



CIMR Research Working Paper Series

Working Paper No.

THE EVOLUTION OF TRIPLE HELIX DYNAMICS: THE CASE OF ENGLISH HIGHER EDUCATION INSTITUTIONS

by

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Date

20 July 2016
ISSN 2052-062X

Acknowledgements

Preliminary versions of the manuscript were presented at the “Micro-foundations of the Triple Helix Workshop” (Grenoble, May 2014) and “2014 EU-SPRI Annual Conference” (Manchester, June 2013) where participants provided valuable insights.

Abstract

Whilst significant attention has been devoted in the literature to examining the institutional configurations, incentives, and the governance of triple helix university-industry-government interactions, less is known about the dynamic micro-foundations of these interactions. In order to address this gap, this paper examines how the third mission has been differently reconfigured and re-shaped over the years across universities in England. The paper articulates a micro-foundations model of the triple helix in terms of the combination and evolution of knowledge exchange activities, triple helix partners, and geography of interactions. Using data from the Higher Education Business Community Interaction Survey (HEBCI) for England between 2003/04 and 2011/12, our results demonstrate that each university has recognised their own entrepreneurial opportunities and heterogeneous set of activities, increasing differentiation and specialisation in patterns of triple helix interactions. While ‘elite’ research intensive universities show a concentration of knowledge exchange income, particularly in research oriented and ‘harder’ forms of engagement, newer universities tend to focus on softer forms of engagement. Additionally, there is overtime a decreased engagement with SMEs and a lower share of knowledge exchange activities at the regional level.

JEL classification: I23 I25 I28 R11

Key words: university; third mission; knowledge exchange; triple helix; micro-foundations.

1 Introduction

The contribution of universities and other Higher Education Institutions (HEIs) to economic growth is an area of increasing concern for scholars and practitioners alike (e.g. Geuna, 2001; OECD, 2007). In the so-called ‘knowledge economy’, universities are perceived as fulfilling an ever-growing spectrum of roles: educate and train students; conduct and disseminate excellent research; boost productivity through collaborative relations with external partners; contribute to the socio-economic well-being of their localities and enhance civic value in the public realm.

The role of universities in broader economic and community development is not new, but has been given greater impulse by recent policies and incentive schemes designed to encourage interactions among universities, government and industry. Governments in most OECD countries are actively supporting the so-called ‘third mission’ of universities in addition to teaching and research (Molas-Gallart et al., 2002;

Rasmussen et al., 2006), via their active involvement in a variety of knowledge exchange activities with societal and economic/industrial partners (Kenney and Goe 2004; Philpott et al., 2011; Guerrero and Urbano, 2012; Huyghe and Knockaert, 2015; Louis et al., 1989).

Concepts such as the ‘triple helix’ university–industry–government interactions (Etzkowitz and Leydesdorff, 2000), the ‘entrepreneurial university’ (Clark, 1998; Guerrero and Urbano, 2012) and more recently the idea of public sector entrepreneurship (Leyden and Link, 2015; Hayter, 2015) have been proposed in order to understand the determinants, institutional dynamics and incentives underpinning these interactions for the exploitation of academic knowledge. Considerable attention has been given for instance to the institutional configurations and the governance underpinning triple helix relationships (Geuna and Muscio, 2009). However, triple helix approaches have typically adopted a macro-level, aggregate view, thus obscuring the dynamic micro-foundations of university-industry-government interactions (Tuunainen, 2005). As a result the transition towards the ‘entrepreneurial university’ is too often portrayed as a “global phenomenon with an isomorphic developmental path” (Etzkowitz and Leydesdorff, 2000; p.313), overlooking the diverse and dynamic ways in which universities are pursuing this ‘entrepreneurial’ agenda.

This paper aims to contribute to a better understanding of the micro-foundations of the triple helix. Using a ‘micro-foundations as levels’ approach, that regards ‘actors’ not only as individuals but also as organisations (Felin et al., 2012; 2015), this paper aims to shed light on how actors, their interactions, and the mechanisms and contexts of these interactions produce university level and collective system level heterogeneity.

More specifically, this paper contributes to the micro-foundations of the triple helix literature by building on the theoretical model proposed by Leydesdorff (2010). This framework revolves around three dimensions: the ‘relational’ dimension focuses on the forms of knowledge exchange relations among the actors. The second dimension focuses on the multi-layered, geographically embedded actor configurations in triple helix interactions. The third element is ‘reflexive’ and includes a temporal dimension

based on the possibility of agent-based and discursive learning. All these dimensions are analysed empirically in this paper in order to address how the third mission has been re-configured over time across different types of universities. Focusing on HEIs in England and using data from the Higher Education Business Community Interaction Survey (HEBCI) for the academic years 2003/4 to 2011/12, the paper therefore addresses the following key question, namely how have the dynamics of the third mission changed over time? Using a micro-foundations perspective, the paper aims to more specifically understand the sub-dimensions of third mission interactions in terms of the types of knowledge exchange activities, the mix of triple helix partners, and the geography of interactions. The correspondence between these two approaches (unpacking the link between micro-foundations and triple helix) is described in the next section that provides a critical account of the entrepreneurial university model as well. The Third section presents the third mission policy and the diverse institutional context of UK higher education. The Fourth section explains the empirical approach of the paper: the data sources used, methodology adopted and key findings and interpretation of the study. Discussion and conclusion follow.

2 Literature review

2.1 The 'entrepreneurial university' under the triple helix approach

The triple helix model of university–industry–government interactions (Etzkowitz and Leydesdorff, 2000) has gained scholarly as well as policy attention over the past years. It argues that the boundaries of previously separated spheres of industry, government and higher education are becoming increasingly blurred and intertwined. As a result, an 'entrepreneurial university' model is emerging as a hybrid organisation that combines the activities of industry, university, and public authorities to promote innovation (Etzkowitz, 2008). According to Rothaermel et al. (2007), the entrepreneurial university is a step in the natural evolution of a university system that emphasizes economic development in addition to the more traditional mandates of education and research. This entrepreneurial university model thus incorporates a 'third mission' of economic development, alongside teaching and research, "with the objective of improving regional or national economic performance as well as the

university's financial advantage and that of its faculty" (Etzkowitz and Leydesdorff, 2000; p.313).

This evolution is allegedly motivated by pressures to access additional funding sources, and the active promotion of collaboration between universities and multiple triple helix partners through a range of public policies and infrastructure (Abreu and Grinevich, 2013; Miller et al., 2014). In this context, universities are placing a higher priority on being relevant and responsive to national, regional and local needs, and these efforts have resulted in a progressive 'institutionalisation' of third mission activities (see Charles et al., 2014). Increasing competition for funding as well as policy drivers for the entrepreneurial turn could therefore be seen as top-down coercive, normative and mimetic 'isomorphic' forces acting upon universities (DiMaggio and Powell, 1983).

