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ORIGINAL PAPER

Levelling-up national economies through regional development? a panel fsQCA approach applied to Great Britain

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Abstract
There is currently renewed policy focus on 'levelling-up' economic performance across Great Britain's regions and nations. Heterogeneous historical regional economic experiences lead to questions over the need for policy differences and trade-offs, and roles of regional, versus national level, policies in the longer term. This paper examines, using panel fuzzy-set qualitative comparative analysis (fsQCA), combinations of education and human capital, entrepreneurship, and economic activity conditions driving economic development differences across local authorities in Great Britain. Analysis identifies three and six condition-based pathways for the presence and absence of high local economic development (LED), respectively, absence pathways having a particular geographical focus. This identifies different sets of regions, where disadvantage is 'deep-rooted' (and non-traditional policy-making is needed), advantage is long-established, or where policy is most likely to make a positive difference. It also identifies a need to tailor policy according to the pathway(s), rather than assuming homogeneous approaches are appropriate. Finally, exemplar regions offer case studies of how future policy can assist movement from absence to presence of high LED.

JEL classification O (Economic Development, Innovation, Technological Change and Growth)

1 Introduction

Uneven economic development and persistent, 'embedded' differences in regional growth, and the 'north–south divide' debate (Rowthorn 2010), has characterised United Kingdom (UK) economic debate for many years. McCann (2020) found the UK to be one of the economically unequal (in terms of economic disparities between its regions and nations) when compared to other OECD and European countries.

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Similarly, Carrascal-Incera et al.'s (2020) study of UK and international data concluded that UK's relatively high spatial inequalities restrict rather than facilitate its economic growth. Unsurprisingly, therefore, the Conservative UK Government has put forward its recent 'levelling-up' agenda (McCann and Ortega-Argilés, 2021).

This can also be seen in the context of potential impacts of issues such as Brexit, which Chen et al. (2018) identify as having far more serious consequences for UK regions and nations than their EU counterparts, with these effects particularly concentrated in regions and nations already lagging in the UK context. Thissen et al. (2020) also identify this outcome, the regional concentration of specific industrial sectors having the consequence of reinforcing these regional and national economic inequalities. This increasing recent focus on 'levelling-up' regions and localities across the UK generally, but particularly Great Britain (GB), has seen renewed interest in regional industrial strategy approaches (Bailey et al. 2020).

This is also interesting in broader contexts because, as Panzera and Postiglione (2022) found in their study using EU data for 2003–2016, regional growth rates are positively related to inequality *within* the region but negatively to inequality *with* neighbouring regions. Less developed regions were also found to be converging faster than more developed regions, potentially because of European Union (EU) convergence policy but also because of combinations of growth promoting factors.

Specific, longstanding, economic, and social issues faced by different types of deprived regions, such as inner cities (Whysall 2011), rural (Osborne et al. 2004), and coastal regions and localities (Agarwal et al. 2018), have, however, hindered their economic progress and renewal (Glaeser et al. 2015; Huggins et al. 2021a). Panzera and Postiglione (2022) also found that human capital has a positive impact on growth in more developed, but not less developed, regions, supporting the view that policy support needs tailoring to the environment faced, with the local or regional development being in a form that benefits the population of the whole area (Pike et al. 2007), rather than assuming blanket approaches will benefit all lagging regions effectively and evenly, implying a need for more local engagement (Jarvis et al. 2011).

This paper uses panel fuzzy-set qualitative comparative analysis (fsQCA) to examine the different sets of conditions (the sets of conditions called pathways) driving local economic development (LED) differences across GB. FsQCA captures complexity through testing theory-based conditions and contextual influences, identifying pathways consisting of multiple conditions, as opposed to focussing on single effects of individual variables captured by standard regression-based statistical analysis (Huang et al. 2021). As a configurational-based approach, fsQCA focuses on understanding how or why multiple conditions combine to explain a phenomenon (see Furnari et al. 2021).

Nascent panel fsQCA (Garcia-Castro and Ariño, 2016; Guedes et al. 2016) has recently been employed in Beynon et al. (2020) on entrepreneurial attitudes and activity, and Rodrigues et al. (2020), on corporate governance and research and development (R&D) investment. This facilitates evaluation of the complex nature of LED in widely differing regions (see also Ragin 2008), and the longitudinal relevance inherent in the data (Beynon et al. 2020; Garcia-Castro and Ariño, 2016; Guedes et al. 2016). This also allows examination of longitudinal evidence to identify breadth and depth of pathways, in terms of changes in geographical scope and stability over time. As a result, panel fsQCA generates specific, configurational, geographically defined findings (see, for example, Beynon et al. 2021a) creating novel insights for stakeholders including academics and policymakers.

We also adopt Furnari et al.'s (2021) three stage model of configurational theorising to structure the analysis. The scoping stage identifies individual conditions that may affect the outcome, allowing identification of relevant conditions in the analysis, by considering previous studies that examined the influence of individual conditions on LED. Because these individual conditions can connect in a multitude of different combinations (configurations), linking then focuses on how these conditions may ultimately connect with each other (as pathways) to generate outcomes, allowing creation of an analytical framework from which we derive research questions. Following the fsQCA analysis itself, the paper considers longitudinal evidence for the strength (in terms of breadth and depth) of these pathways over time, in terms of changes in geographical coverage and strength. Naming these fsQCA pathways then identifies their overarching, higher-level themes, assisting discussion of results.

This allows several important contributions. First, clear identification of different combinations of conditions (pathways) driving possible presence or absence of high LED, measured in terms of gross value added per head over time across GB. Second, identifying regions where disadvantage is 'deep-rooted' and non-traditional policy-making is needed, regions where advantage is long-established, and regions between these two extremes, where policy is most likely to make a positive difference. It also indicates a need to tailor support according to the pathway(s), rather than assuming homogeneous approaches are appropriate to all lagging regions (Jarvis et al. 2011). Finally, exemplar regions offer case studies as to how future policy can assist movement from absence to presence of high LED.

2 Addressing spatial economic unevenness

The section begins the scoping stage of the Furnari et al. (2021) approach, after which, we outline a framework in which conditions link, and through which research questions are subsequently developed. Sutton and Arku (2022) identify that globalisation and the increasing shocks inherent in the global system make regional economies more and more vulnerable. Zhang and Lucey (2019) highlight this in terms of the movement of skilled labour within Europe. Rodríguez-Cohard et al. (2020) find that cultural values can help and hinder regions in dealing with the consequences of globalisation. For Europe, changing patterns of global trade and development have therefore made resilience and competitiveness of European regions a core concern of the EU and governments of constituent nation states, as well as aspiring members (Koschatzky and Stahlecker 2010).

The Lisbon Strategy, for instance, emphasised the importance of confronting structural problems faced by European regions to increase productivity growth (Denis et al. 2005). Only within certain northern nations of Europe, however, was a significant relationship found between regional growth and intensity of R&D and higher education, suggesting a fragmented pattern of knowledge-based growth across regions (Rodríguez-Pose and Tselios 2010; Huggins and Izushi 2013), Crescenzi and Giua (2020) find that very different effects occurred as a result of the EU's cohesion policy, a large proportion of the positive growth effects concentrated in Germany, employment impacts largely confined to the UK, and much more time limited effects in Southern Europe. Looking into the German experience in more detail, Harfst et al. (2020) find that policy was focussed on a mixture of urban development, risk management, heritage, and tradition maintenance.

Much of the UK's discussion around levelling-up, however, has assumed that large investments in infrastructure, which partly address historical imbalances in public investment per head (Martin et al. 2016), are key in achieving greater parity of outcomes across regions (Connolly et al. 2021). Clearly, such investments may help, there being evidence that some larger northern cities of the UK, such as Liverpool and Manchester, are enjoying improvements in local competitiveness thanks to investments through their city deals (Huggins et al. 2021a). However, it has also been argued that relationships of territorial competition created by this approach are likely to lead to greater rather than less inequity between localities, with the ability to access these resources in part reflecting the information and resources used by these localities when seeking to make these deals (O'Brien and Pike 2015). Furthermore, the UK government's simultaneous focus on retaining the global competitiveness of London continues to result in more resources being sucked into London at the expense of other regions of the UK (Pike et al. 2019).

Additionally, previous interventions in the UK and elsewhere such as across the European Union have failed to address inequalities between regions in a lasting fashion (Petrakos et al. 2011). Specifically, investments in infrastructure and business support in lagging regions of the EU were found to be ineffective at best (Rodríguez-Pose and Fratesi 2004). Indeed, some argue that infrastructure investments may have worsened disparities, with more peripheral regions being more easily served from central locations (Iammarino et al. 2019). Furthermore, from the perspective and contrasting experiences of old industrial regions, the culture and institutions established to support historical activities prevented creation of new development paths (Huggins and Thompson 2022).

Whilst Malecki (2004) points out that regions *can* compete based on low wages, compliant labour, and low taxes, it is the link between knowledge, entrepreneurial, and innovation bases of regions and their growth capacity and capability that is at the heart of the concept *of competitiveness-led development* (Malecki 2004; Huggins and Johnston 2009). Such concepts are strongly tied to 'Schumpeter's competitiveness', as it has been termed (Beugelsdijk and Maseland 2011). More generally, contributions from economic geography and spatial economics have become increasingly concerned with understanding and demonstrating the regional microfoundations of macroeconomic growth models (Stimson et al. 2011). As indicated above, endogenous growth theory has focussed on the role of human capital, knowledge, and innovation in regional growth processes, with a need to better understand the mechanisms underlying regional growth patterns identified as a key priority in aiding effective economic development policy (Stimson et al. 2011).

