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Leveraging knowledge as a competitive asset? The intensity, performance and structure of universities' entrepreneurial knowledge exchange activities at a regional level

Qiantao Zhang · Niall G. MacKenzie · Dylan Jones-Evans · Robert Huggins

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Abstract Universities are no longer considered to be isolated islands of knowledge, but as institutions increasingly engaged with a range of external partners through entrepreneurial activities. This paper examines the associations between the intensity and performance of knowledge exchange activities undertaken in UK universities with non-academic actors. Drawing on data concerning the structural factors of interactions of universities in the UK with external partners, the paper sheds further light on the nature of these activities through a prism of competitive and uncompetitive regions in order to better understand how universities may be able to leverage both their knowledge and partnerships more effectively as competitive assets. On the one hand, it is found that academics in uncompetitive regions are more intensively engaged in entrepreneurial activities but generate less income from them than their counterparts in competitive regions, suggesting that there are differences in the income-generating capacity of academics across regions. On the other hand, academic knowledge is found to be more strongly bounded within a certain distance in uncompetitive regions whilst geographical distance seems less of a hindrance to academics in competitive regions.

Keywords Entrepreneurial universities · Knowledge exchange · Academic entrepreneurship · Regional development · Competitiveness

JEL Classifications H4 · I2 · O3 · R1

Q. Zhang
School of Business, Trinity College Dublin, Dublin 2, Ireland
e-mail: qizhang@tcd.ie

N. G. MacKenzie (✉)
Hunter Centre for Entrepreneurship, Strathclyde Business School, University of Strathclyde, Glasgow G4 0GE, UK
e-mail: niall.mackenzie@strath.ac.uk

D. Jones-Evans
Bristol Business School, University of the West of England, Frenchay Campus, Coldharbour Lane, Bristol BS16 1QY, UK
e-mail: Dylan.Jones-Evans@uwe.ac.uk

R. Huggins
School of Planning and Geography, Cardiff University, Glamorgan Building, King Edward VII Avenue, Cardiff CF10 3WA, UK
e-mail: HugginsR@cardiff.ac.uk

1 Introduction

Prior research has suggested that the economic role played by universities at a regional level can be best understood through the range of entrepreneurial activities they undertake to exchange knowledge with non-academic actors (Abreu and Grinevich 2013; Etzkowitz and Klofsten 2005; Guerrero et al. 2014, 2015; Kitson et al. 2009; Lawton Smith and

Bagchi-Sen 2012; MacKenzie and Zhang 2014; Power and Malmberg 2008; Urbano and Guerrero 2013). This has tended to focus on how various types of entrepreneurial knowledge exchange activities—such as collaborative research, contract research, consultancy research, facilities and equipment (F&E)-related service, courses for business and intellectual property (IP)-related undertakings—can influence regional economic performance (Howells et al. 2012; Klofsten and Jones-Evans 2000; Mowery and Shane 2002; Page 2007; Perkmann et al. 2013; Roberts and Eesley 2009; Simha 2005). However, there has been little detailed consideration of how these entrepreneurial activities are structured (what the activity is, who the partner is and where the partner is) and how this differs across various types of regions. As a result, the relationship between the intensity of each type of entrepreneurial knowledge exchange activity (the proportion of academics in a given region involved in the activity) and the performance of this activity (the subsequent financial income from the activity) remains unclear. This distinction, we argue, is crucial to the understanding of universities' entrepreneurial activities. For instance, it could be assumed that high performing universities would be more actively involved in entrepreneurial knowledge exchange activities given the demand for high-quality knowledge in modern economies, but the opposite could also be true. As a result, there may be a dilemma when attempting to compare both types of university and in such circumstances, regional policies that are developed on the basis of university performance in specific knowledge exchange activities alone may fail to maximise their effect without a full acknowledgement of the structural factors that contribute to differences in performance.

Previous studies that have examined the phenomenon of various entrepreneurial knowledge exchange activities within the higher education sector have tended to focus on examining examples of best practice especially in terms of identifying extraordinary universities in competitive regions (Etzkowitz and Klofsten 2005; Lawton Smith 2003; Saxenian 1994). As a result, there is a lack of recognition of the difficulty of transplanting models of university engagement with business and the wider community from successful regions to weaker regions (Abreu et al. 2008; Kitson et al. 2009; Lawton Smith 2007). As weaker regions have a tendency to look to their advanced counterparts for 'best practice' policies as means of boosting competitiveness, it would be detrimental if the specific contexts of each region were overlooked in the process. To this end, it is important to consider the regional differences that may exist when analysing the intensity and performance of the entrepreneurial activities of universities and their non-academic partners. In doing so, our intention is to shed further light on the nature of these different entrepreneurial activities through the prism of competitive and uncompetitive (or weaker) regions in order to enhance our understanding of the role entrepreneurial universities play in regional economic development.

This paper seeks to address the following key research questions: (1) In what way are the intensity and performance of the university's entrepreneurial knowledge exchange activities associated with each other? (2) In what way is the regional context associated with the relationships between the intensity and performance of the university's entrepreneurial knowledge exchange activities? (3) In what way does the relative importance of entrepreneurial knowledge exchange activities differ across regions and between regional groups? The remainder of the paper is organised into five sections. Section 2 examines the role of university entrepreneurial knowledge exchange activities in facilitating regional economic development, explains the key issues and also presents our propositions aligned with the conceptual framework. This is followed by an outline of the data and methodology in Sect. 3 underlying the empirical analysis. The main results of the UK regions are presented in Sect. 4, with the implications of these results for policy makers and university stakeholders discussed in more detail in Sect. 5. Finally, Sect. 6 presents our conclusions plus suggestions for further research.

2 Universities, entrepreneurial knowledge exchange activities and regional development

2.1 Knowledge production in the endogenous growth model

Over the last two decades of the twentieth century, our understanding of the role that knowledge can play in productivity and economic growth was significantly redefined with the rise of the endogenous growth

model. Romer (1986), Lucas (1988) and others began to acknowledge that knowledge, along with the traditional factors of physical capital and labour, was a key factor of production and had a substantial impact on economic growth through two main channels. Whilst previous investment in knowledge can stimulate more creation and stock of it, knowledge can also spill over from organisations (such as the firm or a university) so that it can be appropriated by others to enhance their own productivity. This is especially the case with knowledge generated from universities that both academics and policymakers have identified as a key contributor to national and regional competitiveness (Benneworth and Hospers 2007; Goldstein and Renault 2004; Huggins and Johnston 2009; Lawton Smith 2003; Urbano and Guerrero 2013).

