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The roles of entrepreneurial university and regional conditions for graduate entrepreneurship: a configurational approach

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ABSTRACT

This study conceptualizes graduate entrepreneurship as a spatial phenomenon. Specifically, we explore how combinations of university-related (knowledge exchange intensity and entrepreneurship support) as well as regional conditions (economic prosperity and entrepreneurial culture) might explain the presence or absence of high graduate entrepreneurship as possible (or likely) explanations based on a configurational approach. We applied fuzzy-set qualitative comparative analysis (fsQCA) to a dataset using HE-BCIS (Higher Education-Business Community Interaction Survey) survey and the UK's ONS (Office for National Statistics) data for England covering a five-year period, combined with map-based analysis to identify distinct pathways that explain the presence or absence of graduate entrepreneurship across different regions. Findings demonstrate that university-related and regional conditions can complement each other in different ways to explain high levels of graduate entrepreneurship, but absence of one can also suppress the effect of the other, resulting in the absence of high graduate entrepreneurship.

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fsQCA; universities; map-based analysis; graduate entrepreneurship; regions entrepreneurship support

1. Introduction

While there is now a significant body of literature on the entrepreneurship that takes place within a university (Siegel and Wright 2015), research on graduate entrepreneurship as a distinct phenomenon has only recently started to emerge (e.g. Beyhan and Findik 2018; Breznitz and Zhang 2019; Breznitz, Lawton Smith, and Bagchi-Sen 2022; Fuller, Beynon, and Pickernell 2017; Marzocchi, Kitagawa, and Sánchez-Barrioluengo 2019). Extant research suggests that the number of graduate start-ups, and the employment opportunities and turnover they create are much higher than those by academic staff (Åstebro, Bazzazian, and Braguinsky 2012; Boh, De-Haan, and Strom 2016; HEFCE 2017), although graduates typically have comparably less relevant experience and fewer resources (Bergmann, Hundt, and Sternberg 2016). Graduate entrepreneurship is thus a potentially important mean to contribute to regional economies and to strengthen regional economic competitiveness (Kitagawa et al. 2022).

Prior research on graduate entrepreneurship has predominately focused on the role of the university, but there is still limited evidence on the role regions play in fostering graduate entrepreneurship (Bergmann, Hundt, and Sternberg 2016; Eckhardt et al. 2022). As a result, Breznitz et al. (2022) argue that to advance knowledge on graduate entrepreneurship, we require novel

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perspectives to advance understanding of the complex relationships between universities and regions. There have also been calls for further comparative work, across economic regions to understand the role that space plays for entrepreneurship more generally (Qian 2016). Indeed, recent evidence suggests graduate entrepreneurship is unevenly distributed across regions (Drejer, Rubæk Holm, and Nielsen 2022; Eckhardt et al. 2022; Kitagawa et al. 2022), but graduate entrepreneurship has not yet been systemically explored across regions.

Consequently, this research aims to explore *how combinations of university-related conditions and regional conditions might explain the presence or absence of high graduate entrepreneurship*, as possible (or likely) explanations based on a configurational theorizing approach (Meyer, Tsui, and Hinings 1993). Specifically, rather than identifying significant linear relationships between individual determinants of graduate entrepreneurship, we use an inductive approach to further understand the combinations of internal-university and external-regional conditions that are associated with graduate entrepreneurship across different regions. Given that graduate entrepreneurship itself can also be seen to be a 'fuzzy' measure, open to different definitions, it is also necessary to make explicit the definition used in this study. Consequently, graduate entrepreneurship is defined, in this study, as all new business started by recent graduates (within two years) where formal support was provided by the higher education provider (HESA 2023).

The short timeframe as well as the provision of formal support are important criteria to strengthen the causal relationship between university education and subsequent new venture creation (Åstebro, Bazzazian, and Braguinsky 2012). We conceptualize graduate entrepreneurship as a spatial phenomenon in which the presence or absence of high graduate entrepreneurship depends on internal university vis-à-vis external regional conditions. We follow Furnari et al'.s (2021) three-stage configurational theorizing approach to advance understanding of graduate entrepreneurship as a complex spatial phenomenon, explained by distinct configurations of multiple conditions related to regions as well as universities.

Specifically, we first conduct a comprehensive literature review to *scope* the key conditions of relevance from universities (i.e. knowledge exchange intensity and entrepreneurship support) and regions (i.e. regional prosperity and entrepreneurship culture) related to the presence or absence of high graduate entrepreneurship. We then *link* the identified conditions in a configurational framework that allows us to explore how combinations of university-related conditions and regional conditions might explain the presence or absence of high graduate entrepreneurship *as possible (or likely) explanations*. We then apply fuzzy-set qualitative comparative analysis (fsQCA - C. C. Ragin 2008) to a dataset covering the years 2015–2019 and containing 100 universities from different regions in England. We integrate data from two sources, the Higher Education Business and Community Interaction Survey (HE-BCIS) for university data and the Office for National Statistics (ONS) for regional data. Finally, we conduct additional, map-based, analysis to depict the landscape of graduate entrepreneurship across England and to effectively name each of the identified pathways, providing a more nuanced understanding of graduate entrepreneurship as a geographically situated phenomenon.

This study facilitates several contributions. First, the study extends the graduate entrepreneurship literature by framing it as a spatial phenomenon, building on recent works suggesting graduate entrepreneurship is unevenly distributed across regions (Drejer, Rubæk Holm, and Nielsen 2022; Eckhardt et al. 2022; Kitagawa et al. 2022). Utilizing fsQCA and mapped-based analysis, the study delineates pathways to high graduate entrepreneurship across different regions. It identifies distinct pathways such as the 'metropolitan advantage-driven', 'urban entrepreneurial synergy-driven', and 'urban knowledge-driven' pathways in various urban settings, challenging assumptions about the role of universities as key catalysts in all contexts. Particularly notable is the discovery of a 'necessity-driven' pathway in peripheral and rural areas, highlighting the resilience of graduates in less-favoured regions. Second, the study enriches the entrepreneurial university literature by examining the interplay between university and regional conditions, demonstrating that synergistic combinations of both are necessary for high graduate

entrepreneurship. By contrast, findings highlight that where universities offer entrepreneurship support but the region lacks an entrepreneurial culture, such support becomes ineffective. The findings reveal suppression effects rather than substitution effects between universities and regions, indicating that the absence of beneficial regional conditions hampers the potential benefits of university-related conditions, and vice versa. This challenges the assumption that universities can compensate for the absence of an entrepreneurial culture in their regions by providing entrepreneurship support (Fini et al. 2011). These suppression effects between universities and their regions are novel and contribute to understanding the role of entrepreneurial universities in promoting graduate entrepreneurship. Overall, the research underscores the importance of recognizing regional diversity and the intricate dynamics between universities and their environments in promoting graduate entrepreneurship. Findings from this study are also of practical relevance as they allow us to formulate recommendations on how to best support graduate entrepreneurship in different geographic regions.

1.1. Literature review

The concept of entrepreneurial universities has attracted increasing attention in the past decade (Cunningham, Lehmann, and Menter 2022; Guerrero and Urbano 2012). In addition to the traditional missions of teaching and research, entrepreneurial universities also embrace a third mission, which includes fostering the entrepreneurial activities of the university community (Compagnucci and Spigarelli 2020). Indeed, increasing research has highlighted that entrepreneurial universities play an important role in supporting entrepreneurship (Abreu et al. 2016; Guerrero and Urbano 2012). Moreover, evidence suggests the teaching, research, and entrepreneurial activities pursued by the university community can generate significant positive economic impact in the region (Guerrero, Cunningham, and Urbano 2015). Given that entrepreneurial universities can contribute to economic growth and regional development through fostering entrepreneurial activities, it is not surprising that researchers have devoted substantial attention to examine the entrepreneurial activities pursued by the university community (Abreu and Grinevich 2013; Abreu et al. 2016). However, previous research on entrepreneurial universities often focuses on the role of faculty members, while graduate entrepreneurship is an area that remains under researched (Beyhan and Findik 2018; Breznitz, Lawton Smith, and Bagchi-Sen 2022).

This study shifts the focus to graduate entrepreneurship and explores how combinations of entrepreneurial university and regional conditions might explain the presence or absence of high graduate entrepreneurship across different regions (of England), as possible (or likely) explanations, based on the following considerations. First, the role played by graduate students has recently attracted attention in the literature (Breznitz, Lawton Smith, and Bagchi-Sen 2022), partly because the number of graduate start-ups are higher than those launched by faculty members (Åstebro, Bazzazian, and Braguinsky 2012; Boh, De-Haan, and Strom 2016; HEFCE 2017). Second, Guerrero et al. (2018) argue that the conditions for graduate entrepreneurship differ significantly between economies, suggesting that graduate entrepreneurship is consequently unevenly distributed across regions. It is therefore important to explore graduate entrepreneurship as a spatially situated phenomenon that needs to consider the regional conditions in which the universities are located. Finally, there is limited research on the role of graduate entrepreneurship in peripheral and less-advantaged regions (Breznitz, Lawton Smith, and Bagchi-Sen 2022), which is of significance given Drejer et al'.s (2022) emphasizes on the importance of retaining graduate entrepreneurs in peripheral regions.