Against a depiction of the entrepreneurial university model as an inevitable, homogeneous and 'isomorphic' development path (Etzkowitz and Leydesdorff, 2000), a number of scholars have questioned the implicit universality of the phenomenon (Tuunainen, 2005; Philpott et al., 2011). Specifically, authors have highlighted the multiple tensions and contradictions that are likely to emerge between different university missions and activities and argued that the degree and form of entrepreneurial transformation is likely to vary across countries and types of universities (Slaughter and Leslie, 1997; Jacob et al., 2003; Martinelli et al., 2008; Huyghe and Knockaert, 2015; Miller et al. 2014). For instance Philpott et al (2011), in a European university case study, observed a lack of unified culture regarding the appropriateness of the third mission, as well as clear tensions and divides across disciplines on the meaning and type of entrepreneurial engagement. In a study of Spanish universities, Sanchez-Barrioluengo (2014) identified strong differences in the performance and capabilities of universities to balance teaching and with the new third mission. Marginson and Considine's (2000) study on Australian universities found differences in the way universities responded to government funding cuts and the emergence of new managerial models, with new, less academic universities adopting a greater focus on industrial relations and applied professional education, and old-established universities maintaining collegial loyalties and academic cultures despite reforms.

Different types of universities seem to have a mix of different triple helix activities in a variety of national and regional contexts. Hewitt-Dundas (2012) found that in the UK different types of universities exhibited different degrees and types of knowledge transfer activity. While high research intensive universities focused on the exploitation of IP and maximizing returns from research (see also Guerrero et al., 2015), low research intensive ones focused mainly on activities related to human capital development. Hussler et al. (2010), through the examination of academic entrepreneurship in Italy, Germany and China, put emphasis on the regional dimension of interactions. Their results suggest that differences among the technology transfer models emerge depending on regional characteristics: while European regions are characterized by an under-representation of mechanisms for the adoption/exploitation of academic research (like spin-offs, mobility of human capital or training programs), the Chinese region seems to put greater stress on direct valorisation mechanisms.

These findings should stand as a cautionary tale against an adoption of the ‘one-size-fits-all’ model of the entrepreneurial university (Philpott et al., 2011; Sánchez-Barrioluengo, 2014). Some authors even conclude that there is no “unique and best way for academic research to contribute to regional economic development” (Hussler et al., 2010; p.515). Hence, we need to understand the ways in which the entrepreneurial university model has developed with a variety of triple helix interactions and orientations. The next sections explain how we adopt micro-foundations approach in our research – we ask how the triple helix actors and their interactions have led to the heterogeneity of universities’ knowledge exchange activities over time, through the selection of different partners and geographical levels of interactions.

2.2 The ‘micro-foundations’ approach to the triple helix interactions

As the previous section suggests, there is growing evidence that rather diverse pathways can co-exist within the so-called ‘entrepreneurial university’. However, a holistic understanding of how HEIs are actually undergoing this transition towards an entrepreneurial university model is lacking (Rothaermel et al., 2007). University-industry-government interactions are generally studied from a (neo-) institutional

perspective, often in the form of case studies of selected universities, or in terms of specific linkages or types of relations. The triple helix model adopts a macro level approach to describe the workings of national systems of education and innovation, in terms of aggregates of institutional units of analysis. However this macro-level and generic view tends to obscure “the intrinsic dynamic, internal variance and contradictory tendencies present in scientific practices and universities” (Tuunainen, 2005; p.284). In order to adequately understand the complexity and heterogeneity of triple helix relations, a micro-foundations perspective to the triple helix has been called for (Cunningham et al, 2016).

The notion of micro-foundations has attracted considerable interest in strategy and organisational theory over the past decade (Barney and Felin, 2013; Foss and Linberg, 2013; Felin et al., 2015). Micro-foundations research has been concerned with how individual-level factors impact organisations, namely how the “interaction of individuals leads to emergent, collective, and organisation-level outcomes and performance, and how relations between macro variables are mediated by micro actions and interactions” (Felin et al., 2015, p.586). Interest on micro-foundations has emerged as a response to an excessive emphasis on macro-macro relationships (for instance in neo-institutional theories of organisation) and a perceived neglect of the roles actors and their interactions play in generating, sustaining and changing institutions (Barney and Felin, 2013; Felin et al., 2015; Coleman, 1990).

The notion of micro-foundations has however different conceptions and there is “little agreement about what they in fact are” (Barney and Felin 2013: p.150). Felin et al. (2015) distinguish between two main distinct interpretations, namely a “micro-foundations as levels” and a “micro-foundations as an explanatory primacy of individuals” argument. Barney and Felin (2013) note that micro-foundations are not solely about individuals, and there is a risk of focusing on the individual level at the expense of the interactions among them as well as the context of the organisation itself.

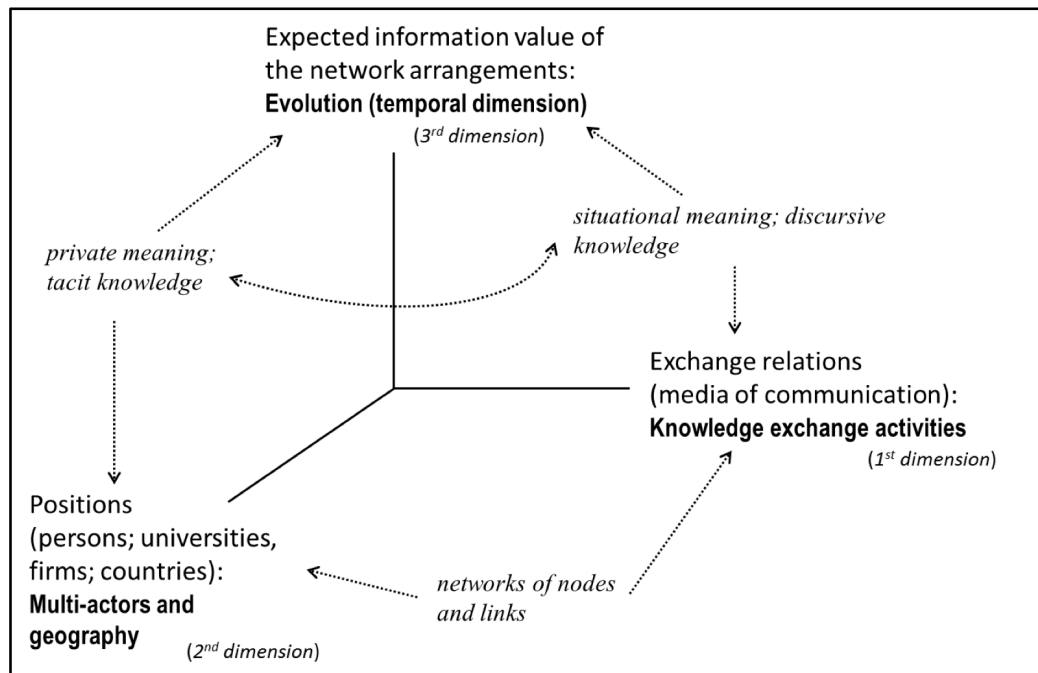
Relating both the micro-foundations notion and the triple helix approach, Cunningham et al. (2016) have suggested that a micro-foundations perspective of the triple helix can for instance help to understand the basis of capability and capacity