As a result, universities have become increasingly engaged in using this knowledge to support economic and entrepreneurial development rather than focusing their mission exclusively on teaching and research (Audretsch 2014; Cash et al. 2010; Etzkowitz 1998; Klofsten and Jones-Evans 2000). These entrepreneurial activities have led policymakers to increasingly portray universities as important actors within systems of regional innovation, especially in providing knowledge for business and the community (Benneworth et al. 2009; Cooke et al. 2004; Czarnitzki et al. 2014; Fritsch 2002; Huggins et al. 2008; Kitagawa 2004). As a result, they play a vital economic development role by establishing programmes and facilitating networks to support the exploitation of the knowledge generated and, as a result, becoming more closely aligned with the needs of the regions where they are situated (Benneworth et al. 2010).

2.2 Configuring university entrepreneurial knowledge exchange activities: intensity and performance in competitive and uncompetitive regions

As various studies have shown, universities' links with their regional economies have evolved during the last two decades from a simple process of knowledge transfer through mechanisms such as patent licensing (i.e. deploying academic know-how to specific users) to multifaceted channels and mechanisms of knowledge exchange (Agrawal 2001; D'Este and Patel 2007; D'Este and Perkmann 2011; Meyer-Krahmer and Schmoch 1998; Schartinger et al. 2002). Indeed, there has been criticism that the study of knowledge transfer is too specific (and narrow) to include the much more diverse channels of communication in which academics are now engaged (Hughes 2011; Perkmann and Walsh 2007). Studies such as Klofsten and Jones-Evans (2000) highlight a range of knowledge exchange activities—such as contract research, consultancy, patenting and licensing, spin-off firms and provision of short courses—that are outside the normally accepted duties of academics (i.e. teaching and research) but which carry a degree of risk and potential for economic return and can therefore be termed 'entrepreneurial'. In addition, Cohen et al. (2002) considered the following channels as being critical in connecting firms and universities: patents, informal information exchange, publications and reports, public meetings and conferences, recently hired graduates, licenses, joint or cooperative research ventures, contract research, consulting and temporary personnel exchanges. Recent reports from the UK have supported the notion that strategic business–university research collaborations provide a myriad of benefits to their participants (Royal Academy of Engineering 2015). As a result, universities should make the facilitation of economic growth a core strategic goal (Wilson 2012) as higher education has 'extraordinary' potential to enhance economic growth at the local level through various knowledge exchange activities (Witty 2013). Nonetheless, the regional dimension of such interactions remains lacking in the analyses. Given this, a comparison of university entrepreneurial knowledge exchange activities across different types of regions in terms of intensity and performance could help identify contextualised and embedded factors which explain regional differences in the role of university knowledge in innovation and growth (Lorentzen 2008).

2.3 Intensity of university entrepreneurial knowledge exchange activities

In much of the literature on university knowledge exchange through various entrepreneurial activities, the main focus has been on the performance of those activities (Hewitt-Dundas 2012) with the intensity of such activities receiving less attention. Whilst the performance of knowledge exchange activities typically refers to the financial income generated, intensity measures the percentage of academics engaged in

entrepreneurial knowledge exchange activities. The relationship between the intensity of academics engaged in entrepreneurial activities and the characteristics of the region they are located in is an area that is worthy of deeper investigation. For instance, in weaker regions that lack a dense system of research infrastructure outside the university sector, governments often reinforce their expectations of universities by piling new functions and activities onto them to increase the financial income from those new activities. This leaves universities with an impossible mission as they are unable to handle the intensity of all three missions (Jacob et al. 2003; Nedeva and Boden 2006). The intensity of activity should therefore be an important consideration in understanding the role that universities play in regional economic development.

Academics in uncompetitive regions tend to rely more on collaboration with the public sector than those in competitive regions (Cunningham et al. 2014). One explanation for this is that uncompetitive regions tend to lack a high density of knowledge-based firms, so there is a limited demand for university knowledge from such businesses (Asheim et al. 2003; Benneworth and Charles 2005; Doloreux and Dionne 2008; Hewitt-Dundas et al. 2005; Malecki 2007; Tödtling and Trippl 2005). Consequently, we propose that:

Proposition 1 *Academics in competitive regions will be more intensively engaged across the different modes of academic entrepreneurial knowledge exchange activities than their counterparts in uncompetitive regions.*

Proposition 2 *Academics in competitive regions will be more intensively engaged in entrepreneurial knowledge exchange activities with the private, public and third sectors than their counterparts in uncompetitive regions.*

Whilst universities have been viewed as an important source of competitiveness by regional policymakers, many studies have noted that the entrepreneurial activities of universities are not only restricted to local or regional economies but can also be at a national and international level (Andersson and Karlsson 2007; Hewitt-Dundas 2013), thus giving a spatial dimension to the structure of such activities. There are various studies that have discussed the growing role of non-proximate networks (Amin and Cohendet 2004; Bunnell and Coe 2001; Huggins and Izushi 2007; MacKinnon et al. 2002) in regional economic competitiveness and development. Knowledge sourced globally by firms may be superior to that from local sources (Davenport 2005; Johnson et al. 2006), a phenomenon that might help explain the rising levels of distant (national or international) partnerships involving academics and businesses. Also, large collaborative projects tend to involve multinational companies with abundant financial resources and technological needs from universities. Nonetheless, the higher education policy arena still tends to encourage universities to become more engaged with regional business and innovation activities, thus bringing economically productive university knowledge exchange practices to the fore of policy landscapes (Etzkowitz and Klofsten 2005; Lambert 2003). Further, being employed in an uncompetitive region is associated with being more proactive in reaching out to the proximately close business community (Benneworth 2006). These arguments lead us to propose that:

Proposition 3 *Academics in uncompetitive regions are more intensively engaged with regionally based partners than with internationally based partners across the different modes of engagement in academic entrepreneurial knowledge exchange activities.*

Proposition 4 *Academics in competitive regions are more intensively engaged with internationally based partners than regionally based partners.*