Breznitz et al. (2022) suggests that graduate entrepreneurship is the result of complex relationships between universities and the regions in which they are embedded in. Reviewing the literature on graduate entrepreneurship, we identify the role of two relevant university conditions – *knowledge exchange intensity* as a general attribute and *entrepreneurship support* as an entrepreneurship-specific attribute. We then identify two relevant regional economic conditions – *economic prosperity* as a general attribute and *entrepreneurial culture* as an entrepreneurship-specific attribute. In the

following, we discuss how the different university and regional conditions might influence graduate entrepreneurship.

1.2. The role of universities for graduate entrepreneurship

Universities have long been considered 'a breeding ground' for entrepreneurship (Breznitz and Zhang 2019, 3), but the extent of graduate entrepreneurship varies significantly across universities (Guerrero et al. 2018). One reason for this variation could be related to the university's *knowledge exchange intensity*, which refers to the extent of knowledge exchange activities universities undertake with partners (Research England 2020). The knowledge exchange activities include examples such as research partnerships, working with business, IP and commercialization, among others, the knowledge exchange process involving bi-directional knowledge flow between universities and external partners (Ankrah and Al-Tabbaa 2015; Meyer-Krahmer and Schmoch 1998).

However, universities differ in the nature and extent of knowledge exchange activities they pursue (Ishizaka et al. 2020) providing different opportunities to involve students in knowledge exchange activities. As such, knowledge exchange can have direct and indirect impacts on graduate entrepreneurship. First, knowledge exchange can influence graduate entrepreneurship directly through students' involvement in knowledge exchange activities, which in turn allow students to develop different types of knowledge related to norms, market information and application contexts (Meng, Li, and Rong 2019). Norms reflect a set of values and behavioural principles (Jain, George, and Maltarich 2009; Meng, Li, and Rong 2019), developed during interactions with external partners (Bjerregaard 2010; Jain, George, and Maltarich 2009), including entrepreneurs. These norms orient students to place greater emphasis on practical applicability and commercial relevance of their ideas, which might also lead students to new business opportunities. The type of information is also relevant here, market information concerning data about potential customers, suppliers, and competitors (Jaworski and Kohli 1993), whereas the application context refers to the settings where the product will be used (D'Este and Patel 2007). As external partners are closer to customers, interaction with such partners allows students to develop entrepreneurship-relevant knowledge regarding market and application contexts. Indeed, Ankrah and Al-Tabbaa (2015) found that such knowledge exchange between university and industry offers benefits such as exposing students to practical problems and creating new business opportunities.

Second, knowledge exchange can also influence graduate entrepreneurship indirectly. For example, academics are likely to develop new knowledge through engaging with external partners (Meng, Li, and Rong 2019), in activities such as collaborative research projects, contract research, consultancy, and knowledge transfer partnership, among others. The new knowledge, informed by practical problems faced by external partners, can contribute to curriculum development (Ankrah and Al-Tabbaa 2015). This in turn will likely enhance students' understanding of market problems. Moreover, academics also engage in knowledge exchange activities concerning IP and commercialization such as licencing or establishing spin-offs (Abreu and Grinevich 2013). The opportunities to interact with such academic entrepreneurs provide students with potential role models that will likely contribute to graduate entrepreneurship (Wyrwich, Stuetzer, and Sternberg 2016).

However, university knowledge exchange activities might not be sufficient for graduates to start their ventures. The extent to which students engage in new venture creation will likely also depend on the specific *entrepreneurship support* they receive from the university. In fact, data from the higher education sector show that some universities provide more entrepreneurship support to their students and graduates than others (HEFCE 2017). Entrepreneurship support may come in different forms through the provision of or access to funding, training, and infrastructure (Hayter et al. 2018; Wright, Siegel, and Mustar 2017). The provision of or access to funding represents one important mechanism of entrepreneurship support. For example, seed-funding from universities is critical to

promote new venture creation among students and staff (Kirby 2006), because venture capitalists are less likely to invest in early-stage ventures (Wright et al. 2006).

Entrepreneurship training is another mechanism that is often used by universities for entrepreneurship support (Boh, De-Haan, and Strom 2016). In a meta-analysis, Martin et al. (2013) found that entrepreneurship training and education is positively related to new venture creation. Entrepreneurship training not only positively impacts students' attitudes to starting up (Packham et al. 2010), but also allows students to develop competency in opportunity identification (DeTienne and Chandler 2004), and to acquire knowledge concerning the entrepreneurial process (Shah and Pahnke 2014). However, research has highlighted that entrepreneurial training can reduce start-up activities due to an improved understanding of the risks and challenges associated with venture creation (Marzocchi, Kitagawa, and Sánchez-Barrioluengo 2019).

Universities can also support graduate entrepreneurship through providing access to infrastructure, such as incubators (Barbero et al. 2014; Boh, De-Haan, and Strom 2016), or science parks (Link and Scott 2017; Zou and Zhao 2014). Prior research on the impact of incubators and science parks on graduate entrepreneurship has generated mixed results. Some studies argued that incubators and science parks contribute to graduate entrepreneurship (Boh, De-Haan, and Strom 2016; Wright, Siegel, and Mustar 2017), whilst others found that they only have limited impact on graduate entrepreneurship (Guerrero et al. 2018; Marzocchi, Kitagawa, and Sánchez-Barrioluengo 2019). Hayter et al. (2018) suggested the inconclusive results are explained by regional variations. This suggests that university conditions might play a different role in graduate entrepreneurship depending on the characteristics of the region in which the university is embedded in. In fact, entrepreneurial activity has long been explained as the outcome of complex relationships between university and regional conditions (Spigel 2017), but for graduate entrepreneurship our understanding of these relationships remains incomplete.

1.3. The role of regions for graduate entrepreneurship

An important regional condition is *economic prosperity*, measured as gross domestic product (GDP) per capita and reflecting the extent of regional economic development in the region (Sternberg 2009). A region with high GDP per capita is associated with greater purchasing power than its counterpart with low GDP per capita. As such, the extent of regional economic prosperity determines consumer demands for products or services provided by a new business in the region (Leendertse, Schrijvers, and Stam 2021; Stam and van de Ven 2019). Moreover, a region with high GDP per capita might result in greater investments in the region, leading to improved physical infrastructures and easier access to finance to start and grow a venture (Leendertse, Schrijvers, and Stam 2021; Stam and van de Ven 2019).

Consequently, it has been argued that individuals are significantly more likely to perceive entrepreneurial opportunities in regions with a higher GDP per capita (Stuetzer et al. 2014). However, Bosma and Schutjens (2011) found that the relationship between regional economic prosperity and entrepreneurial activity is not significant or even negative. In fact, regional prosperity may reduce individuals' willingness to start their own ventures due to the presence of more attractive alternative career options (Meoli et al. 2020). In the context of graduate entrepreneurship, evidence remains limited, but Bergmann et al. (2016) suggested that regional economic prosperity has a positive effect as ventures started by graduates are often more idea-driven than demand-driven and thus benefit more from the agglomeration effects of prosperous and populous regions.

This suggests that regional economic prosperity needs to be complemented by a supportive *entrepreneurial culture* in the region, to explain the presence of high graduate entrepreneurship and consequently constitute a possible (or likely) explanation. This reflects a generally positive attitude towards entrepreneurs and entrepreneurship, an encouragement of individuals to start and grow their own ventures as well as a tolerance towards risk-taking and failure (Stuetzer

et al. 2014). As an informal institution, entrepreneurial culture is relatively stable (Eriksson and Rataj 2019), compared to GDP which tends to be more volatile. Entrepreneurial culture has thus been identified as a key condition of entrepreneurial activities in the region (Leendertse, Schrijvers, and Stam 2021; Stam and van de Ven 2019). In fact, regions with a more pronounced entrepreneurial culture have exhibited higher start-up rates (Bosma and Schutjens 2011; Stuetzer et al. 2014).

