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The geography of intellectual property protection in the UK – 2011 to 2016

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EXECUTIVE SUMMARY

The success of organisations and businesses, in the form of growth or performance, often derives from innovation. In this paper, we provide a new perspective on the geographical patterns of innovation activities in the UK. Using data on three output-based indicators of innovation (patents, trade marks and registered designs), we generate a picture of the distribution of IP protection in the UK, uncovering geographical concentrations of intellectual property (IP) protection activity.

In exploring the geography of IP protection, we reveal the potential knowledge bases that existed in 2011 and 2016 in 373 local authority districts (LADs) across the UK, providing policy makers with an indication of the types of knowledge (e.g., analytical, synthetic or symbolic) that exist within local districts and the types of innovation (e.g., "hard" technological or "soft" service) that take place in those local areas.

The analysis suggests:

- Innovation (IP right) intensity varies markedly across space in the UK, suggesting marked differences in areas' ability to generate and protect innovations. Firms in many more rural areas have little or no engagement with the IP system.

- The geography of innovation (IP right) intensity in the UK varies across IP protection methods, suggesting differences in the types of innovation being undertaken locally and potentially, the value of locally attuned innovation policies.

- There is a somewhat dynamic nature to the IP protection landscape, with evidence of a change in intensity rankings during the 2011-2016 period. To the extent that IP intensities provide a picture of areas' innovation potential, this may provide a degree of reassurance for those seeking to support levelling-up or local development.

- There is a significant overlap in the use of patents, trade marks and registered designs in some areas, suggesting complementary among the three IP protection methods.

This short paper is intended as the first step in a more in-depth analysis of what shapes IP protection use in different areas of the UK and what this can tell us about local development potentials. We plan to examine, in more depth, those areas identified as being most IP right intensive. We will examine the characteristics of those areas/firms in those areas (e.g., whether the area is urban or rural, the number of firms in the area, the size decomposition of firms in the area, the industry decomposition in the area, the skills and knowledge base in the area). In addition, we will explore the dynamic nature of the UK's IP protection

landscape in more depth. An examination of local economic indicators and important eco-system factors may shed light on why the IP protection landscape can change quite quickly.

The most recent comprehensive data available relates to 2016. With Brexit and the Covid-19 pandemic occurring after 2016, the opportunity arises to explore, firstly, whether a shift in the geography of IP protection has occurred since Brexit, and secondly, whether the IP protection profile of an area contributes towards the resilience of that area during the years after a time of crisis or structural change.

ACKNOWLEDGEMENTS

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1. INTRODUCTION

The success of organisations and businesses, in the form of growth or performance, often derives from innovation. Successful firm innovation, or the completeness of the development and exploitation of new knowledge (Roper et al. 2008), yields considerable benefits for the innovating firm: higher profits, increased market value, improved credit ratings and a higher chance of survival (Geroski et al. 1993; Hall 2000; Czarnitzki and Kraft 2004; Cefis and Marsili 2005). The potential for firms' innovation activities to contribute significantly to economic growth and prosperity has fuelled a demand among policy makers and analysts for documenting the level and nature of innovation. The Oslo Manual (OECD/Eurostat 2018) provides details on how to conceptualise and measure business innovation so that an evidence base can be produced and used to inform policy development, monitor and evaluate implemented policy, and support future investments in innovation to promote economic and social development.

Much of the academic literature surrounding the measurement of firm innovation focuses on indicators of the innovation process, typically classifying these indicators as being based on inputs (e.g., R&D expenditures) or outputs (e.g., patents) of the innovation process. Indicators of innovation based on innovation inputs are grounded in the assumption that the innovation process is completed successfully. Innovation, however, is characterised by uncertainty, and innovation activities may not lead to new products or processes. In this sense, an innovation input is a necessary condition, but not sufficient to ensure a successful innovation. Despite this limitation, numerous studies use innovation inputs as indicators of innovation (Flor and Oltra 2004). In contrast, indicators of innovation based on outputs are assumed to fulfil the requirement that a technological innovation occurs. In the literature, the most commonly used indicator based on outputs is the number of patents registered or cited. In practice, however, patents may better indicate technological invention rather than innovation, as many patents are never put to use or commercialised. Intellectual property (IP) protection methods (e.g., patents, trade marks and registered designs) are often viewed as output-based indicators of innovation, as they are mechanisms used by firms to help them realise the returns from their research and development (R&D) and overcome the appropriability problem (Laursen and Salter 2005; Greenhalgh and Rogers 2007; IPO 2022). The appropriability problem occurs when innovating firms are unable to successfully exploit their knowledge – they fail to limit imitation, fail to appropriate returns and cannot sustain a competitive advantage (Ceccagnoli and Rothaermel 2008; Laursen et al. 2013).

When a firm innovates, a process of knowledge sourcing (e.g., R&D activities), transformation (i.e., turning knowledge into an innovation) and exploitation (i.e., an attempt to improve performance and generate value added) takes place (Roper et al. 2008). The use of IP protection is important during each stage of this innovation process (Turner and Roper 2023). Patents are particularly important for the protection of analytical and synthetic knowledge – the knowledge associated with the upstream activities of "hard" or technologically driven innovation (Castaldi and Mendonça 2022). Trade marks and registered designs help protect symbolic knowledge – the knowledge associated with "soft" innovation that typically includes strategies involving aesthetics and design (Filitz et al. 2015; Stoneman 2010) – and the downstream activities linked with "hard" innovation (Mendonça et al. 2019) that involve softer tasks such as marketing, design and business development (Castaldi and Mendonça 2022). The three knowledge bases – analytical, synthetic and symbolic – broadly relate to the three main phases of the innovation process: research, development and marketing (Castaldi and Mendonça 2022). In addition, trade marks are often the protection method of choice for young and small firms due to resource and capability constraints (Helmers and Rogers 2010) and in firms where patents are deemed to be an unsuitable protection method (Block et al. 2021).

In recent years, there has been a strong policy focus in the UK on levelling-up economic performance across regions, particularly through productivity improvements (Huggins et al. 2022). Understanding the spatial pattern of innovation activities in the UK is therefore important for both firms and policy makers if they are to implement suitable practices and policies to sustain innovation in the long term, boost productivity and enhance growth and living standards.

In this insight paper, we aim to provide a new perspective on the geographical patterns of innovation activities in the UK. Using data on three output-based indicators of the innovation process (patents, trade marks and registered designs), we generate a picture of the distribution of IP protection in the UK, uncovering geographical concentrations of IP protection activity. In exploring the geography of IP protection, we reveal the potential knowledge bases that exist in 373 local authority districts (LADs) across the UK, providing policy makers with an indication of the types of knowledge (e.g., analytical, synthetic or symbolic) that exist within local districts and the types of innovation (e.g., "hard" technological or "soft" service) that may take place in those local areas.

The remainder of this paper is organised as follows: Section 2 discusses patents, trade marks and registered designs and their value as indicators of innovation, Section 3 details the data we use to explore IP protection profiles across the UK, Section 4 discusses the distribution of IP protection across 373 LADs in the UK and Section 5 summarises our main findings and details future work.

