Across 347 LADs with a population denominator, train-station density has a patent rank association of −0.085.

These preliminary findings suggest that no single non-R&I factor is necessary or sufficient to explain local innovation disparities. The next section examines the relationships more systematically through the multilevel analysis.

5. Place Conditions and Innovation Outcomes

5.1 Overall findings

Innovation in the UK is highly concentrated. Patent activity is dominated by a relatively small number of regions and localities, and this concentration has increased over time. In 2022, the patent Theil index reached 1.479, with 82.4% of measured inequality arising from differences between local authority districts within the same ITL1 regions, rather than from differences between the twelve ITL1 regions. This confirms that the geography of innovation is not adequately represented by a simple regional or north-south divide.

The econometric analysis reinforces this conclusion. Innovate UK project numbers and award values are positively and consistently associated with both patents and trademarks when comparing different places. For patents, these relationships are concentrated primarily at the between-place level. Trademark activity also exhibits strong between-place relationships but shows more evidence of responding to changes in project activity within places. Patents therefore appear more closely associated with established and spatially embedded innovation capacity, while trademarks may capture a more commercially oriented form of innovation that responds more quickly to changes in local business and project activity.

The results also support the central proposition that innovation is not determined by R&I investment alone. The context, characteristics and connectivity of places condition their capacity to generate, absorb, and commercialise knowledge. However, no individual non-R&I factor provides a sufficient explanation of local innovation performance. The descriptive analysis similarly finds mostly weak-to-moderate pairwise correlations between patenting and individual place indicators, suggesting that innovation emerges from multidimensional local systems rather than simple one-to-one relationships.

Three principal conclusions emerge:

- Place context matters, but mainly as part of a wider local system. Crime and engagement with local politics do not operate as simple independent drivers of innovation. Their relationships vary by innovation outcome and level of analysis.

- Local characteristics are particularly important for differentiating innovation trajectories. Housing-market conditions and established skills concentrations are more strongly associated with patents, while changes in higher-level skills and project activity are more consistently related to trademarks.

- The use and quality of connectivity matter more than infrastructure presence alone. Station usage is positively associated with both innovation outcomes, whereas simply having a station is not. Similarly, advanced broadband and the elimination of residual access gaps are more informative than basic broadband availability.

Place-based innovation interventions should combine evidence that analyse the interactions of R&I support with evidence on localised skills, labour-market functioning, housing, transport use and digital capability as appropriate policy mixes vary across places because the same intervention can operate differently depending on existing institutional capacity, human capital and connectivity.

5.2 Public R&D business support - Innovate UK support

The innovation models distinguish changes within local areas (local authority districts LADs or local statistical units ITL3s) outcomes over time from persistent differences between subregional areas, with separate specifications for the number of Innovate UK projects and the value of the awards.

The clearest and most consistent patent results is at the between LAD level. Across crime, housing, health, broadband, skills, rail, station usage and turnout models:

The coefficient for Innovate UK projects is positive and significant in every report model. It generally ranges from approximately 0.97 to 1.37, depending on the specification. The coefficient for award value is also consistently positive and highly significant, generally ranging from approximately 0.26 to 0.36. By contrast, the direct within-LAD project and award coefficients are usually small and statistically insignificant.

This shows a strong cross-sectional or place-level association: areas that receive more Innovate UK-supported projects or funding also tend to produce more patents. The results provide much less evidence that a short-term increase in support within a given area is immediately followed by a corresponding increase in patents.

Figure 7. Multilevel estimate for Innovate UK support and patents

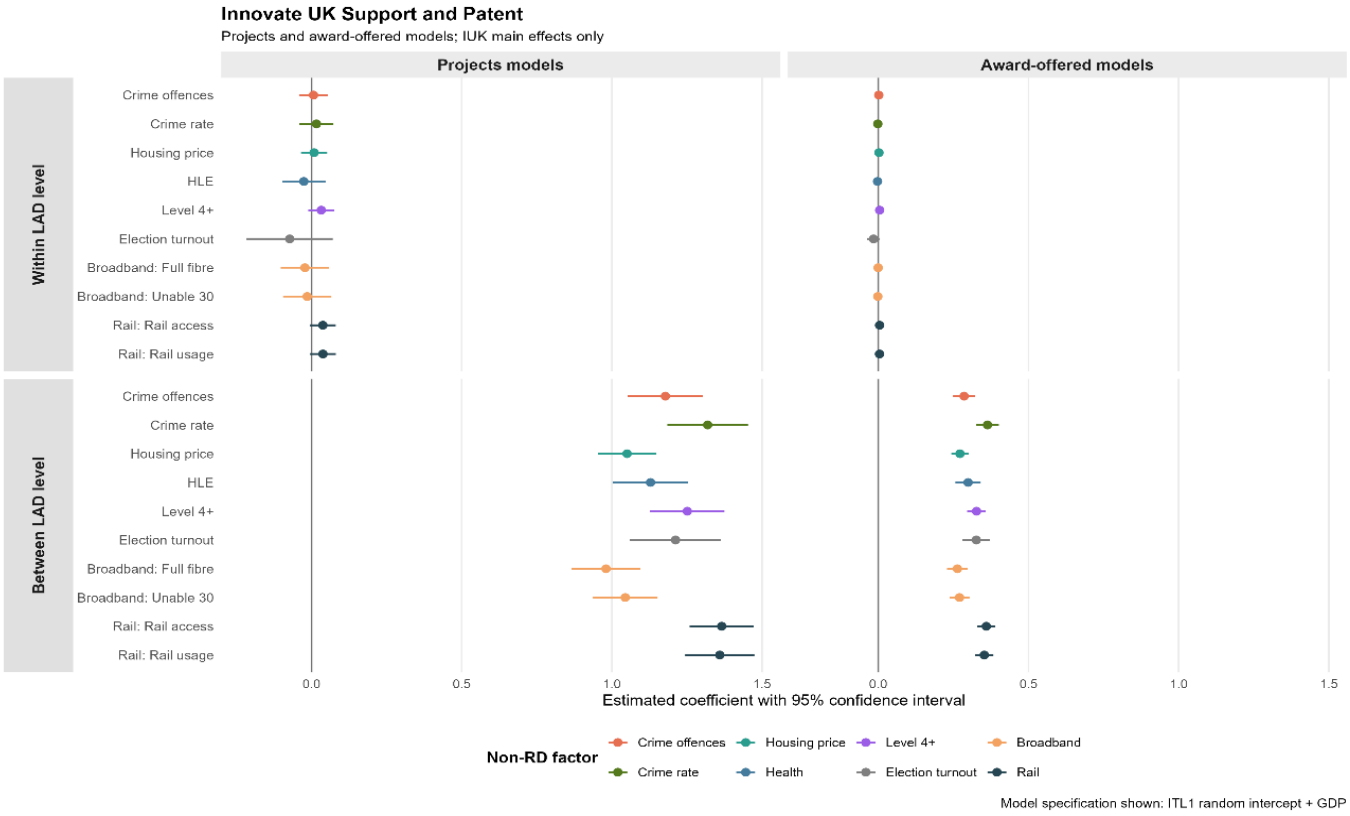
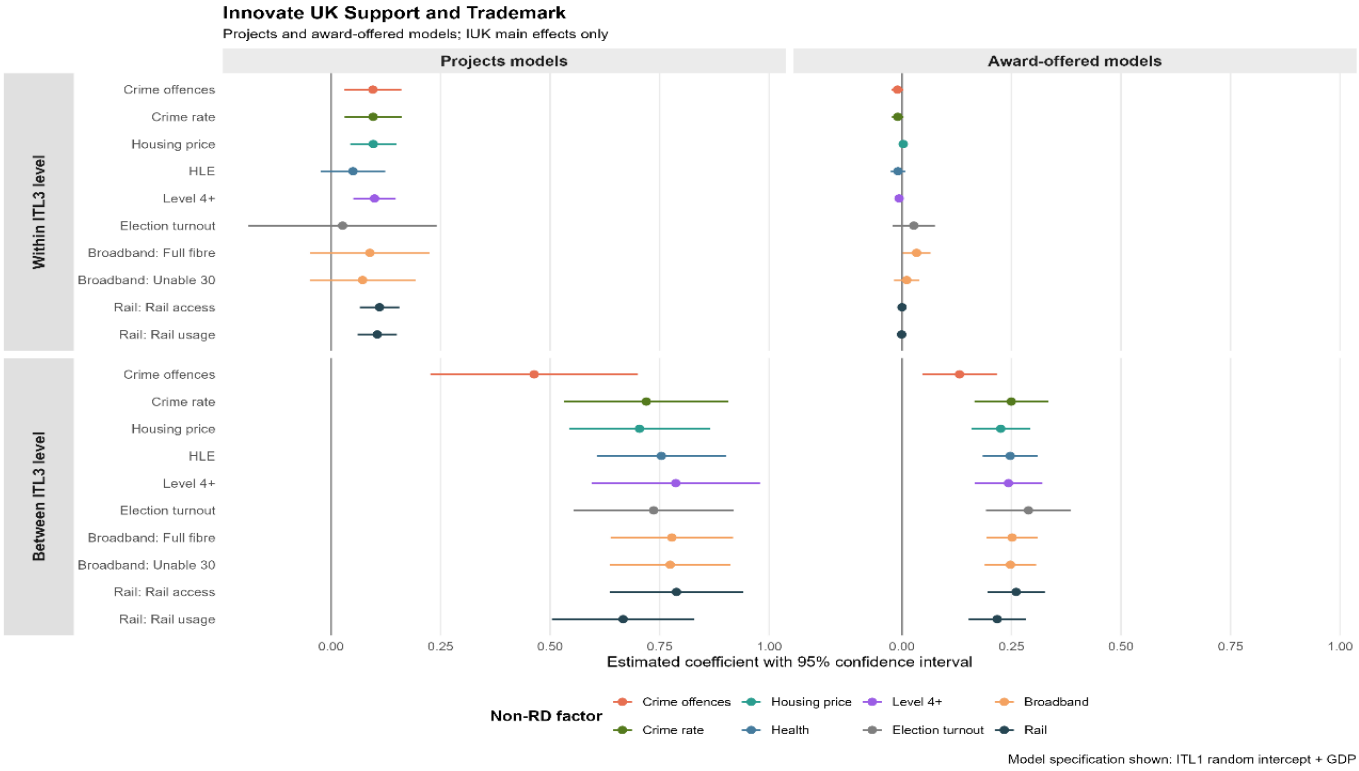


Figure 8. Multilevel estimate for Innovate UK support and trademark



5.3 Place context

We define place context as the institutional and macroeconomic environment that shapes the risks, expected returns and coordination costs associated with innovative investments. Credible institutions, predictable policy frameworks and effective coordination can extent firms' investment and facilitate collaboration among the private sector and public bodies.