Regional entrepreneurial culture can influence graduate entrepreneurship in several ways. First a high start-up rate in the region implies greater presence of entrepreneurial role models (compared to a low start-up rate). The prominence of entrepreneurial role models signals to students the attractiveness of entrepreneurship as a career option (Parker 2005). The opportunities to observe and interact with entrepreneurial role models also offers students learning opportunities about the tasks and capabilities required in running a new venture (Wyrwich, Stuetzer, and Sternberg 2016). Indeed, entrepreneurial role models have been found to explain higher levels of entrepreneurial activities in a region (Venkataraman 2004). Similarly, Bosma and Schutjens (2011) found that knowing start-up entrepreneurs is positively related to people's tendency to engage in entrepreneurial activities.

Furthermore, recent research suggests the share of people launching and running a new business in a region can also influence the entrepreneurial intentions of others in that region (Bade 2021). As such, a pronounced entrepreneurial culture in the region might induce students to create their own ventures. Alternatively, it could be argued that in regions where an entrepreneurial culture is absent, universities might be able to substitute for this absence by providing their own entrepreneurship support to their students and graduates. This potential substitution effect of universities' entrepreneurship support is particularly relevant in the context of graduate entrepreneurship but has not yet been explored.

1.4. A configurational framework of graduate entrepreneurship

Figure 1 summarizes our discussion thus far in a configurational framework. Figure 1 indicates that there are potential (e.g. complementary/substituting) relationships between the conditions that means they act together, rather than individually. We argue that the availability of entrepreneurship support, as well as knowledge exchange intensity at universities are important to foster graduate entrepreneurship. We also argue that regional conditions, including entrepreneurial culture and regional economic prosperity are also relevant for graduate entrepreneurship to thrive. While

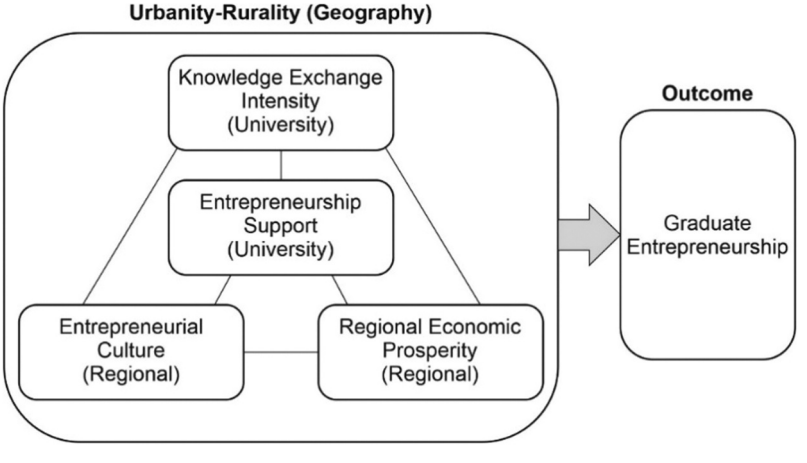

Figure 1. Configurational framework of graduate entrepreneurship.

previous research has offered useful insights about the individual effects of these conditions on graduate entrepreneurship, our understanding of their combined effects is still limited. This is evidenced by the often inconsistent and conflicting findings on the roles universities and regional economies play for graduate entrepreneurship. Given the heterogeneity of universities (Abreu et al. 2016; Hewitt-Dundas 2012; Ishizaka et al. 2020), reflecting different strategic priorities related to research and knowledge-intensity in addition to entrepreneurship and the heterogeneity of regional economies reflecting different levels of economic prosperity and entrepreneurial culture, a complex picture emerges that accounts for several configurations that are associated with graduate entrepreneurship.

Our theoretical discussion is thus indicative of the potentially complex combined effects between university and regional conditions. From a geographic perspective, it is likely that different conditions play different roles in different spatial settings. The relationship between geography and entrepreneurship is still not well understood (Sternberg 2022), but recent research points towards the importance of distinguishing between urban and peripheral geographic regions when explaining variations in start-up rates (Eriksson and Rataj 2019). In large metropolitan regions, resources are generally more abundant, but the costs of living are often higher and the quality of living lower. Smaller cities might compensate lower resource availability through relative proximity to large metropolitan regions, but also improved digital infrastructure.

The more peripheral regions are, the likelihood it is that their access to resource-rich environments and critical infrastructure is reduced (Muradian, Walter, and Martinez-Alier 2012). Finally, rural regions often suffer from unfavourable regional conditions and general resource scarcity (Eriksson and Rataj 2019; Sternberg 2022). These different spatial characteristics are thus likely to influence the role universities and regions play resulting in variations in prevalence as well as nature of graduate entrepreneurship across regions. This suggests that certain conditions might be more relevant in some spatial setting than in others.

2. Methodology

Fuzzy-set qualitative comparative analysis (fsQCA) is particularly useful when analysing complexity, i.e. situations 'in which an outcome may follow from several different combinations of conditions' (C. C. Ragin 2008, 23). Compared to regression-type analysis, fsQCA is ideal for understanding complexity of variations of graduate entrepreneurship across regions, given its potential for analysing multiple conditions simultaneously and identifying complex combined effects between these conditions (Kraus, Ribeiro-Soriano, and Schüssler 2018). Importantly, it can help to uncover the complementarity of university and regional conditions to improve our understanding of the nature and prevalence of graduate entrepreneurship across different regions. FsQCA is based on three assumptions that allow the identification of potential causal complexity, firstly conjunctional causation, where some conditions might have an effect in conjunction with other conditions, but not on their own (Woodside 2013). The second is equifinality, where more than one combination may explain the same outcome (Fiss 2011). Lastly, it is assumed there is potential for asymmetrical relationships between conditions and outcomes (Fiss 2011), where configurations for presence of an outcome, such as high graduate start-up numbers, differ from configurations for absence of that outcome.

2.1. Data

This study uses data from two sources. Specifically, we integrate university-level data from the Higher Education Business and Community Interaction Survey (HE-BCIS) with regional-level data from the ONS to construct a dataset using data covering the period 2015–2019. The regional-level data is based on the unit of local authorities in the UK. The ONS data entails 309 local authorities in England.

While HE-BCIS data have been used previously for research on entrepreneurial universities (Fuller, Beynon, and Pickernell 2017; Ishizaka et al. 2020; Rossi and Rosli 2015), our amalgamation of 5 years of data and use of statistical techniques (logging) of several of the descriptors creates a dataset of unique relevance and usability for fsQCA in the context of graduate entrepreneurship across different regions.

As a UK government sponsored dataset, HE-BCIS is the most comprehensive data set concerning the extent of English' universities graduate entrepreneurship available to researchers. Its broad scope has induced other countries to adopt similar survey methods to improve their own data on universities' third mission activities (Rossi and Rosli 2015). The integrated dataset includes 159 higher education institutions (HEI) in England (equivalent data not available for the other constituent nations of the UK). We excluded universities that did not record any graduate start-ups in any of the 5 years of data, resulting in a final sample of 100 universities included in this study. A map-based representation of the included universities is shown in Appendix A.

2.2. Measurement

2.2.1. Outcome of interest: graduate entrepreneurship

Graduate Entrepreneurship, as measured in the HE-BCIS survey has been used in several studies focused on aspects of the entrepreneurial university (Kitagawa et al. 2022; Marzocchi, Kitagawa, and Sánchez-Barrioluengo 2019). It captures 'all new business started by recent graduates (within 2 years) regardless of where any IP resides, but only where there has been formal business/enterprise support from the HE provider' (HESA 2023). The HE-BCIS survey asked HEI to provide information about the number of graduate start-ups in the past year. We used the average number of graduate start-ups per HEI over a five-year period (i.e. between 2015 and 2019) to represent Graduate Entrepreneurship (GE). We used the five-year average rather than relying on single year data to account for year-on-year fluctuations for individual universities. Given recent graduates are those graduate within 2 years, using a five-year average also allows us to capture potential time-lags in the venture creation by students.

2.2.2. Considered conditions

University knowledge exchange intensity (UKEI) was measured based on the clusters from the Knowledge Exchange Framework (KEF). Specifically, KEF groups universities into clusters that capture the extent of knowledge creation and knowledge exchange of universities (Research England 2020). The UKEI measure is taken from the UK Government's own knowledge exchange framework, the cluster titles taken from the framework's description of each of the clusters and the ranking system explicitly based on the framework's scores for the seven dimensions used to create the clusters, namely, research partnerships, working with business, working with public and third sector, continuing professional development and graduate start-ups, local growth and regeneration, IP and commercialization and public and community engagement.