2.4 Performance of university entrepreneurial knowledge exchange activities

The ability of universities to heighten regional economic impact through their entrepreneurial activities is better understood when the specific contexts of regions are taken into consideration. This may be particularly meaningful for less competitive regions that have fewer favourable background conditions such as cultures, economic structures and institutional arrangements (Benneworth 2006). In general, these weaker regions tend to lag behind their more competitive counterparts in terms of headline indicators such as economic output per capita and employment levels, as well as knowledge-based indicators such as innovation, patenting and densities of knowledge-intensive firms. As Benneworth (2007) noted, without the

extraordinary assets of places like Silicon Valley, it might be difficult for ordinary regions to make the leap from an old-economy paradigm to one based on innovation in services and high-technology industries. Less competitive regions are also challenged by the so-called regional innovation paradox (European Commission 2014; Oughton et al. 2002), i.e. universities in weaker regions are more likely to be amongst the most important research and innovation assets and therefore are found to be a key part of policy efforts in those regions to support knowledge-based economic development (Boucher et al. 2003). Policy interventions to increase territorially focused university–industry interactions are often justified by the claim that university knowledge tends to spill over within a certain geographical distance, thus demonstrating the phenomenon of localised knowledge spillovers (Raspe and van Oort 2011; Munari et al. 2012; Giuri and Mariani 2013). It is therefore fair to assume that competitive regions will have more embedded regionally proximate networks than lagging (uncompetitive) regions which are characterised by a weak industrial base where firms have lower levels of absorptive capacity to access and implement university knowledge (Cohen and Levinthal 1990; MacKenzie and Zhang 2014). In addition, as knowledge spillovers through a university's entrepreneurial activities are geographically bounded, spatially proximate knowledge exchange networks are more likely to form (Malmberg and Maskell 2006). Consequently, we propose that:

Proposition 5 *Universities in competitive regions will outperform their counterparts in uncompetitive regions in the performance of entrepreneurial knowledge exchange activities across the different modes of entrepreneurial knowledge exchange activities.*

Knowledge flows between universities and private sector firms have been the focus of a large body of literature which has tended to further distinguish between different types of firms and universities in terms of size, sector, research intensity and geographical location (Bonacorssi et al. 2013; Huggins et al. 2008; Klofsten et al. 1999; Meyer-Krahmer and Schmoch 1998; Pavitt 1984; Rasmussen et al. 2006; Urbano and Guerrero 2013). Academics in uncompetitive areas have a tendency to undertake small-scale collaboration that often involves SMEs and regional partners and face difficulties in being part of collaboration at a large scale (Huggins et al. 2012). In addition to private sector businesses, university academics also work closely with government bodies and third sector organisations which give them further opportunities to realise economic returns from their knowledge generation (Abreu et al. 2008, 2009; CBR 2009). It is still unclear about the breakdown of income generated by academics from entrepreneurial knowledge exchange activities amongst these three types of organisations. Consequently, we propose that

Proposition 6 *Universities in competitive regions will outperform their counterparts in uncompetitive regions in the performance of entrepreneurial knowledge exchange activities with external partners.*

2.5 Propositions and conceptual framework

Our tentative propositions outlined above seek to offer an exploratory analysis of the differences between academics engaging in entrepreneurial knowledge exchange activities in both competitive and uncompetitive regions. Propositions 1 and 2 seek to reveal the relative levels of intensity of academic entrepreneurial knowledge exchange activity in relation to the different modes of activity and partner types in the UK. Propositions 3 and 4 seek to reveal the regional differences between academics in both the intensity of engagement with and in terms of the location of their knowledge exchange partnerships. Propositions 5 and 6 test the relative performance in terms of the economic return per academic of entrepreneurial knowledge exchange activities considering both the different modes of activities and the types of partners engaged. The literature at present posits that competitive regions benefit from a number of characteristics which come together to create a system that works to encourage economic development which taken to its logical conclusion should result in more demand (and therefore opportunity) for academic knowledge exchange activities and a higher economic return to the academics engaging in such activities.

Figure 1 summarises the above concepts and shows how the propositions are deployed for the analysis of entrepreneurial knowledge exchange activities in UK universities. What we are seeking to understand in this approach is not causal relationships, but whether such relationships exist in the first place. The propositions are constructed around the idea that the region has an

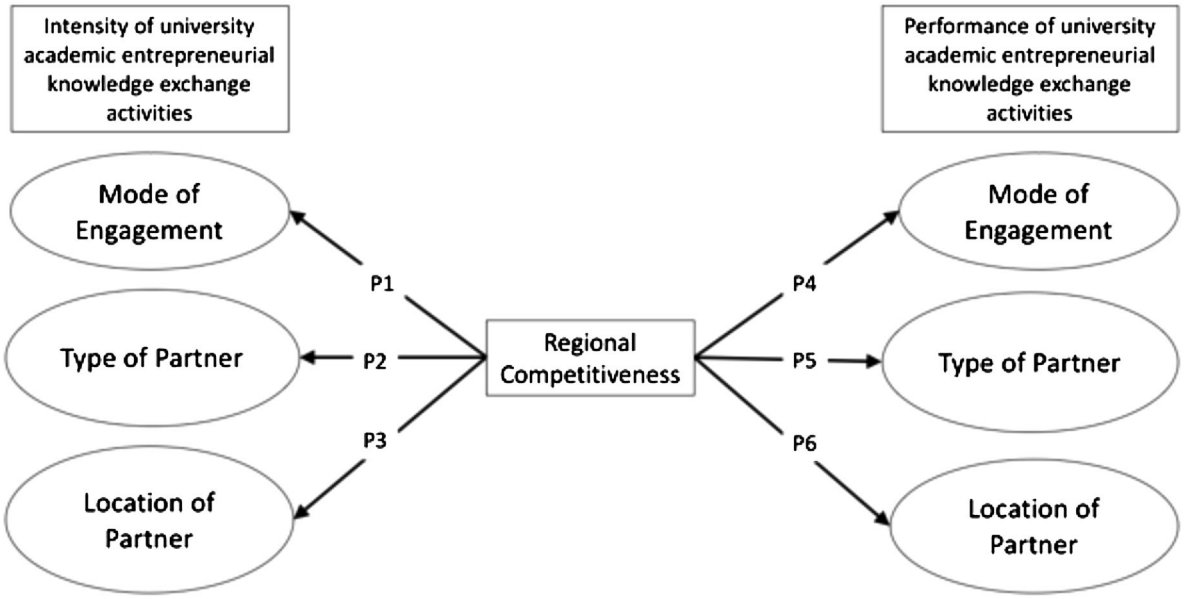

Fig. 1 Framework for understanding the intensity, performance and structure of university academic entrepreneurial knowledge exchange activities

effect on academic entrepreneurial knowledge exchange activities. This arises from our analysis of the literature that implies that the regional context will result in certain outcomes. The work contained in this paper therefore seeks to understand whether that is the case and should be considered an antecedent to future work that tests causality in relation to the different constructs outlined above and investigated below.