5.3.1 Crime and the wider urban environment

The descriptive statistics show that crime varies substantially between and within regions. Its geography is locally differentiated, with no uniform national distribution.

The multilevel linear patent models are consistent with this descriptive evidence. Crime has no robust direct association with patents within LADs or across LADs in separate models. A positive interaction between between-place crime and Innovate UK award value nevertheless indicates that the association between funding and patenting may vary across different local contexts with coefficients between 0.073 and 0.086. This means that the positive place-level association between Innovate UK funding and patents is stronger in higher-crime areas. This should not be interpreted as evidence that crime promotes innovation. Rather, crime may proxy unobserved aspects of urban scale, economic structure or local institutional conditions.

The trademark linear results differ. Crime has no significant within-area relationship with trademarks, but its between-area coefficient is positive and highly significant across the

specifications. This suggests that higher-crime areas also tend to be places with more trademark activity, after accounting for the model controls. Again, the result is likely to reflect broader structural characteristics of economically active and urbanised places, rather than a beneficial effect of crime.

The multilevel econometric results confirm that a simple linear specification provides an incomplete account of this relationship. When crime is expressed as a rate, its direct coefficient is not statistically significant for patents, either within LADs or between LADs. Innovate UK project numbers and award values nonetheless remain positive and highly significant between places, demonstrating that the principal relationship between Innovate UK support and patenting is robust to the use of a crime-rate measure.

Figure 9. Multilevel estimate for place-context factors and patent

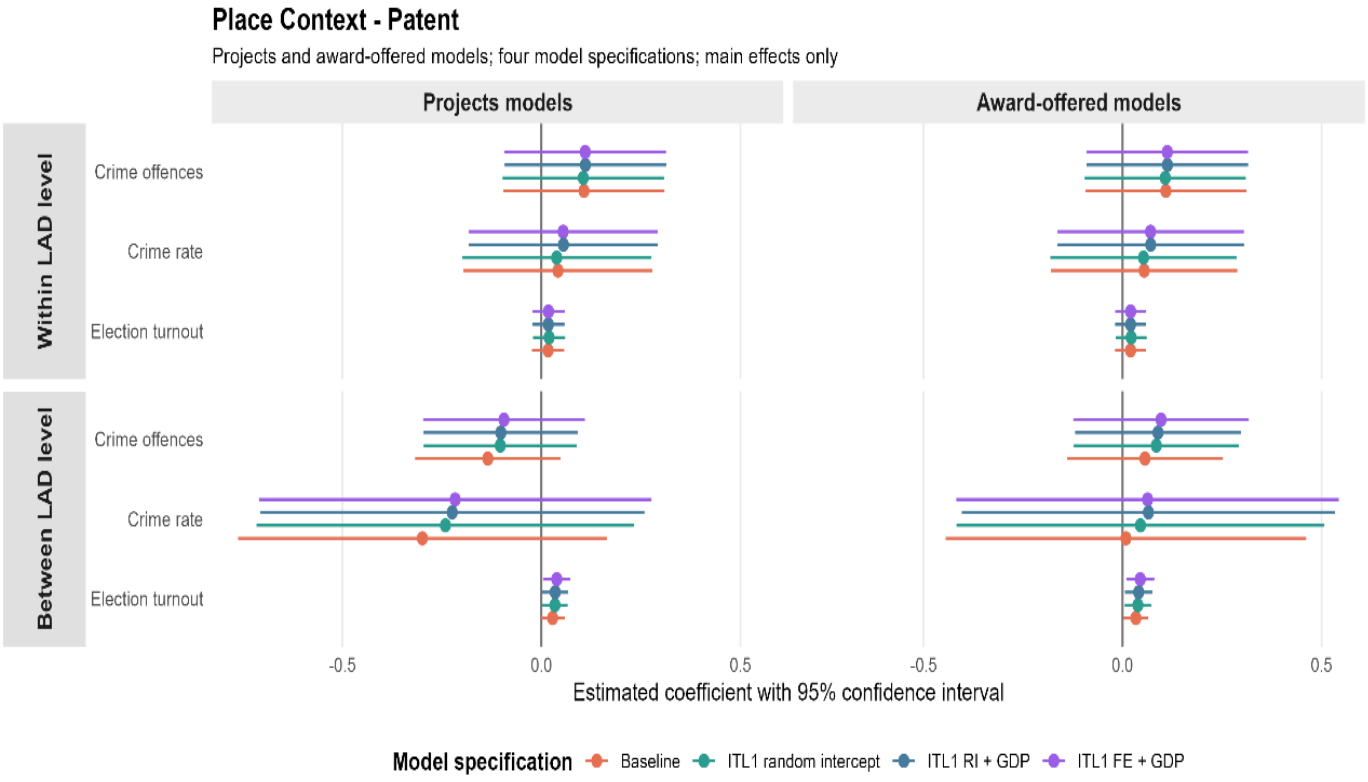
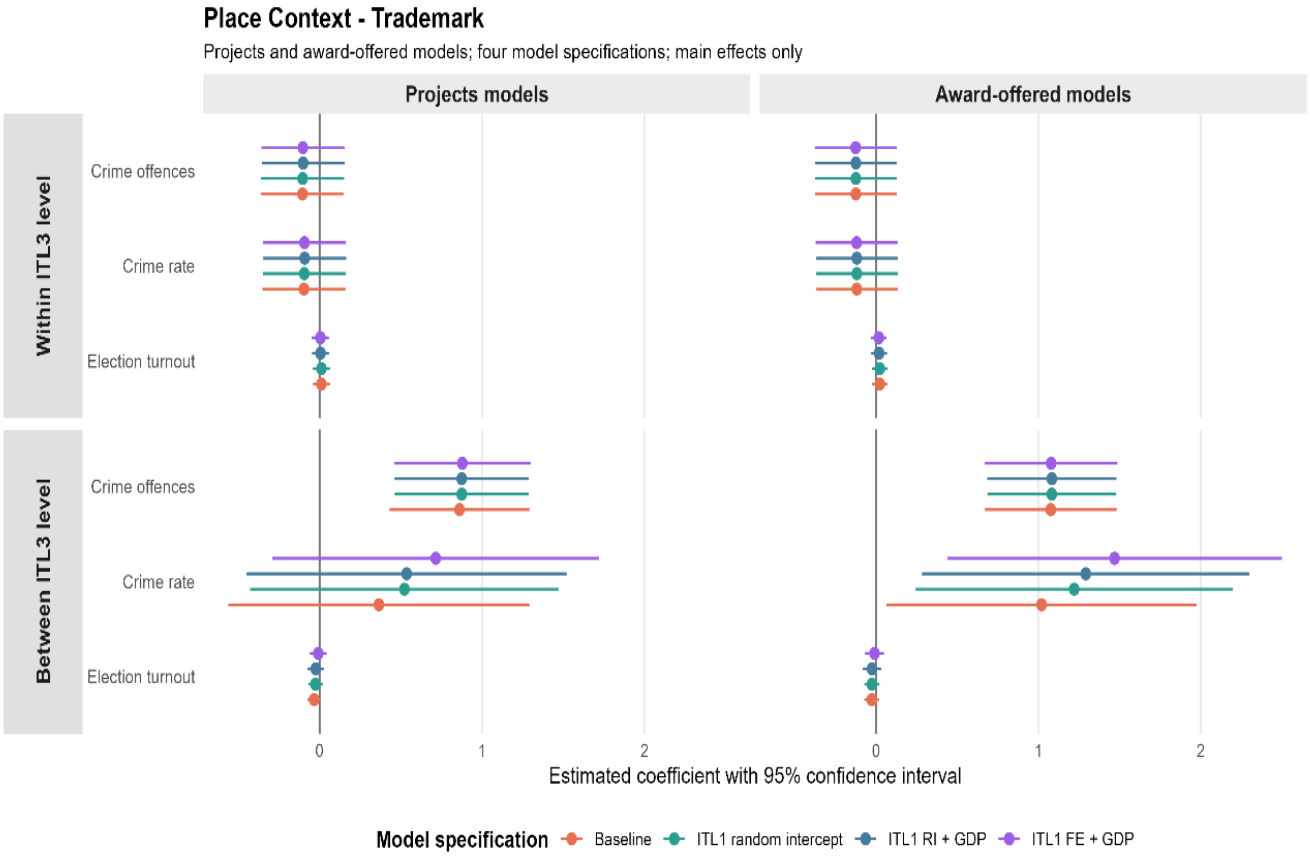


Figure 10. Multilevel estimate for place-context factors and trademark



The non-linear specifications reveal a more complex pattern. Within LADs, the crime-rate coefficient is positive and statistically significant, while the squared crime-rate coefficient is negative and significant across all project and award models. This combination is consistent with an inverted U-shaped association. Patenting initially increases with the crime rate, but the estimated relationship weakens and eventually becomes negative as the crime rate rises. Because the workbook does not report marginal effects or an explicitly calculated turning point, the precise threshold should not be inferred from the coefficients alone.