In summary, the discussion of policies needed to promote regional economic development is a longstanding issue in the literature (see, for example, Polèse and

Shearmur 2006). Furthermore, a wide range of elements have been identified as of potential importance, such as clustering and spillover effects (Shearmur and Bonnet 2011), self-employment (Rupasingha and Goetz 2013), and infrastructure (Crescenzi and Rodríguez-Pose 2012). In choosing an overarching framework within which to situate the analysis a range of choices are available. Szerb et al. (2020), for example, provide a comprehensive, smart specialisation-focussed framework for analysis of the main drivers of regional economic development, combining the regional innovation system with the regional entrepreneurship ecosystem as they drive entrepreneurial discovery processes and improvements, as well as industry diversification and specialisation, consequently generating emerging industries, new firm formation and ultimately innovation, growth, employment, and LED. This study, however, uses the UK's Competitiveness Index framework (see Huggins and Thompson (2013). This is focussed on the factors which improve the capability of a locality to attract and maintain firms with stable or rising market shares in an activity, whilst maintaining stable or increasing standards of living for those who participate in it.

Innovation (Capello and Lenzi 2015), human capital (Gennaioli et al. 2013), and entrepreneurship (Gennaioli et al. 2013) are then identified as relevant, have data available in the UK context at a local level of relevance to the focus of the research, and link (implicitly and explicitly) into the wider range of factors of relevance. Henley (2020), for example, finds the existing local economic and entrepreneurial environment important because of its effects on the ability of small firms to attract the required quantity and quality of resources, including financial and human capital. Hassink (2005) goes further, arguing that older industrial regions face deleterious lock-ins and path dependencies determined by the effects of their previous economic experiences, making it more difficult for policy to be effective without development of learning-clusters (as opposed to learning—regions which Hassink believed were too fuzzy and vague), in particular sectors. This implies a need for detailed analysis of the structural make up of regions, to identify if such clusters exist and if they can overcome longstanding economic problems. This also suggests that local economic conditions such as business density (as a proxy for traditional 'main street' business, Beynon et al. 2019), and labour activity (as a proxy for labour efficiency, Dunford 1996), social efficiency (Cyrek 2017), and impacts of previous economic shocks on productive capacity (Martin 2012), are also relevant.

Economic geography heterogeneity also suggests that there will be no single pathway for LED. Indeed, focussing specifically on the role of small business growth and LED, Henley (2020) identifies that a positive link between SME and LED is not guaranteed, depending on access to resources such as financial, networking, and human capital, entrepreneurial orientation, start-up activities and crucially, how to mix these to use knowledge and generate innovation. The linking stage of the Furnari et al. (2021) approach therefore considers how these conditions may work together.

Dunford (1996) sees labour mobilisation as intrinsically linked to innovation in determining economic development. Martin (2012) identifies the ability of a region to adapt (be resilient) and productive to be related to activity rates linked to entrepreneurship. Huggins and Harries (2004) find links between economic activity and human capital; Gennaioli et al. (2013) also find human capital and entrepreneurship connected with each other in this relationship with LED. Dunford (1996) and Audretsch and Keilbach (2005) associate entrepreneurship with innovation (via knowledge spillovers) to LED, whilst Beynon et al. (2019) find that entrepreneurship and SME density (as substitutes rather than complements) affect LED (as measured by income). Huggins and Johnston's (2009) work also suggests that links between SME density (proxying for entrepreneurial networks), entrepreneurship, and innovation can generate regional growth. This review of the literature allows the authors to create the following analytical framework, as shown in Fig. 1.

3 Uneven development in GB

To provide context for this analytical framework, prior to the generation of the research questions, we also provide examples from a cross-section of localities and regions, chosen for the heterogeneity of their economic history, and their potential to provide policy exemplars for successful change. Aberdeen in Scotland has for the past four decades, for example, been a locality with a strong connection to the North Sea oil and gas industry. Initially a branch-plant economy for oil sector multinational enterprises, it upgraded its position over time (Cumbers and Martin 2001), developing a cluster of knowledge intensive businesses providing support to the sector (Spigel 2016). As local reserves of oil reduced, the United Kingdom Competitiveness Index (UKCI) showed Aberdeen decline compared to the UK average (100.0) from a score of 118.4 in 2013 to 107.8 in 2021 (Huggins and Thompson 2013; Huggins et al. 2021b). Yusuf et al. (2014) note, however, that cluster membership promoted agility in oil and gas sector firms, enabling them to identify alternative opportunities, initially, within the oil sector, diversifying geographically to serve export markets (Chapman et al. 2004). Both public sector and the higher education institutions in the city have also made investments to promote a more diversified, less carbon-intensive economy. This included investment from the Aberdeen City Region Deal which created the Oil and Gas Technology Centre (OGTC), subsequently renamed,

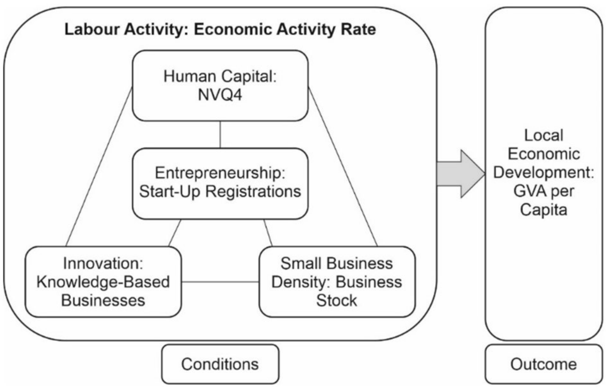

Fig. 1 Analytical framework

and refocussed to become the Net Zero Technology Centre (NZTC), with a focus on R&D projects that reduce emissions in collaboration with the private sector (OGTC 2021).

Contrastingly, Leeds, in the North of England suffered deindustrialisation for much of the twentieth century, before becoming a success story late in the twentieth and early in the twenty-first century through growth and development of its financial (Gonzalez and Oosterlynck 2014) and service clusters (Department for Business, Energy, and Industrial Strategy 2017a). In the twenty-first century Leeds further benefitted from consolidation of the banking and building society market, developing expertise in accounting, call centre operations, specialist financial boutiques, venture capital, insurance, and broader associated activities such as PR firms, management and IT consultancy, property, and business outsourcing (Henderson 2006). Prior to the financial crisis, however, Rudd (2006) noted that the more prosperous (financial services employed) elements of the population lived on Leeds's outskirts (Schmuecker and Viitanen 2011; Gonzalez and Oosterlynck 2014), those living in deprived parts of Leeds disconnected from this labour force (Hughes and Lupton 2016). Further, during the 2008 financial crisis, whilst the financial sector proved resilient, the city's manufacturing, construction, retail, accommodation, and food sectors shed many lower skilled jobs, Leeds was worse hit than the average of UK larger cities (Gonzalez and Oosterlynck 2014). Funding secured through the 'Leeds City Region Deal', however, looks to have supported a reversal of this (Ward 2020). By 2015, both business registrations and economic activity improved, suggesting that start-ups and spinouts were beginning to benefit from an entrepreneurial knowledge-spillover effect (Acs et al. 2013) and, by 2017, evidence of a stronger business presence in the city (Devins et al. 2017). Local Enterprise Partnerships (LEPs), with Leeds at the centre of the Leeds City Region, also provided a source of economic leadership, supported by creation of the West Yorkshire Combined Authority in 2014 and a mayor elected in 2021. Stated priorities of the Leeds City Region LEP now place less emphasis on the financial sector and more on the support and growth of businesses more broadly (Leeds City Region Enterprise Partnership 2019).

Turning to examples from the south of England, Swindon's growth in the nineteenth and early twentieth century was based around the Great Western Railway's locomotive works (Bassett and Harloe 2006). Unlike cities further north, such as Derby, however, which retained their transport industry manufacturing facilities (Smith and Ibrahim 2006), Swindon's train manufacturing closed in the 1980s. However, in a similar fashion to Derby, it built on this engineering expertise to retain high levels of advanced engineering and high value manufacturing (Swindon and Wiltshire LEP 2016), including, until recently, Honda (Holweg 2019). However, the economic downturn led to cuts and eventually closure of the Honda plant. Whilst some former employees struggled to find work, for others their skills have allowed them to redeploy their labour (Rootham and McDowell 2017), despite the overall reduction in advanced manufacturing and increase in the wider knowledge economy and professional and business services (Regeneris Consulting 2018), Swindon's economy remaining specialised in advanced manufacturing. There is, however, reduced reliance on it for providing highly rewarded employment, strong transport connections also allowing Swindon to serve larger agglomerations to both the East

(London) and West (Bristol and Cardiff). Consequently, it has been referred to as a safety valve for London and the South-East of England, both in terms of population (Harloe and Boddy 1987) and industry (Bassett 1990). Whilst fragmentation of planning processes and local government reorganisation in the 1990s hindered achievement of this potential (Lambert and Boddy 1998), development of the Swindon and Wiltshire LEP is likely to have helped overcome these constraints to some degree as the LEP can instigate better place sensitive strategic planning if allowed to take advantage of opportunities to benefit localities (Peck et al. 2013). Questions remain, however, regarding whether individual LEP plans will create greater regional success when industry supply chains extend beyond the local and require a more joined-up approach to support (Harris et al. 2020). Swindon may therefore have benefited from spillovers from both the east and west.