2. PATENTS, TRADE MARKS AND REGISTERED DESIGNS AS INDICATORS OF INNOVATION

Measuring innovation is complicated by the fact that it is a continuous process. Consequently, innovation indicators developed by intergovernmental organisations have evolved around a model of inputs and outputs. However, finding an adequate measure of innovation is still an ongoing process, with Griliches noting that, "The dream of getting hold of an output indicator of inventive activity is one of the strong motivating forces for economic research in this area," (Griliches (1990 p.14). In practice, the innovation performance of sectors, regions and nations is generally assessed by individual metrics or aggregations of individual metrics. These typically consist of input measures (e.g., R&D expenditure) and output measures (e.g., patent counts), with R&D indicators being the most widely used measure of innovation and proxy for the level of innovative effort (Potters 2009). However, output measures such as patents, trade marks and registered designs may be an imperfect and partial measure of innovation. A variety of knowledge protection methods are used by firms to protect innovations and aid appropriability. Formal protection methods are legally enforceable and typically include registered rights such as patents, design rights and trade marks, and unregistered rights such as copyright. In some cases, formal rights may be granted but never used or commercialised. In addition, informal protection methods – those not based on regulated structures and statutory enforcement possibilities (Hurmelinna-Laukkanen 2014) – are also used by firms to protect their innovations. These include secrecy, complexity of design and lead-time on competitors.

In this paper, we use patents, trade marks and registered designs (i.e., three commonly recognised output-based indicators of innovation) to explore the IP protection profiles of LADs across the UK. The three IP protection methods have previously been used as proxies for particular forms of innovation (e.g., Griliches 1990; Filippetti et al. 2019; Filitz et al. 2015), although there is evidence to suggest that complementarities exist between them (e.g., Thomä and Bizer 2013).

2.1 Patents

Patents protect the exploitation of inventions that are "new, involve an inventive step (non-obviousness) and are capable of industrial application," (TRIPS, Article 27, 1994). Reflecting invention rather than innovation, patents indicate innovation activity rather than signalling innovation success (Coombs et al. 1996). Patents cover how products work, what they do, how they do it, what they are made of and how they are made.[1] Patents solve the problem of appropriability by vesting an ownership right with the inventor and preventing others from profiting from the new knowledge. A patent allows an inventor to take legal action against anyone who makes, uses, sells or imports an invention without the inventor's permission. Rather than keeping an invention secret, a patent shares how to create or replicate an invention with the public, and once the patent has expired, others can make and sell the invention.[2] Patents protect innovations such as machines, industrial processes, pharmaceuticals and their production methods, computer hardware, electrical appliances and biological products and processes; they cannot protect literary, dramatic, musical or artistic works, or anything that is an idea, a way of thinking, or a scientific or mathematical discovery. Applying for a patent can be an expensive and lengthy process and may take several years. Once granted, renewal fees are payable for twenty years – the full period of protection (IPO 2018). During this period, it is the inventor's responsibility to enforce the patent and ensure that an invention is protected. Any legal action that may take place as a result of a dispute or an infringement must be paid for by the inventor.

Patents are an exploited measure of innovation, both at the national, regional and firm level (Filippetti et al. 2019). They are viewed as a reliable measure of technological innovation, and widely used as a proxy for technological innovations that have been developed for commercial purpose (Griliches, 1990). Research suggests that patents are strongly correlated with increased innovation, knowledge sharing, and economic growth, [3] supporting their use as an indicator of innovation. Moreover, numerous empirical studies find patents to be of high value for innovating firms, in particular those in science-based, R&D intensive, technology-oriented industries (Arora et al. 2008; Park and Lippoldt 2008; Lo 2011; Arora and Athreye 2012). However, these studies are based on a technological

[1] https://www.gov.uk/government/publications/ip-basics/ip-basics
[2] However, in reality, the pace of innovation means that many inventions become redundant long before the patent for them expires, and absorptive capacity barriers in some firms mean that they are unable to access and use the knowledge contained in expired patents.
[3] https://www.forbes.com/sites/marshallphelps/2015/09/16/do-patents-really-promote-innovation-a-response-to-the-economist/#20c6d4691921

or science-based understanding of innovation – so-called "hard" innovation – that assumes innovation to be the result of technological or scientific effort. Patents are associated with upstream innovation activities, i.e., the analytical and synthetic dimensions of the innovation process (Castaldi and Mendonça 2022). Although patents are an intermediate measure of the innovation process – they are an indicator of invention rather than innovation (OECD 2009) – a high level of inventiveness does tend to reflect a potentially high level of innovativeness (Griliches 1990).

Despite patent counts or citations often being used as a proxy for firm innovation, several limitations to their use for this purpose exist. First, as patents reflect invention rather than innovation, they do not necessarily signal a successful innovation (Coombs et al. 1996). Second, the heterogeneous nature of patents, in terms of their technological level and economic value (Griliches, 1990), makes comparisons across firms difficult. The value of patents is highly skewed – there are a small number of highly valuable patents and a large number of patents with little value. Moreover, firms often use patents strategically. For example, they may register patents on inventions to block other firms' patents or to deter entry (Nagaoka et al. 2010). In addition, differences in the propensity to patent across firm sizebands and sectors also make comparisons difficult (Leiponen and Byma 2009; Cohen et al. 2000), and third, patent indicators do not provide information about non-patented innovation that may take place (Nagaoka et al. 2010).

2.2 Trade marks

Registered trade marks protect brands, be it a business name, a product or a service. However, a brand is much more than a company logo – a brand is a 'promise of an experience' and offers consumers assurance about the nature of the product or service they will receive.[4] A trade mark can be a word, a phrase or logo, a shape, a colour, a sound, an aspect of packaging, it can be action based, or it can be any combination of these. The most effective trade marks are those 'distinctive' to the products and services they protect. Drawing on the economic theories of information and reputation (Economides 1988; Landes and Posner 1987), trade marks are designed to signal to consumers the distinctiveness and quality of a product, addressing the presence of asymmetric information between buyers and sellers. They are designed to differentiate products from those

[4] https://www.gov.uk/government/publications/ip-basics/ip-basics#trade-marks

provided by other firms, so that they have a significant role in the marketing of innovations (Turner 2019).

By registering a trade mark, it is much easier for a firm to take legal action against another firm that uses the trade mark without permission. In addition, it allows authorities to bring criminal charges against counterfeiters if they use the trade mark. A firm can sell a registered trade mark, franchise it or provide firms with a licence which allows them to use it. A firm pays a fee when registering a trade mark, and registration must be renewed every ten years for an indefinite period (IPO 2018). The application process is less time consuming than for patents, with the applicant receiving a formal report detailing the outcome of the examination within two weeks of the date of the application. If the trade mark is accepted, it can be registered in around three months from the original filing date.

Interest in trade marks as an indicator of innovation developed due to the need for an output-based indicator of innovation in low-technology, less-scientific industries (Mendonça et al. 2004; Schmoch 2003). In contrast to patents, trade marks have been shown to be an indicator of so-called “soft” innovation i.e., innovation in less technology-oriented industries such as advertising-intensive, creative and service-related industries (Mendonça, 2014; Castaldi 2018; Filippetti et al. 2019). Soft innovations encompass service innovations, organisational innovations, business model innovations and other innovation activities that are difficult to measure using conventional innovation indicators (Mendonça 2014; Schmoch and Gauch 2009). They also include non-functional forms of innovation that typically include strategies involving aesthetics and design to shape a product (Filitz et al. 2015; Stoneman 2010). This type of innovation often develops in differentiated markets and creative industries (Castaldi 2018; Forti et al. 2020: Millot 2009), but is also a crucial downstream activity in technologically driven processes (Mendonça et al. 2019). Accordingly, as an indicator of innovation, trade marks may provide information about the knowledge bases that exist within regions (Castaldi and Mendonça 2022). In addition, as an indicator of both “soft” innovation and the downstream activities associated with “hard” innovation, trade marks have the potential to provide a more complete and holistic picture of innovation within regions than patents.