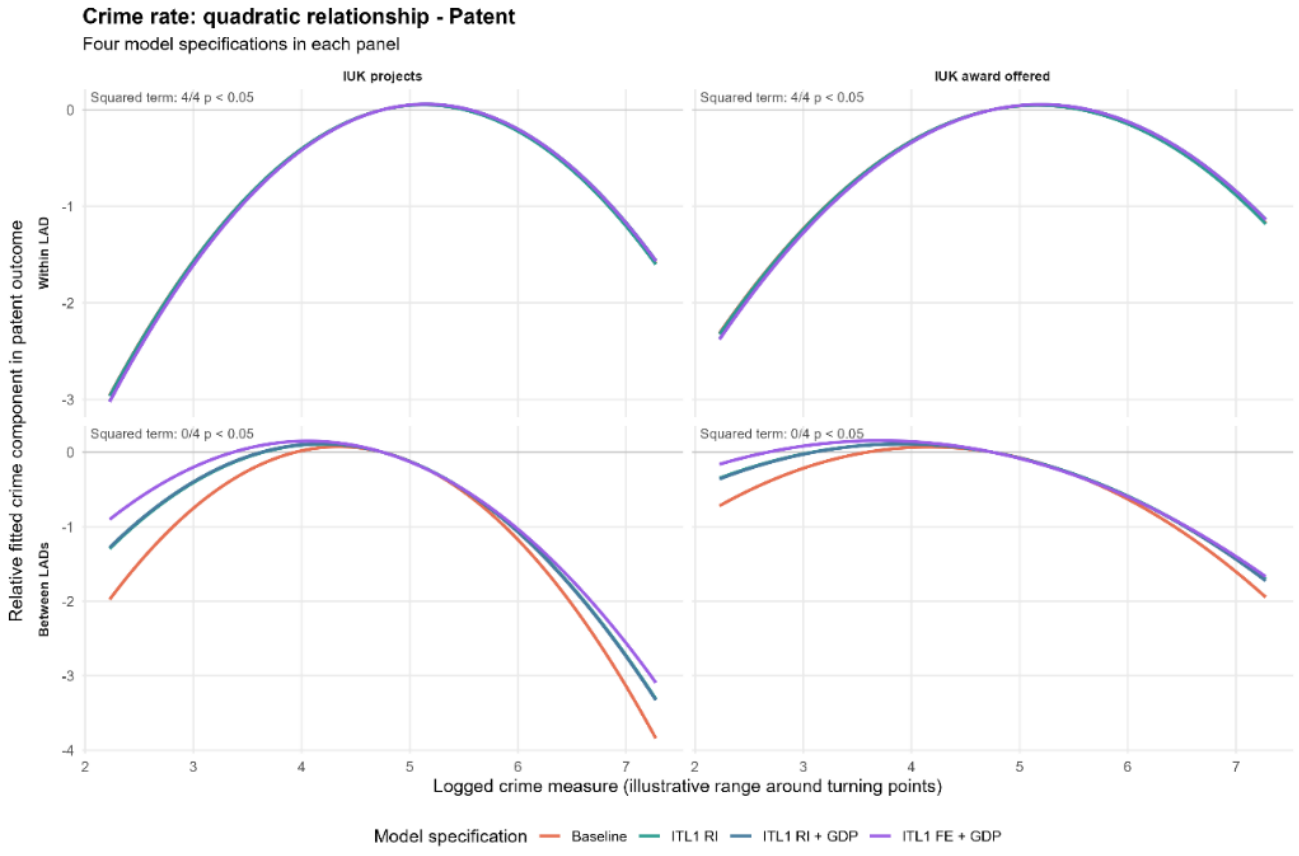
The interactions between crime rates and Innovate UK project activity are also non-linear. Within LADs, the interaction between the crime rate and project numbers is negative, while the interaction involving the squared crime rate is positive. The equivalent between-place interactions follow the same pattern and are statistically significant. The association between Innovate UK projects and patenting therefore varies across the crime-rate distribution rather than changing at a constant rate. Interactions with award value provide weaker evidence, although selected between-area terms are significant or marginally significant.

For trademarks, the linear crime-rate coefficient is negative but statistically insignificant within ITL3 areas. Between areas, crime rates have positive and statistically significant coefficients in

the award models, particularly after regional controls are introduced. Innovate UK project and award coefficients remain positive and highly significant between areas.

The direct squared crime-rate terms are not statistically significant in the trademark models. However, the interaction results provide strong evidence of non-linearity in how local context conditions Innovate UK support. For projects, the interaction with the crime rate is negative, and the interaction with the squared crime rate is positive, both within and between areas. The between-area interactions are highly significant across all specifications. The award models show an equivalent pattern between areas, with negative linear and positive squared interaction terms.

Figure 11. Quadratic relationship between crime rate and patents from multilevel models



Taken together, these findings modify the interpretation of crime in three respects. First, the absence of a strong simple correlation does not rule out a more complex association. Second, the direct relationship differs between patents and trademarks: non-linearity is evident in the direct patent relationship but is concentrated in the Innovate UK interactions for trademarks. Third, crime should not be interpreted as an innovation input or policy lever. It is more appropriately regarded as an indicator of the broader local environment within which innovation and public support operate.

5.3.2. Local political and institutional context

Local election turnout has no statistically significant within-place association with either patents or trademarks. Between LADs, however, turnout is positively associated with patents, while the corresponding trademark relationship is not statistically significant. The descriptive analysis likewise shows only a weak negative rank association of −0.143 between patents and the non-status-quo seat share across 209 LADs. Political variables should therefore be treated as indicators of the broader local context rather than as standalone explanations of innovation performance.

Overall, context of place findings support a systems interpretation. Institutional and political conditions may shape innovation by affecting credibility, coordination and firms' expectations, but the available indicators do not identify a single contextual factor that consistently determines both patents and trademarks.

5.4 Characteristics of place

Place characteristics shape innovation through scale, workforce capabilities and the capacity to attract and retain workers and investment. Among them highlight the importance of human capital, health, housing, local amenities, and labour-market functioning in determining whether places can generate and absorb knowledge.

5.4.1 Skills and absorptive capacity

The skills results reveal an important distinction between innovation outcomes. The share of the population qualified at Level 4 or above is positively and consistently associated with patenting between LADs, but not with changes in patent activity within the same LAD. Higher skills therefore distinguish places with stronger established patenting capacity, but annual or short-term changes in the skills indicator do not correspond to immediate changes in patents.

For trademarks, Level 4+ qualifications have a positive and statistically significant within-area association across all specifications. Innovate UK project activity is also positive and significant within these models. Trademarking consequently appears more responsive to local changes in higher-level human capital and project activity.

These results are consistent with previous evidence that puts human capital as a clear determinant of absorptive capacity. Skills enable firms to adopt, adapt and generate knowledge and increase local problem-solving capacity. They may also complement connectivity and public innovation investment by allowing firms to exploit external knowledge and collaborative opportunities.

5.4.2 Housing and place attractiveness

Housing prices are one of the most robust predictors of patenting. House prices have positive and statistically significant associations with patents both within LADs over time (ranging from 0.379 and 0.494) and between LADs (0.294 and 0.868). The result remains consistent across project and award specifications. House prices vary markedly between regions, particularly between London and the South East and the rest of the UK, but there are also substantial differences between LADs within each region. Higher house prices are concentrated in major urban and economically dynamic areas and broadly overlap with the geography of economic opportunity and innovation intensity. The positive patent coefficient should not be interpreted as evidence that increasing housing costs directly causes innovation. House prices may capture agglomeration, demand for productive locations, access to skilled labour, local amenities and expectations about future economic performance. At the same time, the literature reviewed in the report identifies a potential countervailing mechanism: unaffordable housing can restrict labour mobility and increase wage and occupancy costs for innovative firms.

The relationship is weaker for trademarks. House prices are not statistically significant within areas, and positive between-area coefficients emerge only in the more fully controlled award models. However, the positive within-area interaction between house prices and Innovate UK award value suggests that funding may be associated with more trademark activity in areas experiencing stronger housing-market conditions.

Housing conditions therefore appear to be more closely associated with the established innovation capacity captured by patents than with trademark activity.

5.4.3 Health and workforce participation

Healthy life expectancy varies substantially across and within regions and changes more slowly than housing prices or crime. It can be treated as an indicator of long-term local wellbeing, deprivation, health behaviour and access to public health-related services rather than a measure that captures short-term economic adjustment.

The econometric relationship is not straightforward. Healthy life expectancy is negatively associated with patents within LADs, while some between-LAD estimates are weakly positive. Health has no robust direct association with trademarks, although selected interactions indicate that it may condition the association between Innovate UK support and innovation.

The negative within-LAD patent coefficient should be interpreted cautiously. It does not imply that poorer health promotes innovation. The direction may reflect differences in measurement periods, compositional change, omitted local dynamics or the distinctive trajectories of highly innovative urban areas. The wider evidence supports treating health as part of the workforce and participation environment rather than as an isolated predictor of innovation.