development at the micro level. Similarly, Leydesdorff (2010) argued that understanding the emergence of a knowledge base requires a triple helix model that is micro-founded. In this paper, following the “micro-foundations as levels” approach, we apply the micro-foundations perspective to the theoretical development of triple helix interactions between university-firm-government actors. The “micro-foundations as levels” interpretation suggests the need to locate the proximate causes of a phenomenon (or explanation of outcome) at a level of analysis lower than the phenomenon itself. In this context “micro-foundations are concerned with understanding how actors, their interactions, and the mechanisms and contexts that influence such interactions, produce firm level and collective heterogeneity” (Felin et al., 1995: p.605). Specifically, we are interested in understanding the collective heterogeneity resulting from triple helix relations and to this effect we adopt a micro-foundation perspective to the triple helix model by taking into account the interactions between a variety of agents and various dimensions of knowledge exchange activities embedded in a variety of institutional conditions. As a result of these interactions, institutional logics and dynamics arise that may set off unexpected and divergent paths from the one-size-fits all model of the entrepreneurial university, thus potentially counteracting top-down isomorphic policy and mimetic pressures.

3 Activities, partners and geography within the triple helix model of interactions

Our micro-foundations approach arises from conceptualizing the three analytical dimensions of the triple helix model suggested by Leydesdorff (2010) in Diagram 1. One dimension is ‘relational’ and focuses on the forms of (economic and other forms of) ‘exchange relations’ among the actors. The second dimension resides in geographically embedded and multi-layered actors as units of analysis (such as universities, firms or public sector). Each agent (or aggregate of agencies) has different preferences and attributes and, we argue, their internal capacities vary. A third element is ‘reflexive’ and constitutes a ‘meta-perspective’ based on the possibility of agent-based and ‘discursive learning’. In Diagram 1 the conceptual model developed in this paper is presented building on Leydesdorff (2010).

Diagram 1. Micro-foundation of the Triple Helix Model



Source: Adapted from Leydesdorff (2010).

Note: The way through which authors articulate the theoretical model appears in bold.

The triple helix covers a wide range of communication channels or knowledge exchange interactions (Etzkowitz and Leydesdorff, 1997) and constitutes the first dimension of Leydesdorff's (2010) model. An extensive literature has dealt with so-called 'entrepreneurial activities', 'academic entrepreneurship', 'knowledge transfer', 'academic engagement' and 'knowledge exchange' activities (Kenney and Goe 2004; Philpott et al., 2011; Huyghe and Knockaert, 2015; Louis et al., 1989; Rothaermel et al., 2007). They include a broad spectrum from 'soft' activities (advisory roles, consultancy, industry training, production of highly qualified graduates), which are closer to the traditional academic paradigm, to 'hard' initiatives such as patenting, licensing and spin-off activities (Philpott et al., 2011) closer to the entrepreneurial university model (Guerrero and Urbano, 2012; Guerrero et al., 2015)¹.

Despite this wide ranging set of activities, policy and research interests have mainly concentrated on a narrow set of 'hard' or more codified forms of activities such as the

¹ In this paper we use the term 'knowledge exchange' referring to different types of university activities because it portrays university-society interactions in a broad encompassing and diverse way (Perkmann and Walsh, 2007). Unlike 'academic entrepreneurship', it acknowledges interactions that go beyond commercial benefit, including engagement with the public sector and non-governmental organisations.

commercialisation of intellectual property (IP) emanating from university research (through e.g. patents or licences), neglecting other types of entrepreneurial activities which are less visible, but equally or even more important (D'Este and Patel, 2007; Howells et al., 2012). This narrow emphasis may also overlook possible interconnections and complementarities between different types of activities (Uyarra, 2010). Triple helix interactions often entail the use of several activities simultaneously (Bercovitz and Feldmann, 2006) and there is an increased tendency for universities and businesses to forge longer-term, strategic alliances encompassing a range of links closely tailored to the needs of the companies, rather than single, ad-hoc links (Geiger and Sá, 2008). Activities such as training, internships and consultancy tend to go hand in hand and generally enable the development of capacities to initiate other 'harder' or more formal knowledge exchange activities (Laredo, 2007). Concerns have therefore been raised about the appropriateness of encouraging all universities to effectively pursue the same narrow set of activities (Hewitt-Dundas, 2012).

The second aspect of our micro-foundation perspective is the institutional dimension of triple helix interactions. In the triple helix model, the main institutional actors have been defined as university, industry and government. Actors from the different institutional spheres present their own behaviour and motivations (economic gain, novelty generation, etc.) and selectively negotiate and define new projects and knowledge exchange activities, and thus different configurations of actors will be involved in networks of knowledge exchange. These actors are multi-layered and heterogeneous. As such, exchange activities are mainly articulated at the level of the individual, but also groups and organisations according to different functional dynamics (Leydesdorff, 2010). Knowledge transfer processes may be enhanced or hindered by the institutional context in which the actors are embedded. In this context, the ability of a university to engage in entrepreneurial activities hinges on its institutional context and resource-based capability and capacity (Williams and Kitaev, 2005).