As with patents, much of the empirical literature surrounding trade marks and performance suggests them to be of high value for firms. Trade marks, for example, have been positively linked to gross value added and turnover growth (Greenhalgh et al. 2011), and positively linked to cash flows, Tobin’s q, stock returns, return on assets (ROA) and return on sales (ROS) (Krasnikov et al. 2009). However, there are some limitations to using trade marks

as an indicator of innovation. Service firms that have no innovative content can register trade marks, firms can register trade marks to increase visibility, to differentiate their service, and to discourage potential new entrants into the industry (Hipp and Grupp 2005).

2.3 Registered designs

A design registration protects the visual appearance of a product, part of a product, or its ornamentation (IPO 2018), providing it is new and has individual character. To be registered, the design must have a special shape, configuration, pattern or ornamentation. By registering a design, a firm is able to prevent other firms from using that design without permission. The process of registering a design is relatively short compared with applying for a patent. Once the application has been made and fees have been paid, the process takes around two months, providing the design meets the required criteria. Design protection lasts for five years and can be renewed every five years, for up to twenty-five years (IPO 2018).

The literature surrounding registered designs and their link to innovation is much more limited than that for patents and trade marks (Turner and Roper 2023). Consequently, design registrations are less used as an indicator of innovation (Filippetti et al. 2019). In the UK, firms can choose to use unregistered designs rather than registered designs to protect creations, resulting in a lower propensity to use registered designs in the UK compared to other countries where only registered designs are available (e.g., the US). Furthermore, the short innovation life cycles in some industries (e.g., fashion) may also limit the use of registered designs. However, despite this, design registrations can be a good proxy for innovation in some sectors, particularly those sectors in which patents do not play an important role (e.g., furnishing, clothing and packaging) as well as R&D in low-technology manufacturing sectors. Evidence also exists of a complementarity with patents in some high-technology industries (e.g., electronic equipment and transportation) in Germany (Filitz et al. 2015).

There is evidence to suggest that effective design protection is important for design innovation, and that attitudes towards registered designs, together with attitudes towards enforcement, have a significant effect on a firm's motivation to create or innovate (Ahmetoglu and Chamorro-Premuzic 2012). In contrast, there is also evidence of negative correlations between registered designs and process and organisational innovation in Australia (Jensen and Webster 2009). Further evidence suggests that design registrations in the UK improve commercial success because product design allows consumers to

successfully differentiate (Moultrie and Livesey 2011). This is supported by Bascavusoglu-Moreu and Tether (2011) who also find registered designs to be positively related to firm performance and commercial success; registered design use is associated with a 17 per cent performance benefit in terms of sales per employee in the UK. The positive correlation between registered design use and innovation observed in much of the design literature available is evidence in support of the use of registered designs as an indicator of innovation.

3. DATA

To explore the geography of IP protection, we calculate IP right intensities (i.e., IP right per 10,000 employees[5]) for 373 LADs across the UK in 2011 and 2016. To do this, we use UK Intellectual Property Office (IPO) data detailing all live patents and trade marks during the 1995-2016 period and all live registered designs during the 1997-2016 period, company postcode data obtained from FAME,[6] local authority identifiers taken from the ONS Postcode Directories for 2016 and 2021, and local authority employment data for the 2011-2016 period from NOMIS[7] and NISRA.[8]

The IP protection data used in this study covers businesses only, excluding other institutions (e.g., universities) who may also hold patents, trade marks or registered designs. The patent data covers patents granted by the IPO that are live during the 1995-2016 period. Each record includes the patent application number, the name and address of the applicant, the company reference number (CRN, obtained from FAME data /Companies House records), the date the patent was granted, the date of the most recent renewal payment and the year of protection provided by the most recent renewal payment (renewal fees are required for the 5th-20th year of protection). The trade mark data details trade marks registered in the UK that are live between 1995 and 2016. Each record includes the published trade mark number (be it a standard, certification or collective trade mark), the CRN, the year of registration and the next renewal date (renewal is necessary every 10 years), and the trade mark class (goods, service or 'complex' – trade marks that relate to both goods and services). IPO registered design data covers designs registered

[5] Following methodology in Tinguely (2013)
[6] FAME, (Financial Analysis Made Easy), https://www.bvdinfo.com/en-gb/our-products/data/national/fame
[7] NOMIS, official census and labour market statistics, https://www.nomisweb.co.uk/
[8] NISRA, Northern Ireland Statistics and Research Agency, https://www.nisra.gov.uk/

in the UK that are live during the 1997 to 2016 period. Each record includes the design number, the applicant's name, the CRN, the date of registration, the number of registration renewals that have been made (the first renewal takes place 5 years after the initial registration, with a maximum of four renewals being permitted, providing 25 years of protection in total), and the date the next renewal is due (dates in the past indicate lapsed registrations). Using the IPO data, we derived the number of live patents, trade marks and registered designs associated with each business (CRN) for each year during the 1995-2016 period.

3.1 Data matching

Postcode data are added to the details for businesses in the IP protection data file. These postcode data are obtained from FAME and matched to the businesses according to the unique CRNs. Next, these postcode data are matched with postcodes in the ONS Postcode Directory (2016 and 2021) to obtain local authority identifiers for each business. The number of live patents, trade marks and registered designs held by businesses in each LAD are then aggregated for each year, i.e., giving a stock of each IP protection method for each LAD in each year. Using employment data for each LAD (obtained from NOMIS and NISRA), patent, trade mark and registered design intensities (IP right per 10,000 employees) are calculated for the 373 LADs in 2011 and 2016.

4. THE DISTRIBUTION OF IP PROTECTION IN THE UK, 2011 AND 2016

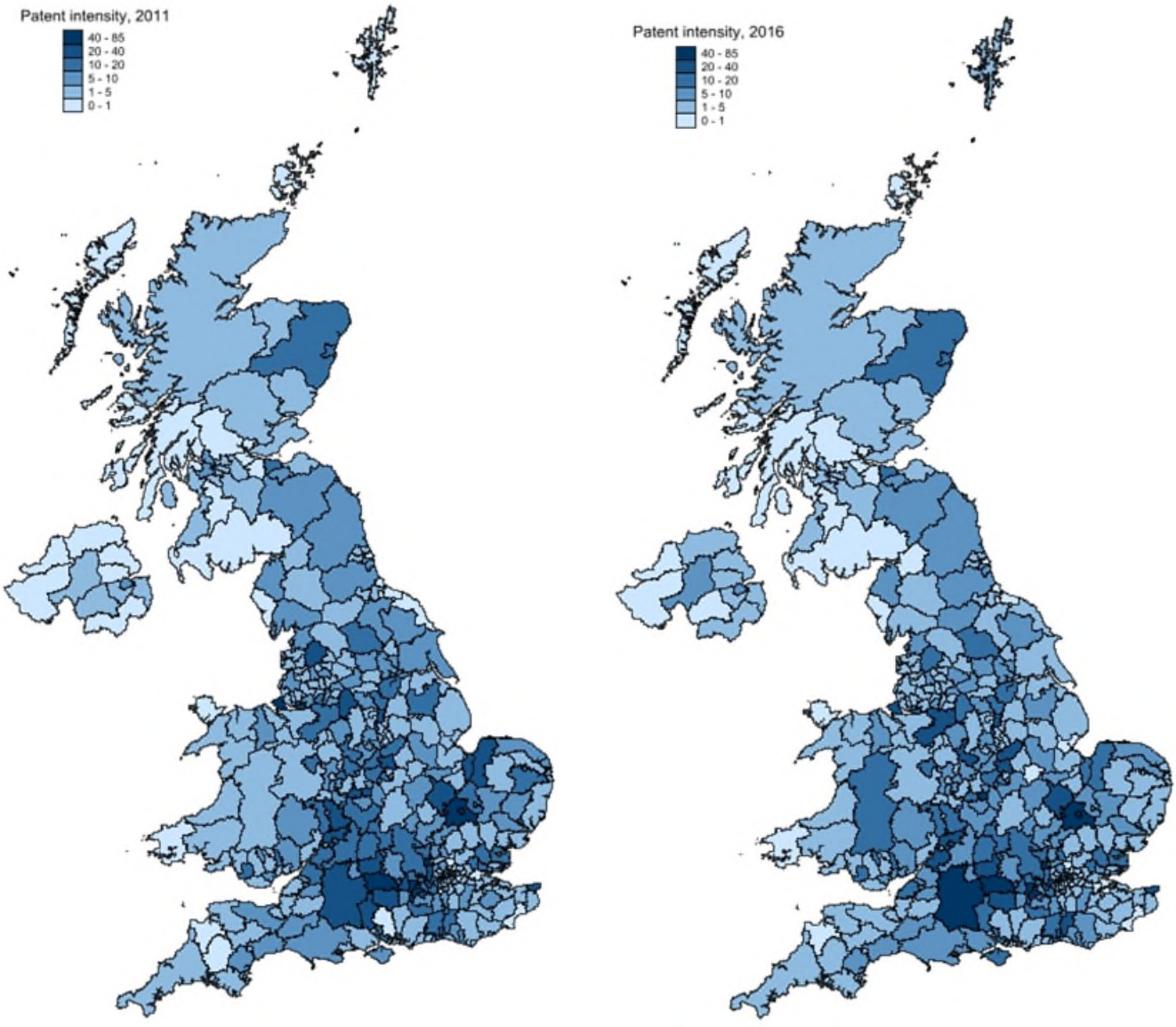
Here, we explore the three measures of IP right intensity, and in line with the discussion above, consider that potentially, patents indicate technological innovation, trade marks indicate innovation in the service sector (particularly in the knowledge-intensive sector) or downstream activities in technological industries, and registered designs indicate innovation in medium and low-technology industries in the manufacturing sector.