3 Data and methodology

The empirical analysis has been conducted by utilising four data sources operationalising the framework shown in Fig. 1. Measures of academic entrepreneurial activity intensity and performance are established through analysis of the mode of activity (the types of revenue-generating knowledge exchange activities they undertake), the type of external non-academic partner they engage with (public, private and third sector) and the geographical location of the universities and the knowledge exchange partners (regional and international). These are analysed through the prism of the competitiveness of the regions in which the academics are located to gain an understanding of the structure, intensity and performance of university entrepreneurial activity at the regional level.

3.1 Mode of activity

To capture the comprehensive aspects of universities' entrepreneurial knowledge exchange activities, we compile the mode of activity that academics engage in using the following typology. First, the definitions identified by the HE-BCI survey are applied in our analysis to examine how academics in the UK engage themselves in the following entrepreneurial knowledge exchange activities:

- Collaborative research: research projects with public funding from at least one public body and a material contribution from at least one external non-academic collaborator.
- Contract research: contracts meeting the specific research needs of external partners, excluding any already returned in collaborative research involving public funding and excluding basic research council grants.
- Consultancy contracts: advice and work crucially dependent on a high degree of intellectual input from the institution to the client (commercial or non-commercial) without the creation of new knowledge.
- Facilities and equipment (F&E)-related services: income associated with the use of the university's

physical academic resources by external parties and captures provision which can be uniquely provided by a university.
- Courses for business and the community: revenue generated by continuing professional development (CPD) courses, i.e. a range of short and long training programmes for learners already in work who are undertaking the course for purposes of professional development, upskilling or workforce development.
- Intellectual property (IP): commonly in the form of licenses granted to private companies, allowing them to exploit an invention protected by a patent. IP includes patents, copyright, design registrations and trademarks.

It is worth noting that whilst university spin-off activity in terms of numbers of spin-offs created is captured by the HE-BCI survey, it does not capture the financial return on spin-off companies to universities making it difficult to assess the performance of universities regarding this measure. This measure is therefore excluded from our analysis on the basis of a lack of consistently recorded data.

3.2 Intensity

The data source used to establish intensity is an academic survey conducted by the Centre for Business Research (CBR) at the University of Cambridge (CBR 2010). A web-based survey was created and then sent to a specially constructed sampling frame of 125,900 individual academics in all disciplines in virtually all UK universities who were active in research and/or teaching in 2008–2009. The survey asked academics to indicate their engagement in entrepreneurial activities between a 3-year period between 2005–2006 and 2007–2008. It finally achieved a sample of 22,170 responses, representing a response rate of over 17 % and from this, this paper selects 18,991 respondents who specified their region, position and academic discipline in the survey (CBR 2010). For the purposes of this paper, we define intensity as the proportion of academics in the CBR study that indicated that were involved in each type of entrepreneurial activity.

3.3 Performance

The data source used to define the performance and mode of activity for academic entrepreneurial activities is the 2009 HE-BCI survey that covers the year of 2007–2008 (which gives a direct comparison with the CBR data set). The survey results report the income of entrepreneurial activities raised by 159 universities across the UK out of 165, giving 96.4 % coverage of the UK higher education landscape. The HE-BCI survey is published by the Higher Education Funding Council for England (HEFCE) on behalf of all UK higher education institutions (HEIs) and the national funding bodies. It has collected data related to knowledge exchange activity in UK universities since the academic year of 1999–2000. In order to control for the difference of the size of UK universities, the number of academics full-time equivalents (FTEs) in the corresponding year has been drawn from the Higher Education Statistics Agency (HESA). Utilising this data, performance is defined as the financial income per FTE academic that the university derives from each type of entrepreneurial activity identified within the HE-BCI survey.

Table 1 shows the characteristics of academic respondents in the CBR survey and universities in the HE-BCI survey, which are later analysed in terms of the relationship between the intensity, performance and structure of university entrepreneurial activities.

3.4 Regional competitiveness

Building on the approach of Guerrero et al. (2015), the paper also utilises a Regional Competitiveness Index (UK Competitiveness Index 2010) to categorise the 12 UK NUTS1 regions, as defined by the European Union (EU Regional Innovation Scoreboard 2014), as competitive and uncompetitive in order to test the relationship between the regional context and the entrepreneurial activities of the universities (Table 2). Area competitiveness is the result of a complex interaction between input, output and outcome factors, and thus it is better measured in a single index that intends to reflect, as fully as possible, the measurable criteria constituting area competitiveness (Huggins 2003). The index assesses the competitiveness of the UK's regions and localities focusing not only on the development and sustainability of businesses but also on the economic welfare of individuals. The South East of England, London and the East of England were categorised as competitive regions, whilst the remaining nine regions were categorised as being uncompetitive (Huggins and Thompson 2010). It is on this basis

Table 1 Characteristics of academic and university respondents

Region	Academic respondents		University respondents	
	N	% of sample	*N*	% of sample
East Midlands	1214	6.4	9	5.7
East of England	1476	7.8	8	5.0
London	3324	17.5	41	25.8
North East England	884	4.7	5	3.1
North West England	1737	9.1	14	8.8
Northern Ireland	583	3.1	2	1.3
Scotland	2684	14.1	17	10.7
South East England	2249	11.8	17	10.7
South West England	1069	5.6	12	7.5
Wales	934	4.9	11	6.9
West Midlands	1156	6.1	12	7.5
Yorkshire and the Humber	1681	8.9	11	6.9
Competitive regions	7049	37.1	66	41.5
Uncompetitive regions	11,942	62.9	93	58.5
UK	18,991	100.0	159	100.0

Authors' calculation from CBR (2010) and HEFCE (2009)