Triple helix interactions are defined by institutional as well as geographical conditions occurring at regional, national, and international levels. Acknowledging the importance of localised knowledge spillovers (Audretsch et al., 2005), universities have been in the last two decades encouraged to facilitate knowledge exchange and

adopt a stronger and more direct role in fostering entrepreneurship in their regions, supported by regional policies and institutions such as regional development agencies and other intermediaries (Uyarra, 2010; Kitagawa, 2004). While geographical proximity has indeed been found to influence the likelihood of university-industry interaction (Laursen et al., 2011), the spatial dimension of these relations is far from simple and uniform (D'Este and Iammarino, 2010). The importance of geographical proximity is for instance contingent on the type of university (e.g. age and research intensity) and structural characteristics of firms. Hewitt-Dundas (2012) found that in the UK, the type and intensity of knowledge transfer is determined by the research quality of the university, but interactions also differ across partner types, namely small and medium sized firms (SMEs), large firms or non-commercial organisations. Whereas large companies tend to be more attracted to work with a university because of its research reputation in a particular area of interest, small firms may demand more routine services and consultancy, which are more likely to be sourced from their local university (see Siegel et al., 2007; Pinto et al., 2015).

Finally, the third dimension that we are seeking to explore is the evolutionary development of the triple helix interactions. In fact, the triple helix denotes “not only the relationship of university, industry and government, but also internal transformation within each of these spheres” (Etzkowitz and Leydesdorff, 2000; p.118). Institutional actors will be reproduced and changed through (both individual and relational) reflexive learning. Actors learn and build competences, and reflexive communications transform networks of relations in an evolutionary mode. Overtime, universities and mechanisms for engagement such as Technology Transfer Offices (TTOs) build legitimacy, which helps them access resources and reduce contestation when promoting commercialisation activities and practices within the university (O’Kane et al., 2015).

This evolutionary mode implicitly includes a temporal dimension that has been also highlighted in the definition of the “micro-foundations as levels” approach (Felin et al., 2012 p.1355). As Jacob et al. (2003) note, the transition towards an entrepreneurial university is an evolutionary process that takes several years because both infrastructural and cultural changes are necessary. As a consequence of these evolutionary mechanisms, the entrepreneurial university will take different and

heterogeneous forms and develop some dimensions and not others despite common isomorphic policy and mimetic pressures. However, there is a limited understanding of the dynamics of change underpinning these activities– namely how different universities select and shift their focus and their strategic interaction with different triple helix partners, the ways in which such differences have evolved over time and how external environments have configured such processes.

In summary, this paper adopts a micro-foundations perspective in order to shed light on the heterogeneity of institutional practices within the HE sector. More specifically, this paper draws attention to three main issues:

- 1) The breadth of activities underpinning university–industry–government interactions.
- 2) The geographical and multi-actor dimension of triple helix interactions.
- 3) The evolutionary nature of knowledge exchange activities within the third mission of universities and the institutional differences across the HE sector.

3 The UK policy and institutional context

3.1 Third Mission as a policy instrument for triple helix micro-foundations

Similar to other OECD countries, UK government policies since the late 1990s have sought to encourage triple helix interactions by developing third mission activities in universities. For example, in 2003, the Lambert Review of Business-University Collaboration (Lambert, 2003) focused on issues of university start-ups, and institutional constraints on Intellectual Property Rights (IPRs), pointing out the “weak demand from businesses for the knowledge and skills created in the universities” (Lambert, 2003). Subsequent reviews (such as the Sainsbury Review, 2007) recognized significant progress made since the Lambert Review and also stressed that universities should voluntarily choose appropriate functions (see Sainsbury, 2007). However, Hewitt-Dundas (2012) notes that third mission policies in the UK have tended to be applied uniformly with little account for organisational differences within the sector.

Specifically, this study focuses on HEIs in England as distinct from other parts of the UK. Whilst research policy and research funding allocation is UK-wide, higher education policies including third mission policy, have been differentiated between England, Scotland, Wales and Northern Ireland (Huggins and Kitagawa, 2011; Kitagawa and Lightowler, 2013). In England, the Higher Education Funding Council (HEFCE) has funded ‘third stream’ initiatives since the late 90s, initially through the Higher Education Reach Out to Business and the Community initiative (HEROBC) and since 2001 through the Higher Education Innovation Fund (HEIF). HEROBC and HEIF have led to a considerable expansion of knowledge exchange infrastructure and capabilities in HEIs (PACEC, 2009). The mechanism for allocating third mission funding has also evolved (see Rosli and Rossi, 2016) and is currently based on a formula using the share of overall knowledge exchange income as reported in the annual Higher Education Business Community Interaction Survey (HEBCI) survey. As a result of this funding mechanism, a large proportion of income from knowledge exchange funding concentrates in a few elite universities (Coates-Ulrichsen, 2014). Income measures as proxy for KE carry with them potential biases (Rossi and Rosli, 2015) in terms of the type of institutions (larger, more prestigious universities may be able to charge more for services) and the types of activities (some generate higher income, others may be very valuable and yet be offered for free or at low cost). The income based allocation model thus rewards those institutions that derive the largest income from third mission activities.

Intermediaries have played an important role increasing interactions between universities and other triple helix partners (see Figure 2). Following the example of the USA although without a Bayh–Dole act counterpart (Chapple et al., 2005), universities in the UK have developed their own TTOs in order to exploit academic outputs and bring near the knowledge and technology transfer from universities to the private sector (Decter et al., 2007). Additionally, during late 1990s and 2000s, third mission policy was a key component of regional economic and innovation policy. The nine Regional Development Agencies (RDAs) in England developed various instruments to encourage regional engagement of universities (Kitagawa, 2004), promoting innovation and entrepreneurship activities and collaboration at the regional level. They constitute part of the governmental dimension of the triple helix approach specifically at a sub-national dimension. The RDAs were abolished in 2010 and

replaced with smaller scale Local Enterprise Partnerships (LEPs), endowed with lower levels of funding than those under the RDAs (Bentley and Pugalis, 2013). This has meant a loss of income for many universities (especially newer ones) both in terms of regeneration income, match funding for European structural funding and grants for knowledge exchange activities and infrastructure (Charles et al., 2014). These governance changes happened against the backdrop of the financial and economic crisis (Hutton and Lee, 2012) leading to other knock-on effects on universities through reduced investments in innovation of the private sector, and public sector budgetary constraints, reducing demand for services such as consultancy (Charles et al., 2014).

Finally, higher education in England underwent a radical shift in 2012 with a drastic reduction in teaching-related public funding and the introduction of higher tuition fees for home and EU students. This has led to a widely differentiated ‘institutional vulnerability’ affecting both universities and places (Goddard et al., 2014). While research funding has remained relatively stable, it is increasingly concentrated in a few research-intensive universities as a result of the performance based research funding regime (see, Hughes et al., 2013). Other changes in the higher education sector such as more ‘marketised’ student behaviour, greater emphasis on graduate employability (Tomlinson, 2012) and the research ‘impact’ agenda (Watermeyer, 2014) may also influence the ‘micro-foundations’ of universities’ third mission strategies. Finally, it has been pointed out that other changes on the demand side such as an increased tendency towards open innovation strategies in many industries may also influence the third mission performance of universities (Scott, 2014).