The scores for each of these dimensions are totalled, the clusters ranking order directly linked to the total score order. We converted the six clusters into fuzzy membership scores (over the 0–1 domain). The details of the conversion of the different clusters of universities into fuzzy membership scores (over the 0–1 domain) is given in Table 1. Following the process adopted by Beynon et al. (2018), experts on the issues and use of fsQCA (university professors with extensive research experience in overlapping entrepreneurship and economic development issues) discussed how the clusters should be scaled over the 0–1 domain. Specifically to evaluate the potential effect of the inclusion of a graduate startups measure amongst the seven dimensions used to calculate the UKEI condition, this measure was excluded from the calculations and found to have no effect on the ordering used in Table 1. Following discussion, it was decided to employ the conversion shown below, to capture the order of knowledge creation and knowledge exchange of the universities that is most beneficial to entrepreneurship.

Table 1. University knowledge exchange intensity.

Cluster type	Description	Number	Fuzzy membership scores
ARTS	Specialist institutions covering arts, music and drama, as defined by a very high concentration of academic staff in these disciplines. A range of sizes of institutions, although many are small.	1	0
M	Smaller universities, often with a teaching focus. Academic activity across disciplines, particularly in non-STEM. Highest amount of research activity funded by industry.	2	0.2
J	Mid-sized universities with more of a teaching focus.	3	0.4
E	Large, broad-discipline university generating excellent research across all disciplines. Academic activity across STEM and non-STEM	4	0.6
X	Large, high research intensive and broad-discipline universities generating a significant amount of excellent research. Academic activity balanced across STEM and non-STEM, lowest amount of research activity funded by industry.	5	0.8
V	Very large, very high research intensive and broad-discipline universities generating a significant amount of excellent research. Significant academic activity in STEM.	6	1.0
STEM	Specialist institutions covering bioscience and veterinary, engineering and agriculture, generating often high amounts of excellent research.	Excluded*	NA

*STEM was excluded as seven of the nine institutions in this cluster have reported zero graduate startups, with the remaining two reporting very small numbers.

Table 1 provides a description of the different cluster types and their key characteristics (Research England 2020). The conversion shown in the table reflects the relative extent of knowledge creation and knowledge exchange of the universities in the different clusters.

University entrepreneurship support (UES) is an additive composite variable made up of four individual items. Specifically, the HE-BCIS survey asked HEI: (1) whether helping student and graduate enterprises is one of the HEIs main contribution to economic development, coded 1 if the answer is yes, otherwise 0; (2) whether the HEI provides access to seed-investment and/or venture capital to support the new venture, coded 1 if at least of one of them exists, otherwise 0; (3) whether the HEI support graduate start-ups through mechanisms such as providing access to incubators or science parks, coded 1 if one or more mechanisms existed, otherwise 0; and (4) whether the HEI supports graduate start-ups through providing access to entrepreneurship training, coded 1 if entrepreneurship training exists, otherwise 0. We first calculated the data (ranging from 0 to 4) for each HEI in each year. After that, we used the average of the data from each HEI over a five-year period (2015–2019) to capture UES.

GDP per capita is typically used as a measure of prosperity (Gough 2020; Gudgin 1996; Ryan 2005) Regional economic prosperity (REPR) is therefore measured by the GDP per head for the local authorities regions using data from the ONS. Specifically, we used the average GDP per head over a 5-year period (2015–2019) to represent REPR. Similarly, one measure of the health of a region's entrepreneurial culture can be seen as the rate at which it generates new firms (Bergmann, Hundt, and Sternberg 2016; Stuetzer et al. 2014). *Regional entrepreneurial culture* (REC) is thus measured by the birth rates of new ventures in the local authorities' regions, the data obtained from business demography data provided by the ONS. Specifically, we first calculated the birth rates of new ventures by using the number of new businesses divided by the number of active businesses in the region. After that, we used the average birth rates of new ventures in the regions over a five-year period (2015–2019) to represent REC.

2.3. Data calibration

Calibration, in fsQCA terms, is the transformation of the conditions and outcome, from their original scales of values, to sets of fuzzy membership values (consistently described over the domain 0 to 1). For those conditions and outcome requiring such calibrations, the calibration process employed here, is termed the Direct Method (see C. C. Ragin 2008).

Table 2. Descriptive statistics and data calibration approach.

Conditions	Descriptives				Calibration approach
	Mean	S.D.	Min	Max	
Graduate entrepreneurship (GE) [outcome]	34.44	47.90	0.20	261.00	Calibrated fuzzy values using direct method approach on log10(x) of the "Graduate entrepreneurship" values.
University knowledge exchange intensity * (UKEI) [condition]	–	–	–	–	Recoded based on the "KEF Cluster Number" 1 => 0, 2=> 0.2, 3 => 0.4, 4 => 0.6, 5 => 0.8, 6 => 1.0
University entrepreneurship support (UES) [condition]	2.76	0.66	1.00	4.00	Calibrated fuzzy values using direct method approach on "University entrepreneurship support" values.
Regional economic prosperity (REPR) [condition]	126,730	814,570	15,388	8,220,816	Calibrated fuzzy values using direct method approach on the log10(x) of the GDP per capita values.
Regional entrepreneurial culture (REC) [condition]	0.15	0.03	0.10	0.23	Calibrated fuzzy values using direct method approach on the "Regional entrepreneurial culture - venture birth rate in %" values.

*Descriptive statistic is not applicable to this condition as the cluster number is based on the KEF.

Table 2 summarizes the calibration approach concerning how the different conditions and outcome were transformed into fuzzy membership values. It should be noted that for conditions including graduate entrepreneurship and regional economic prosperity, the original values were statistically adjusted through log10(x) transformation to account for nonlinearity of the data before data calibration. Technical details of the data calibration process are given in Appendix B (including also evidence of expert opinion intervention), and a sample of calibrated fuzzy values are illustrated (including also examples of fsQCA related strong membership).

3. Data analysis and results

3.1. Analysis of necessary conditions

We first conducted necessity analysis to assess whether the presence (or absence) of a condition is necessary to guarantee the presence (or absence) of the outcome (see Del Sarto et al. 2021 for further discussion). Here, a graphical depiction of the considered necessity results is given, see Figure 2.

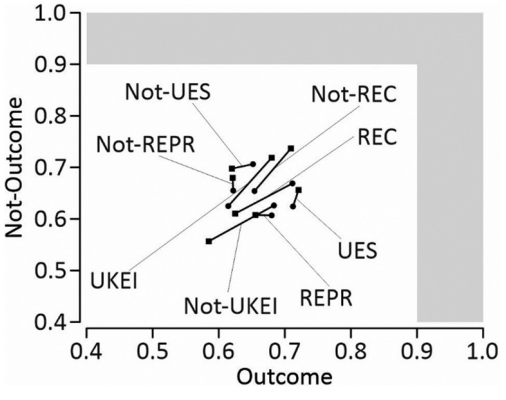

Figure 2. Necessity results based on consistency and coverage scores for each condition (condition and not-condition) against outcome (outcome and not-outcome). Note: University knowledge exchange intensity (UKEI); University entrepreneurship support (UES); Regional economic prosperity (REPR); Regional entrepreneurial culture (REC).

Table 3. Truth table.

Configuration	University knowledge exchange intensity	University entrepreneurship support	Regional economic prosperity	Regional entrepreneurial culture	No.	Consistency | PRI score: Presence of high graduate entrepreneurship		Absence of high graduate entrepreneurship	
1	0	0	0	0	7	**0.833**	0.532	0.805	0.453
3	0	0	0	1	5	0.754	0.384	**0.834**	0.584
4	0	0	1	1	3	**0.868**	0.635	0.761	0.341
5	1	0	0	0	4	0.802	0.409	**0.863**	0.591
6	1	0	1	0	5	0.794	0.429	**0.845**	0.571
7	1	0	0	1	5	0.804	0.436	**0.846**	0.557
8	1	0	1	1	5	**0.826**	0.518	0.814	0.482
9	0	1	0	0	8	0.787	0.446	**0.827**	0.549
10	0	1	1	0	2	0.804	0.469	**0.827**	0.531
11	0	1	0	1	9	**0.881**	0.712	0.705	0.288
12	0	1	1	1	4	**0.915**	0.778	0.701	0.222
14	1	1	1	0	6	**0.822**	0.510	0.811	0.482
15	1	1	0	1	12	**0.884**	0.692	0.737	0.299
16	1	1	1	1	9	**0.863**	0.648	0.747	0.349
FsQCA threshold details		Frequency threshold ≥ 1.5 Consistency threshold > 0.815 PRI-score > 0.500				8 (55)		6 (29)	

In Figure 2, each pair of square and circle points joined by a line are with respect to a condition (either condition or not-condition) and outcome (x-axis) and not-outcome (y-axis). Each square and circle is the respective necessity consistency and coverage values (see C. C. Ragin 2008). Following Greckhamer (2011) and Greckhamer et al. (2018), no consistency value is above the 0.9 value (shaded region in graph shows where consistency values would be above 0.9), also see Ragin (2008) and Del Sarto et al. (2021), indicating no condition was considered necessary for an outcome (or not-outcome).