The maps reported in Figures 1-3 illustrate patent, trade mark and registered design intensity in 373 LADs across the UK in 2011 and 2016.

The maps in Figure 1 illustrate that patent intensity varied in LADs across the UK in 2011 and 2016. Patent intensity was greatest in LADs in England (with the exception of Aberdeenshire in north-east Scotland). In 2011, we observe an area of patent concentration running down through central England and towards the London region. In

2016, this concentration weakened slightly, with some LADs in central southern England and the Midlands having a lower patent concentration. The lowest patent intensity in 2011 and 2016 was in LADs in western Scotland, Northern Ireland, and coastal areas in Wales, south west England and south east England. However, the distribution of patents across the UK did not change substantially during the 2011-2016 period.

Figure 1: Patent intensity (patents per 10,000 employees) in 373 LADs across the UK, 2011 and 2016



Sources: Live IP right data 1995-2016 (IPO); postcode data (FAME); LAD identifiers (ONS Postcode Directories 2016 and 2021); LAD employment data (NOMIS and NISRA).

The distribution of trade marks in LADs across the UK in 2011 and 2016 is shown in Figure 2. The distribution is more widespread than that of patents making it more difficult to clearly distinguish between LADs. Again, although less clear than for patent intensity, LADs with the highest trade mark intensity are in England, being concentrated in north west England, the Midlands and the London/Greater London area. In 2011, the lowest trade mark intensity was in LADs in the South West, coastal LADs in west Wales, and LADs in north west Scotland. Stand-out LADs include Na h-Eileanan Siar, East Ayrshire, Copeland, Conwy and West Devon. However, by 2016, trade mark intensity had increased most of these areas. Overall, the maps in Figure 2 support the view that trade marks are a widely used IP protection method.

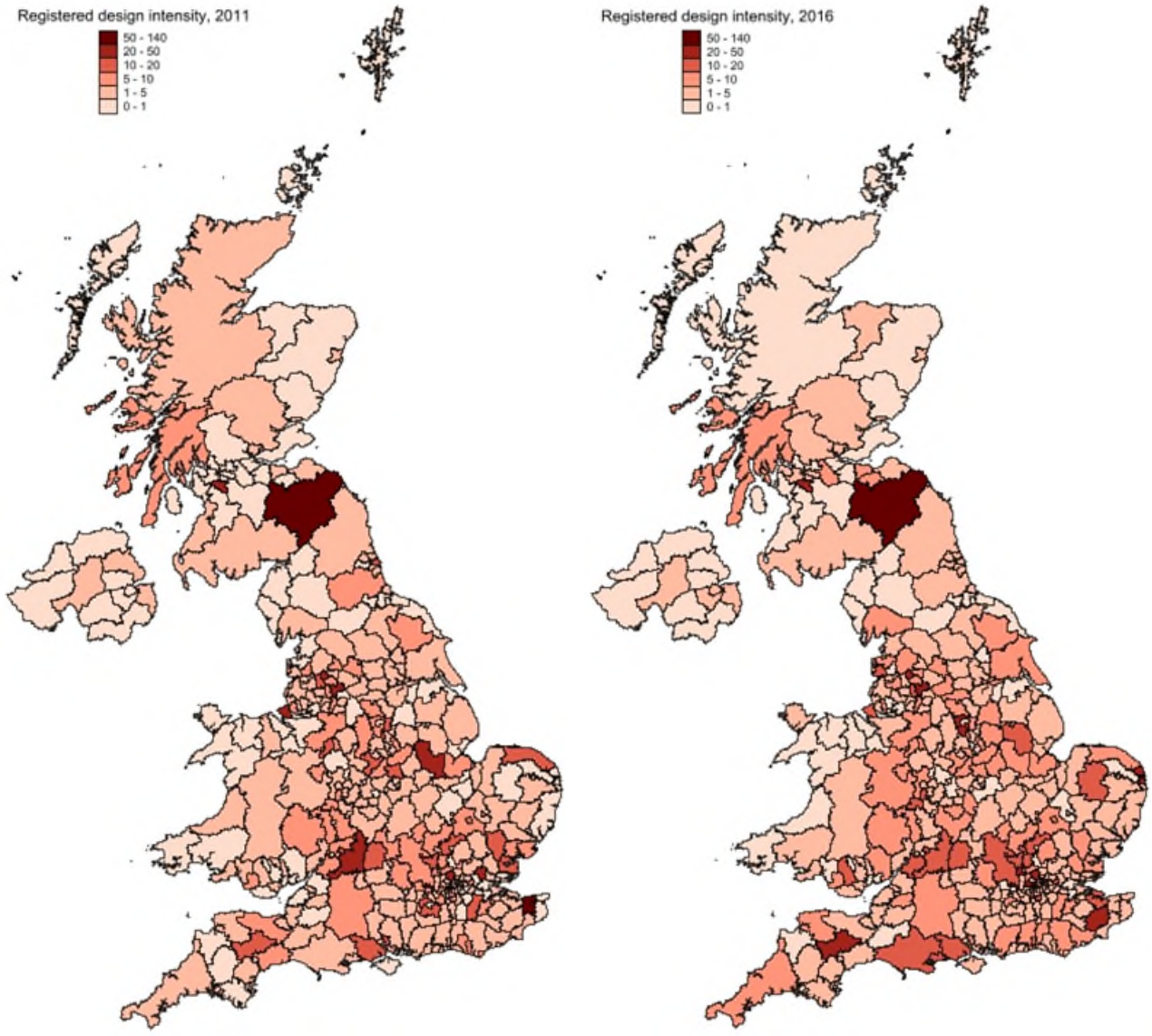
The distribution of registered designs in LADs across the UK in 2011 and 2016 is shown in Figure 3. As with patents and trade marks, LADs with the highest registered design intensity were in England (with the exception of the Scottish Borders). Registered design intensity was lowest in Northern Ireland, Scotland (with the exception of the Scottish Borders) and Wales. Between 2011 and 2016, intensity increased slightly in many LADs in England and fell in some, distributing registered designs more evenly. However, changes are less noticeable in Northern Ireland, much of Wales and Scotland.