Figure 12. Multilevel estimate for place-characteristic factors and patent

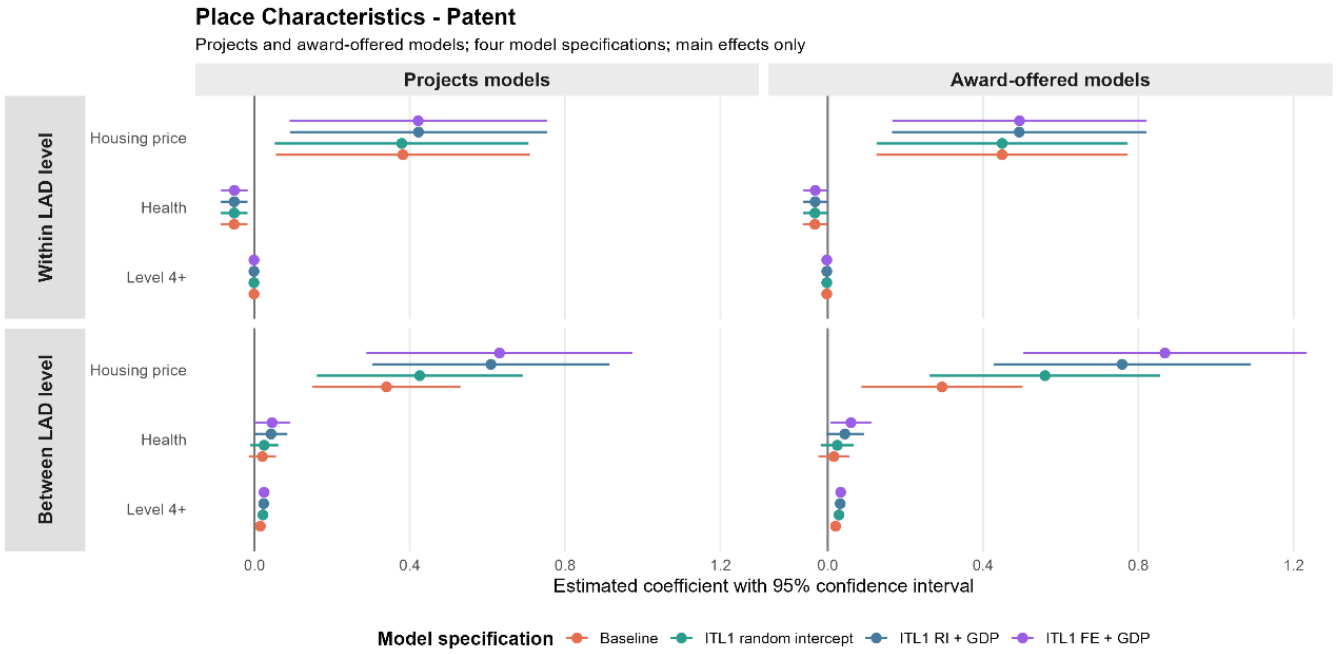
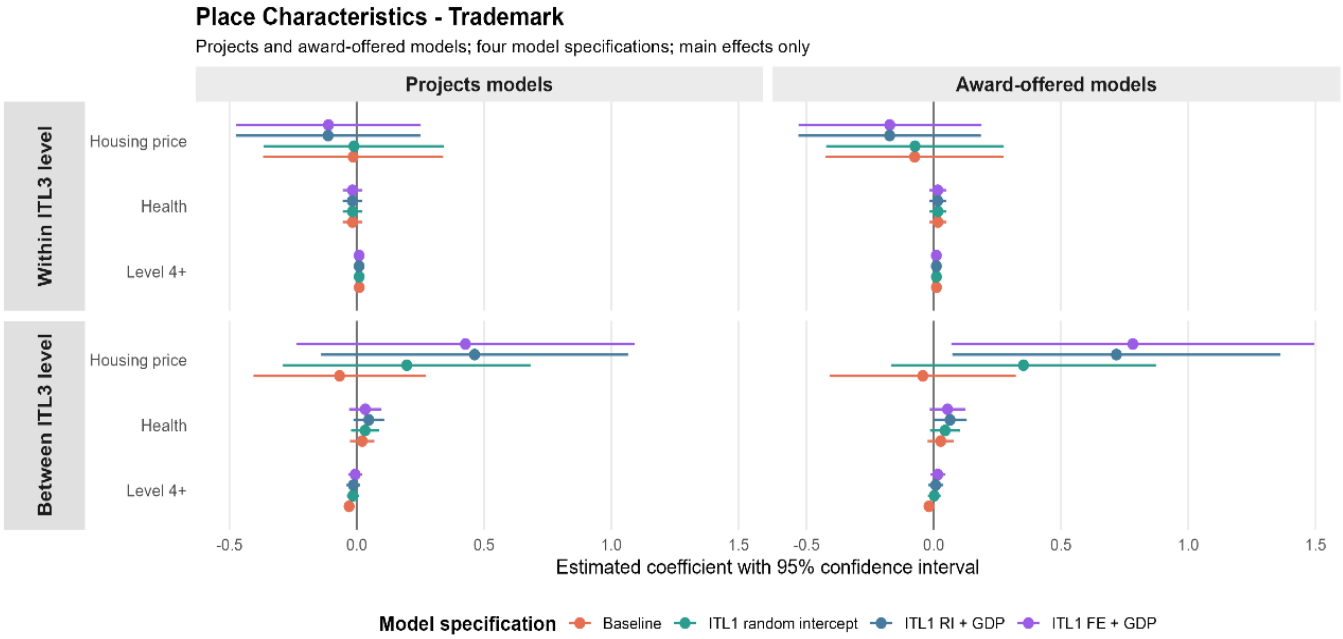


Figure 13. Multilevel estimate for place-characteristic factors and trademark



5.5 Connectivity of place

Connectivity influences innovation by expanding access to markets and labour, facilitating interactions and enabling knowledge circulation between firms, workers and research organisations. Access to infrastructure may not be sufficient in itself. Innovation effects depend on infrastructure quality, actual use and the complementary capabilities of firms and workers.

5.5.1 Digital connectivity

Our descriptive analysis shows that broadband access has improved markedly, but continuing differences in quality, speed and residual access gaps exist. Spatial disparities increasingly concern access to full fibre, ultrafast services and last-mile connectivity rather than basic broadband coverage. These disparities are especially pronounced between LADs within the same region.

The econometric findings support this more differentiated interpretation:

- Full-fibre coverage is positively associated with patents between LADs, but not with changes in patenting within LADs.
- The between-place interaction between full fibre and Innovate UK award value is positive and highly significant, indicating that stronger digital infrastructure may complement innovation funding.
- A higher share of premises unable to receive 30 Mbps is negatively associated with patents within LADs.
- Full fibre has no consistent direct association with trademarks, but it positively moderates the within-area relationship between award value and trademark activity.
- Poor broadband access weakens the within-area association between Innovate UK support and trademarks.

Taken together, these results are consistent with the literature that treats broadband as a potential threshold condition. Once basic coverage is widespread, marginal differences in headline availability provide limited explanatory power. Connection quality, residual access gaps and firms' capacity to use the infrastructure become more important.

5.5.2 Transport connectivity

The simple presence of a rail station is not robustly associated with patents and has no consistently positive relationship with trademarks. The descriptive patent analysis similarly reports a weak rank association of −0.085 between station density and patenting across 347 LADs.

Actual station usage produces a substantially clearer pattern. Usage is positively and significantly associated with patents within LADs in every specification, with additional positive between-place results in the funding models. Rail usage is also positively associated with trademarks within areas and becomes positive and significant between areas once regional controls are introduced.

This distinction is important. It suggests that innovation is more closely related to the effective use of transport networks than to the mere availability of physical infrastructure. Frequently used connections may provide better access to specialised labour markets, customers, suppliers, universities and knowledge networks. This interpretation supports the evidence on interaction intensity, market reach and access to proximate innovation centres.

Figure 14. Multilevel estimate for place-connectivity factors and patents

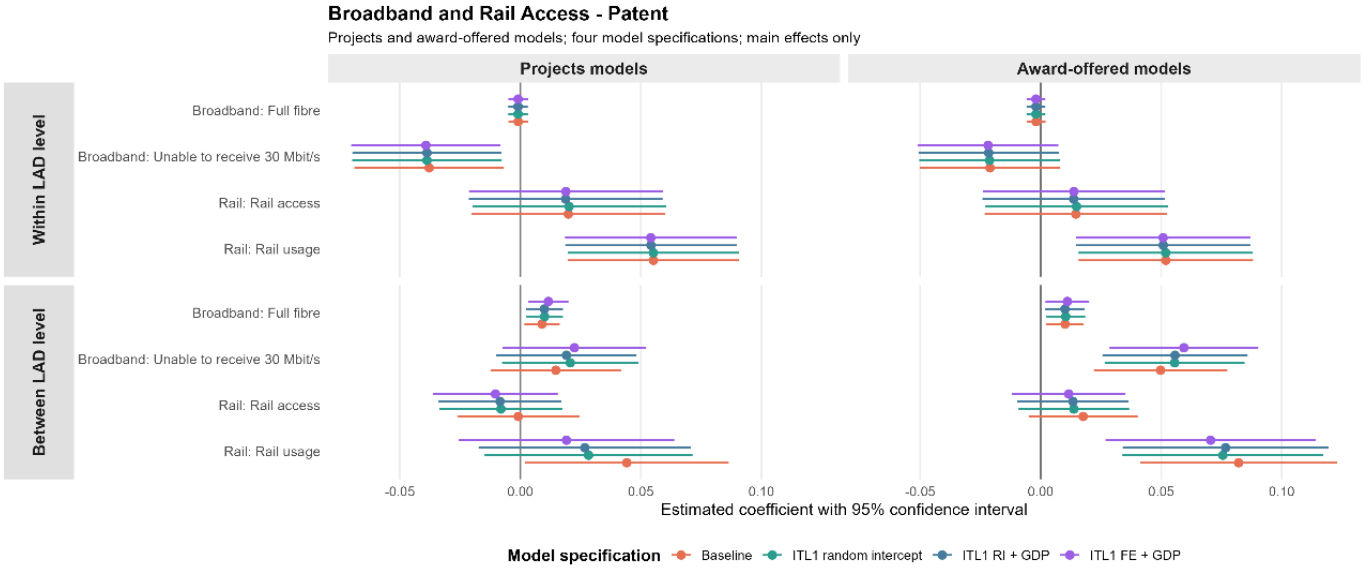
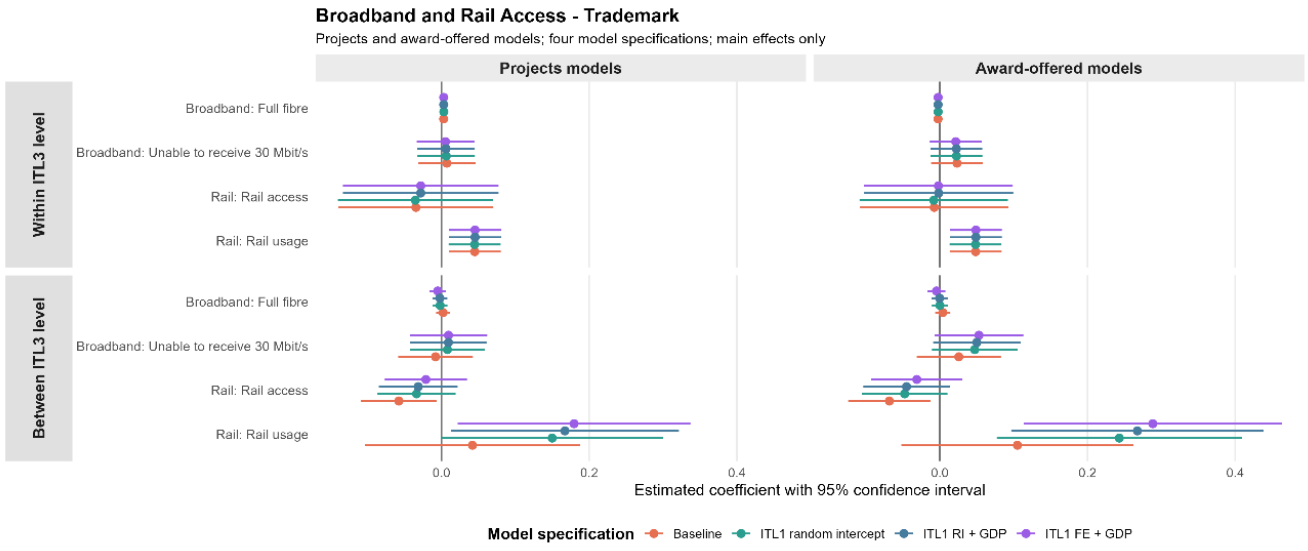