3.2 Institutional Context

The UK higher education system is diverse for historical reasons (Scott, 2014; Goddard et al., 2014). Arguably, universities with different organisational heritage play different roles, reflecting institutional priorities, cultures and governance structures, and also a different mix of discipline areas and research intensity (Perkmann et al., 2011; Hewitt-Dundas, 2012; Abreu and Grinevich, 2013; Abreu et al., 2016).

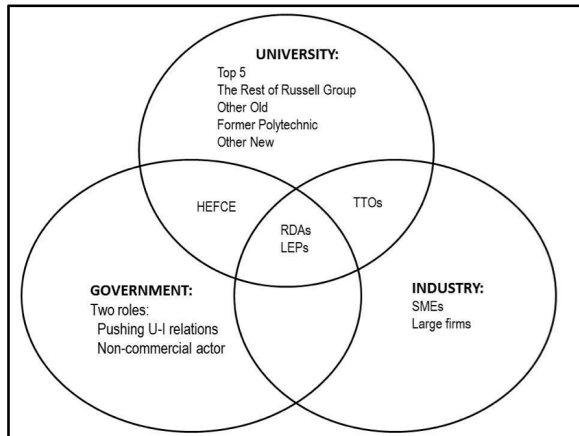
In this paper, individual English HEIs constitute our unit of analysis in line with the “micro-foundations as levels” approach. They are divided into five categories adopting and refining the frameworks used by recent studies such as McCormack et al. (2014). The main division within the higher education sector is between the so-called ‘Old universities’, founded before 1992, which are typically more research focused, and ‘New universities’ which were granted university status after 1992 as a result of the Further and Higher Education Act (HMSO, 1992) and also former University Colleges that have become universities in recent years. ‘New universities’ are more teaching focused, and their third mission activities are assumed to be ‘locally oriented’ given their traditional focus on vocational education and training, and their relatively low engagement in basic research (Charles et al., 2014; Goddard et al., 2014).

Within these two groups, there are self-organised ‘sub-divisions’ of universities within the national system, which are seen as the result of an informal stratification into ‘mission groups’ (Scott, 2014), including the ‘Russell Group’, with 24 self-selecting ‘elite’ universities in the UK. The Russell Group universities represent less than 15% of the sector in terms of the number of universities but capture around 75% of the total quality-related research (QR) funding granted by HEFCE to universities in 2014-15². In this study, five universities (Imperial College, Universities of Cambridge, Oxford, Manchester and University College London) were separated from the rest of the Russell Group as ‘Top 5’ universities based on the distribution of research funding: this group of 5 universities receive a disproportionate share (32%) of QR funding by HEFCE. Consequently, within the ‘Old universities’, three groups are distinguished: ‘Top 5’, ‘the rest of the Russell Group’ and ‘Other Old universities’. Within the ‘New universities’, two groups are identified: ‘Former Polytechnics’ consisting of HEIs which were originally established as polytechnics under local authority funding and control, and converted to university status since 1992, and ‘Other New universities and HEIs’, which includes HEIs that were granted university status after 2004, primarily former further and higher education colleges, specialist colleges and current higher education colleges.

² HEFCE Annual funding allocations for 2013-14. Source: <http://www.hefce.ac.uk/whatwedo/invest/institns/annalocns/1314/>

To sum up, this paper classifies the UK HEIs into five groups as institutional types³: (1) ‘Top 5’; (2) ‘The rest of the Russell Group’; (3) ‘Other Old’ universities; (4) ‘Former Polytechnics’ and (5) ‘Other New’ HEIs. Diagram 2 identifies the elements of the triple helix model proposed by Etzkowitz and Leydesdorff (2000) adopted in analysing the English context in this paper⁴.

Diagram 2. Triple Helix Model in the UK context



Source: Adapted from Etzkowitz and Leydesdorff (2000)

4 Data and methodology

4.1 Source of information

The analysis of this study is based on the Higher Education Business Community Interaction Survey (HEBCI) data for the academic years 2003/4 to 2011/12. HEBCI is an annual survey⁵ carried out by the HEFCE since 2001. The questionnaire collects data on a broad range of third mission activities encompassing the contributions of universities to both economy and society, covering all the HEIs in England, Scotland, Wales and Northern Ireland. More specifically, HEBCI collects information on a range of ‘third mission’ or ‘third stream’ activities, defined there as: a set of selected knowledge exchange (KE) activities in which a university/HEI strategically engages as an institution.

³ Annex I lists individual HEIs included in each group.

⁴ We recognise the existence of other elements and actors involved in the triple helix model. However with this diagram authors aim to schematically present the alignment between the main elements analyzed in the empirical section and the theoretical conception of the triple helix model.

⁵ The HEBCI survey questionnaire is available at:

http://www.hesa.ac.uk/index.php?option=com_collns&task=show_colln&Itemid=232&c=C11031&s=5&wvy=any&wvs=1&isme=1

The key KE activities used in this paper are: collaborative research (collaborations), consultancy (consultancy), contract research (contracts), facilities and equipment related services (facilities), continuing professional development and continuing education (CPD), IP activities including shares, sales (patents and licences) and spin-offs (spin-offs). Table 1 presents a detailed description of the selected variables for the analysis as well as descriptive statistics for the whole period. Due to differences in the nature of the variables, our analysis uses normalized variables by year⁶.

We examine 107 out of the 130 English HEIs (176 in the UK) covered in the HEBCI survey. We exclude from the analysis HEIs for which no information was available for the whole time-window as well as those HEIs solely specialised in Arts and Design. In terms of the institutional types described in previous section, the breakdown of our population is as follows: 45.8% pre-1992 universities (5% ‘Top 5’, 14% ‘Other Russell Group’ and 27.1% ‘Other Old’) and 54.2% post-1992 universities (29% ‘Former Polytechnics’ and 25.2% ‘Other New HEIs’).

⁶ In addition, those variables that measure amount of money are deflected using 2003/04 as year of reference.