Table 2 Regional UK Competitiveness Index 1997–2010 (UK = 100)

Rank 2010	Region	2010	2008	2006	2005	1997	Δ 1997–2010
1	South East England	110.5	109.7	110.5	114.6	115.1	−4.6
2	London	109.6	112.5	113.9	114.7	119.2	−9.5
3	East of England	108.9	105.6	106.0	109.0	106.4	2.5
4	North West England	93.8	94.5	92.3	91.2	89.9	4.0
5	East Midlands	93.5	97.7	96.1	95.5	94.1	−0.6
6	South West England	91.8	95.0	94.9	93.2	91.1	0.8
7	West Midlands	90.3	94.4	92.7	91.8	94.0	−3.7
8	Scotland	89.4	94.3	94.2	91.0	94.1	−4.7
9	Northern Ireland	89.0	88.8	88.0	84.0	81.8	7.2
10	Yorkshire and the Humber	87.3	89.6	90.5	86.7	85.6	1.7
11	North East England	86.5	83.1	84.2	81.2	79.2	7.3
12	Wales	83.9	86.8	86.7	83.5	81.5	2.4
	UK	100.0	100.0	100.0	100.0	100.0	0.0

Authors' compilation from Huggins and Thompson (2010)

that this paper examines whether and how the regional context (i.e. regional competitiveness) is related to the scale and scope of knowledge exchange between academics' entrepreneurial activities and the wider community.

It is considered that concerns that arise out of using secondary data (for the purpose of conducting UK-wide comparisons) have been appropriately dealt with by virtue of using the original raw data sets. Firstly, with the guidance of our research framework shown in the previous section, the data from the first two sources (the CBR survey and the 2009 HE-BCI survey) have been critically selected, restructured and analysed in an innovative way. Secondly, by combining these unique data sources together, our analysis is able to reveal how the intensity and performance of UK universities' entrepreneurial knowledge exchange activities are related to each other, which serves as a contribution to the literature's understanding of the evolving roles of higher education in economic development.

3.5 The variation of advantage across regions

An investigation of how the 12 NUTS1 UK regions compare against each other in each mode of knowledge exchange activity is interesting for two reasons. First, the categorisation of regions by their economic competitiveness demonstrates the differences between the two regional groups but fails to detect the possible variances within each group. For instance, it would seem reasonable to expect that academics situated in the nine uncompetitive regions show different levels of involvement with partners. Second, more tailored regional innovation strategies that specifically aim to foster collaboration between academics and external partners can only be successfully designed and effectively implemented through recognition of all aspects of academic knowledge exchange activities, especially the structure and intensity of university involvement. In fact, previous studies have addressed the difficulties of transferring a particular policy from one location to another successfully and have called for differentiated regional innovation policies that fully consider a range of specific backgrounds of regions such as the level of economic development, the industrial structure and the presence of universities (Etzkowitz and Klofsten 2005; Mowery and Sampat 2005).

The descriptive material contained in Table 3 reveals the intensity and performance in each type of entrepreneurial knowledge exchange in the 12 UK regions. The findings show that collaborative research was the research-based activity that contributes the highest level of income (as compared to contract and consultancy research). Academics across the regions also appeared to have differentiated strengths in gaining financial returns from these types of engagement between themselves and partners. Nevertheless, with the exception of the East of England, none of the other regions showed better performance than the UK average in all the three types of collaboration. This suggests that universities in different regions may have advantages only in specific (rather than all) types of research-based entrepreneurial knowledge exchange activities.

Another emerging type of entrepreneurial knowledge exchange activity during the last few decades is the way scientific discoveries at universities and federal laboratories are commercially exploited. Policy changes in both developed and developing countries have encouraged universities to exploit intellectual property rights through patenting and licensing agreements. For example, a large body of literature has examined the influences of the policies such as the Bayh–Dole Act (Grimaldi et al. 2011; Mowery and Sampat 2005; Powers and McDougall 2005; Sampat et al. 2003). However, IP-related activities were the lowest performer in terms of both intensity and performance suggesting that the academic focus on these activities may be better placed elsewhere.

3.6 Statistical analysis

Descriptions of the intensity and performance of knowledge exchange activities in the UK cover Propositions 1–4, followed by a series of inferential statistical analyses undertaken to test Propositions 5 and 6, as we were interested in the differences between the two types of regional groups in the performance of university entrepreneurial knowledge exchange activities. In particular, we wanted to understand whether (a) universities in competitive regions generated significantly more income per FTE academic from entrepreneurial activities than their counterparts in uncompetitive regions on the one hand and (b) whether academics in competitive regions were significantly more intensively engaged in those activities than their counterparts in uncompetitive regions. Analysis of performance was tested using a pair of nonparametric Mann–Whitney U tests whilst the analysis of intensity was tested using Chi-squared tests to test for statistically significant differences between the two types of regions. As such, we attempted to describe the associations between the intensity and performance of entrepreneurial activities but have not sought to explain the causality relationships between the two aspects. This could form the basis of future research utilising multilevel modelling such as hierarchical regressions to better understand the dynamics at play once relationships and differences have been established. The focus of this paper was on providing a comprehensive initial picture of the knowledge exchange process to establish whether there are relationships between the competitiveness of a region and the ability of academics to engage in economically productive activities with external partners; thus, initial propositions were developed arising out of the literature review and then tested.

Table 3 Intensity and performance of university academic entrepreneurial knowledge exchange activities by region, % and £000s per FTE academic