Although further from London than Swindon, South Gloucestershire is also strategically placed, in this case between the agglomerations around Bristol, Newport, and Cardiff, placing it towards the centre of the Western Gateway partnership (Deloitte 2021). Proximity to Bristol means it is included in their clusters associated with performing arts, movie making and broadcasting (Department for Business, Energy, and Industrial Strategy 2017b). Compared to (adjacent) Bristol, Bath and North-East Somerset and North Somerset, South Gloucestershire also like Swindon has a relatively high proportion of employment in medium and high-technology manufacturing (South Gloucestershire Council 2015). In some regards, therefore, South Gloucestershire appears to benefit from spillovers from adjacent localities. Withdrawal of demand potentially leads to a more rapid increase in firm deaths, but then a more rapid return as the economy recovers and net births surge (Thompson and Zang 2018). This growth, however, is likely hampered by the low proportion of the population with NVQ Level 4 qualifications or higher (equivalent to a university undergraduate degree). Whilst on the surface surprising, as South Gloucestershire is the home of the University of the West of England and the Bristol and Bath Science Park (Wasim 2014), it may be that this indicates a negative effect from being located close to agglomerations in which such qualified people may prefer to reside. This raises the prospect of South Gloucestershire representing one of the weaker, less robust, regions, if entrepreneurial endeavours are not supported by strong knowledge resources or a historical culture of enterprise (Huggins and Thompson 2015).

Finally, and further south again, the Bournemouth region, comprising Bournemouth, Christchurch, and Poole, represents a smaller urban area formed from the combination of the three constituent local authorities in April 2019. Like Leeds, it also has an industrial past and has developed a financial services cluster (Department for Business, Energy, and Industrial Strategy 2017a). In other regards, however, it is more like Derby, retaining engineering specialisms (Smith and Ibrahim 2006), robotics and aerospace, focussed on Bournemouth airport (Dorset LEP 2014; Department for Business, Energy, and Industrial Strategy 2017b). Like Swindon, its current advanced manufacturing expertise reflects an evolution of previous industrial history, but rather than repurposing those skills (locomotive to automotive), it has focussed on more closely related sectors (aerospace to defence, ship building to luxury yacht production). More than the other localities studied, it also benefits from the tourist industry. Consequently recognised as a more diversified economy (Beatty and Fothergill 2003), Carlisle et al. (2016) identify multiple stakeholder groups looking to make use of amenities available for educational visitors, younger people, and more traditional tourist visitors, to generate further diversification, but again building on existing tourism (Dorset LEP 2014; Carlisle et al. 2016). Hart (2004), considering scenarios for Bournemouth and Poole nearly 20 years ago, might have considered the approach as 'incremental growth—solid silver' where the economy remains diverse rather than the 'maximising growth—golden prospect' where transformation to a service-based future is sought (Department for Business, Energy, and Industrial Strategy 2017b).

The heterogeneity of these cases illustrates the need for a configurational approach to be used to explain how order emerges from combinations of conditions, rather than being pre-designed (Meyer et al. 1993). Consequently, pre-specified, hypothesised, relationships are unsuitable for use with the configurational approach, because they go against the explorative nature of the study. This leads to the following (and acknowledging the exploratory nature of the research using the fsQCA techniques described later) research questions, derived from the review of the literature, and the GB context, and adapting the question structure set out in papers such as Huang et al. (2021):

Research Question 1: Does presence of high levels of LED *require* multiple conditions to work together?

Research Question 2: Is presence and absence of high levels of LED driven by multiple, non-mirroring pathways?

Research Question 3: Does the strength (in terms of the relationship of the pathway with the outcome and the geographical coverage of the pathway) change over time?

4 Methods

The geographical units of analysis focussed on in this study are local authority (LA) areas, including London Boroughs, in GB (England, Scotland, and Wales), see Fig. 2 later, but acknowledging the absence of the City of London and Isles of Scilly due to incomplete data issues. This results in a total of 366 LA regions considered. Although these areas are geographical administrative areas, rather than necessarily being more self-contained areas of economic activity, their administrative role and availability of comparable data across GB make them suitable for analysis relative to alternatives. For example, bodies made responsible for local economic development in England, Local Economic Partnerships (LEPs), were until recently given significant responsibility by the UK government for delivering economic development policy in England (see Pickernell et al. 2019). LEPs replaced the Regional Development Agencies that had responsibility for regional development programmes and covered much larger regional areas (the 9 International Territorial Level (ITL) 1 regions of England plus Wales, Scotland, and Northern Ireland), and covered

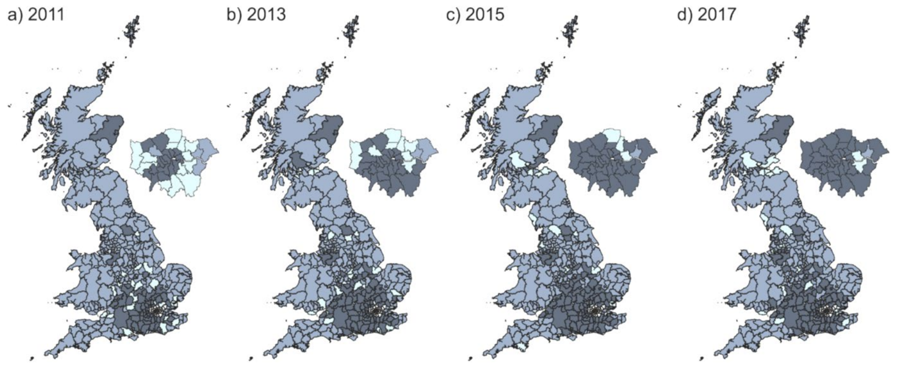

Fig. 2 Map-based breakdown of truth table details to presence of high LED (dark grey), absence of high LED (medium grey), and no outcome (near white) (colour figure online)

generally smaller areas each consisting of a smaller number local authority areas surrounding the larger agglomerations, for example, the D2N2 LEP consists of the two cities of Derby and Nottingham plus their more rural surrounding county areas of Derbyshire and Nottinghamshire. The relative access to funding, other resources, and strategic capacity of LEPs was diminished (Rossiter and Price 2013). In addition, delivery of many elements of development strategies remained the responsibility of local authorities (Marlow 2019). However, the rest of GB (Scotland and Wales) have devolved responsibility for enterprise policy and have not adopted the LEP approach. The alternative, but overlapping, concept of the city region (see Harrison 2011), where cities and their surrounding areas are used as a focus for policy, also lacks complete geographical coverage, given that much of the UK is not covered by a city region. At a more disaggregated level, Census Areas Statistics (CAS) are available for wards which reflect different areas of cities or rural local authorities, and at the super output area level (equivalent to neighbourhood), but generally on a less frequent basis and are much more restricted in the variables available. These areas whilst allowing for the heterogeneity of cities, for example, to be recognised such as areas of prosperity and deprivation have little or no economic development policy tools available. Therefore, LAs, with their remits over transport, housing, education, and, crucially, local economic development (Almond et al. 2015), are best suited for this comparative study (see Fig. 2).

As part of the longitudinal aspect of this study, four years of data are included, namely 2011, 2013, 2015, and 2017, resulting in 1464 (=4×366) LA-year observations making up the complete dataset, derived from UK Competitiveness Index data (see Huggins and Thompson (2013) and http://cforic.org/ for further details). Those years were chosen as 2011 allowed time for the 2008 economic crisis effects to begin to dissipate and 2017 was chosen as minimising the impact of Brexit. The data considered in this study, derived from the scoping of the literature, in terms of conditions and outcome, are described in Table 1.

The central methodology applied to this data is (panel) fuzzy-set qualitative comparative analysis (fsQCA), introduced in Ragin (2008). FsQCA analysis is

Table 1 Description of conditions and outcomes

Conditions	Condition description and unit of scale [mean, SD, min, max]	Similar studies where condition/similar used
Innovation	KNOWLEDGE-BASED.BUSINESSES [22.449, 8.185, 4.332, 45.856]	Huggins and Johnston (2009)
Human capital	WORKING AGE WITH NVQ4 [34.923, 10.025, 11.000, 71.300]	Gennaioli et al. (2013)
Entrepreneurship	BUSINESS REGISTRATIONS PER 10.000 INHABITANTS [51.567, 34.912, 6.430, 595.794]	Audretsch and Keilbach (2005); Erken et al. (2018)
Small business density	BUSINESSES PER 1000.INHABITANTS [37.351, 14.626, 13.966, 195.551]	Erken et al. (2018)
Labour activity	ECONOMIC ACTIVITY RATE WORKING AGE [78.294, 4.487, 62.500, 92.600]	Erken et al. (2018); Gennaioli et al. (2013)
Outcome	*Description and unit of scale*	
Local economic development	GVA.PER.CAPITA [24549.340, 16,163.565, 8886.687, 260,980.572]	Erken et al. (2018); Gennaioli et al. (2013)

now an increasingly popular technique (Kraus et al. 2018) used as an alternative to regression and structural equation modelling (SEM) in certain circumstances. Regression models identify the importance of individual conditions in isolation, or interactions between two variables, rather than the combinations of multiple conditions working together (Deng et al. 2019). This conjunctional causation, where conditions only have effect in conjunction with other conditions, not on their own (Woodside 2013), is an important consideration when considering issues of economic geography. Second, SEM cannot account for potential equifinality, where more than one causal combination of conditions can lead to same outcome (Fiss et al. 2013).