Figure 15. Multilevel estimate for place-connectivity factors and trademark



5.6 Synthesis

The results on patents reflect a more established and spatially embedded technological capacity across the UK local areas, while trademarks appear more responsive to local changes in skills and project activity. It is important to note that the model coefficients should not be compared directly because the samples and geographies differ.

The results show that Innovate UK support is positively associated with local innovation, but outcomes also depend on wider place conditions. More enabling conditions include higher skills, good population health, affordable and accessible housing, strong full-fibre coverage, minimal broadband gaps, and well-used, reliable transport links. Lower crime and stronger civic participation are desirable in their own right, although their links with innovation are less direct. Overall, innovation funding is likely to be more effective when combined with place-specific measures that strengthen these complementary conditions.

6. Policy Implications, Investment Opportunities and Concluding Remarks

6.1 Policy Implications and Investment Opportunities

Our findings suggest that place-based innovation funding should be part of a broader, integrated innovation policy rather than a standalone intervention. Research and Innovation funding (Innovate UK projects and awards) remains important for both patent and trademark activities across places, but its effectiveness depends on the institutional conditions, capabilities and connections available within each place. The following priorities translate the report's evidence into areas for policy development.

- *Target innovation interventions below the subnational level.* The analysis shows that innovation disparities are primarily local. In 2022, 82.4% of measured patent inequality was explained by the differences between local authorities within the same ITL1 regions. Regional averages can therefore hide substantial variation in innovation capacity, skills, housing conditions or connectivity. Policy design should use evidence at local-authority or comparable subregional level wherever data quality allows. This does not require every locality to receive a separate programme. Rather, broad regional initiatives should incorporate differentiated local delivery models, eligibility criteria and complementary support. Local diagnostics should identify established capabilities, barriers to innovation participation and connections to neighbouring innovation centres.

- *Align innovation funding with local and regional strategies.* Innovate UK projects and award values are positively associated with both patents and trademarks when comparing places. However, the predominance of between-place relationships

suggests that funding is embedded in wider innovation ecosystems rather than operating independently of them. National innovation programmes should therefore be aligned with local economic strategies, cluster initiatives and place-based governance arrangements.

- *Strengthen the capacity of places to access innovation support*. The spatial funding distribution may partly reflect local differences in the ability to identify opportunities, prepare applications and coordinate partnerships. Places with well-established universities, intermediaries and innovation-active firms may be better positioned to secure support, independently of their underlying innovation potential. Policy should therefore complement competitive funding with capacity-building measures.

- *Integrate skills development with innovation programmes.* Higher-level skills are associated with stronger patenting capacity across places and with changes in trademark activity within places. This indicates that human capital supports both the generation of new knowledge and its translation into commercially oriented innovation. Innovation programmes should be linked more systematically with higher education, technical education and workforce-development provision.

- *Address housing and labour-market constraints.* Higher house prices are strongly associated with patent activity. This relationship is likely to reflect the concentration of innovation in productive, high-demand locations with established labour markets and knowledge networks. However, high housing costs may also restrict the movement and retention of skilled workers and increase operating pressures for start-ups and scale-ups. Innovation policy should therefore be coordinated with housing, planning and labour-market policy. In established innovation centres, the priority may be to prevent affordability and space constraints from undermining access to specialised employment and business premises. In emerging locations, the focus may be on strengthening amenities, employment opportunities and connections that make those places attractive to firms and skilled workers.

- *Prioritise the quality and effective use of connectivity.* The results suggest that digital connectivity operates as an enabling or threshold condition of innovation. Full-fibre availability is associated with patenting across places, while residual broadband gaps appear to constrain some innovation relationships. For trademarks, full fibre strengthens the within-area association between award value and activity, while poor access weakens the relationship between Innovate UK support and trademarking. Policy should therefore move beyond headline measures of basic broadband availability. Priorities should include eliminating persistent access gaps, improving connection quality and reliability, and ensuring that businesses can afford and effectively use advanced digital services. Infrastructure investment complemented with support for

technology adoption, digital literacy, and managerial skills in digitalisation and organisational change.

- *Connect places to innovation networks, not simply infrastructure.* The positive relationship between rail usage and innovation (both patents and trademarks), alongside the limited role of station presence, suggests that effective connectivity matters more than existence of physical infrastructure. Transport policy should focus on effective connections to labour markets (journey frequency, reliability, affordability) and access to major employment and research centres, such as universities and research institutions, rather than infrastructure presence alone. Transport and innovation strategies should be coordinated around functional economic relationships rather than administrative boundaries.

- *Evaluate outcomes using multiple innovation indicators.* Patents and trademarks capture different forms and stages of innovation. Patents are more closely associated with technological invention and established innovation capacity, whereas trademarks may capture commercially oriented activity and appear more responsive to changes in local project activity and skills. Programme evaluation should use both indicators, alongside other measures (product and process innovation, business R&D, collaboration, technology adoption, firm formation, scale-up activity, firm performance indicators) where available, and should distinguish between persistent differences across places and changes within places. Place-based programmes should incorporate evaluation frameworks that assess how local conditions affect implementation and outcomes.

6.2 Concluding remarks

Taken together, these priorities support a shift from viewing place-based innovation policy principally as the geographical allocation of funding towards viewing it as the coordinated development of local innovation capacity.

The central policy implication is that innovation support should be adapted to the specific barriers and opportunities of different places, while remaining connected to national priorities and neighbouring economic systems.

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APPENDIX A. Data and Supporting Descriptive Evidence

This appendix provides additional information on data construction, geographical coverage and the descriptive analysis supporting Sections 3 and 4. Definitions, sources and periods for all indicators are reported in the summary table in Section 3. The main findings on the geographical distribution of patents and trademarks and the decomposition of innovation inequality are presented in Section 4.

A.1 Data construction and coverage

A.1.1 Patents

The Orbis IP patent search was based on patents with either inventors or applicants based in the UK, using priority dates from 01/01/2009 to 31/12/2025. This search returned 1,144,950 patents.

Within the downloaded patent data, patents can be divided into three broad groups: patents involving only UK-based applicant firms; patents involving both UK and foreign applicant firms; and patents in which all applicant firms are foreign, but at least one inventor is based in the UK. The third group is important because it captures UK inventive activity that would be missed if patents were identified only through applicant location.

Across the full 2009–2025 period, most UK-inventor patents include at least one UK applicant: 832,381 patents, or around 72.7% of the total. The remaining 312,569 patents, or around 27.3%, have UK inventor involvement but no UK applicant. Between 2009 and 2022, the share of UK-inventor patents with no UK applicant generally ranges between about 25% and 30%.

This distinction is important for the regional analysis. Patents with UK inventors but no UK applicant are UK-linked in terms of inventive activity, but they cannot be assigned to UK regions using applicant-firm geography. In contrast, patents with UK applicants can be used for applicant-based regional allocation, subject to the availability of firm-level geography. For the regional descriptive analysis, patents are therefore attributed to regions based on the location of the applicant, using the applicant's mapped UK geography. A patent is attributed to a region when one of its applicants is located there.

Patent numbers fall sharply in the most recent years, reflecting the timing and incompleteness of patent publication and data availability. The main descriptive analysis therefore focuses on 2009–2022, with later observations interpreted cautiously.

A.1.2 Trademarks

Trademark data are drawn from EUIPO and measure the number of trademark applications in the local area. Applications are assigned to ITL3 areas using applicant geography. Trademarks provide a broader measure of commercially oriented innovation, while patents primarily capture technological invention.

The patent and trademark analyses use different geographical units, samples and periods. Direct comparisons of the magnitude of coefficients should therefore be avoided.

A.1.3 Innovate UK Support

We use two indicators to proxy the effect of public support for R&I – the funding activity of Innovate UK. In particular, we use:

- **Innovate UK funding:** The total value of Innovate UK awards allocated to organisations in the local area. This indicates the financial scale of public R&I support and is the report's principal measure of Innovate UK support.
- **Innovate UK projects:** The number of Innovate UK-funded projects associated with organisations in the local area. This indicates the volume of supported project activity, but not the scale of funding received.