It is clear from Figures 1-3 that there is a significant degree of overlap among patents, trade marks and registered designs in LADs across the UK, suggesting complementarity among the three IP protection methods, or many types of innovation activity. In addition, some LADs had high intensity in one or two of the three protection methods suggesting some degree of specialisation in innovation in those locations.

Figure 2: Trade mark intensity (trade marks per 10,000 employees) in 373 LADs across the UK, 2011 and 2016

Sources: Live IP right data 1995-2016 (IPO); postcode data (FAME); LAD identifiers (ONS Postcode Directories 2016 and 2021); LAD employment data (NOMIS and NISRA).

Figure 3: Registered design intensity (registered designs per 10,000 employees) in 373 LADs across the UK, 2011 and 2016



Sources: Live IP right data 1995-2016 (IPO); postcode data (FAME); LAD identifiers (ONS Postcode Directories 2016 and 2021); LAD employment data (NOMIS and NISRA).

Our methodology follows that of Tinguely (2013), calculating IP right intensity as the number of IP rights per 10,000 employees in each local area. In line with a report by the IPO exploring IP right intensities across industries (IPO 2022), we consider four classifications of IP right intensity across the 373 LADs – above average, high, medium and low. The descriptions of these classifications are included in Table 1.

Table 1: Classifications of IP right intensity

Classification of IP right intensity	Description
Above average IP right intensity	The LAD has an above average IP right intensity when all LADs are considered
High IP right intensity	The LAD has an above average IP right intensity out of the LADs in the 'above average' subset
Medium IP right intensity	The LAD has a below average IP right intensity out of the LADs in the 'above average' subset
Low IP right intensity	The LAD has a below average IP right intensity when all LADs are considered

The results of our classification are shown in Table 2. 371 (99.5 per cent) of 373 LADs had at least one registered trade mark in 2011, increasing to 372 (99.7 per cent) in 2016. The number of LADs with at least one patent increased from 369 (98.9 per cent) to 371 (99.5 per cent) between 2011 and 2016. Registered designs, however, are less widely used across LADs, with 349 (93.6 per cent) of LADs having at least one registered design in 2011, increasing to 360 (96.5 per cent) of LADs in 2016.

Despite the widespread use of all three IP protection methods across the UK, the number of LADs in 2011 with an above average IP right intensity[9] is 99 (26.5 per cent) for patents, 125 (33.5 per cent) for trade marks and 110 (29.5 per cent) for registered designs. By 2016, values had increased slightly for patents and trade marks but remained constant for registered designs.

The number and percentage of LADs with high IP right intensity is relatively low. Values are 30 (8 per cent) for patents in 2011 and 2016, 33 (8.8 per cent) for trade marks in 2011, rising to 41 (11 per cent) in 2016, and 30 (8 per cent) for registered designs in 2011, falling slightly to 29 (7.8 per cent) in 2016.

[9] The group of LADs with an above average IP right intensity is comprised of high IP right intensity LADs and medium IP right intensity LADs.

Table 2: Patent, trade mark and registered design usage in 373 LADs across the UK

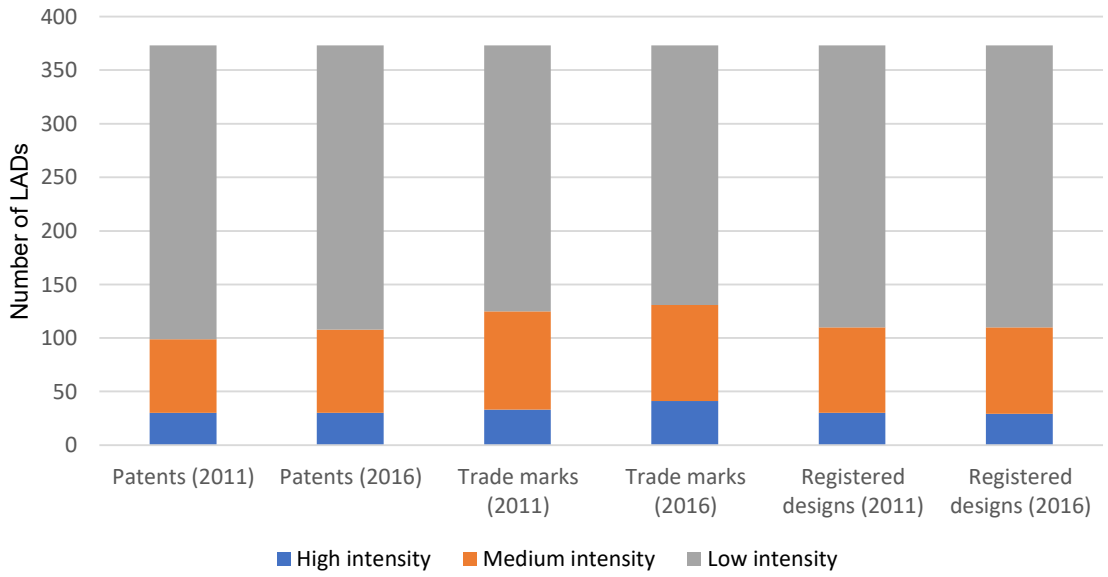
IP right usage (of 373 LADs)	Patents		Trade marks		Registered designs	
	2011	**2016**	**2011**	**2016**	**2011**	**2016**
Number and percentage of UK LADs with the IP right	369 98.9%	371 99.5%	371 99.5%	372 99.7%	349 93.6%	360 96.5%
Number and percentage of UK LADs with above average IP right intensity (high and medium)	99 26.5%	108 29.0%	125 33.5%	131 35.1%	110 29.5%	110 29.5%
Number and percentage of UK LADs with high IP right intensity	30 8.0%	30 8.0%	33 8.8%	41 11.0%	30 8.0%	29 7.8%
Number and percentage of UK LADs with medium IP right intensity	69 18.5%	78 20.9%	92 24.7%	90 24.1%	80 21.4%	81 21.7%
Number and percentage of UK LADs with low IP right intensity	274 73.5%	265 71.1%	248 66.5%	242 64.9%	263 70.5%	263 70.5%

Sources: Live IP right data 1995-2016 (IPO); postcode data (FAME); LAD identifiers (ONS Postcode Directories 2016 and 2021); LAD employment data (NOMIS and NISRA).

The number and percentage of LADs with low IP right intensity in 2011 and 2016 is relatively high, although values do fall slightly for patents and trade marks in 2016. In 2011, 274 LADs (73.5 per cent) had low patent intensity, falling to 265 LADs (71.1 per cent) in 2016. 248 LADs (66.5 per cent) had low trade mark intensity in 2011, falling to 242 LADs (64.9 per cent) in 2016. 263 LADs (70.5 per cent) had low registered design intensity in 2011, remaining constant in 2016.

A stacked bar chart to show the intensity distribution of each IP protection method in the 373 LADs is shown in Figure 4. There is little change in the 2011 distributions after 5 years, but we do observe that the number of LADs with high trade mark intensity increases slightly over the time period, and the number of LADs with medium patent intensity and medium trade mark intensity also increases slightly. The chart shows that the number of LADs with an above average trade mark intensity is greater than the number of LADs with an above average patent or registered design intensity. Furthermore, the intensity distributions for patents and registered designs prove to be rather similar.