3.2. *Analysis of sufficient conditions*

Progressing from the necessity analysis, the investigation of logically possible configurations is next considered. This is done through a truth table (C. C. Ragin 2008), see Table 3, which shows all configurations for which they have at least one university case associated with them in strong membership terms. For each configuration, columns two to five show the presence (1) and absence (0) of the conditions.

Overall, 15 configurations are shown, from 16 possible configurations ($2^4 = 16$), with one configuration (i.e. 2–0010) missing due to not having any universities associated with it in strong membership terms. The No. column shows the number of universities associated with each configuration. There are then two sets of consistency results (incl. PRI score) for the association of a configuration to either the presence or absence of high graduate entrepreneurship. The bottom row describes the employed threshold values, and subsequent bold values in the consistency columns offer the subsequent association of configurations to either the presence or absence of high graduate entrepreneurship. The evaluation of these required frequency and consistency threshold values are discussed in Appendix C, following Andrews et al. (2016), and the original explanation in Ragin (2008). In the case of the PRI-score, a 0.500 threshold was employed, following Mello (2021).

Using the details in the truth table (and the fuzzy values representing the cases) we now move onto the sufficiency analysis to identify all the combinations of conditions sufficient for the presence or absence of high graduate entrepreneurship to occur (see Del Sarto et al. 2021; C. C. Ragin 2008), starting with the consideration of which solution to include. The three solutions possible to consider are, complex, intermediate, and parsimonious (C. C. Ragin 2008). Following Beynon, Battisti et al.

Table 4. Results from sufficiency analysis.

	Presence of high graduate entrepreneurship				Absence of high graduate entrepreneurship		
Complex solution	CO1	CO2	CO3	CO4	CN1	CN2	CN3
University knowledge exchange intensity			●	⊖	●	⊖	
University entrepreneurship support	●		●	⊖	⊖	●	⊖
Regional economic prosperity		●	●	⊖			⊖
Regional entrepreneurial culture	●	●		⊖	⊖	⊖	●
Configurations	11, 12, 15, 16	4, 8, 12, 16	14, 16	1	5, 6	9, 10	3, 7
Consistency*	0.814	0.800	0.804	0.832	0.835	0.816	0.840
PRI score*	0.653	0.603	0.554	0.532	0.586	0.573	0.608
Raw coverage*	0.526	0.501	0.425	0.329	0.442	0.346	0.426
Unique coverage*	0.097	0.041	0.035	0.081	0.097	0.080	0.143
Solution consistency, PRI score, coverage	0.756, 0.581, 0.760				0.791, 0.598, 0.678		
Parsimonious solution	PO1	PO2	PO3	PO4	PN1	PN2	PN3
Configurations	11, 12, 15, 16	4, 8, 12, 16	14, 16	1	5, 6	9, 10	3, 7
Consistency*	0.814	0.800	0.804	0.818	0.835	0.816	0.840
PRI score*	0.653	0.603	0.554	0.530	0.586	0.573	0.608
Raw coverage*	0.526	0.501	0.425	0.355	0.442	0.346	0.426
Unique coverage*	0.097	0.041	0.035	0.081	0.097	0.080	0.143
Solution consistency, PRI score, coverage	0.752, 0.576, 0.760				0.791, 0.598, 0.678		

(2021), because individual conditions (presence or absence) are relevant only in combination with others, and the exploratory nature of this study, in the opinion of the authors, no 'easy' counterfactuals could be identified to facilitate use of the intermediate solution. Consequently, the intermediate solution equates to the complex solution (Andrews, Beynon, and McDermott 2019; Douglas, Shepherd, and Prentice 2020). Here, initially the results for the complex, and parsimonious solutions are presented (following, M. Beynon, Jones, and Pickernell 2021; Schneider and Wagemann 2010), for the discussion of results the complex solution results in the analysis are prioritized (Cooper and Glaesser 2011).

The results from the sufficiency analysis are presented in Table 4. Each main column shows the relevant details for an identified pathway to either the presence or absence of high graduate entrepreneurship. To explain the pathways presented, and using the approach followed by Ragin and Fiss (2008), solid and clear circles describe the presence and absence of the condition respectively, with no circle denoting non relevance of that condition to that pathway. In terms of size, large and small circles would denote core and peripheral conditions, respectively. Small circles (see pathway CO4) also denote where a condition is included in the complex solution but not in the parsimonious solution results. We note here that the complex and parsimonious solutions have a large overlap, due to the very limited remainders, namely configurations without evidential support, as indicated by the truth table in Table 3, where only Cnfg 2 is absent.

In the table, below the condition details, specific metrics are also shown, including consistency (the extent to which, on a scale of 0–1, for the cases in the included configurations, the combination is related the outcome), PRI score (which indicate the consistency with which the configurations are related the outcome relative to its absence, where a value under 0.5 indicates significant inconsistency), raw coverage (showing the proportion of cases covered by multiple configurations), and unique coverage (the proportion of cases covered by a single configuration), along with solution consistency, PRI score, and coverage values for all the pathways taken together (see C. C. Ragin 2008; M. Beynon, Jones, and Pickernell 2021, for recent descriptions).

In terms of the complex solution results, there are four pathways (CO1, CO2, CO3 and CO4) that are sufficient to produce the presence of high graduate entrepreneurship. Pathway CO1 shows that university entrepreneurship support in combination with regional entrepreneurial culture can produce the presence of high graduate entrepreneurship, where the remaining two conditions are irrelevant. Pathway CO2 indicates that the two regional conditions can explain the presence of high

graduate entrepreneurship, as a possible explanation, where the two university conditions are irrelevant. Pathway CO3 demonstrates that the joint presence of two university condition together with regional economic prosperity can produce the presence of high graduate entrepreneurship, where regional entrepreneurial culture is irrelevant. Pathway CO4 illustrates that the absence of all conditions can also explain the presence of high graduate entrepreneurship, as a possible explanation.

The results in Table 4 highlight that there are three pathways (CN1, CN2 and CN3) that are sufficient to result in the absence of high graduate entrepreneurship. Pathway CN1 suggests the presence of university knowledge exchange intensity when combined with the joint absence of university entrepreneurial support and regional entrepreneurial culture can explain the absence of high graduate entrepreneurship, where regional economic prosperity is irrelevant. Pathway CN2 shares similar pattern with CN1, except that university knowledge exchange intensity is absent and university entrepreneurship support is present. Finally, pathway CN3 indicates that the joint absence of university entrepreneurship support and regional economic prosperity when combined with the presence of regional entrepreneurial culture can explain absence of high graduate entrepreneurship, where university knowledge exchange intensity is irrelevant.

In the case of the parsimonious solutions, in summary, the same numbers of pathways as for the complex solution are found, for presence of high graduate entrepreneurship (PO1, PO2, PO3 and PO4) and absence of high graduate entrepreneurship (PN1, PN2 and PN3) with the only noted difference being in PO4 where there is no absence of regional entrepreneurial culture required.

3.3. Location mapping of universities associated with different outcomes

To undertake a more detailed geography-orientated analysis, and to effectively name the fsQCA established pathways (see later) and explore issues of economic geography, the results were integrated into maps of England. Specifically, these illustrate the locations (as determined by the postcode of their head office address) of the universities associated with each pathway. This then allowed evaluation of the degree of geographical concentration of a specific pathway, and whether it was predominantly urban or rural.

Figure 3 elucidates this map-based representation of the universities associated with the presence of the pathways established. For the presence of high graduate entrepreneurship pathways, 55 universities are included across them. Pathway CO1 being the pathway with the largest presence (34), pathway CO2 the second largest (21), pathway CO3 third largest (15) and pathway CO4 smallest, with only seven universities. In terms of universities included in multiple pathways, there is an overlap between pathway CO1 and CO3 for 13 universities, whilst nine universities are included in pathways CO1, CO2 and CO3. The Universities covered by CO1, CO2, and CO3, are those associated with a configuration (16) containing presence of all four conditions. This is a large city-based group (specifically London and Manchester), with inclusion of Russell Group Universities, Manchester, Imperial, Kings College, and University College London, joined by Manchester Metropolitan, Birkbeck, Queen Mary, Brunel, and City University. This group are clearly able to simultaneously link their own university-based entrepreneurship promoting activities with those of the wider region. Conversely, there is no overlap between universities included in pathway CO4 with pathways CO1, CO2 and CO3.

Figure 4 then illustrates a map-based representation of the universities associated with absence of high graduate entrepreneurship. For the absence of graduate entrepreneurship pathways, 29 universities are included. The three pathways, CN1, CN2, and CN3, having very similar numbers of universities included, 9, 10 and 10 respectively, with no overlap of universities, each pathway being distinct. The implications of Figures 3 and 4 are discussed next.