This is important for economic geography where it is important to understand whether and how localities with very different economic structures may attain the same outcomes. Third, neither regression nor SEM techniques can account for asymmetrical relationships (Fiss et al. 2013), where the causal configurations for outcome presence and outcome absence differ. FsQCA incorporates the causal complexity from all three of these possibilities (Ragin 2008; Misangyi et al. 2017), Kraus et al. (2018, p. 33), concluding that fsQCA is therefore becoming an increasingly popular technique, creating value for academics and policymakers through the provision of detail that can assist future research and policy making.

Following Ragin (2008) and Beynon et al. (2020), the initial fsQCA investigation of the dataset is broken down into the following stages (certain additional graphical details presented in the Appendix), i) calibration details, ii) necessity analysis, iii) truth table construction (including frequency and consistency threshold exposition), iv) complex, intermediate, and parsimonious solution options for sufficiency analysis, v) geographical breakdown of LA-year observations to pathways, and vi) panel fsQCA. This allows construction of solutions of pathways describing the relationship between conditions and outcome (with emphasis in the main text on the interpretation of the established pathways).

4.1 Calibration

The calibration process when applying fsQCA is to move the conditions and outcome originally described in terms of interval scale values into being described in terms of fuzzy membership scores (see Ragin 2008). Here, the direct method is employed whereby a set of numerical qualitative anchors are found, then using the method of log-odds, the required fuzzy membership scores are created (ibid.). Here, the approach originally described in Andrews et al. (20,016), and more recently in Beynon et al. (2020) in a panel fsQCA setting. Moreover, for each condition and outcome, a probability density function (pdf) is first constructed, and the respective, 5th, 50th, and 95th, percentiles of the pdf initially denoting the required qualitative anchors, lower-threshold, crossover-point, and upper-threshold, respectively (see Fig. 6). Following Beynon et al. (2020), the established quantitative anchors were considered by the authors, and acknowledging the longitudinal nature of the data, were considered for their appropriateness.

A consequence of the calibration process across the considered LA-year observations is the transformation of the condition and outcome values into different forms used across the analysis, see Table 2.

In Table 2, the top rows report the original ‘interval’ scale values for the considered conditions and outcome, for a sample of three LA-year observations. The middle rows show the same LA-year observations now described in terms of fuzzy membership scores (found from the calibration process based on the details in Fig. 6). The bottom rows describe the LA-year observations, for the conditions only, in strong membership terms (whereby a fuzzy membership score < 0.5 or ≥ 0.5 are labelled 0 and 1—respectively), which illustrate the configuration-based thinking going forward (see Ragin 2008).

4.2 Necessity analysis

The necessity analysis presented here (see Ragin 2008), is premised on evaluation of consistency and coverage values of each condition (and separately each of their negations) to the outcome (and separately its negation), see Table 3. In this necessity terms the consistency and coverage terms denote the strength of consistency of cases within the pathway and the empirically (number of cases) importance of a pathway, respectively, and which often work against each other (Ragin 2008).

Table 2 Interval scale, fuzzy, and strong membership score values for sample of three individual LA-year observations

Sample	Innovation	Human capital	Entrepreneurship capital	Small business density	Labour activity	High LED
Interval scale*	29.16	34.5	42.42	29.77	79.5	29,964.1
	11.80	22.2	33.17	41.73	75.9	19,078.4
	22.32	17.4	28.96	23.67	71.8	20,099.6
Fuzzy membership score**	0.803	0.524	0.405	0.249	0.612	0.741
	0.072	0.072	0.172	0.679	0.282	0.297
	0.545	0.027	0.108	0.096	0.078	0.364
Strong membership***	1	1	0	0	1	
	0	0	0	1	0	
	1	0	0	0	0	

Figures in bold indicate outcome (presence or absence of productivity) that the configuration is associated with; Figures struck through indicate that the configuration is not associated with presence or absence of productivity

"Strong membership" refers to cases that have a quantified high degree of belonging to a particular set, using membership scores which range from 0 to 1, where a fuzzy membership score < 0.5 is labelled 0 and a fuzzy membership score of ≥ 0.5 is labelled 1 (see Ragin 2008)

* Original scale values for conditions and outcomes of sample of three LA-year observations

** Fuzzy membership value versions of condition and outcomes of sample of three LA-year observations

*** Strong membership representation of conditions of sample of three LA-year observations

Table 3 Necessity-based consistency and coverage values for each condition (and negation)

Condition		High LED			
		High LED (presence of high LED)		~High LED (absence of high LED)	
		Consistency	Coverage	Consistency	Coverage
Innovation	Condition	0.837	0.775	0.531	0.591
	Not-condition	0.557	0.497	0.798	0.855
Human capital	Condition	0.774	0.727	0.563	0.636
	Not-condition	0.612	0.538	0.758	0.801
Entrepreneurship capital	Condition	0.788	0.761	0.552	0.641
	Not-condition	0.629	0.539	0.794	0.818
Small business density	Condition	0.734	0.698	0.564	0.645
	not-condition	0.626	0.545	0.735	0.769
Labour activity	Condition	0.749	0.672	0.614	0.662
	Not-condition	0.623	0.573	0.696	0.769
Descriptive statistics	Min	0.557	0.497	0.531	0.591
	Max	0.837	0.775	0.798	0.855

Inspection of the consistency and coverage values in Table 3 shows that no values are above the regularly employed 0.9 threshold (see Greckhamer 2011; Greckhamer et al. 2018). It follows progression to the next stage of the analysis can be undertaken, with all considered conditions retained (Ragin 2008).

4.3 Truth table construction

This sub-section elucidates the configurations presented within the dataset (illustrated in bottom rows in Table 2). With five conditions considered, there are $2^5 = 32$ logically possible configurations to consider (different combinations of 0 s and 1 s across the considered conditions), which Table 4 presents the associated truth table for.

In Table 4, the early details (columns) discern the presence or absence of conditions supporting each configuration, the middle columns give the number of LA-year observations associated with each presented configuration in strong membership terms, with the No. column the total number of LA-year observations, then this total broken down by which year they are specifically associated with (biannually from 2011 to 2017), the last columns give consistency and PRI values for the configurations to the outcome and not-outcome. There are 24 configurations shown (main rows), less that the 32 available configurations, the reason for this subset shown is premised on the employed frequency and consistency thresholds (see Ragin 2008), next elucidated (also employing a PRI score threshold of 0.5, see Mello 2021). Following Andrews et al. (2016), the subsequent choice of consistency threshold, after frequency threshold is chosen (given by *x*-axis in Fig. 7b in Appendix), is premised

Table 4 Truth table elucidation of configurations based on conditions and associations to the outcome High LED

Config	Innovation	Human capital	Entrepreneurship capital	Small business density	Labour activity	No	2011
1	0	0	0	0	0	253	97
2	0	0	0	0	1	85	33
3	0	0	0	1	0	53	21
4	0	0	0	1	1	77	22
5	0	0	1	0	0	33	1
6	0	0	1	0	1	18	1
8	0	0	1	1	1	20	2
9	0	1	0	0	0	38	11
10	0	1	0	0	1	18	2
11	0	1	0	1	0	30	8
12	0	1	0	1	1	58	8
16	0	1	1	1	1	30	1
17	1	0	0	0	0	43	17
18	1	0	0	0	1	23	10
21	1	0	1	0	0	30	4
22	1	0	1	0	1	26	3
24	1	0	1	1	1	39	6
25	1	1	0	0	0	44	11
28	1	1	0	1	1	22	10
30	1	1	1	0	1	32	5
31	1	1	1	1	0	105	23
32	1	1	1	1	1	240	29
	Frequency threshold—13.5		Consistency Threshold—0.891				

Config	2013	2015	2016	High LED			
				High LED		~High LED	
				Cons	PRI	Cons	PRI
1	69	48	39	0.621	0.081	**0.949**	0.877
2	22	13	17	0.762	0.161	**0.950**	0.825
3	12	10	10	0.785	0.109	**0.973**	0.889
4	15	20	20	0.801	0.195	**0.949**	0.794
5	8	14	10	0.814	0.158	**0.965**	0.84
6	10	4	3	0.856	0.249	**0.951**	0.743
8	5	7	6	0.874	0.268	**0.953**	0.725
9	7	10	10	0.799	0.129	**0.969**	0.867
10	5	4	7	0.838	0.211	**0.956**	0.788
11	5	5	12	0.840	0.144	**0.973**	0.854
12	10	18	22	0.843	0.270	**0.938**	0.712
16	8	14	7	0.891	0.342	**0.942**	0.649

Table 4 (continued)

Config	2013	2015	2016	High LED			
				High LED		~High LED	
				Cons	PRI	Cons	PRI
17	11	7		0.838	0.324	**0.921**	0.67
18	7	1	5	0.873	0.431	**0.903**	0.567
21	11	11	4	0.883	0.437	**0.908**	0.558
22	10	11	2	**0.899**	0.522	0.889	0.478
24	10	14	9	**0.911**	0.567	0.882	0.425
25	6	14	13	0.871	0.434	**0.901**	0.566
28		1	11	**0.920**	0.596	0.881	0.404
30	15	8	4	**0.908**	0.603	0.859	0.388
31	25	31	26	**0.919**	0.737	0.766	0.241
32	56	70	85	**0.907**	0.752	0.694	0.183
				6 (464)		16 (853)	

Figures in bold indicate outcome (presence or absence of productivity) that the configuration is associated with; Figures struck through indicate that the configuration is not associated with presence or absence of productivity

on the desire to employ a consistency threshold large enough to exclude a configuration being associated to both the outcome and not-outcome but noting the larger the consistency threshold the more configurations excluded from association to either outcome or not-outcome. It follows, progression across the x-axis (increasing frequency threshold) infers a 'lowest' allowed consistency threshold (left *y*-axis) and subsequent per cent of LA-year observations associated with either outcome or not-outcome (right *y*-axis). With the intention to retain as many of the LA-year observations in the subsequent analysis, inspection of the graph suggests a frequency threshold of 13.5 and consistency threshold 0.891 enabled (as highlighted).