Table 1. Definition of variables, descriptive statistics^a and factor analysis

VARIABLE	DEFINITION	MEAN	STD. DEV.	MIN.	MAX.	FACTORS
£ Collaborations	Total income from collaborative research involving both public funding and funding from business (£000s)	5,173.82	9,089.56	0	67,326	RESEARCH-ORIENTED ACTIVITIES
# Contracts	Total number of contract research (excluding any already returned in previous variable - £ Collaborations- and Research Councils)	206,21	315,64	0	2,591	
£ Contracts	Total value of contract research (excluding any already returned in previous variable - £ Collaborations- and Research Councils (£000s)	7,158.36	14,628.23	0	124,583	
Patent app	Number of new patent applications filed in year by or on behalf of the HEI	13.34	28.76	0	298	
Patent grant	Number of patents granted filed in year by or on behalf of the HEI	4.73	14.11	0	175	
# Licences	Total number of non-software and software licences granted	378,86	1,074.71	0	9,822.6	
£ Licences	Total revenues from IP income	32,09	107.32	0	1,729	
# Consultancy	Total number of consultancy contracts	474,74	1,750.93	0	17,846	CONSULTANCY
£ Consultancy	Total value of consultancy contracts (£000s)	2,476.34	3,943.18	0	32,064.53	
# Facilities	Total number of facilities and equipment related services	134,95	300.97	0	4,186	FACILITIES
£ Facilities	Total value of facilities and equipment related services (£000s)	810,79	1,612.94	0	11,485.32	
# CPD	Courses for business and the community – CPD courses and CE: Total learner days of CPD/CE courses delivered	28,855.27	64,295.17	0	758,340	TRAINING
£ CPD	Courses for business and the community – CPD courses and CE: Total revenue	4,067.89	5,196.29	0	35,803.23	
Spin-off	Number of spin-offs established with some HEI ownership	1,16	2.29	0	20	SPIN-OFF
Spin-off NHE	Number of formal spin-offs established with no HEI ownership	0.17	0.66	0	8	

^a Monetary variables are deflected using 2003/04 as reference value. Number of observations: 963.

4.2 Methodology

We employ two main quantitative analysis techniques. First, we apply a factor analysis based on a principal components technique with Kaiser Normalization (Hair et al., 1998) in order to summarize the information provided by universities on the range of KE activities they engage in. The factors scores obtained allow the characterization of the evolution of the specificities in university performance for triple helix interactions across universities through temporal graphs. This methodology is used to understand the first dimension of Leydesdorff's (2010) model. This information is used also to understand how universities prioritize their third mission engagement, including the ways in which they have shifted their focus and strategic activities over the years (third dimension of the model).

Second, we probe the evolution and variations in university triple helix interaction by means of temporal graphs with a) annual growth rates in income from different types of triple helix partners involved and b) the share of income from the collaborations that takes place within the boundaries of the region where each HEI exists. With this information we look at the actors and geographically embedded nature of triple helix interaction (second dimension of the model). The average annual growth rate (AGR) is calculated by dividing the slope by the income. The slope is determined by the regression line formed by the matrix corresponding to the years of study 2003/04-2011/12 and income raised by the universities by the type of partners. Changes in these patterns of interaction reflect the variety, scale and scope within university's third mission strategies that define the micro-foundations of triple helix.

5 Results

5.1 Sub-dimensions of third mission interactions: evolution of activities, partners and geography.

Firstly, according to the results of the factor analysis⁷ KE activities are categorised into five groups, namely: ‘research-oriented’ activities, ‘facilities’, ‘consultancy’, ‘training’ and ‘spin-offs’ (Table 1, last column). Such groups of activities highlight the relational dimension in our micro-founded triple helix model. Summarizing original activities in five factors explains almost 70% of the total data variability, which is considered as satisfactory for social science studies (Hair et al., 1998). Additionally, and in order to check the factors’ internal reliability, we calculate the Cronbach-alpha index. The coefficients for all groups are around 0.6⁸, which is also considered as a satisfactory value (Hair et al., 1998). This result goes a step further in the decomposition and categorization of university activities proposing a different, more nuanced, way to group KE activities. Categories such as “commercialisation activities” (Huyghe and Knockaert, 2015; Abreu and Grinevich, 2013; Jain et al., 2009) ‘entrepreneurial activities’ (Guerrero and Urbano, 2012; Guerrero et al., 2015) or “soft/hard activities” (Philpott et al.; 2011) are arguably too broad to capture university KE performance.

Secondly, and in order to understand the evolution of interactions over time by different types of universities, the obtained factors scores are graphically described in Figures 1 to 5. The results show how different types of HEIs engage in different mixes of KE activities. They illustrate how efforts of universities vary within the HE sector but also how over time universities have (re-)configured and changed their third mission strategies despite isomorphic policy pressures. This reconfiguration can be understood as a learning process where universities as organisations develop their capacities based on their trajectories and path dependencies.

⁷ Factor analysis was also carried out splitting the time-window in two periods 2003- 2007 and 2007-2011 in order to evaluate whether the exogenous event of economic crisis can bias the model. Results maintain equally number of factors and include the same variables within each factor, except for licenses that appears mixed between research-oriented activities and training group in the last period.

⁸ Specific values are: 0.88 for ‘Research-oriented activities’; 0.586 for ‘Facilities’; 0.516 for ‘Consultancy’; 0.481 for ‘Training’ and 0.522 for ‘Spin-offs’. Although some of them could be lower than the minimum recommended, the explanation is that this coefficient is a direct function of the number of items explaining the construct. In consequence, factors composed by few items obtain lower value of Cronbach-alpha.

Figures 1-5. Evolution of Third Mission activities by university-cluster

Figure 1. 'Top 5'

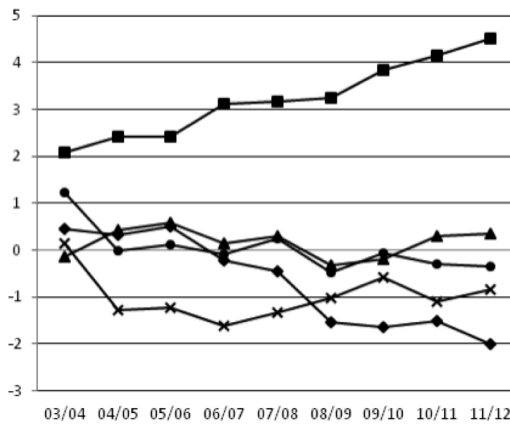


Figure 2. 'The rest of Russell Group'

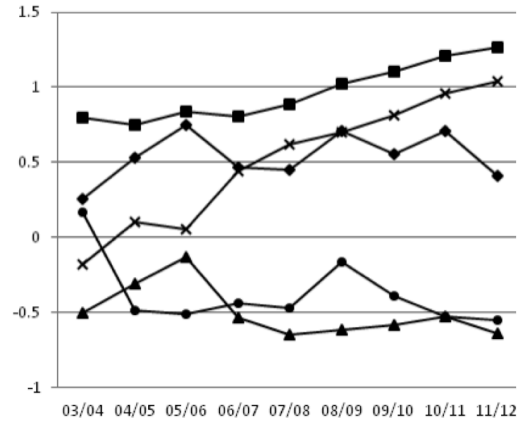


Figure 3. 'Other Old'