Figure 3. Map-based breakdown of association of 'strong membership based' universities to the presence of high graduate entrepreneurship.

4. Discussion and interpretation of findings

The purpose of this study was to explore how combinations of entrepreneurial university and regional conditions might explain the presence or absence of high graduate entrepreneurship across different regions, as possible (or likely) explanations. We identify four pathways related to the presence and three pathways related to the absence of high graduate entrepreneurship. The results show that neither university entrepreneurship support, knowledge exchange intensity, regional economic prosperity, nor entrepreneurial culture, on their own, are sufficient to explain the outcome. For example, for pathways explaining high graduate entrepreneurship, CO1 to CO3 entail the presence of at least two conditions. For pathways explaining the absence of high graduate entrepreneurship, CN1 to CN3 entail the absence of two conditions combined with the presence of one condition. These results demonstrate conjunctional causation, equifinality, and asymmetry, justifying the use of fsQCA.

Figure 4. Map-based breakdown of association of 'strong membership based' universities to the absence of high graduate entrepreneurship.

For pathways (CO1 to CO4) explaining the presence of high graduate entrepreneurship, CO1 and CO2 both entail presence of regional entrepreneurial culture. This finding is consistent with previous literature suggesting entrepreneurial culture can contribute to venture creation (Leendertse, Schrijvers, and Stam 2021; Stam and van de Ven 2019; Stuetzer et al. 2014). Our study extends previous works, however, demonstrating that presence of regional entrepreneurial culture alone is not sufficient to explain high graduate entrepreneurship. For example, CO1 requires entrepreneurial culture to be combined with university entrepreneurship support, while CO2 requires it to be combined with regional economic prosperity. Importantly, our results also highlight that regional

entrepreneurial culture is irrelevant in CO3 and absent in CO4, suggesting a lack of regional entrepreneurial culture will not necessarily hinder presence of high graduate entrepreneurship.

Previous research into entrepreneurial universities suggests entrepreneurship support provided by universities can also contribute to venture creation (Hayter et al. 2018; Wright, Siegel, and Mustar 2017). In line with this view, both CO1 and CO3 entail presence of university entrepreneurship support. Again, however, presence of university condition(s) alone is not sufficient to explain the presence of high graduate entrepreneurship. For example, CO1 requires joint presence with one regional condition (e.g. entrepreneurial culture), while CO3 requires joint presence with another regional condition (e.g. economic prosperity) in combination with university knowledge exchange intensity. These findings suggest high graduate entrepreneurship is often a function of interplay between university and the region in which they are located. However, as CO2 highlights, university activity is not required to generate presence of high graduate entrepreneurship. The fact that this group is London and Manchester specific, as shown in Figure 3, indicating the 'free rider' benefits that universities located in these large cities benefit from. Indeed, there has been an ongoing global trend for graduates to migrate to major cities to seek employment and self-employment opportunities (Imeraj et al. 2018).

Interestingly, CO4 shows complete absence of university and regional conditions can also explain high graduate entrepreneurship, as a possible explanation. The explanation for this pattern is potentially multifaceted. First, three out of the seven institutions in this pathway are known creative arts universities that would produce graduates who would naturally move into self-employment as a career choice. The reason being that it is often more challenging for them to find gainful employment. Indeed, it has been found that creative graduates are more likely to combine employment with self-employment (Ball, Pollard, and Stanley 2010). Several institutions were also in rural areas such as Falmouth and Cumbria that offered limited employment opportunities for graduate employment. Thus, graduates might be induced to seek self-employment through necessity and lack of career alternatives in these peripheral and rural regions. It is also likely that other elements may be of importance for entrepreneurship in such peripheral regions, such as social networks (see, for example, Freire-Gibb and Nielsen (2014), and Habersetzer et al., (2021).

For pathways (CN1 to CN3), providing possible explanations for absence of high graduate entrepreneurship, generally, universities represented by these pathways are more geographically peripheral, with stronger bias towards more Northern regions. The results show presence of a single university condition is not sufficient to compensate for absence of other conditions. Specifically, CN1 shows presence of university knowledge exchange cannot compensate for absence of entrepreneurship support and regional entrepreneurial culture, while CN2 shows that presence of university entrepreneurship support cannot compensate for absence of university knowledge exchange and regional entrepreneurial culture. Similarly, presence of a single regional condition is not sufficient to compensate for absence of other conditions. Specifically, CN3 shows that regional entrepreneurial culture alone is not sufficient to compensate for absence of entrepreneurship support and economic prosperity. As Furnari et al. (2021) pointed out, asymmetry requires thinking about not only presence but also absence of conditions. Our findings demonstrate asymmetry as pathways explaining absence of the outcome, do not mirror those explaining presence of the outcome.

As for geography, pathways explaining high graduate entrepreneurship, as possible (or likely) explanations, also show distinct geographical profiles. While CO1 and CO3 are predominantly linked to urban locations, CO2 reflects a pathway linked to large metropolitan areas, specifically London and Manchester. Lastly, CO4 is mostly linked to peripheral and rural areas. By contrast, pathways explaining absence of high graduate entrepreneurship, as possible (or likely) explanations, have less distinct geographical profiles with universities associated with CN1 to CN3 located in urban as well as peripheral locations, with peripheral locations being overall more

Table 5. Naming of pathways.

Pathway	Presence of high graduate entrepreneurship is explained through . . .	Geographical location	Naming of pathway
CO1	. . . the presence of university entrepreneurship support as well as the presence of a regional entrepreneurial culture creating synergies between universities and regions.	Urban	Urban entrepreneurial synergy-driven
CO2	. . . the presence of regional conditions only, namely the presence of regional economic prosperity and regional entrepreneurial culture. Conditions related to the university are not relevant, suggesting a strong geographic advantage.	Large metropolitan areas	Metropolitan advantage-driven
CO3	. . . the presence of university knowledge exchange intensity and university entrepreneurship support, complemented by regional economic prosperity.	Urban	Urban knowledge-driven
CO4	. . . the absence of all conditions related to the university as well as the region.	Mostly peripheral and rural	Peripheral necessity-driven
	Absence of high graduate entrepreneurship is explained through . . .		
CN1	. . . the absence of university entrepreneurship support and regional entrepreneurship culture. The presence of university knowledge exchange intensity cannot compensate for the absence of these two entrepreneurship-related conditions.	Urban as well as peripheral	Knowledge-intense, but non-entrepreneurial
CN2	. . . the absence of university knowledge exchange intensity as well as regional entrepreneurial culture. The presence of university entrepreneurship support does not compensate for the two absent conditions.	Urban as well as peripheral	Supportive, but non-entrepreneurial and non knowledge-intense
CN3	. . . the absence of university entrepreneurship support as well as regional economic prosperity. The presence of regional entrepreneurial culture does not compensate for the two absent conditions.	Urban with some peripheral	Entrepreneurial, but non-supportive and non-prosperous

common than in pathways explaining, *as possible (or likely) explanations*, high graduate entrepreneurship (CO1 to CO4).

Based on the above discussion, the presence or absence of entrepreneurial university and regional conditions, as well as the geographical locations of the universities belonging to the pathways, we name the pathways explaining presence and absence of high graduate entrepreneurship, as possible (or likely) explanations as described in Table 5. The naming of pathways concludes the last stage of the configurational theorizing approach (Furnari et al. 2021).

5. Conclusions

5.1. Contributions

Our study contributes to research on graduate entrepreneurship. Specifically, we conceptualize graduate entrepreneurship as a spatial phenomenon, building on recent works suggesting graduate entrepreneurship is unevenly distributed across regions (Drejer, Rubæk Holm, and Nielsen 2022; Eckhardt et al. 2022; Kitagawa et al. 2022). The use of fsQCA in combination with map-based analysis allows for more nuanced descriptions of pathways to advance understanding of geography's role in graduate entrepreneurship. Our findings demonstrate that high graduate entrepreneurship can occur in different geographical locations (regions), from large metropolitan areas to urban locations and also peripheral and rural locations. Depending on the geographical location, pathways that explain, as possible (or likely) explanations, the presence of high graduate entrepreneurship are very different. The identification of a 'metropolitan advantage-driven' pathway (C02) in large cities like London and Manchester is novel. It underscores advantages inherent in urban agglomeration effects (Audretsch and Fritsch 1994; Knoben, Ponds, and van Oort 2011) in driving graduate

entrepreneurship challenging the assumption of universities being key catalysts of graduate entrepreneurial activity.