These indicators describe the geographical distribution of Innovate UK activity and should not be interpreted as causal measures of programme impact.

A.1.4 Geographical harmonisation

The analysis combines information at different geographical levels: LADs for patents, ITL3 areas for trademarks and ITL1 regions for regional comparisons. Local data are harmonised to consistent geographical boundaries where possible.

Crime data are harmonised to LAD2025 geographical boundaries using conservative mapping rules. Records with missing geography codes, unmatched ambiguous spatial units, or Community Safety Partnerships that could not be safely assigned to a single LAD2025 were excluded. The final dataset is aggregated consistently across approximately 258 matched LADs.

Healthy life expectancy is reported in rolling three-year periods. For the purpose of linking with annual patent data, each period is assigned to the final year of the rolling window. Broadband coverage percentages are recalculated from the underlying premises counts following geographical harmonisation, producing premises-weighted coverage measures.

A.2 Descriptive statistics

Table A1 reports descriptive statistics for variables used in the LAD-level patent models. The patent measure covers 2009–2024, while Innovate UK project and funding data cover 2006–2024. The place variables span different periods and sample sizes, reflecting their availability across LADs and years. For most variables, between-LAD variation is larger than within-LAD variation, particularly for Innovate UK funding, qualifications and broadband availability. By contrast, crime, crime rate and rail access show greater within-LAD variation relative to between-LAD variation.

Table A1. Descriptive statistics for variables in the LAD-level patent models

Variable	N	LADs	Period	mean	sd	min	max	within_sd	between_sd
Innovation Performance									
Patents	5776	361	2009-2024	3.373	1.758	0	8.824	0.927	1.496
R&I Support									
InnovateUK projects	6859	361	2006-2024	1.634	1.11	0	5.545	0.698	0.864
InnovateUK funding	6767	361	2006-2024	11.092	5.111	0	19.401	4.022	3.169
Place Context									
Recorded crime	4104	296	2009-2023	7.888	0.766	5.361	10.546	0.191	0.737
Recorded crime rate	3546	291	2011-2023	5.082	0.395	3.982	7.733	0.184	0.359
Election turnout	883	294	2018-2023	33.58	4.646	22.006	51.366	1.751	4.286
Place Characteristics									
Housing price	5400	360	2009-2023	12.215	0.495	11.122	14.264	0.19	0.458
Health	2146	195	2013-2024	62.101	3.612	50.9	74.1	1.376	3.422
Level 4+ qualifications	6626	349	2006-2024	36.53	12.026	5.801	100	7.256	9.725
Place Connectivity									
Broadband (full fibre)	2281	359	2018-2024	29.632	26.517	0.005	99.142	22.64	14.129
Broadband (below 30 Mbit/s)	2281	359	2018-2024	4.671	4.76	0.015	46.016	1.854	4.705
Transport (rail access)	6650	350	2006-2024	4.413	5.042	0	94.225	0.827	4.98
Transport (rail usage)	6650	350	2006-2024	13.731	2.907	0	21.283	0.713	2.822
Control Variables									
ITL1 GDP per head	216	12	2006-2023	10.349	0.22	10.066	11.074	0.045	0.225
Population density	6859	361	2006-2024	6.413	1.482	2.197	9.728	0.044	1.483

Table A2. summarises variables used in the ITL3-level trademark models. Trademark and Innovate UK measures cover 2006–2024, while the place variables have varying periods and numbers of observations. As in the LAD-level table, several measures—especially Innovate UK funding, qualifications and full-fibre broadband—show more variation between areas than within areas. Crime, crime rate and rail access show comparatively more within-area variation. These descriptive statistics provide context for the model samples and should be interpreted alongside the differences in geographic level and data coverage.

Table A2. Descriptive statistics for variables in the ITL3-level trademark models

Variable	N	ITL3	Period	mean	sd	min	max	within_sd	between_sd
Innovation Performance									
Trademark	3097	163	2006-2024	2.735	1.225	0	8.155	0.548	1.099
R&I Support									
InnovateUK projects	3458	182	2006-2024	2.279	1.157	0	5.793	0.728	0.902
InnovateUK funding	3432	182	2006-2024	13.045	3.875	0	19.721	3.041	2.44
Place Context									
Recorded crime	1925	144	2009-2023	8.694	0.566	6.452	10.546	0.182	0.534
Recorded crime rate	1925	144	2009-2023	5.189	0.333	4.158	6.66	0.171	0.297
Election turnout	475	141	2018-2023	33.317	4.249	22.006	47.346	1.927	3.911
Place Characteristics									
Housing price	2730	182	2009-2023	12.163	0.494	11.292	13.952	0.186	0.458
Health	2151	182	2013-2024	62.498	3.237	51.35	70.2	1.29	2.971
Level 4+ qualifications	3249	171	2006-2024	36.113	10.908	13.732	77.963	6.636	8.681
Place Connectivity									
Broadband (full fibre)	1270	182	2018-2024	33.173	27.137	0.084	99.142	23.488	13.611
Broadband (below 30 Mbit/s)	1270	182	2018-2024	4.432	3.907	0.015	29.994	1.982	3.378
Transport (rail access)	3249	171	2006-2024	4.152	2.872	0	23.063	0.217	2.872
Transport (rail usage)	3249	171	2006-2024	14.335	1.362	0	18.764	0.627	1.212
Control Variables									
ITL1 GDP per head	216	12	2006-2023	10.349	0.22	10.066	11.074	0.045	0.225
Population density	3458	182	2006-2024	6.491	1.5	2.463	9.728	0.042	1.503

A.3 Data Limitations

Data coverage, geography and measurement vary across indicators. Patent and trademark analyses use different geographical units and periods; recent patent records are incomplete because of publication lags; crime data cover England and Wales rather than the whole UK; and some observations cannot be matched safely to consistent local boundaries. Healthy life expectancy changes slowly and is based on rolling periods, while broadband coverage and station presence do not measure affordability, reliability or effective use. These limitations should be considered when interpreting the descriptive and econometric findings.

APPENDIX B. Econometric Methods and Full Results

B.1 Model specification and interpretation

For each non-R&D factor, we estimate separate patent models using Innovate UK (IUK) project activity and award-offered value. Each model includes the factor, the relevant IUK measure, and their interaction at both the within- and between-LAD levels. Within-LAD coefficients describe associations with changes in the same LAD over time; between-LAD coefficients describe associations with differences in average conditions across LADs.

- **Non-R&D factor:** Its coefficient describes the association with patenting when the centred IUK measure is zero.
- **IUK support:** Its coefficient describes the association with patenting when the centred non-R&D factor is zero.
- **Interaction (moderation by place conditions):** The interaction tests whether the association between IUK support and patenting varies with a non-R&D place factor. A positive coefficient means that the estimated IUK–patenting association becomes more positive as the factor increases; a negative coefficient means it becomes less positive. At a given level of the factor, this association equals the IUK main coefficient plus the interaction coefficient multiplied by that factor level. Within- and between-LAD interactions are interpreted separately.

We estimate four specifications for each factor: a baseline model with year effects and a LAD random intercept; a model adding an ITL1 random intercept; a model also controlling for ITL1 GDP per head; and an alternative using ITL1 fixed effects with the within-ITL1 GDP control. Comparing the four shows how sensitive the estimates are to these regional controls. The grouped coefficient plots report all four specifications, while the all-factors overview displays the **ITL1 random intercept + GDP** specification for readability. Points show coefficient estimates; 95% confidence intervals crossing zero indicate that an individual coefficient is not statistically distinguishable from zero at the 5% level.