It follows, the 24 configurations shown in Table 4 have at least 14 LA-year observations associated with them in strong membership terms (noting Cnfgs 7, 13, 14, 15, 19, 20, 23, and 27 are not presented since they have less than 14 LA-year observations associated with them in strong membership terms—termed remainders). Further, the consistency values above the threshold of 0.891 in the last columns shown in bold gives those configurations association to either the outcome or not-outcome (those striked through values indicate consistency values below the consistency threshold)—at the base of these columns the number of such configurations and individual LA-year observations are given (a total of 464 + 853 = 1317 is 90% of the present LA-year observations as indicated the case in Fig. 7b).

To elucidate the association of LA-year observations with configurations related to either the presence or absence of high LED, we show pertinent LA maps over biannual years between 2011 and 2017 (see Fig. 2). In each map, there are three shadings of LAs, premised on findings in Table 4, associated with, neither the presence nor absence of high LED (near white), the absence of high LED (medium grey), and the presence of high LED (dark grey).

In Fig. 2, further, the 'near white' shaded LAs (across different years—LA-year observations) are those contained in configurations not further associated with either the presence or absence of high LED. They are either in configurations with less than 14 LA-year observations associated with them, or configurations without a strong enough consistency to be associated with either the presence or absence of high LED (Cnfgs 26 and 29 in Table 4). The dark grey LA-year observations are then those associated with the presence of high LED (a total of 464 LA-year observations in Table 4), medium grey LA-year observations those further associated with the absence of high LED (a total of 853 LA-year observations as shown in Table 4). It is also worth noting the relative concentration of LAs in or around London associated with the presence of high LED (see Fig. 2). This becomes more prominent as the considered biannual years go from 2011 to 2017. In later years, there is movement west towards Bristol/Bath, as well as increasing concentration in or around the Manchester area. The maps in Fig. 2, and the relevant shading, will form the basis of map-based elucidation of pathways later shown.

4.4 Sufficiency analysis

An integral prior part of the sufficiency analysis stage of the analysis is consideration of which solutions to consider (Ragin 2008), from complex, intermediate and parsimonious, possible. The existence of multiple solutions is premised on how remainder configurations are considered, those configurations not flagged as being associated to neither the outcome nor not-outcome (see Table 4), which are dependent on the associated frequency threshold employed. Figure 3 gives a visual understanding to these solutions which were adapted from Ragin (2008) and presented previously in Beynon et al. (2021b).

In this study, no easy counterfactuals are considered appropriate (the longitudinal nature of the study mitigates ability to consider easy counterfactuals at the LA level or year level separately—as both would need to be considered). Hence, following Figure 3, two solutions are considered here, complex (equating to intermediate) and parsimonious.

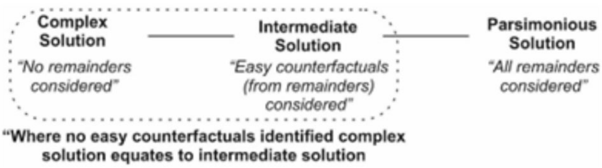

Fig. 3 Complexity/parsimonious continuum (adapted from Ragin (2008) and Beynon et al. (2021b))

5 Results and interpretation of pathways

Following Ragin (2008), as described in Table 4 (right-hand side of truth table), configurations are associated with either the presence of high LED or absence of high LED. The complex and parsimonious solutions' details presented in Table 5, use the circle notation adapted from Ragin and Fiss (2008), and employed in papers such as Beynon et al. (2020). Concentrating on the complex solution initially, there are three and six pathways describing the presence of high LED (initially labelled COUT1, COUT2, COUT3) and the absence of high LED (CNOUT1, CNOUT2, CNOUT3, CNOUT4, CNOUT5, CNOUT6), respectively. The top rows show the presence (solid circle), absence (transparent circle), or does not matter (no circle) role of each condition in a pathway. The middle rows give technical details in the pathways, including configuration details, consistency, and coverage metrics. The bottom rows give the same results for the parsimonious solution, described in the top rows by the larger circles (solid or transparent denoting the presence or absence of high LED, respectively). The findings in Table 5 are interpreted in the next section, along with the longitudinal analysis, discussed below and summarised in Tables 6 and 7.

5.1 Longitudinal analysis

A further feature of this study is consideration of panel fsQCA (see Garcia-Castro and Arino, 2016; Guedes et al. 2016; Beynon et al. 2020, for fuller technical details), which adds a longitudinal dimension to the analysis. In this study, we concentrate on novel 'panel based' consistency measures. The two measures are (noting POCONS is the original consistency values shown in the truth table in Table 4).

BECONS (between consistency): BECONS splits the POCONS values into individual year values. A BECONS above the original consistency (POCON) means there is a better subset relationship for that specific year (less counterfactual evidence than existing across all years). Consequently, if the BECONS regression line (as later shown) is sloping up over time then the set of conditions are becoming more consistently associated with the outcome (and opposite is true).

WICONS (within consistency): WICONS splits the POCONS values into individual LA values. Any WICONS below 1.000 indicates an inconsistent subset relationship existing. A WICONS above the original consistency (POCON) means there is a better subset relationship for that specific LA (less counterfactual evidence than existing across all LAs).

Each of these measures produce sets of values for the pathways associated with the presence of high LED and absence of high LED), (see Figs. 8, 9, 10, and 11) in Appendix for BECONS and WICONS exposition. Table 6 then shows the pathways over time in terms of number of LA-year observations associated with them and relative change over the considered time range.

As also illustrated in Fig. 2, of the 366 regions, 212 (58%) are associated only with the absence of high LED pathways across the 4 years of observations.

Table 5 Sufficiency analysis results from consideration of conditions against the presence and absence of high local economic development

Conditions	Local economic development								
	Presence of high local economic development			Absence of high local economic development					
Complex solution	*COUT1*	*COUT2*	*COUT3*	*CNOUT1*	*CNOUT2*	*CNOUT3*	*CNOUT4*	*CNOUT5*	*CNOUT6*
Innovation	●	●	●	⊖	⊖	⊖			
Human capital		•	•		⊝		⊖	⊖	
Entrepreneurship	●	•		⊝			⊖		⊖
Small business density		●	●			•	⊝	⊝	⊝
Labour activity	●		•		•	•		⊖	⊖
Configurations (in strong membership terms)	**22, 24, 30, 32**	**31, 32**	**28, 32**	**1, 2, 3, 4, 9, 10, 11, 12**	**2, 4, 6, 8**	**4, 8, 12, 16**	**1, 2, 17, 18**	**1, 5, 17, 25**	**1, 9, 17, 25**
Consistency*	0.865	0.887	0.892	0.899	0.925	0.895	0.881	0.888	0.886
PRIs core*	0.675	0.744	0.723	0.806	0.782	0.682	0.750	0.761	0.759
Raw coverage*	0.582	0.570	0.501	0.718	0.457	0.400	0.578	0.531	0.537
Unique coverage*	0.093	0.081	0.012	0.057	0.004	0.012	0.009	0.026	0.016
Solution consistency, PRI score, coverage	0.844, 0.673, 0.675			0.824, 0.693, 0.827					
Parsimonious Solution	*POUT1*	*POUT2*		*PNOUT1*			*PNOUT2*	*PNOUT3*	*PNOUT4*
Configurations (in strong membership terms)	**22, 24, 30, 32**	**24, 28, 31, 32**		**1, 2, 3, 4, 8, 9, 10, 11, 12, 16**			**1, 2, 3, 4, 17, 18**	**1, 3, 5, 17, 21**	**1, 3, 9, 11, 17, 25**
Consistency*	0.865	0.849		0.855			0.874	0.878	0.881
PRI score*	0.675	0.682		0.743			0.752	0.751	0.762
Raw Coverage*	0.582	0.640		0.798			0.673	0.588	0.603
Unique Coverage*	0.057	0.115		0.086			0.013	0.012	0.019

Table 5 (continued)

Conditions	Local economic development	
	Presence of high local economic development	Absence of high local economic development
Solution consistency, PRI score, coverage	0.834, 0.660, 0.697	0.792, 0.653, 0.864

* The consistency and coverage values are over the whole dataset of cases (not just from those configurations shown associated in strong membership terms). The consistency value shows the proportion of cases that share both the combination of causal conditions and the predicted outcome. The coverage value identifies the proportion of the outcome that is accounted for by the causal combination, similar to variance in regression analysis

Note: Presence of the condition is represented by a solid circle, whilst absence is represented by a transparent circle, and does not matter is shown by no circle. pathway. The middle rows give technical details in the pathways, including configuration details, consistency, and coverage metrics. The bottom rows give the same results for the Parsimonious solution, described in the top rows by the larger circles (solid or transparent). Larger circles represent core conditions in the parsimonious (and complex) solution, whilst smaller circles represent peripheral conditions only in the complex solution