By contrast, in urban locations we find university-related conditions playing a more important role, albeit always in combination with regional conditions. As such, we identify two distinct pathways related to urban locations – the 'urban entrepreneurial synergy-driven' pathway (CO1) and the 'urban knowledge-driven' pathway (CO3) to high graduate entrepreneurship. Most strikingly, however, we identify a distinct pathway related to mostly peripheral and rural locations. These peripheral and rural locations exhibit high graduate entrepreneurship rates despite lacking favourable university-related and regional conditions, suggesting a 'necessity-driven" nature (CO4). This finding highlights the resilience and resourcefulness of graduates in less-favoured regions. Overall, conceptualizing graduate entrepreneurship as a spatial phenomenon highlights that different regions exhibit distinct pathways to high graduate entrepreneurship. Recognising these pathways allows for targeted interventions based on regional nuances. Unlike pathways explaining high graduate entrepreneurship, as possible (or likely) explanations,which exhibit distinct geographical profiles, pathways related to absence of high graduate entrepreneurship lack distinct geographical patterns, broadly linked to urban as well as peripheral locations. This suggests that advancing our understanding of absence of high graduate entrepreneurship rates is more complex opening up avenues for future research.

The present study also contributes to the entrepreneurial university literature by critically examining the role of entrepreneurial universities within the broader regional environments in which they are located. Specifically, we integrate university conditions with the regional contexts universities are embedded. Recent research highlighted that one key challenge to making universities more entrepreneurial is to create 'synergetic combinations' of both internal and external environment factors (Klofsten et al. 2019, 151). Supporting this view, we provide evidence demonstrating the complex interplay between university and regional conditions, which determine both extent i.e. whether high graduate entrepreneurship is present or absent, but also, potentially, the nature of graduate entrepreneurship, such as e.g. being 'knowledge-driven' (CO3) or being 'necessity-driven' (CO4). With the exception of large metropolitan areas (CO2) and peripheral and rural areas (CO4) our findings show that 'synergetic combinations' of university-related and regional conditions are needed to potentially explain the presence of high graduate entrepreneurship rates. In both, the 'urban entrepreneurial synergy-driven' pathway (CO1) and the 'urban knowledge-driven' pathway (CO3) university-related and regional conditions complement each other in different, but still synergetic ways.

By contrast, pathways related to absence of high graduate entrepreneurship (CN1 to CN3) clearly show that university-related or regional conditions on their own are insufficient. These pathways show the entrepreneurial university cannot substitute for the lack of beneficial regional conditions. For example, CN2 illustrates that universities providing entrepreneurship support are ineffective if the region does not provide an attractive entrepreneurial culture at the same time. Instead of substitution effects between universities and regions, our findings point to suppression effects. In other words, absence of beneficial regional conditions supresses the potentially beneficial effect of the presences of university-related conditions and vice versa. As such, neither university-related conditions nor regional conditions are effective on their own challenging the assumption that in regions where an entrepreneurial culture is absent, universities might be able to substitute for this absence by providing their own entrepreneurship support to their students to foster graduate entrepreneurship (Fini et al. 2011). The suppression effects between universities and the regions in which they are embedded, are novel and advance the understanding of the role of the entrepreneurial university in fostering graduate entrepreneurship.

Our findings are important because they indicates that a one-size-fit-all approach to fostering graduate entrepreneurship might not be effective because universities and regions they are embedded within are heterogeneous. We provide specific evidence demonstrating that university-related and regional conditions can complement each other in different ways to potentially explain

high levels of graduate entrepreneurship, but absence of one can also suppress the effect of the other, resulting in the absence of high graduate entrepreneurship.

5.2. Policy recommendations

Our results provide useful practical implications for university and regional policymakers. Given that universities differ in their strategic priorities (Ishizaka et al. 2020) and regional conditions vary (Stuetzer et al. 2014), universities and policymakers need tailored strategies for graduate entrepreneurship in line with the characteristics of respective universities and regions. Analysing the type of participation of universities in their region, allows identification of groups of universities in similar positions, facilitating future benchmarking and mutual learning.

Universities and policy makers should also acknowledge that neither university-related conditions nor regional conditions are effective on their own in fostering graduate entrepreneurship. Instead of assuming substitution effects, efforts should be directed towards addressing the absence of beneficial regional conditions to maximize the impact of university initiatives. Despite lacking favourable university-related and regional conditions, peripheral and rural locations exhibit high graduate entrepreneurship rates, suggesting a 'necessity-driven' nature. Policy makers should explore ways to support and harness the resilience and resourcefulness of graduates in less-favoured regions. Initiatives could include targeted funding, infrastructure development, and access to resources and networks.

5.3. Limitations and future research

In terms of study limitations, which provide directions for future research, the present study examined the interdependence between the university and regional context in shaping graduate entrepreneurship. Given that individuals differ in their value, experiences, and capabilities (Bosma and Schutjens 2011; Guerrero et al. 2018; Hayter et al. 2018), future research explaining graduate entrepreneurship could also integrate conditions at the individual-level. Recent studies suggest regional conditions might influence graduate entrepreneurship indirectly, such that regional context affects entrepreneurial activities through influencing individuals' perception of opportunities in the region (Stuetzer et al. 2014). Thus, further research is required to uncover and fully understand these potential additional individual-level as well as cross-level mechanisms that explain the presence of high levels of graduate entrepreneurship.

Moreover, the industry specialization of the region might also influence the entrepreneurial activities pursued by graduates. Future research can therefore examine how university and regional contexts might shape not only the extent but also the nature of ventures created by graduates. In line with previous research on entrepreneurial universities (Fuller, Beynon, and Pickernell 2017; Ishizaka et al. 2020; Rossi and Rosli 2015), we used data from the HE-BCIS survey. However, the survey data is not without limitations. For example, the survey only captures new businesses started by recent graduates (e.g. within two years), but graduates might become entrepreneurs after this short period. Furthermore, the survey only covers graduate entrepreneurs who have received formal support from the university. Given that not all graduates will seek formal support from the university, the graduate entrepreneurship measure adopted in this study is thus an incomplete measure of start-up activities.

Finally, given that the research utilized England-only data, there is a potential context specificity of the findings. The extent to which implications of the findings also apply to other contexts is therefore to a degree uncertain, suggesting a need for future research to examine the relevance of these findings to other contexts, most obviously the other constituent nations of the UK (Northern Ireland, Scotland, and Wales) in the first instance.

5.4. Concluding remarks

Universities have long been encouraged to contribute to economic development through fostering the entrepreneurial activities of the university community (Compagnucci and Spigarelli 2020). In response to recent calls to consider the impact of contextual factors on graduate entrepreneurship (Bergmann, Hundt, and Sternberg 2016), this study explored how combinations of university-related and regional conditions might explain the presence or absence of high graduate entrepreneurship. Our findings indicate that while universities play an important role in supporting graduate entrepreneurship, it is also important to consider the conditions of the region in which a university is located. Findings demonstrate that university-related and regional conditions can complement each other in different ways to potentially explain high levels of graduate entrepreneurship, but absence of one can also suppress the effect of the other, resulting in the absence of high graduate entrepreneurship.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix A

This appendix reports a listing of the 100 universities in England considered in the analysis in the study, see Figure A1.

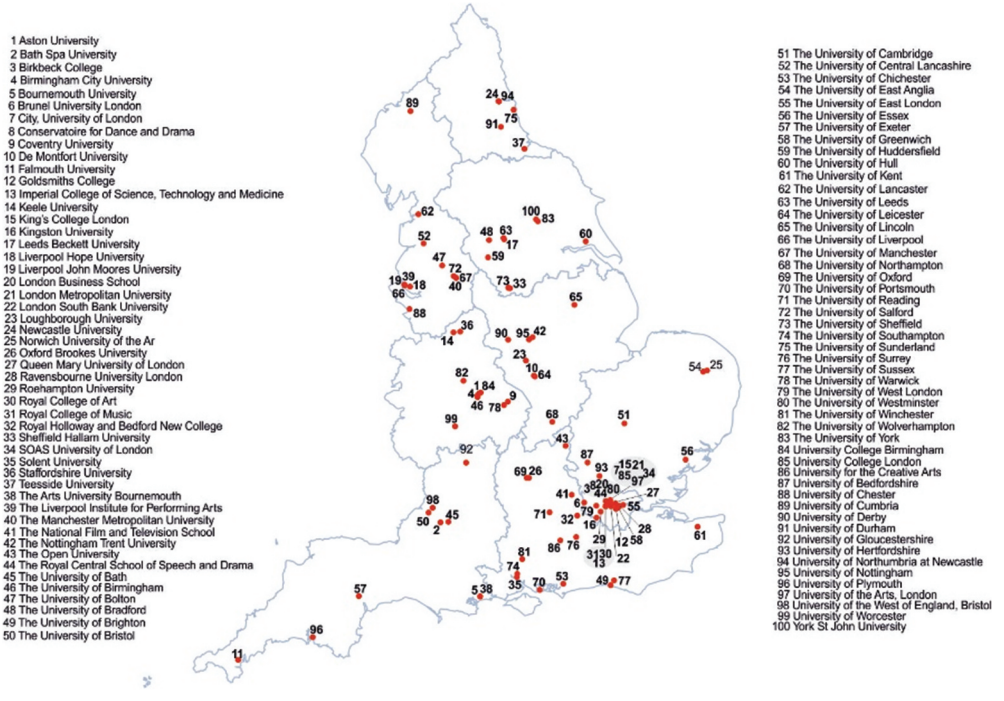

Figure A1. Map based elucidation of 100 included Universities in England, UK. Note: Dots signify the postcode-based position of the contact address of the university (central office). Near London, due to the concentration of universities in this city, grey surrounded index numbers mean the universities are collectively denoted by the respective red dot.