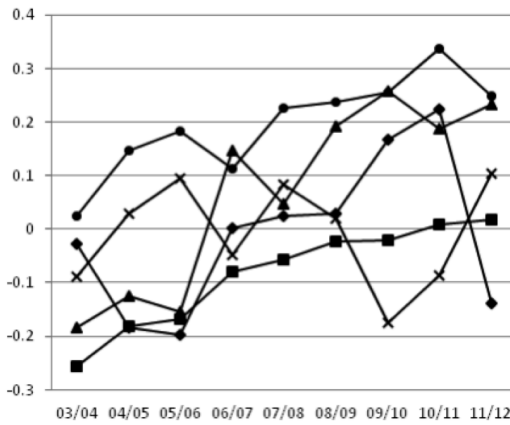


Figure 4. 'Former Polytechnics'

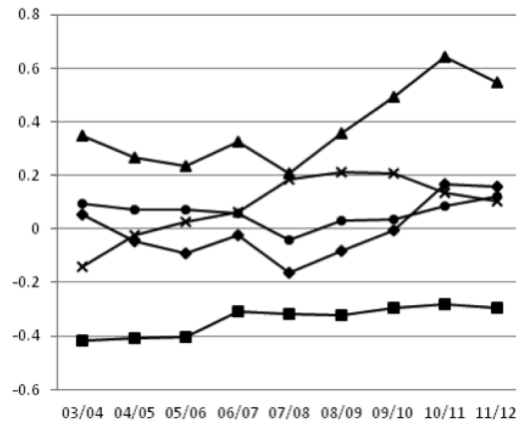
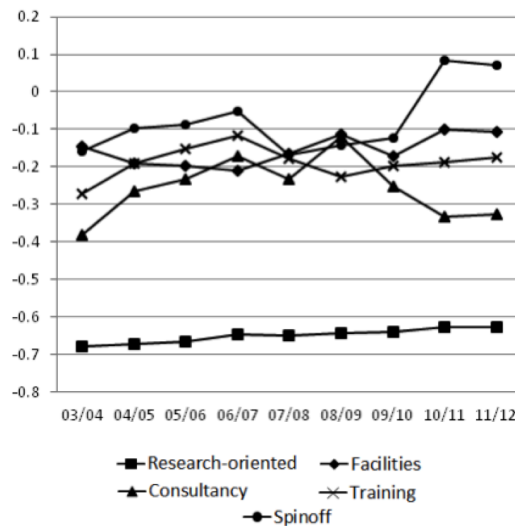


Figure 5. 'Other New'



■ Research-oriented ◆ Facilities
 ▲ Consultancy × Training
 ● Spinoff

Note: Left axis include factor scores from factor analysis.

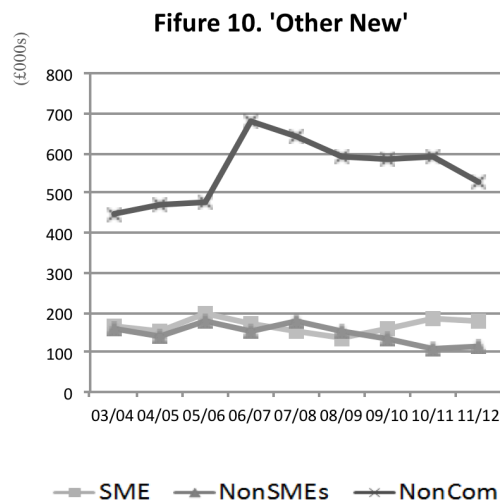
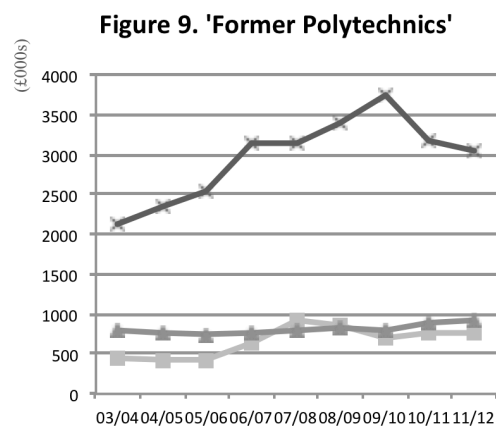
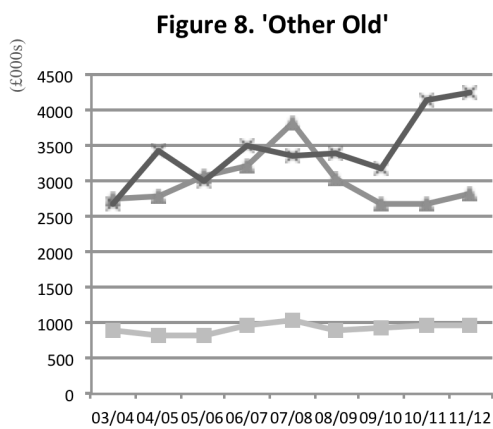
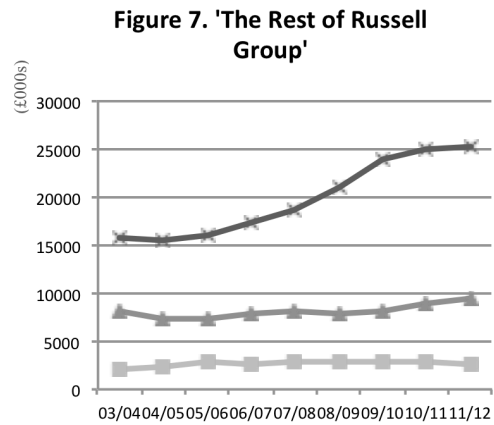
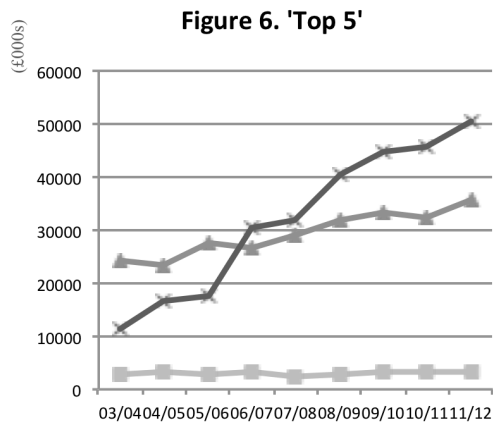
In general all Russell Group universities are more focused on research-oriented activities such as collaborative research, contract research and generation of IPs, which distinguishes them from the rest of HEIs. However, results suggest that within the Russell Group there are some differences. While ‘Top 5’ universities (Figure 1) show an increasingly pronounced focus on research-oriented activities, ‘The Rest of the Russell Group’ universities are not so specialized, balancing instead different activities and using facilities and training increasingly as forms of engagement (Figure 2). ‘Other Old’ universities do not stand out in any factor (Figure 3) and they reflect a mix of entrepreneurial activities throughout the entire period. Post-92 universities exhibit quite different behaviour: in general, they focus on all activities, but less so on the more research-oriented ones. Within this group, ‘Former Polytechnics’ have increased their efforts in consultancy since 2007/08 (Figure 4), while ‘Other New’ HEIs have accelerated the development of university spinoffs particularly in the last two years (Figure 5)⁹.