Seventy-six regions are associated with at least 12 absence of high LED LA-year observations (out of a maximum of 24 = 6 absence pathways over 4 years). This indicates that they are consistently associated with multiple absence of high LED pathways. This includes rural regions in the East of England (six regions), coastal regions in the South-East of England (six regions), but no parts of London. Wales has 10 regions in this situation, with Industrial South Wales having seven regions, along with large parts of the East Midlands (eight regions), North-East of England (nine regions), and North-West of England (12 regions), West Midlands (10 regions), Yorkshire and Humber (eight regions). Conversely, there are much lower numbers in Scotland (four regions), and the South-West of England (three regions). Of the 24 regions with the highest number of absence of high LED pathway LA-year observations (16) and no presence LA-year observations, only one is in Scotland (West Dumbarton), one is in the South-East of England (Isle of Wight), and one is in the East of England (Tendring). Conversely, the North-East of England has three regions, North-West of England having 5, Yorkshire and Humberside having 3, East and West Midlands of England having 2 each, and Wales having 6. This is also a more urban issue with only 14 of the 76 classified as more rural regions. Also illustrated in Fig. 2, in contrast, 109 of 366 LAs (29.8%) are associate only with the presence of high LED pathways, 18 of these regions consistently associated with all three presence pathways across all years (i.e. 12 LA-year observations). These are almost exclusively in London, East of England and, particularly, the South-East of England, only Warwick in the West Midlands coming from a region outside these 3. Only 45 out of 366 (12.3%) regions have moved between the presence and absence of high LED. Only 6 of these moved from presence to absence in 2017, the other 39 (10.7%) moving from absence to presence, almost half of these (18) from the existing core regions of London, the South-East of England, and the East of England. In Wales, only Monmouthshire and Newport move, both from absence to a presence pathway in 2017 (albeit only one), COUT1 for Newport, COUT3 for Monmouthshire, with 10 Welsh regions only being associated with absence pathways.

All three presence of high LED pathways are becoming less consistently associated with the outcome over time (see Fig. 8—with slight exception for COUT1). Therefore, as the three presence of high LED pathways cover more parts of the South-East of England over time, they are also becoming more weakly associated with the presence of high LED, indicating a wider but also shallower coverage. From Fig. 10, the slight strengthening of absence of high LED pathways with the outcome apart from CNOUT3 shows the absence of high LED pathways generally becoming more consistently associated with the absence of high LED. Given the coverage of these pathways also slightly diminishing over time, this indicates that these pathways become geographically narrower but also deeper. This suggests that those regions continuing to be represented by this absence of high LED pathways are ones most likely to remain absent high LED, this situation seemingly entrenched.

To complete Furnari et al.'s (2021) approach, the pathways are next named. Using evidence from Tables 2 and 3, supplemented with map-based details, see Figs. 4 and 5 of LA-year observations for each pathway, Table 4 describes each of the identified

Table 6 Coverage of pathways over time

Pathway	2011	2013	2015	2017	Change 2011–2017
COUT1	43	91	103	100	57
COUT2	52	81	101	111	59
COUT3	39	56	71	96	57
CNOUT1	202	145	128	137	− 65
CNOUT2	58	52	44	46	− 12
CNOUT3	33	38	59	55	22
CNOUT4	157	109	69	69	− 88
CNOUT5	119	99	80	61	− 58
CNOUT6	136	93	79	70	− 66
Total	839	764	734	745	

pathways (for the presence and absence of high LED) and their coverage in relation to the complex solution.

Adding detail to the maps shown in Fig. 2, the black shaded LAs in Fig. 4 show the LAs covered by the three presence of high LED pathways over time, shown in dark grey in Fig. 2. Similarly, the black shaded LAs in Fig. 5 show the LAs covered by the six absence of high LED pathways over time, shown in light grey in Fig. 2.

The configurational approach seeks to generate typologies/taxonomies (Meyer et al. 1993) and it is that context that the results are evaluated.

5.2 Interpretation of pathways

When naming the presence of high LED pathways, the drivers of the competitiveness, rather than geography, provided the strongest descriptive power, given that LAs from London and the South-East of England were predominantly represented, though some places outside this core were also identified as associated with these pathways. Consequently, COUT1 is described as emerging entrepreneurship driven, as it is driven by innovation and entrepreneurship, but does not display the traits of embedded innovation systems. Conversely, COUT3 is described as mature innovation system driven, because it is driven by innovation, human capital, small business density, and labour activity, but entrepreneurship is not relevant. COUT2 sits between these two, described as renewing—entrepreneurial innovation system driven, because it combines innovative businesses and entrepreneurship with human capital and small business density.

The absence of high LED pathways, by contrast, had much more easily identifiable, distinct, historic, economic geography characteristics in the UK context, as discussed in Philip et al. (2017) with regards to connectivity and rurality, Beatty and Fothergill (1996) with regards to old industrial regions, Beatty and Fothergill (2003) concerning coastal regions, and Lee (2014) in terms of urban regions. CNOUT1, where innovation and entrepreneurship were absent, is focussed on geographical

Table 7 Pathway names

	Pathway	Key present/absent conditions	Summary descriptor name
Presence of high LED	COUT1	Innovation, entrepreneurship, labour activity	Emerging entrepreneurship driven
	COUT2	Innovation, human capital, entrepreneurship, Small business density	Renewing—entrepreneurial innovation system driven
	COUT3	Innovation, human capital, small business density, labour activity	Mature—innovation system driven
Absence of high LED	CNOUT1	Absent innovation, absent entrepreneurship	Geographically peripheral
	CNOUT2	Labour activity, absent innovation, absent human capital	Rural old industrial
	CNOUT3	Economic activity, small business density, absent innovation	Rural old tourism
	CNOUT4	Absent entrepreneurship, absent human capital, absent small business density	Urban old industrial
	CNOUT5	Absent human capital, absent small business density, absent labour activity	Urban old high unemployment
	CNOUT6	Absent entrepreneurship, absent small business density, absent labour activity	Coastal detached

peripheral regions, affected by traditional economic policy foci around connectivity. CNOUT2, where labour activity was present but innovation and human capital were absent, was concentrated in rural old industrial regions. CNOUT3, by way of contrast, had the presence of labour activity and small business density but absent innovation-based businesses, has a rural old tourism economic geography. CNOUT4 had a more urban old industrial economic geography where entrepreneurship, human capital, and small business density were all absent. CNOUT5 was also an urban focussed pathway, the absence of both human capital but also small business density and labour activity suggesting an urban old high unemployment economic geography. Finally, CNOUT6, where entrepreneurship, small business density, and labour activity were all absent, described regions which were predominantly coastal and detached from the broader economy.

6 Discussion

Previous research focuses on identifying the effect of individual conditions, whereas the configurational approach (see Ragin 2008) specifically focuses on identifying where conditions in combination are important, emphasising the exploratory nature of our work. This also highlights that when discussing the data used for and results obtained from the configurational approach, they will not be fully comparable with prior literature.

When examining the results in the context of the research questions, the presence of high levels of LED does indeed require multiple conditions to work together such that the presence of one condition alone is not sufficient to explain high levels of LED (Research question 1), the presence and absence of high levels of LED are driven by multiple pathways, the pathways that drive the presence of high LED not mirroring those that drive the absence of high levels of LED (Research question 2) and the strength of these pathways do change over time (Research question 3). More specifically, the analysis reveals several different sets of regional characteristics driving the results. Specifically, where high LED is present, the three pathways highlight entrepreneurial and/or innovation drivers, the combinations of which identify where the innovation system is likely to be mature, renewing or developing. The fact that the strength of the relationships between the pathways and the presence of high LED are weakening, however, also suggests that, just as there is a core-periphery nature to the economy as a whole, there is also one for high LED, with those regions covered by high LED pathways throughout the period likely benefiting from longer standing historical strengths in these conditions whilst those only covered in later years are more vulnerable to having weaker less deeply rooted innovative/entrepreneurial systems.

For the absence of high LED, the longitudinal data show a reducing coverage over time which suggests those covered by pathways for the whole period have more entrenched weaknesses. This is consistent with work that has found historic development can leave a lasting imprint on the local population and society, hindering contemporary economic progress and renewal (Huggins et al. 2021a). The fact that the

Fig. 4 Map-based breakdown of causal recipes to the outcome (presence of high LED)

Fig. 5 Map-based breakdown of causal recipes to the not-outcome (absence of high LED)

naming process drew heavily from their geography/economic history also reinforces this.

Interestingly, of the five configurations associated with the presence of high LED in the three pathways, only one (32) is associated with all three pathways, the regions included here having a wide base of advantage. Conversely for the absence of high LED, there is no configuration associated with all six pathways, configuration 1 being associated with four and configurations 2 and 4 being associated with 3 each, the regions covered here suffering from multiple sets of disadvantages. This is

Fig. 5 (continued)

also suggestive of more specific and different sets of conditions being at play for the absence of high LED, in keeping with the different economic histories described in the pathways. This would fit with findings of those identifying specific issues faced by those living in distinct types of deprived regions, such as the inner city (Whysall 2011), rural locations (Osborne et al. 2004), and coastal regions (Agarwal et al. 2018).