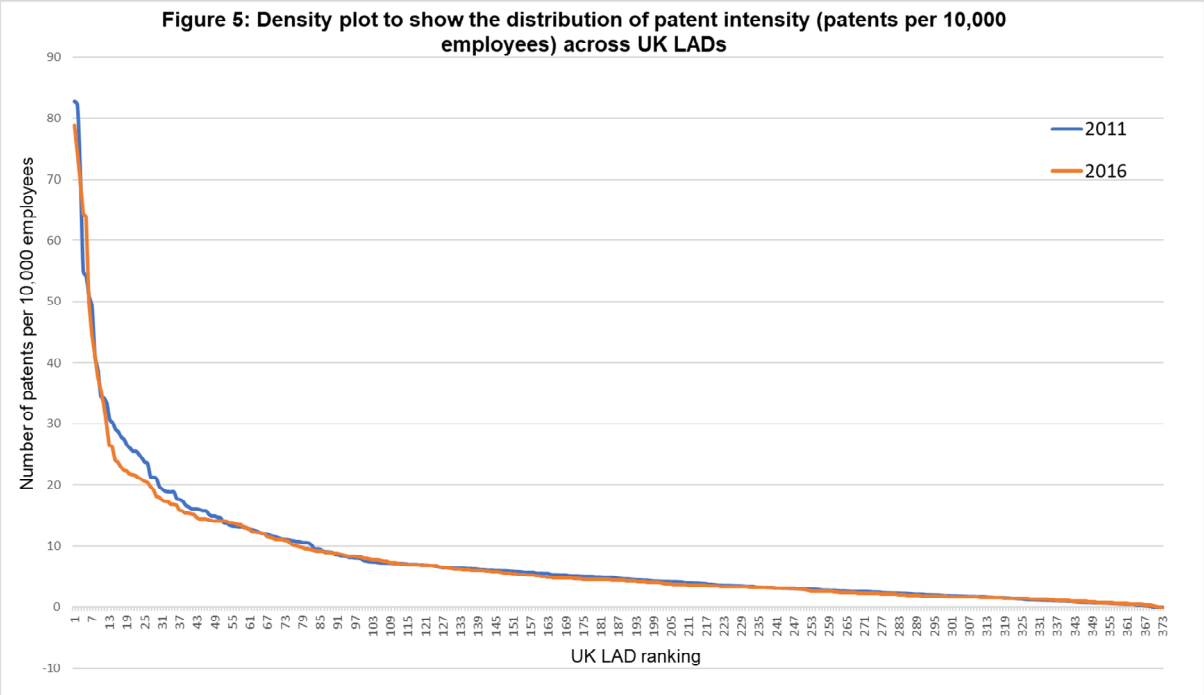
Figure 4: Stacked bar chart to show the intensity distributions of patents, trade marks and registered designs across 373 UK LADs (2011 and 2016)



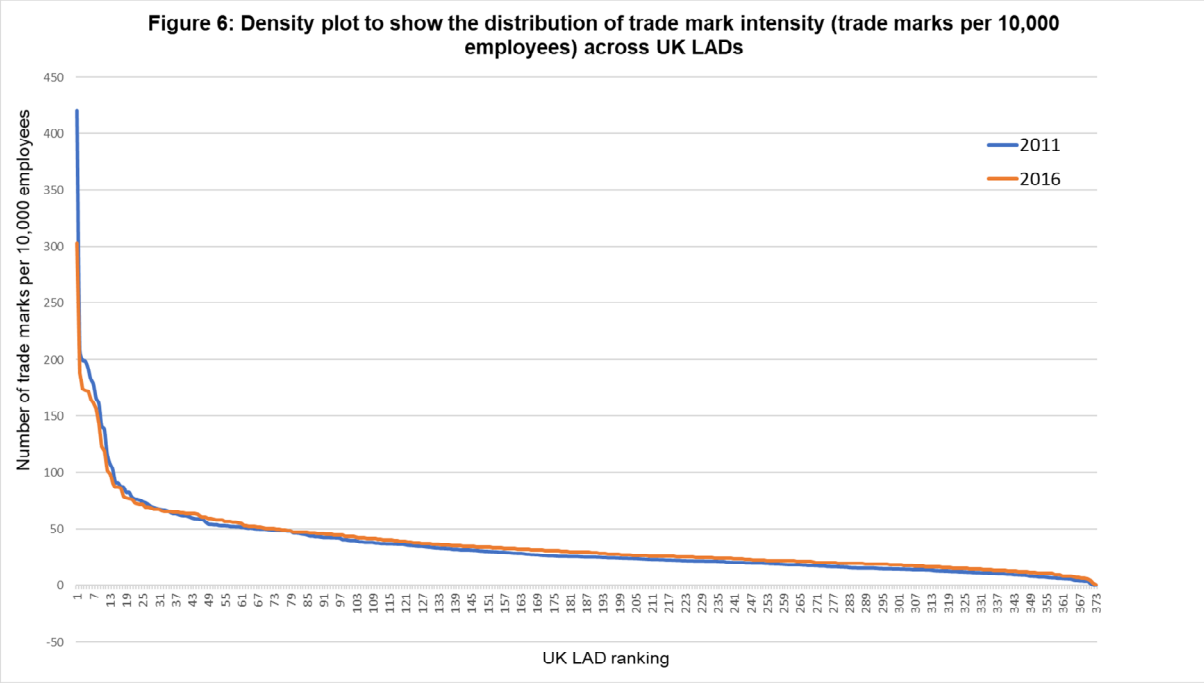
Sources: Live IP right data 1995-2016 (IPO); postcode data (FAME); LAD identifiers (ONS Postcode Directories 2016 and 2021); LAD employment data (NOMIS and NISRA).

The density plots in Figure 5 show the distribution of patents per 10,000 employees across all 373 UK LADs in 2011 and 2016, ranked from highest to lowest. The distribution of patent use across LADs is characterised by a small number of LADs that have high usage and a large number with low usage. The average number of patents per 10,000 employees is 7.82 in 2011 compared to 7.44 in 2016. In 2016, the distribution has a lower maximum value (78.8 patents per 10,000 employees compared to 82.8 patents per 10,000 employees in 2011). 274 LADs have below average patent intensity in 2011, and 265 LADs have below average patent intensity in 2016.

The density plots in Figure 6 show the distribution of trade marks per 10,000 employees across all 373 UK LADs in 2011 and 2016, ranked from highest to lowest.



Sources: Live IP right data 1995-2016 (IPO); postcode data (FAME); LAD identifiers (ONS Postcode Directories 2016 and 2021); LAD employment data (NOMIS and NISRA).