Region	Collaborative research		Contract research		Consultancy research		F&E-related services		Courses for business		IP-related activities	
	Intensity	Performance	Intensity	Performance	Intensity	Performance	Intensity	Performance	Intensity	Performance	Intensity	Performance
East Midlands	45.4	5.2	35.9	2.8	38.5	1.2	16.0	0.6	41.9	4.6	5.8	0.1
East of England*	54.3	4.7	37.9	4.9	44.6	4.2	17.3	0.2	44.4	9.6	7.8	0.3
London*	48.7	5.5	35.9	5.4	43.0	2.6	14.4	1.2	40.3	14.3	6.2	0.6
North East England	48.0	3.6	34.5	5.8	41.2	3.4	17.0	0.3	48.1	4.8	6.3	0.1
North West England	47.8	4.2	35.8	2.8	39.3	2.8	14.5	1.7	45.7	4.2	6.3	0.1
Northern Ireland	53.7	8.0	41.3	4.5	46.3	1.2	20.2	1.1	52.5	2.3	6.7	0.6
Scotland	51.7	6.6	37.9	4.8	40.8	2.5	16.3	0.8	43.9	4.3	6.7	0.3
South East England*	46.1	3.7	33.2	4.1	42.6	4.4	14.5	1.4	41.9	6.1	5.5	0.4
South West England	50.4	2.0	36.5	2.6	41.3	2.1	14.2	0.5	45.7	3.8	6.0	0.1
Wales	51.2	4.7	41.1	3.8	41.2	2.0	18.1	0.1	46.1	3.6	6.5	0.1
West Midlands	45.6	3.2	33.7	4.3	39.6	3.9	17.0	1.0	48.9	3.1	5.4	0.9
Yorkshire and the Humber	46.3	3.3	38.3	5.3	42.0	2.0	15.4	0.7	47.8	4.6	7.3	0.3
UK	48.9	4.6	36.5	4.4	41.7	2.8	15.7	0.9	44.4	7.2	6.4	0.4

Authors' calculation from CBR (2010) and HEFCE (2009). Intensity refers to the percentage of academics who indicated that they were involved in each mode of activity between 2005–2006 and 2007–2008. Performance refers to the average financial income of each mode of activity generated per FTE academic in 2007–2008

* Denotes competitive region

4 Findings

4.1 The intensity and structure of entrepreneurial knowledge exchange activities

Table 4 shows how intensively academics across the UK and within each regional group engaged in the six modes of entrepreneurial knowledge exchange activity. If all UK academics were taken into account, the most popular engagement was collaborative research, which was reported by nearly half of respondents with no significant difference between region types. Some 44.4 % of academics were involved in delivering courses for business and the community whilst consultancy activities were reported by around 41.7 % of respondents. In contrast, facilities and equipment (F&E)-related services were less popular with only 15.7 % of academics reporting that they had participated. These results largely reject Proposition 1. Academics in uncompetitive regions were engaging slightly more intensively in contract research, F&E-related services and courses for business. It was only in consultancy research that academics in competitive regions outperformed their counterparts in uncompetitive regions and there were no significant differences between the two types of region in collaborative research and IP-related activities.

4.1.1 The intensity of academic engagement with private and public sectors

Table 5 illustrates the intensity of engagement of academics in British universities with private, public and third sector partners. Throughout the UK, 54.1 % of academics stated that they had engaged with public sector organisations whilst 43 % of the responding individuals reported interactions with the third sector. Only 42.1 % of the respondents indicated that they had been involved in knowledge exchange activities with private firms. The only significant difference between the two region types in terms of academic engagement with external partners was in the third sector where academics in competitive regions were more intensively engaged than their counterparts in uncompetitive regions with only a small difference observed. This indicates that Proposition 2 is only partially supported. One interesting observation worth noting here is that academics in both region groupings tended to be more intensively engaged with public and third sector partners than with the private sector, suggesting that more needs to be done by universities to facilitate and encourage more engagement with private businesses.

Table 4 Intensity of the six modes of university academic entrepreneurial knowledge exchange activities by regional group, %

Mode of activity	UK academics $N = 18{,}991$ (%)	Regional group		Chi-squared test
		Academics in competitive regions $N = 7049$ (%)	Academics in uncompetitive regions $N = 11{,}942$ (%)	
Collaborative research	48.9	49.1	48.8	
Contract research	36.5	35.4	37.1	*
Consultancy research	41.7	43.2	40.8	**
F&E-related services	15.7	15.0	16.1	*
Courses for business	44.4	41.7	46.1	**
IP-related activities	6.4	6.3	6.4	

Authors' calculation from CBR (2010). Intensity refers to the percentage of academics who indicated that they were involved in each mode of activity between 2005–2006 and 2007–2008. Chi-squared test was used to show whether or not there were significant differences between the two regional groups († $p < 0.1$, * $p < 0.05$, ** $p < 0.01$)

Table 5 Intensity of university academic entrepreneurial knowledge exchange activities with private, public and third sector organisations by regional group, %

Type of partner	UK academics $N = 18{,}991$ (%)	Regional group		Chi-squared test
		Academics in competitive regions $N = 7049$ (%)	Academics in uncompetitive regions $N = 11{,}942$ (%)	
Private sector	42.1	42.5	41.9	
Public sector	54.1	53.6	54.4	
Third sector	43.0	44.2	42.3	*

Authors' calculation from CBR (2010). Intensity refers to the percentage of academics who indicated that they were involved with each type of partner between 2005–2006 and 2007–2008. Chi-squared test was used to show whether or not there were significant differences between the two regional groups († $p < 0.1$, * $p < 0.05$, ** $p < 0.01$)

4.1.2 *The regional divergence of focus on domestic and international partners*

Table 6 shows that UK academics were more engaged with international partners than regional partners. However, significant differences were observed between the region groupings and their intensity of engagement with partners in the regional and international locations. Across all modes of engagement, we found that academics in competitive regions were more intensively engaged with international partners, but academics in uncompetitive regions were more intensively engaged with regional partners. These results support Proposition 3 that academics in uncompetitive regions will be more intensively engaged with regionally based partners and Proposition 4 that academics in competitive regions will be more intensively engaged with international partners. It also suggests that regional competitiveness is directly associated with the structure of academic knowledge exchange activities. However, the reasons for engaging with either domestic or international partners may be a result of personal (Azagra-Caro 2007; Boardman and Ponomariov 2009; D'Este and Patel 2007; Link et al. 2007), departmental (Martinelli et al. 2008; Owen-Smith and Powell 2001) and institutional (Lawton Smith 2003; Lockett et al. 2003) factors and is a research issue that requires further attention.