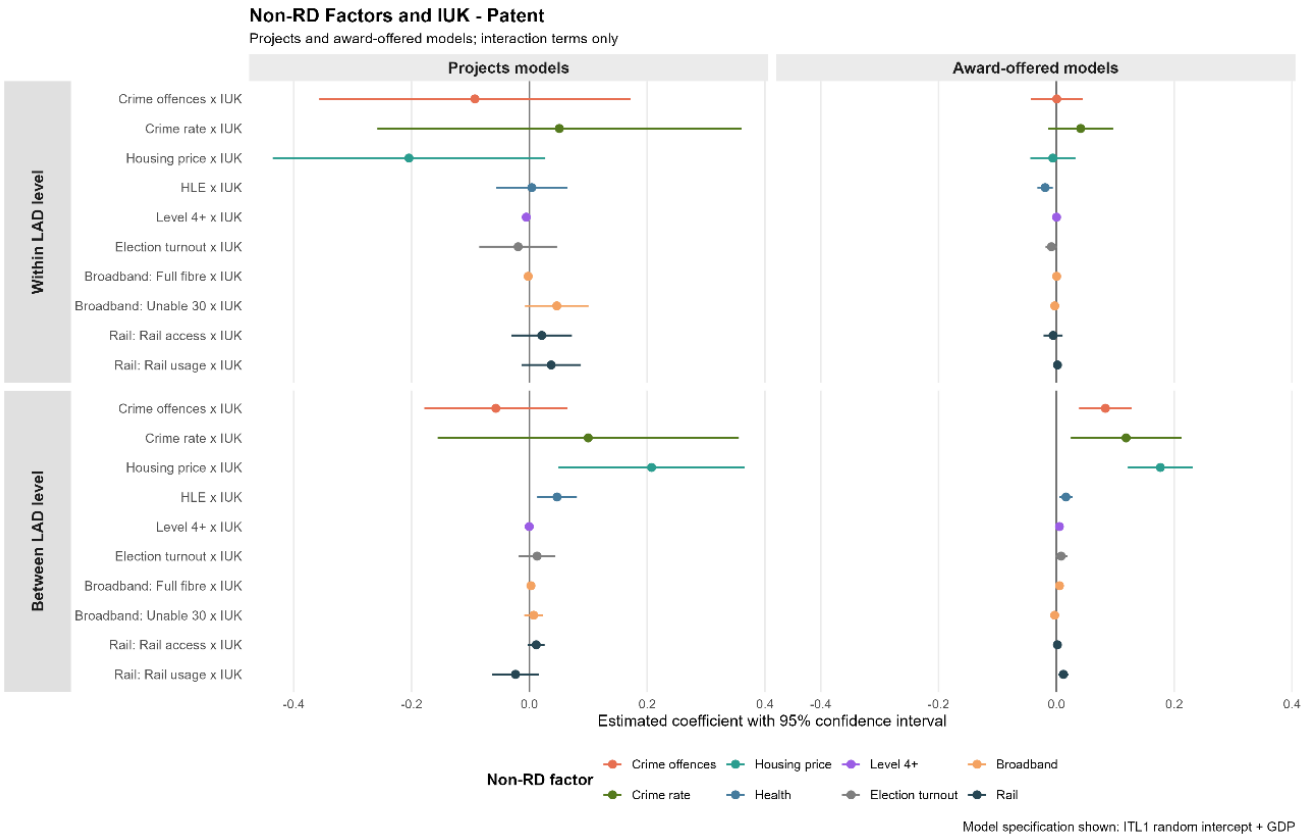
B.2 Interaction and non-linear models

B2.1 Patent model

Interaction effects

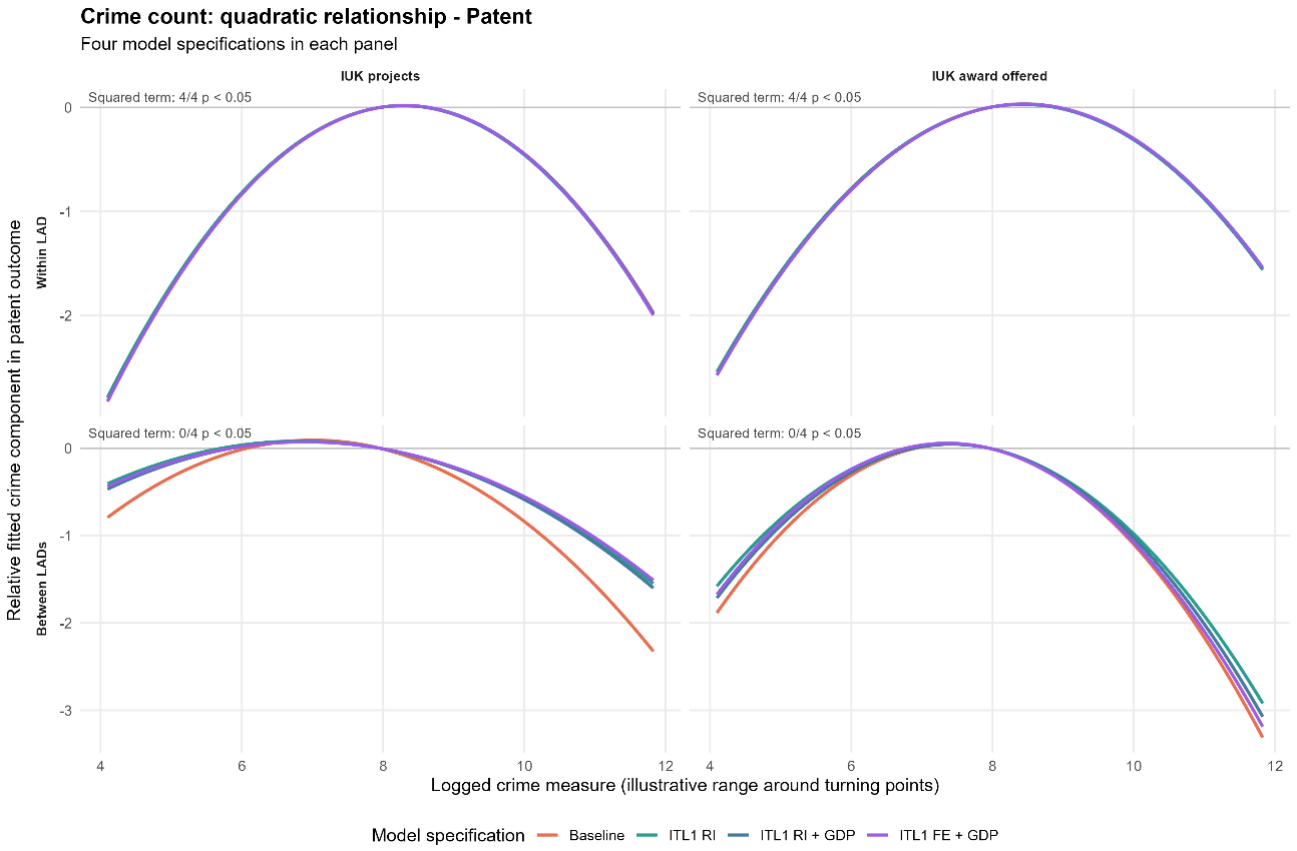
- Most within-LAD interactions are imprecisely estimated, with confidence intervals overlapping zero.
- Between LADs, the interactions between housing price and both IUK measures are positive. Interactions for healthy life expectancy are also positive; the crime-rate interaction is positive in the award-offered model.

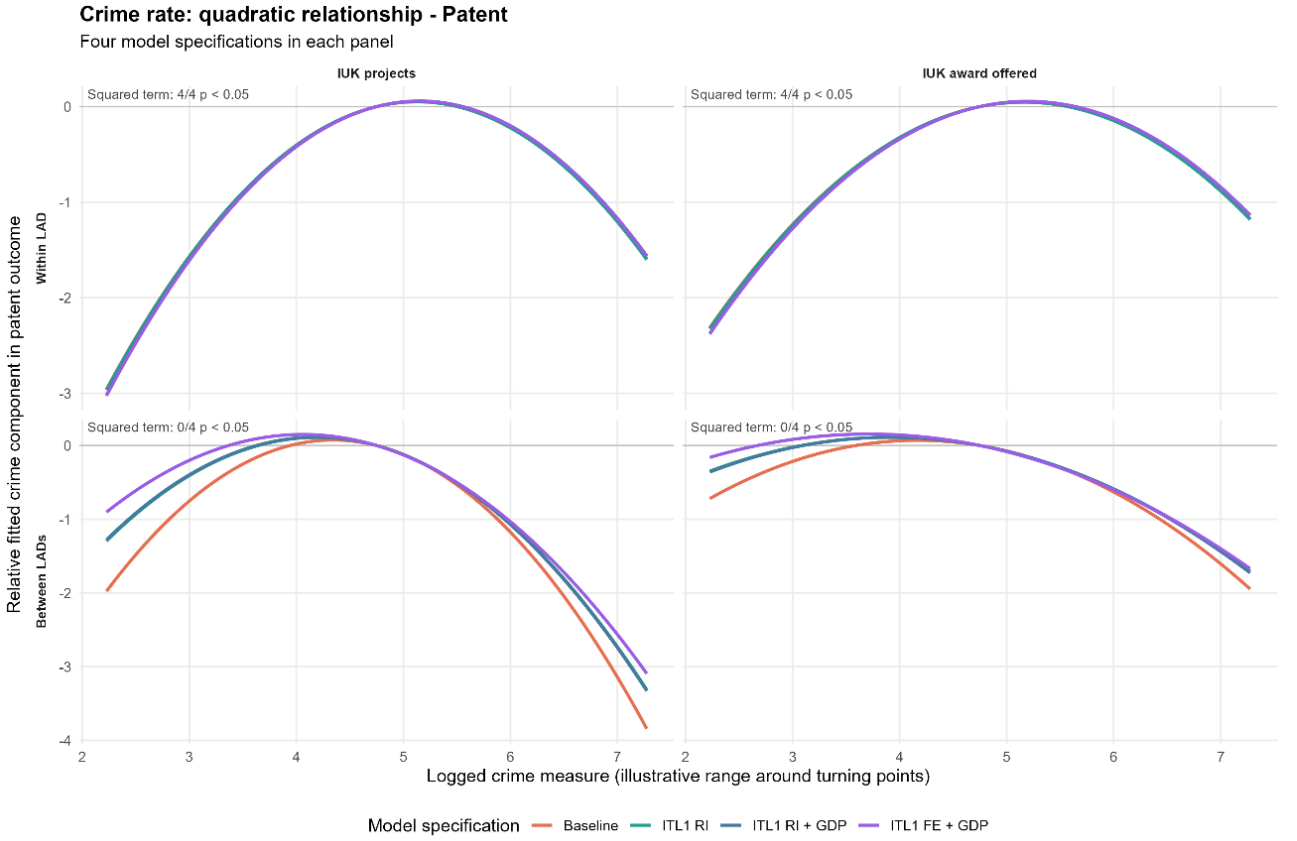
- Overall, Evidence that place-based non-R&D factors moderate the association between IUK support and patenting is concentrated in a few factors; most interaction estimates are imprecise.



Non-linear crime models

- **Crime offences and crime rate show a similar pattern:** within-LAD relationships are concave and inverted U-shaped, with significant squared terms in all four specifications for both IUK measures.
- **An inverted U implies that** the fitted patenting component initially rises with crime, then falls beyond the curve's peak. The plotted turning points are illustrative and should not be treated as confirmed values within the observed data range.
- **Between LADs,** the curves appear inverted U-shaped, but none of the squared terms is statistically significant; the plots therefore provide no robust evidence of between-LAD curvature.