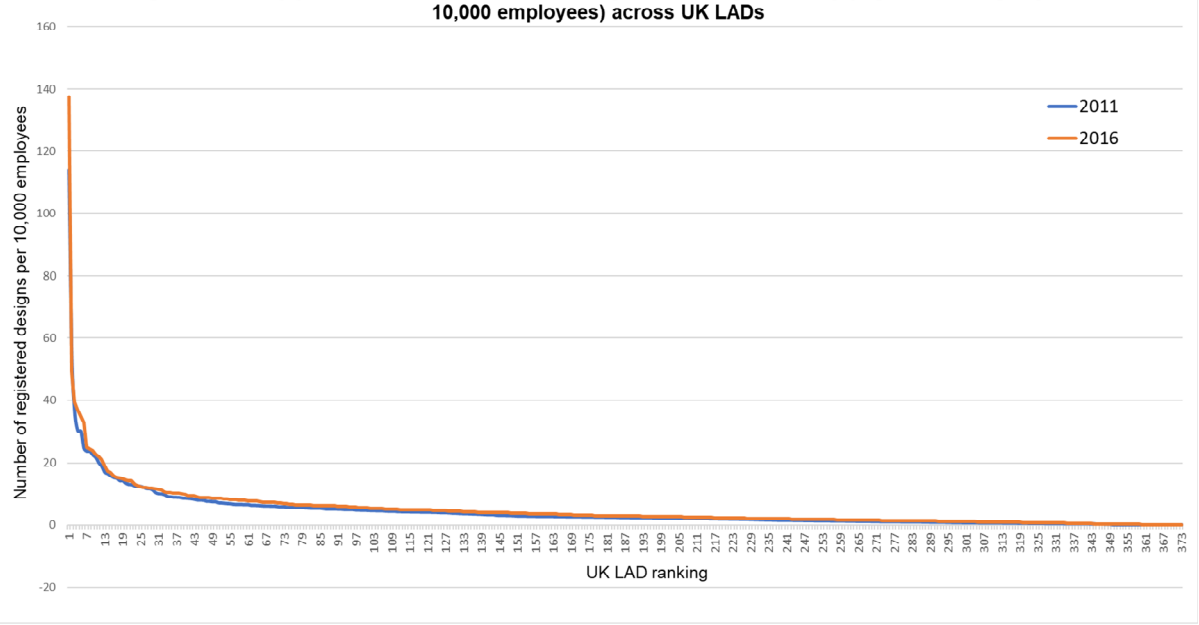
Sources: Live IP right data 1995-2016 (IPO); postcode data (FAME); LAD identifiers (ONS Postcode Directories 2016 and 2021); LAD employment data (NOMIS and NISRA).

The trade mark intensity distributions have a similar profile to one another, being characterised by an initial spike, which represents one LAD having a very high trade mark intensity, followed by a group of LADs with relatively high trade mark intensities, and a long tail that includes those LADs with below average trade mark intensities. Trade mark use is far more intense than both patent and registered design use, indicated by the relatively

high intensity values across LADs. Average trade mark intensity in 2011 was 35.03 trade marks per 10,000 employees, compared to 36.83 trade marks per 10,000 employees in 2016. In 2011, there were 248 LADs with below average trade mark intensities, and in 2016, there were 242 LADs below average values.

The density plots in Figure 7 show the distribution of registered designs per 10,000 employees across all 373 UK LADs in 2011 and 2016, ranked from highest to lowest.

Figure 7: Density plot to show the distribution of registered design intensity (registered designs per 10,000 employees) across UK LADs



Sources: Live IP right data 1995-2016 (IPO); postcode data (FAME); LAD identifiers (ONS Postcode Directories 2016 and 2021); LAD employment data (NOMIS and NISRA).

As with the trade mark intensity distributions, the registered design distributions are characterised by an initial large spike that represents one LAD having a relatively large registered design intensity. This is followed by a large number of LADs with lower usage, tailing off very gradually. The maximum registered design intensity increased over the five-year period (137.6 registered designs per 10,000 employees in 2016 compared to 114.0 registered designs per 10,000 employees in 2011), and more LADs used registered designs in 2016. The average registered design intensity was 4.24 registered designs per 10,000 employees in 2011 compared to 4.98 registered designs per 10,000 employees in 2016, with the same number of LADs (263) having below average usage in both years.

The fifteen LADs with the highest and lowest patent intensities are shown in Table 3. Across all LADs, average patent intensity fell slightly during the 2011-2016 period. The two LADs with the highest patent intensity in 2011 (Wirral and Rushmoor) experienced a large drop in patent intensity in 2016, moving down the distribution ranking. Others (e.g., Cambridge

and South Cambridgeshire) experienced an increase in patent intensity over the five-year period, moving up the distribution ranking in 2016. Many of the fifteen LADs with the lowest patent intensity in 2011 were no longer in the lowest fifteen LADs of the distribution in 2016. Some LADs in the lowest part of the distribution (e.g., East Ayrshire) experienced a slight increase in patent intensity over the five-year period, while others (e.g., Argyll and Bute) experienced a slight fall in patent intensity over the same period.

The fifteen LADs with the highest and lowest trade mark intensities are shown in Table 4. Across all LADs, average trade mark intensity increased slightly between 2011 and 2016. Despite this, trade mark intensity in the fifteen LADs with the highest trade mark intensity fell over the five-year period. The extent of the fall varied across LADs, with some experiencing a large fall in intensity (e.g., Slough) and others experiencing a relatively small fall (e.g., North Warwickshire). In addition, the ranking of those LADs with the highest trade mark intensity changed between 2011 and 2016. In general, trade mark intensity increased over the five-year period in those LADs with the lowest trade mark intensity, and only six of the lowest fifteen LADs in 2011 remained in the lowest fifteen in 2016. These figures suggest that it was LADs at the lower end of the trade mark intensity distribution that determined the increase in average trade mark intensity across all LADs.

The fifteen LADs with the highest and lowest registered design intensities are shown in Table 5. Across all LADs, average registered design intensity increased during the 2011-2016 period. Scottish Borders, the LAD with the highest registered design intensity in 2011, experienced a large increase in intensity over the five-year period. Some LADs experienced a slight fall in intensity during the same period (e.g., Rochdale), and others experienced a slight rise in intensity (e.g., Barnet and Hyndburn). However, two thirds of the top fifteen LADs in the registered design intensity distribution were no longer in the top fifteen of the distribution in 2016. All of the LADs in the bottom fifteen of the registered design intensity distribution in 2011 had no registered designs. Six of these LADs continued to have no registered designs in 2016, with the remaining nine LADs moving out of this part of the distribution.

Table 3: LADs with highest/lowest patent intensity, 2011 and 2016

LADs with highest patent intensity (patents per 10,000 employees)				LADs with lowest patent intensity (patents per 10,000 employees)			
2011		2016		2011		2016	
LAD	Intensity	LAD	Intensity	LAD	Intensity	LAD	Intensity
Wirral	82.8	Cambridge	78.8	Na h-Eileanan Siar	0.0	Na h-Eileanan Siar	0.0
Rushmoor	82.3	South Cambridgeshire	74.3	Barking and Dagenham	0.0	Falkirk	0.0
Cambridge	70.9	Surrey Heath	69.8	East Ayrshire	0.0	Waltham Forest	0.1
Three Rivers	55.0	Wiltshire	64.3	Clackmannanshire	0.0	South Tyneside	0.2
Bracknell Forest	54.2	Three Rivers	63.9	Falkirk	0.2	Argyll and Bute	0.3
South Cambridgeshire	50.9	Coventry	49.7	Folkestone and Hythe	0.2	Dumfries and Galloway	0.3
Surrey Heath	49.1	West Berkshire	44.5	West Lothian	0.3	Lincoln	0.4
West Berkshire	41.2	Bracknell Forest	41.4	Waltham Forest	0.3	West Lothian	0.4
Tewkesbury	39.0	Tewkesbury	37.8	Inverclyde	0.3	Lewisham	0.5
Bolsover	34.5	Wirral	35.7	Hartlepool	0.3	East Ayrshire	0.5
Test Valley	34.2	Huntingdonshire	33.4	Lambeth	0.5	Middlesbrough	0.5
Huntingdonshire	33.4	Rushmoor	30.2	Pembrokeshire	0.5	Fermanagh and Omagh	0.5
Thanet	30.8	Basingstoke and Deane	26.5	Scarborough	0.5	Torridge	0.5
Coventry	30.2	Vale of White Horse	26.3	Isle of Anglesey	0.5	Carlisle	0.5
Spelthorne	29.1	Thanet	24.1	Argyll and Bute	0.5	Barking and Dagenham	0.6

Sources: Live IP right data 1995-2016 (IPO); postcode data (FAME); LAD identifiers (ONS Postcode Directories 2016 and 2021); LAD employment data (NOMIS and NISRA).