Appendix B

The required fuzzy membership values calibration process for the continuous conditions and outcome is undertaken using the Direct method (see C. C. Ragin 2008). Here the approach of Andrews et al. (2016) is followed, which requires the construction of associated probability density functions (pdfs) and subsequent qualitative anchors, and fuzzy membership functions, see Figure B1.

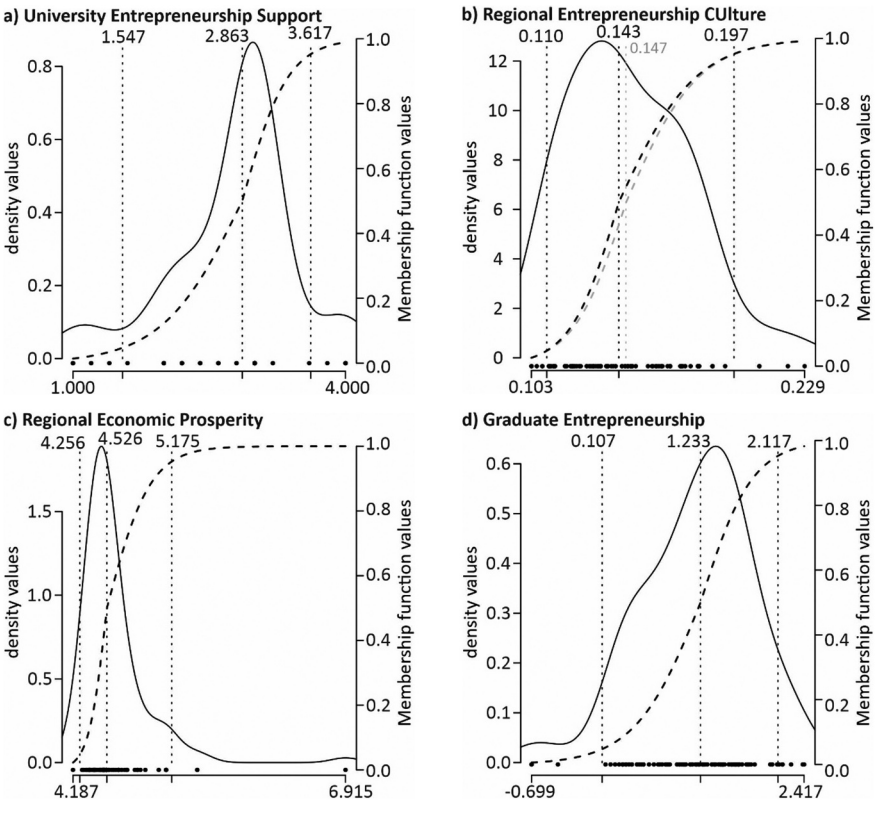

Figure B1. Constructed pdfs, qualitative anchors, and fuzzy membership functions for certain conditions and outcome.

In each graph in Figure B1, the solid lines give the associated pdf, with the three vertical dotted lines the respective lower-threshold, crossover-point, and upper-threshold qualitative anchors, premised on the 5th, 50th and 95th percentiles of the pdfs. The dashed line gives the constructed fuzzy membership function, with points at the base showing the spread of the university values for the condition or outcome.

Included in the calibration process, to ensure robustness, is also a qualitative consideration of the appropriateness of this evidence, here expert opinion considered an appropriate movement of the crossover-point for the Regional Entrepreneurship Culture condition. Moreover, in Figure B1(b), the 50th percentile value was 0.147 (shown in grey above grey shaded dotted line), but either side of this value, in terms of the points along the base of the graph were two gaps in the points. Discussion availed the movement of the crossover-point to the midpoint of the lower gap (a value of 0.143) (in light grey the original membership function is also shown)

Table B1 demonstrates the context of the calibration process, and general fuzzification process for a sample of three universities considered. The original condition and outcome values are presented in the top rows. Based on the different calibration processes employed, the respective fuzzy values for the conditions and outcome are shown for the same universities in the bottom rows. Also shown in the bottom rows are the strong membership versions of the considered condition fuzzy membership values (not required for outcome).

Table B1. Sample university elucidation of conditions and outcome forms, original, fuzzy, and strong membership.

Sample	University knowledge exchange intensity	University entrepreneurship support	Regional economic prosperity	Regional entrepreneurial culture	Graduate entrepreneurship
Original scale	3.000	3.000	4.409	0.187	1.491
	4.000	2.200	4.453	0.142	0.845
	5.000	3.000	4.719	0.157	0.748
Fuzzy membership score	0.400	0.633	0.214	0.920	0.859
	0.600	0.181	0.307	0.467	0.262
	0.800	0.633	0.709	0.681	0.216
Strong membership	0	1	0	1	
	1	0	0	0	
	1	1	1	1	

*Regional economic prosperity and Graduate entrepreneurship are log10(x) of original value.

Appendix C

A part of the sufficiency analysis is the consideration of two threshold values, namely Frequency threshold and Consistency threshold, this appendix includes graphical evidence on their establishment, see Figure C1.

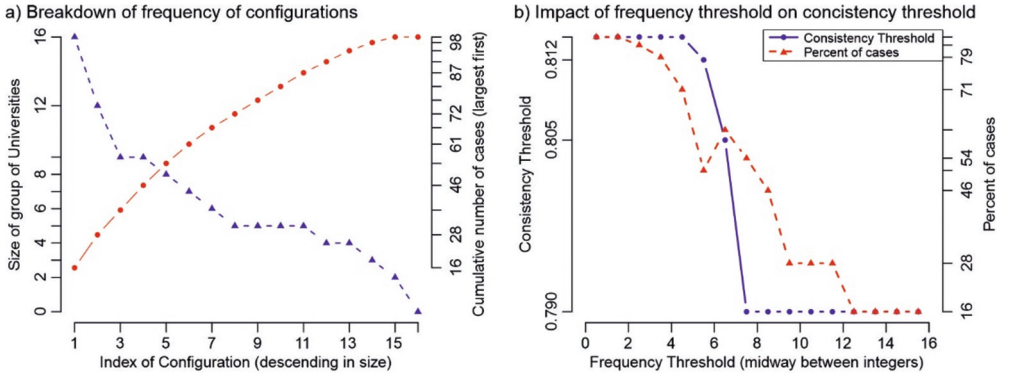

Figure C1. Graphical evidence on the consideration of frequency and consistency threshold establishment.

Each configuration has several universities associated with it, in strong membership terms. Figure C1a gives a breakdown, in an ordered way, of the numbers of universities associated with configurations, ordered left to right, from configurations with largest to smallest numbers of universities (triangle joined lines measured against numbers depicted on left y-axis). A cumulative number of universities is shown as you add together successive largest configurations (circle joined lines measured against numbers depicted on right y-axis).

In Figure C1b, the x-axis depicts the possible Frequency thresholds which could be considered. Once a Frequency threshold has been established, here we follow the criteria in Andrews et al. (2019), whereby the subsequent Consistency threshold needs to make sure no configuration can be associated with both the presence and absence of high graduate entrepreneurship. It follows, for each Frequency threshold, there will be a 'minimum' Consistency threshold which adheres to the previously stated criteria. In Figure C1b, for each Frequency threshold, the circle joined lines shows the respective minimum Consistency values thus found (shown on left y-axis), and through the combination of Frequency and Consistency thresholds the triangle joined lines gives the percentage number of universities further considered in subsequent pathways established (shown on right y-axis).

With a view to retaining the most universities in the analysis, and a high Consistency threshold, a combination of values towards the top left corner of Figure C1b are pertinent here. The Frequency threshold of at least one university associated with a configuration is considered, with subsequent consistency threshold of 0.815 also employed.