Although 39 localities moved from possessing pathways associated with absence to those associated with presence between 2011 and 2017, almost half (18 localities) are in the core regions of London, the South-East, and East of England. It is possible that most of these changes therefore reflect spillover effects from more successful localities in these localities given that 15 of the localities are in London, 33 in the South-East, and 12 in the East of England displayed presence pathways in 2011. As the economy recovered from the 2008 economic crisis, it is also evident that other localities outside the core regions may have also been enjoying spillover effects from these more successful localities.

Examining the examples of the local regions discussed in the literature, Aberdeen moved from being associated with one pathway, COUT1 entrepreneurship-driven competitiveness in 2011, to all three pathways being relevant, consistent with sustainable clusters only really forming after the collapse/decline or acquisition of a key employer/sector. This would release skilled entrepreneurial labour to form a larger number of knowledge intensive firms in a wider variety of related sectors (Mason and Harrison 2006) or supply labour to high growth firms already in existence (Spigel and Vinodrai 2021). In the case of Aberdeen, this is therefore consistent with the gradual decline of the UK's North Sea oil and gas sector, the increase in the number of relevant pathways likely to be the end of a process starting 15 years prior to this.

For Leeds, even prior to the financial crisis, threats to some more low skilled activities associated with call centres from offshoring existed (Henderson 2006).

This may explain why, against this story of growth and regeneration, Leeds in 2011 still had three pathways associated with an absence of higher value LED present, urban old industrial (CNOUT4), urban old high unemployment (CNOUT5) and coastal detached (CNOUT6). Because by 2017 this has been reversed and all three presence pathways are present, Leeds is potentially offering key lessons in rapid economic turnaround.

Swindon, in contrast, moved from possessing one absence of high LED pathway CNOUT4 associated with urban old industrial regions such as those found in the North-East, North-West, Yorkshire and the Humber, and the South Wales Valleys to, from 2013 onwards, being associated with one presence of high LED pathway, COUT1, associated with knowledge-based entrepreneurial activity. Being on the main train link between London and the agglomerations in the South-West of England and Wales and good road link (e.g. M4 motorway) (Swindon and Wiltshire LEP 2016), Swindon may have benefited from spillovers of this type. Therefore, although in the latter twentieth-century concerns were being expressed as to whether Swindon was becoming primarily a dormitory town for London (Harloe and Boddy 1987), the results here suggest that this was avoided and instead spillovers have been beneficial, offering potential lesson for similarly located LAs aiming to create pathways associated with higher LED and economic success.

For South Gloucestershire, in 2011 CNOUT4 reflecting urban old industrial was present where business registrations were low and there was an absence of graduates in the population. New entrepreneurial activity started to emerge in 2013 and 2015 as the presence pathway of COUT1 was found. This would be consistent with an entrepreneurial economy emerging. By 2017, presence pathway COUT3 was also present, indicating that a knowledge-based agglomeration economy is indeed forming, again with likely beneficial spillovers from proximate agglomerations.

Bournemouth, Christchurch, and Poole, the area now covered by the LA in 2011, possessed the absence pathways CNOUT4, CNOUT5, and CNOUT6 associated with old urban industrialisation, urban with high unemployment, and being coastal detached. However, unlike other exemplars, Bournemouth, Christchurch, and Poole are also less well connected physically to larger agglomerations. Like Leeds, Bournemouth, Christchurch, and Poole have moved from having three absence pathways present in 2011 to three presence pathways in 2017, but the conditions and location are quite different, offering important potential policy lessons for other, more peripheral regions, potentially based on a broader multi-sector approach.

Examination of the background evidence for these specific cases where successful movement from absence to presence has occurred also suggests that Harfst et al.'s (2020) identification of (successful) policy in Germany focussing on leveraging combinations of urban development, risk management, heritage, and tradition maintenance, may also offer at least partial explanation in the GB context, and thus worthy of further research.

7 Conclusions

The cases discussed clearly suggest different approaches, based on their economic geography and history, which allowed them to move over time from absence of high LED to presence of high LED pathways, often multiple, showing the potential future economic resilience derived from these approaches. Because the geographies are all quite different, this gives the opportunity for policymakers in lagging regions to consider where best to learn lessons from and tailor their policies accordingly. The cases, however, also all show distinct advantages not shared by lagging regions, also needing consideration when designing policy.

The research makes several important contributions. First it clearly identifies different sets of conditions (pathways) driving the presence or absence of high LED over time. Second, the longitudinal trends or pathways clearly show regions where disadvantage is longstanding and policy is unlikely to be effective, regions where advantage is also firmly established, and regions that are between these two extremes, where policy is most likely to be able to make a positive difference. It also indicates a need to tailor support according to the pathway faced rather than assuming a blanket approach will benefit all lagging regions effectively suggestive of requiring community engagement (Jarvis et al. 2011). Whilst Shearmur and Bonnet (2011) argued that local development is connected to market access, local industrial structure, and wider regional effects, rather than local innovation, this research illustrates that local innovation can make a positive difference, in combination with other conditions, in certain economic geographies.

Any 'Levelling-up' type policy agenda will have a very large mountain to climb in the face of a problem that is entrenched via multiple pathways in many regions of the UK, as represented by the lack of movement between absence and presence of high LED for most regions, the multiple absence of High LED pathways in many of these regions and the geographical concentration of these absence of high LED pathways in non-core regions outside London, the South-East and East of England. Whilst there are regions within these core regions that do have an absence of presence of high LED pathways, regions in the core are more likely to move from absence to presence over time.

Three presence of high LED 'pathways' and six absence of high LED 'pathways' based on different combinations of regional industrial structure; education and human capital; entrepreneurship; and economic activity are identified in this study. Differences are found in the: relevance of these pathways to different geographies; their relevance over time; and the degree to which multiple pathways apply to a region. Because fewer than one in six regions change between low and high rates of LED over a six-year period, and there are distinct geographical contexts associated with high and low LED, however, this highlights the entrenched nature of the issues any 'levelling-up' agenda will need to overcome. The example regions may offer case studies as to how future policy can assist a region move from a low to high LED. Because of the likely importance of spillovers from adjacent LAs, it would also be interesting to specifically model for this in future studies.

Additional avenues for future research are also provided by the limitations in the study. For example, the paper uses only one (outcome of) performance indicator to evaluate the level of development, namely GDP/head. The analysis may of course be sensitive to the indicator used, and consequently future research could examine other potential outcomes of performance. In addition, extending the analysis after 2017 would allow the impact of issues such as Brexit and the COVID pandemic to be analysed. Finally, given the identification of successful policy approaches in other European countries (such as Harst et al. 2020, in Germany), which also appear to have relevance in the context in this study (through the cases evaluated), further research focussing on combinations of conditions, such as (but not restricted to) urban development, risk management, heritage, and tradition maintenance, also seems warranted.

Appendix

This Appendix gives an exposition of several technical aspects of the analysis undertaken in this study. It is broken down into several subsections (see Ragin 2008), (i) calibration details, (ii) frequency and consistency threshold exposition, and (iii) panel fsQCA.

(i) Calibration

The calibration details given here follow the approach presented in Andrews et al. (2016), and recently Beynon et al. (2020), which surround the employment of the Direct method (see Ragin 2008). In Fig. 6, the probability density functions (pdfs) are presented, along with identified qualitative anchors (lower-threshold, crossover-point, and upper-threshold), and subsequent fuzzy membership function.

In Fig. 6, each graph shows the pdf of the values associated with a condition or outcome, the three vertical dotted lines identify the established qualitative anchors, left to right, lower-threshold (5% percentile), crossover-point (50%), and upper-threshold (95%), with the actual values for them given above. The dashed line is the subsequently constructed fuzzy membership function (found using the method of log-odds, see Ragin 2008), with respective 0–1 range as shown on right-hand side y-axis.

(ii) Frequency and consistency thresholds

In Fig. 7, two diagrams are presented which contribute to the understanding of the establishment of the required frequency and consistency thresholds (and their impact on the further considered configurations).

In Fig. 7a, the *x*-axis gives an ordered index of the configurations considered (1–32) based on the size of the configuration (from largest to smallest in size—No. column in Table A3). For example, the first two configurations (far left) have sizes 253 and 240, respectively, as shown on left hand y-axis, their sum is 493 which is shown on right-hand y-axis. As we keep adding the next largest configuration (shown on left y-axis), the cumulative total of LA-year observations increases up