4.2 Performance per academic FTE in competitive and uncompetitive regions

4.2.1 *Performance across modes of interaction*

Table 7 shows income per FTE academic according to the two regional groupings as a measure of performance across the different modes of interaction for academic entrepreneurial knowledge exchange activities in the UK and tests whether or not there are significant differences between the regions. At the national level, a total of £20,300 was generated per FTE academic by UK universities from knowledge exchange activities, but the amount generated from different types of activities varied significantly. There was no significant difference between the two groups in total income suggesting that, on average, universities in each type of region generated similar income from engaging in entrepreneurial activities. When the income was divided into the six modes of interaction of entrepreneurial activities, the median values of income generated by universities in competitive regions were higher than those in uncompetitive regions. However, no significant differences were found except in F&E-related services, i.e. universities in competitive regions reported higher income from F&E-related services than those in less competitive areas (statistically significant at the $p < 0.05$ level). Income from F&E-related services accounted for only a modest share of total income for universities in both types of regions and therefore did not greatly influence the overall pattern. For universities in competitive regions, the most income was generated from courses for business and the community accounting for 44 % of total income. Collaborative research contributed 27 % of the total income for universities in uncompetitive regions. Consequently, Proposition 5 is not supported and universities in competitive regions do not outperform their counterparts in uncompetitive regions in the performance of entrepreneurial knowledge exchange activities across the different modes of entrepreneurial knowledge exchange activities (except in the case of F&E-related services).

Table 6 Intensity of regional and international university academic entrepreneurial knowledge exchange activities by regional group, %

Location of partner	UK academics (%)	Regional group		Chi-squared test
		Academics in competitive regions (%)	Academics in uncompetitive regions (%)	
Collaborative research				
	$N = 9286$	$N = 3459$	$N = 5827$	
Regional	28.7	25.1	30.8	**
International	51.1	55.6	48.5	**
Contract research				
	$N = 6927$	$N = 2497$	$N = 4430$	
Regional	31.6	26.5	34.4	**
International	34.7	41.5	30.9	**
Consultancy research				
	$N = 7914$	$N = 3044$	$N = 4870$	
Regional	34.0	30.6	36.2	**
International	34.0	40.2	30.2	**
F&E-related services				
	$N = 2980$	$N = 1057$	$N = 1923$	
Regional	29.5	24.3	32.4	**
International	30.0	36.7	26.3	**
Courses for business				
	$N = 8439$	$N = 2937$	$N = 5502$	
Regional	44.4	38.6	47.5	**
International	34.5	40.4	31.3	**

Authors' calculation from CBR (2010). Intensity refers to the percentage of academics, those who were actually engaged in each mode of activity, involved with regional and international partners between 2005–2006 and 2007–2008. Chi-squared test was used to show whether or not there were significant differences between the two regional groups († $p < 0.1$, * $p < 0.05$, ** $p < 0.01$)

4.2.2 *Performance according to type of partner*

As shown in Table 8, UK universities secured much less income from private sector firms than from public sector organisations, reflecting prior results concerning the intensity of engagement with these types of external partners. Results in Table 8 show that whilst universities in competitive regions secured more income from both private and public sector organisations than their counterparts in uncompetitive areas, it was not significantly different according to the regional groupings. This indicates that Proposition 6 is supported, albeit not strongly. Non-commercial organisations emerged as the dominant partners of universities in uncompetitive regions accounting for 63.5 % of the total income. In competitive areas, private sector firms and public sector organisations contributed comparable levels of income. This suggests that universities in competitive regions generated income diversely and evenly from both private and public partners whilst those in less competitive regions showed a strong dependency on the public sector organisations. The main difference between academics in the two regional groups was found in their income generation from businesses where academics in competitive regions generated more than twice that in uncompetitive regions. However, the competitiveness of a region does not have a significant relationship with the capacity of an academic securing funding from public sector organisations.

5 Discussion

The analysis has examined the academic entrepreneurial knowledge exchange activities of universities

Table 7 Performance of the six modes of university academic entrepreneurial knowledge exchange activities by regional group, £000s per FTE academic

Mode of activity	UK universities $N = 159$ (£000 s)	Regional group		Mann–Whitney U test
		Universities in competitive regions $N = 66$ (£000 s)	Universities in uncompetitive regions $N = 93$ (£000 s)	
Collaborative research	4.6	5.0	4.3	
Contract research	4.4	5.0	3.9	
Consultancy research	2.8	3.2	2.4	
F&E-related services	0.9	1.1	0.8	*
Courses for business	7.2	11.6	4.1	
IP-related activities	0.4	0.5	0.3	
All total	20.3	26.5	15.9	

Authors' calculation from HEFCE (2009). Performance refers to the average financial income of each mode of activity generated per FTE academic in 2007–2008. Mann–Whitney U test was used to show whether or not there were significant differences between the two regional groups († $p < 0.1$, * $p < 0.05$, ** $p < 0.01$)

in the UK, focusing on the extent to which the regional context influences the relationships between the intensity and performance of these activities through a theoretical framework comprising the mode of activity, the type of partner and the location of the partner. Building on the growing body of literature on localised knowledge spillovers at the heart of which lies the spatially bounded knowledge externalities (Alcacer and Chung 2007; Breschi and Lissoni 2001a, b; Giuri and Mariani 2013), the research shows that UK academics showed a number of significant differences in how intensively they engaged in academic entrepreneurial knowledge exchange activities. Our propositions are restated in the table below alongside the outcomes of the preceding analyses (Table 9).

5.1 Limitations

In terms of limitations, this is exploratory research that has not sought to test causality in the relationships identified but rather to establish what types of relationships they may be. Follow on work could consider these relationships more deeply than we have in order to test a number of other factors including, for example, university type, research intensity, partner type (size) and the relationships between intensity of engagement in certain modes of activity and performance. Consequently, we are aware that the competitive–uncompetitive regional typology deployed in this study may overlook some granularity in terms of differences between regions in the same category. However, the work is exploratory in seeking to understand the relationship between regional competitiveness and entrepreneurial universities exist in the first instance. Given both the number of universities and their distribution across regions, this approach does offer a relatively informative means of analysing the potential role of regional context in influencing the nature of the entrepreneurial activity of universities. Similarly, we are aware that whilst the findings are suggestive of this influence rather than definitively implying causality, the significant associations found clearly indicate that the nature, performance and intensity of university entrepreneurial activity are not totally independent of the locational contexts in which they are situated. As this is exploratory work, we counsel that discrete regional dimensions should be an important consideration of policymakers when seeking to exploit university knowledge for economic gain and regional development. Furthermore, future academic work on this area could use multilevel models to test the stocks and flows of knowledge exchange activities in universities at regional and local levels to better understand the granular dynamics and impacts of these interactions on economic development.