Table 4: LADs with highest/lowest trade mark intensity, 2011 and 2016

LADs with highest trade mark intensity (trade marks per 10,000 employees)				LADs with lowest trade mark intensity (trade marks per 10,000 employees)			
2011		2016		2011		2016	
LAD	Intensity	LAD	Intensity	LAD	Intensity	LAD	Intensity
Slough	419.9	Slough	302.7	Copeland	0.0	Copeland	0.3
Hounslow	208.9	Bolsover	187.8	Na h-Eileanan Siar	0.0	Na h-Eileanan Siar	1.8
Blackburn with Darwen	199.6	Blackburn with Darwen	173.3	Isle of Anglesey	1.5	Isle of Anglesey	4.0
Elmbridge	198.7	Elmbridge	172.4	East Ayrshire	3.4	Orkney Islands	5.5
Bolsover	193.1	Rossendale	171.4	Great Yarmouth	3.5	Derry City and Strabane	5.8
Broxtowe	182.5	North Warwickshire	164.2	Middlesbrough	3.8	Conwy	6.0
Rossendale	177.6	Hounslow	161.4	Derry City and Strabane	4.0	Pembrokeshire	6.7
North Warwickshire	165.4	Broxtowe	156.7	Conwy	4.2	Falkirk	6.9
Wirral	160.7	Wirral	143.4	West Devon	4.4	Gwynedd	7.2
St Albans	141.1	St Albans	123.1	Pembrokeshire	5.2	Gosport	7.6
North West Leicestershire	138.2	North West Leicestershire	119.3	Hartlepool	5.5	Hartlepool	7.7
Dacorum	116.7	Redditch	101.9	Gwynedd	5.6	Middlesbrough	7.8
Redditch	108.3	Dacorum	98.4	Lewisham	5.8	Sunderland	7.9
East Staffordshire	103.3	Mole Valley	90.0	Sunderland	6.0	Redcar and Cleveland	9.0
Mole Valley	90.9	Rushcliffe	86.6	Orkney Islands	6.0	Inverclyde	9.0

Sources: Live IP right data 1995-2016 (IPO); postcode data (FAME); LAD identifiers (ONS Postcode Directories 2016 and 2021); LAD employment data (NOMIS and NISRA).

Table 5: LADs with highest/lowest registered design intensity, 2011 and 2016

LADs with highest registered design intensity (registered designs per 10,000 employees)				LADs with lowest registered design intensity (registered designs per 10,000 employees)			
2011		2016		2011		2016	
LAD	Intensity	LAD	Intensity	LAD	Intensity	LAD	Intensity
Scottish Borders	114.0	Scottish Borders	137.6	Angus	0.0	Broadland	0.0
Canterbury	52.5	North East Derbyshire	49.3	Causeway Coast and Glens	0.0	Cannock Chase	0.0
Wirral	35.1	Hackney	39.3	Derry City and Strabane	0.0	Causeway Coast and Glens	0.0
Rochdale	30.1	Hyndburn	36.8	East Ayrshire	0.0	Conwy	0.0
Hyndburn	30.0	Ashford	35.0	East Dunbartonshire	0.0	East Dunbartonshire	0.0
Cotswold	24.6	Mid Devon	32.8	Lincoln	0.0	Gravesham	0.0
Barnet	23.7	Barnet	25.1	Moray	0.0	Na h-Eileanan Siar	0.0
South Kesteven	23.7	Three Rivers	24.4	Na h-Eileanan Siar	0.0	North Ayrshire	0.0
Brentwood	22.5	Rochdale	23.9	Orkney Islands	0.0	North Warwickshire	0.0
East Renfrewshire	21.7	East Renfrewshire	22.9	Pembrokeshire	0.0	Orkney Islands	0.0
West Oxfordshire	20.0	Ealing	22.0	Redcar and Cleveland	0.0	Redcar and Cleveland	0.0
Slough	18.9	Great Yarmouth	21.1	Richmondshire	0.0	Shetland Islands	0.0
Dacorum	17.0	North Hertfordshire	18.9	Shetland Islands	0.0	Torridge	0.0
Charnwood	16.6	Cheltenham	17.3	Thurrock	0.0	Armagh City, Banbridge and Craigavon	0.1
Newcastle-under-Lyme	15.8	Wirral	16.9	Torridge	0.0	Warrington	0.1

Sources: Live IP right data 1995-2016 (IPO); postcode data (FAME); LAD identifiers (ONS Postcode Directories 2016 and 2021); LAD employment data (NOMIS and NISRA).

The IP right intensities within a LAD give an indication of the knowledge bases present in the area. Out of the fifteen LADs with the highest patent, trade mark and registered design intensities, there is one LAD, Wirral, that is in the highest intensity group of fifteen LADs for all three protection methods. This suggests a high level of knowledge in the area that is eclectic in nature, thus providing the potential for many types of innovation. Bolsover, Slough and Three Rivers are in the highest intensity group of fifteen LADs for two protection methods, suggesting a degree of innovation specialisation in these areas. Further down the intensity distributions there are other LADs with relatively high IP right intensities in two or three IP protection methods, giving an indication of the nature of innovation in those

areas. Na h-Eileanan Siar, Pembrokeshire and East Ayrshire are in the group of fifteen LADs with the lowest IP right intensities. This suggests that the knowledge base is relatively low in these areas, and that the likelihood of innovation is low.

5. MAIN FINDINGS AND FUTURE WORK

In the UK, there has been a strong policy focus in recent years on levelling-up economic performance across regions. It is important, therefore, that firms and policy makers understand the spatial pattern of innovation activities if they are to successfully implement suitable practices and policies to sustain innovation in the long term, boost productivity and enhance growth and living standards.

Using a novel dataset that includes live patents, trade marks and registered designs at the LAD level, we provide an insight into the geographical patterns of innovation activities in the UK. We generate a picture of the distribution of IP protection in the UK, uncovering geographical concentrations of IP protection activity. In doing so, we make several important observations. First, IP right intensity varies markedly across space in the UK, suggesting marked differences in areas' ability to generate and protect innovations. Firms in many more rural areas have little or no engagement with the IP system. Second, the geography of IP right intensity in the UK varies across IP protection methods, suggesting differences in the types of innovation being undertaken locally and potentially the value of locally attuned innovation policies. Third, there is a somewhat dynamic nature to the IP protection landscape, with evidence of a change in intensity rankings during the 2011-2016 period. To the extent that IP intensities provide a picture of areas' innovation potential, this may provide a degree of reassurance for those seeking to support levelling-up or local development, and fourth, there is a significant overlap in the use of patents, trade marks and registered designs in some areas, suggesting complementarity among the three IP protection methods.

To develop this research further, we plan to examine, in more depth, those areas identified as being most IP right intensive. We will examine the characteristics of those areas/firms in those areas (e.g., whether the area is urban or rural, the size decomposition of firms in the area, the industry decomposition in the area, the skills and knowledge base in the area). In addition, we will explore the dynamic nature of the UK's IP protection landscape in more depth. An examination of local economic indicators and important eco-system factors may shed light on why the IP protection landscape can change quite quickly. The most recent data used in this paper dates back to 2016. With Brexit and the Covid-19 pandemic

occurring after 2016, the opportunity arises to explore, firstly, whether a shift in the geography of IP protection has occurred since Brexit, and secondly, whether the IP protection profile of an area contributes towards the resilience of that area during the years after a time of crisis or structural change. However, before we can answer these research questions, more recent IP protection data is required.

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