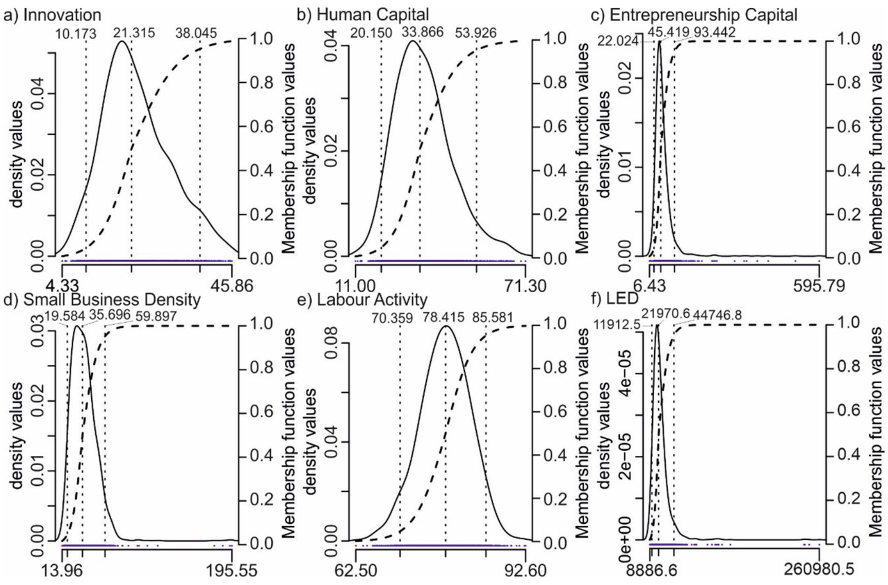

Fig. 6 Probability density functions (pdfs) of considered data

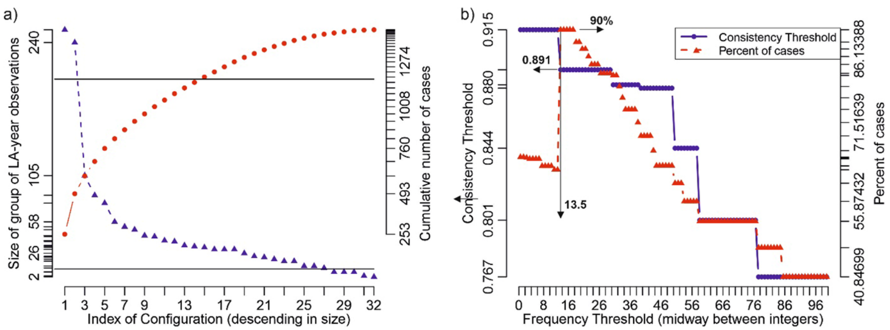

Fig. 7 Diagrams contributing to identification of frequency and consistency thresholds

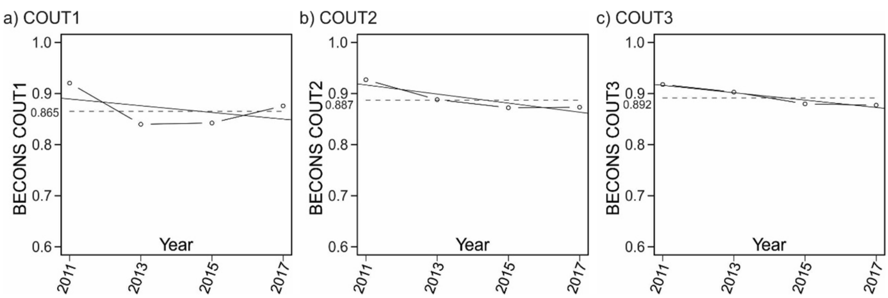

Fig. 8 BECONS diagrams for causal recipes for the outcome (presence of high LED)

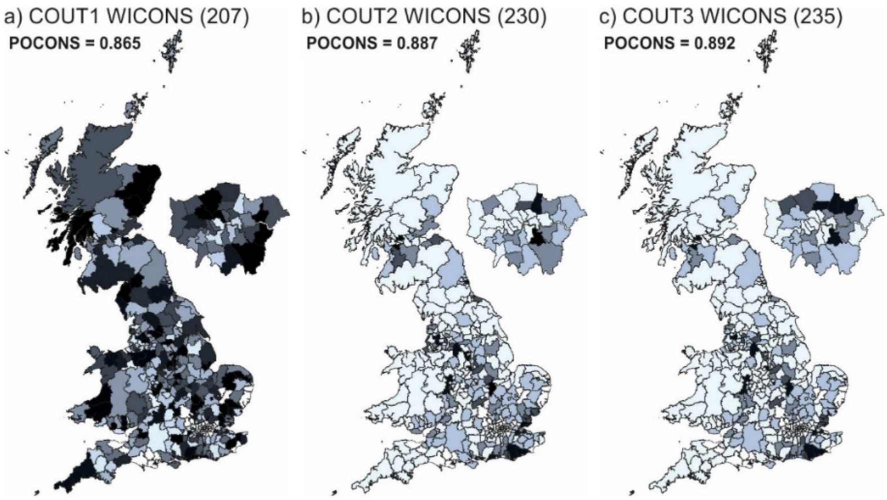

Fig. 9 WICONS diagrams for causal recipes for the outcome (presence of high LED)

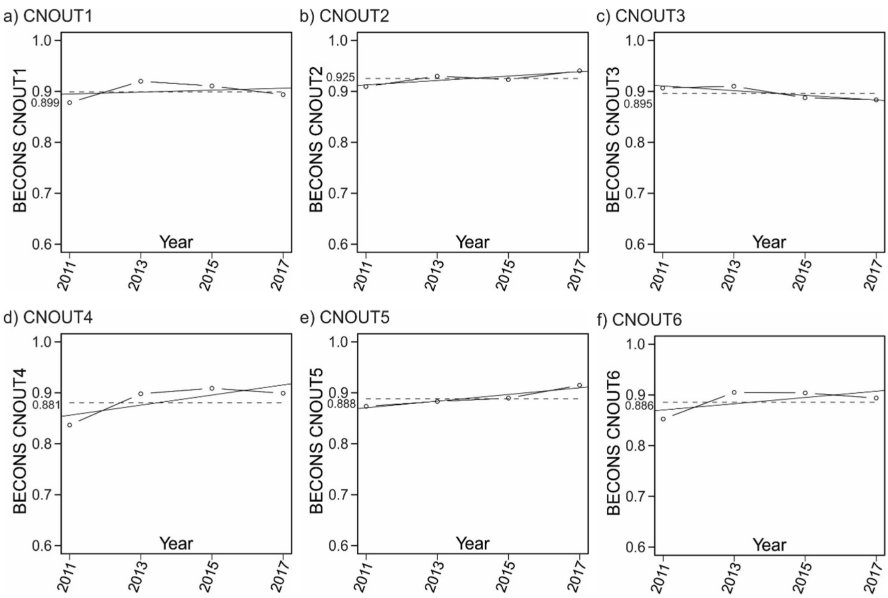

Fig. 10 BECONS diagrams for causal recipes for the not-outcome (absence of high LED)

the right-hand side y-axis. In Fig. 7b, details on the appropriate consistency threshold to employ are given (because of the frequency and consistency threshold values employed—x-axis and y-axis, respectively).

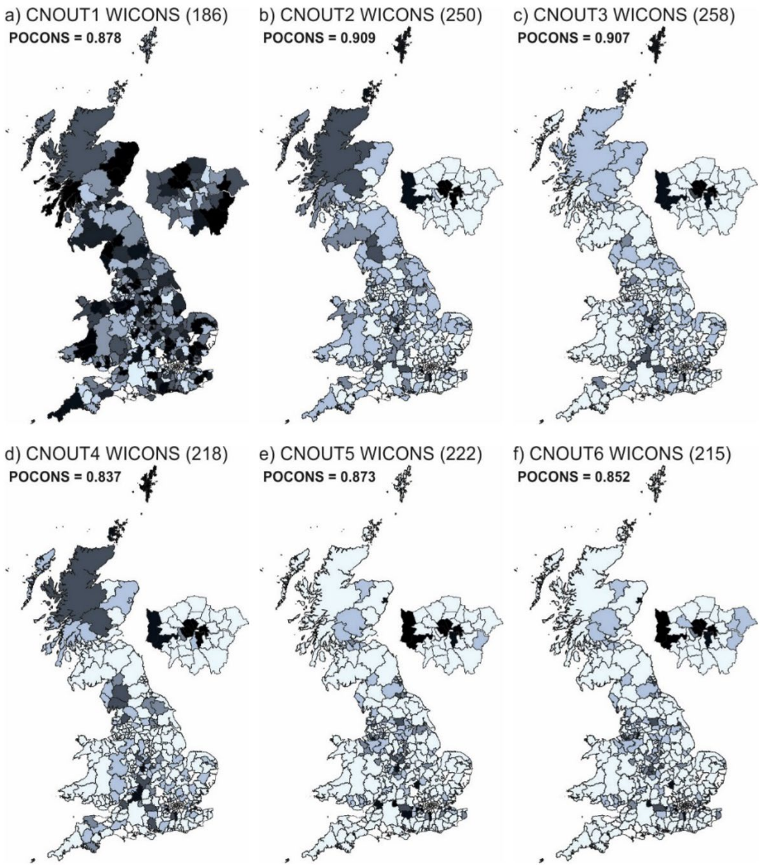

Fig. 11 WICONS diagrams for causal recipes for the not-outcome (absence of high LED)

(iii) Panel fsQCA

The BECONS and WICONS results are next given in diagram form for the outcome, see Figs. 8 and 9, and for the not-outcome see Figs. 10 and 11. In the case of WICONS, the numbers of LAs mean a graph like that employed in Beynon et al. (2020) is not practical, instead a map-based approach is undertaken.[1]

[1] The WICONS results are presented in map form, due to the large number of LA regions considered (see Pickernell et al. 2019, for a plot version form—demonstrating 0–1 range if WICONS values). In each map shown six shades of grey could be present, covering from lightest to darkest, the WICONS values of intervals, 1.00, (1.00, 0.80], (0.80, 0.60], (0.60, 0.40], (0.40, 0.20], and (0.20, 0.00] (this colour ordering is employed since with large numbers of LA regions with WICONS 1.00, the other non-1.00 WICONS regions will be in progressively darker shaded and most noticeable).

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Declarations

Conflict of interest All data were publicly available and there were no sources of funding, financial, or non-financial interests that would have created a conflict of interest. All authors contributed to the study conception and design. Data collection was performed by Rob Huggins and Piers Thompson. Material preparation was prepared by Malcolm Beynon and analysis was performed by all authors. The first draft of the manuscript was written by all authors and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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