5.2 Implications for better understanding the concept and contexts of Entrepreneurial Universities

One unexpected result from the analysis was that academics in uncompetitive regions tended to slightly

Table 8 Performance of university academic entrepreneurial knowledge exchange activities with private and public sector organisations by regional group, £000 s per FTE academic

Type of partner	UK universities $N = 159$ (£000s)	Regional group		Mann–Whitney U test
		Universities in competitive regions $N = 66$ (£000s)	Universities in uncompetitive regions $N = 93$ (£000 s)	
Private sector	7.2	11.5	4.1	
Public sector	10.7	11.8	10.1	
Other	2.4	3.2	1.7	
All total	20.3	26.5	15.9	

Authors' calculation from HEFCE (2009). Performance refers to the average financial income generated per academic FTE from external partners in 2007–2008. Mann–Whitney U test was used to show whether or not there were significant differences between the two regional groups († $p < 0.1$, * $p < 0.05$, ** $p < 0.01$)

outperform their counterparts in competitive regions in the intensity of their engagement in entrepreneurial activities. However, this increased intensity did not translate into more income with universities in competitive regions generating an on average higher income from engaging than those in uncompetitive areas. This paradox suggests that the main constraint of academics in uncompetitive regions was their limited capacity in generating income from engaging in knowledge exchange activities. Possible explanations for this may include their tendency to undertake small-scale collaboration that often involves SMEs and regional partners or their difficulties in being part of large-scale collaborations (Huggins et al. 2012). The over-reliance on non-commercial partners in uncompetitive areas for income is also a weakness that may be symptomatic or indeed causal of the regional context. More investigation of this is required.

More generally, academics were more closely engaged with the public and third sector organisations than with private firms suggesting that recent policy reviews have, to date, had little immediate effect in increasing academic–industry interactions in the UK. However, this did differ geographically with non-commercial organisations being the dominant partners of universities in uncompetitive regions whilst private sector firms and public sector organisations were both important funding sources to universities located in competitive areas. This suggests that a less diverse income portfolio of universities in uncompetitive regions may bring about crucial challenges for them especially in a period of global austerity in the public funding of higher education (OECD 2013). As a result, government policies and university initiatives should be directed to building more linkages through knowledge exchange activities with external partners (especially private sector companies) to address this.

The analysis implies that a key reason as to why academics in uncompetitive regions generated less income from entrepreneurial activities lies not in their attitude towards reaching out to businesses and the community (D'Este and Patel 2007; Ponomariov 2008), but in something else which we term as income-generating capacity or performance. In general, better income-generating capacity is associated with academics involved with large-scale partnerships that tend to involve multinational companies and international partners, which are both features of competitive regions (Huggins and Thompson 2015). Although academics in uncompetitive regions were more actively engaged in knowledge exchange activities than their counterparts in competitive areas, they tended to do so by relying on public sector funding. As a result, the differences in performance from private sector companies could be the determinant of the overall level of economic performance of entrepreneurial knowledge exchange activities although this requires further investigation.

Academics in uncompetitive areas showed a significantly higher level of engagement in locally focused activities whilst those in competitive regions overwhelmingly outperformed in engaging with international organisations. Whilst the internationalisation of knowledge exchange activities affects the financial performance of universities, being part of global knowledge exchange networks adds greater value than just monetary returns including access to cutting-edge

Table 9 Recap of propositions and outcomes of analysis

Proposition	Supported
P1: Academics in competitive regions will be more intensively engaged across the different modes of academic entrepreneurial knowledge exchange activities than their counterparts in uncompetitive regions	No
P2: Academics in competitive regions will be more intensively engaged in entrepreneurial knowledge exchange activities with the private, public and third sectors than their counterparts in uncompetitive regions	Partially
P3: Academics in uncompetitive regions are more intensively engaged with regionally based partners than with internationally based partners across the different modes of engagement in academic entrepreneurial knowledge exchange activities	Yes
P4: Academics in competitive regions lead their counterparts in uncompetitive regions in the intensity of entrepreneurial knowledge exchange activities in terms of locations of partner	Yes
P5: Universities in competitive regions will outperform their counterparts in uncompetitive regions in the performance of entrepreneurial knowledge exchange activities across the different modes of entrepreneurial knowledge exchange activities	Yes
P6: Universities in competitive regions will outperform their counterparts in uncompetitive regions in the performance of entrepreneurial knowledge exchange activities with external partners.	Yes

knowledge, advanced knowledge sharing and knowledge spillovers (Huggins et al. 2008). It is therefore important for universities and businesses within a region to develop both regional and international networks for the exploitation and exploration of knowledge through entrepreneurial activities. Whilst this does not deny the importance of regional knowledge exchange networks (Bathelt et al. 2004; Saxenian 1994; Storper 1997), further research is required to understand how engaging in either regionally based or internationally based activities would impact on academic outputs (intellectual and economic) as well as more widely on the regional innovation system.

6 Conclusions

The notion of the entrepreneurial university has growing currency as knowledge economies develop (Guerrero et al. 2015). However, as public policy-makers increasingly look to universities to promote the concept of knowledge exchange through their external engagement to deliver competitiveness and prosperity, most current policy instruments focus only on the performance of entrepreneurial activities, leaving their intensity and structure less well understood. Our findings confirm that both structure and intensity are important factors in understanding the performance of universities' entrepreneurial knowledge exchange activities within different types of regional economic contexts. Furthermore, our study shows that academic knowledge in uncompetitive regions was more strongly bounded spatially within a certain distance, whilst geographical distance seemed less of a hindrance to academics in competitive regions and their international partners. It is clear then that the competitiveness of a region is related to the ability of universities to derive economic benefit from their knowledge beyond research and teaching by influencing both the type and location of their external partners which, in turn, is associated with their intensity and performance of their entrepreneurial activities. Therefore, simply expecting all universities to act entrepreneurially and to contribute to economic development risks the danger of failing to understand the importance of the types and structure of the entrepreneurial knowledge exchange activity in which they are engaged. This, in turn, can both facilitate and hinder the leveraging of university knowledge as a competitive asset for growth in both competitive and uncompetitive regions. Future academic studies of entrepreneurial universities and their role in new social and economic landscapes should pay heed to the influence of the characteristics of the regions in which they are located and factor in the local economic and social contexts into their understanding of both the impact and potential of entrepreneurial universities.

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