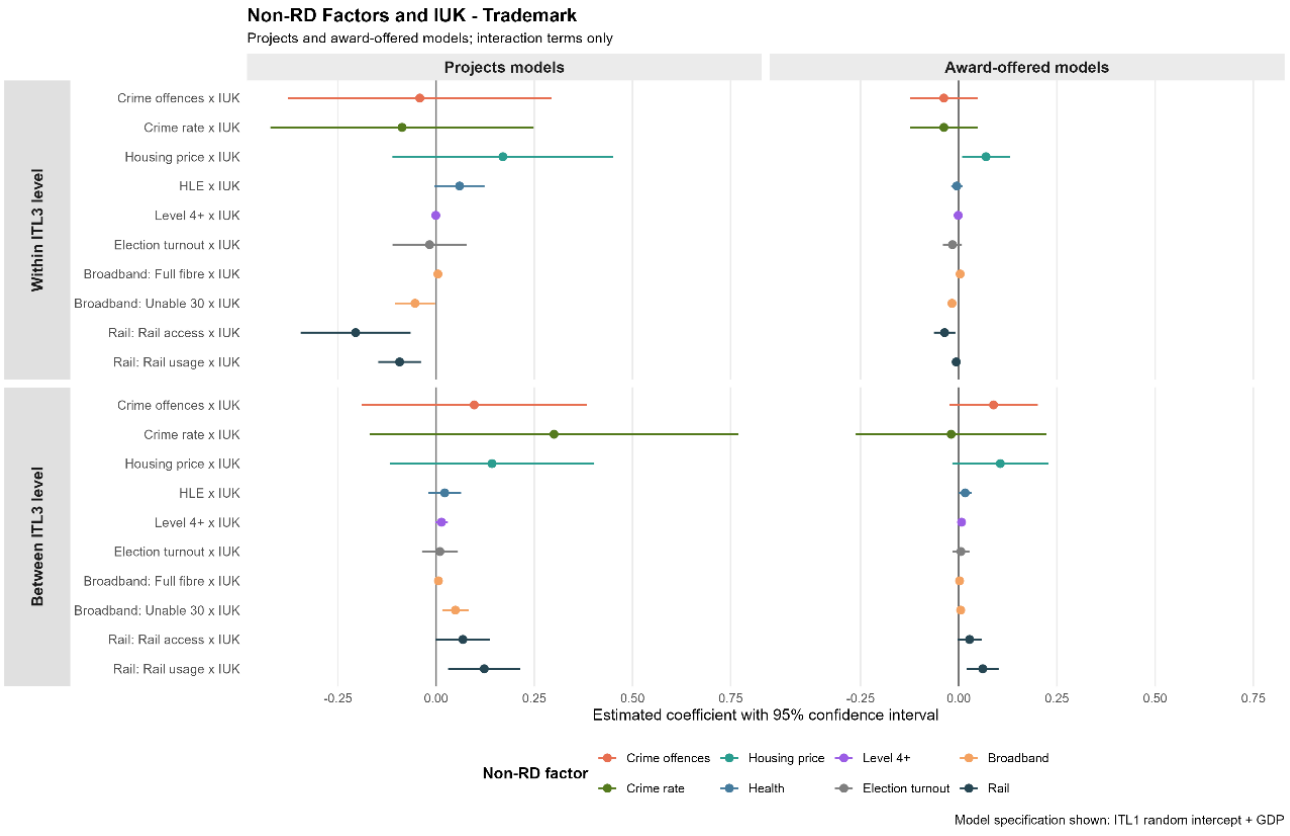

Crime count: quadratic relationship - Patent
Four model specifications in each panel
IUK projects
IUK award offered
Squared term: 4/4 p < 0.05
Squared term: 0/4 p < 0.05
Relative fitted crime component in patent outcome
Within LAD
Between LADs
Logged crime measure (illustrative range around turning points)
Model specification
Baseline
ITL1 RI
ITL1 RI + GDP
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Model specification
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ITL1 RI + GDP
ITL1 FE + GDP

B2.2 Trademark model

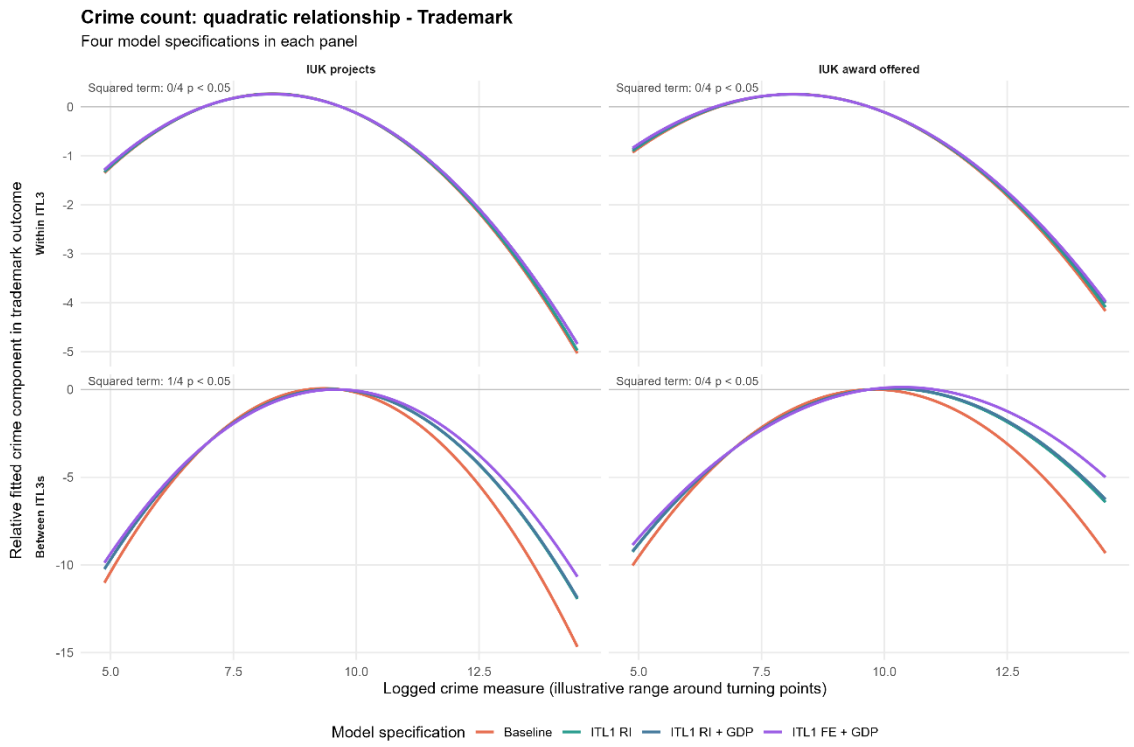
Interaction effects

- **Within ITL3s:** Non-R&D factors negatively moderate the IUK–trademark association for broadband availability below 30 Mbit/s and rail access. Rail usage also shows a negative interaction with IUK projects.
- **Between ITL3s:** Positive interactions appear between IUK projects and rail usage. Award-offered models also show positive interactions for rail usage, housing price, and healthy life expectancy, although the evidence varies across specifications.
- Other interactions, including those for crime, election turnout, and Level 4+ qualifications, are generally weaker. A positive interaction means that a higher value of the place factor strengthens the IUK–trademark association; a negative interaction means it weakens it.

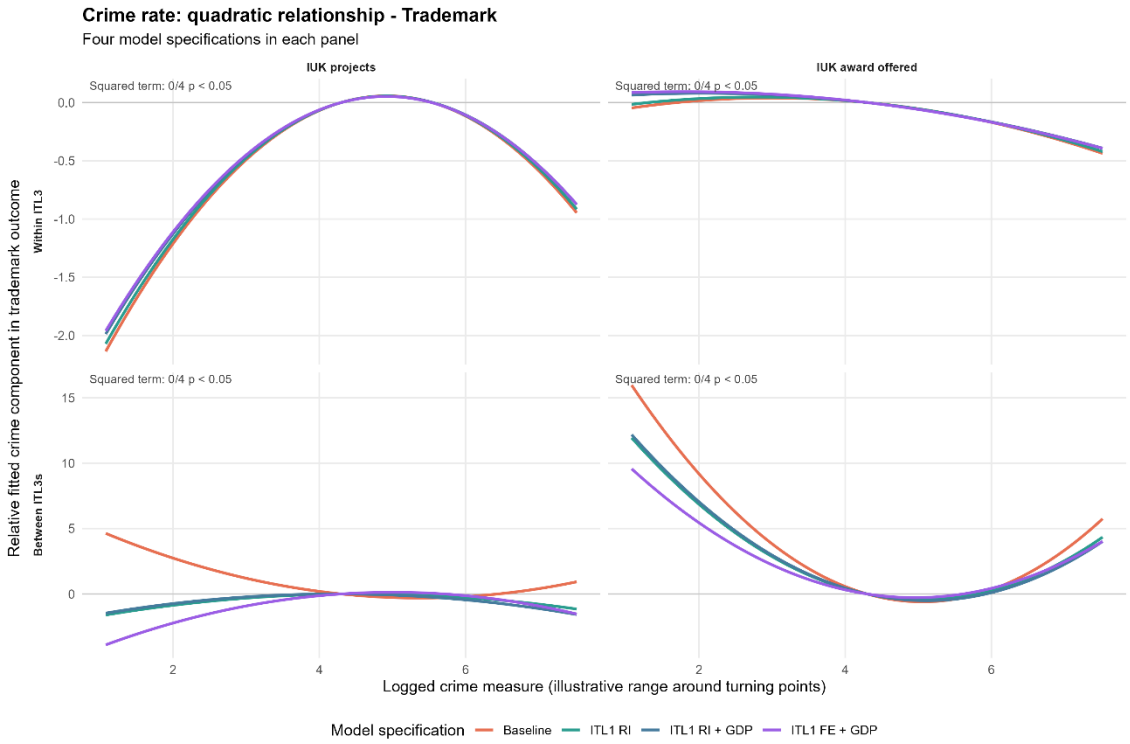


Non-linear crime models

- **Crime count:** The curves appear inverted U-shaped. However, evidence is limited: the within-ITL3 squared terms are only marginally significant in the IUK-project models, and the between-ITL3 squared term is significant in only one of four project specifications. Award-model evidence is weaker.
-



- **Crime rate:** The squared crime-rate terms are not significant across the four specifications. However, the crime-rate-squared interaction with IUK projects is significant at both ITL3 levels in all four specifications; the corresponding award interaction is significant between ITL3s and marginal within ITL3s. This suggests that IUK support may moderate the curvature of the crime-rate relationship.



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