To capture the mix of actors engaged in KE activities and changes in interaction patterns we distinguish the income derived from different type of triple helix partners. Specifically we analyse differences in triple helix interactions between universities and SMEs, Non-SMEs (as a proxy of ‘industry helix’ of our theoretical model) and Non-commercial organisations -such as government bodies and third sector organisations- (as a proxy of ‘government helix’) using the information on income from specific KE activities: collaborative research, contracts, consultancy, facilities and licences (see Table 2 for more details).¹⁰ Results of income evolution are presented in Figures 6-10. We also calculate the evolution of the total income coming from the interaction with each mentioned triple helix partner as well as the annual growth rate for the full period (AGR) and for two sub-periods: 2003/04-2007/08 – the period preceding the economic crisis- (AGR1) and 2007/08-2011/12 (AGR2) (see Table 2).

⁹ Complementary to the descriptive picture presented, we applied multivariate regression techniques to check the correspondence between KE activities (factors) and types of universities (clusters). Results in this case corroborate the existence of clusters of universities selecting specific ‘mixes’ of KE activities: ‘Top 5’ and ‘the rest of Russell Group’ universities are positively and significantly associated with research-oriented activities; spin-offs with the cluster of ‘Other Old’; and consultancy and training activities are to ‘Former Polytechnics’ while ‘Other New’ HEIs do not present any positive signs for any factor.

¹⁰ Income from CPD (related to training activities) is not included in this section because HEBICI survey does not include information that corresponds to specific triple helix partners.

Figures 6-10. Evolution of KT income across multi-layered actors in triple helix interactions



—■— SME —▲— NonSMEs —×— NonCom

Table 2. Annual Growth Rates in KT income by Triple Helix partner

<i>Type of university</i>	<i>Triple Helix partner</i>	Annual Growth Rate 2003/04-2011/12 (AGR)	Annual Growth Rate 2003/04-2007/08 (AGR1)	Annual Growth Rate 2007/08-2011/12 (AGR2)
Top 5	SMEs	0.3%	-5.5%	6.3%
	Non-SMEs	5.0%	4.8%	4.1%
	Non-Commercial	16.0%	25.5%	10.0%
	Total	10.3%	12.9%	7.4%
	<i>% SMEs/Total^{a,i}</i>	-11.2%	-17.7%	-0.9%
	<i>% Regional /Total^b</i>	-5.1%	3.4%	-11.8%
The Rest of Russell Group	SMEs	2.5%	6.2%	-0.5%
	Non-SMEs	2.4%	0.5%	4.3%
	Non-Commercial	7.2%	4.9%	7.3%
	Total	5.5%	3.7%	5.9%
	<i>% SMEs/Totalⁱⁱ</i>	-2.8%	2.6%	-6.5%
	<i>% Regional /Total</i>	-0.5%	4.0%	-4.3%
Other Old	SMEs	1.6%	4.6%	-0.7%
	Non-SMEs	-0.6%	8.1%	-7.8%
	Non-Commercial	4.2%	4.6%	6.8%
	Total	1.9%	6.1%	0.1%
	<i>% SMEs/Totalⁱⁱⁱ</i>	-0.4%	-1.8%	-0.7%
	<i>% Regional /Total</i>	2.7%	7.4%	-4.0%
Former Polytechnics	SMEs	7.5%	19.5%	-5.1%
	Non-SMEs	1.9%	0.0%	3.2%
	Non-Commercial	5.0%	10.8%	-1.3%
	Total	4.8%	9.9%	-1.1%
	<i>% SMEs/Total^{iv}</i>	3.1%	8.8%	-4.0%
	<i>% Regional /Total</i>	-0.9%	2.0%	-4.8%
Other New	SMEs	0.5%	-0.5%	6.7%
	Non-SMEs	-4.2%	3.2%	-12.7%
	Non-Commercial	2.4%	11.0%	-4.0%
	Total	0.9%	7.4%	-3.4%
	<i>% SMEs/Total^v</i>	-0.5%	-7.5%	10.1%
	<i>% Regional /Total</i>	-10.4%	-7.6%	-8.8%
Total	SMEs	2.8%	6.1%	-1.2%
	Non-SMEs	2.6%	3.9%	1.4%
	Non-Commercial	8.5%	9.9%	6.6%
	Total	6.0%	7.4%	4.4%
	<i>% SMEs/Total^{vi}</i>	-3.2%	-1.2%	-4.9%
	<i>% Regional /Total</i>	-2.3%	0.7%	-5.4%

Note: ^a%SMEs/Total=proportion of SMEs income over the total income from Triple Helix partners. ^b% Regional /Total = proportion of regional income over total income from private Triple Helix partners (SMEs and non-SMEs).

Note 2: ⁱ Figures move between 7.8% in 2003-04 to 3.6% in 2011/12. ⁱⁱ Figures move between 8.0% in 2003-04 to 7.3% in 2011/12.

ⁱⁱⁱ Figures move between 14.1% in 2003-04 to 12.0% in 2011/12. ^{iv} Figures move between 13.6% in 2003-04 to 16.0% in 2011/12. ^v Figures move between 21.5% in 2003-04 to 22.0% in 2011/12. ^{vi} Figures move between 10.2% in 2003-04 to 8.0% in 2011/12.

Within this overall trend, there are clear differences in engagement with different partner types. While income with all types grew during the period (6% overall), income from KE activities with non-commercial entities grew more on average than

income with firms (8.5% and 2.5% respectively). In contrast engagement with SMEs increased before 2007/08 and declined afterwards (-1.2%).

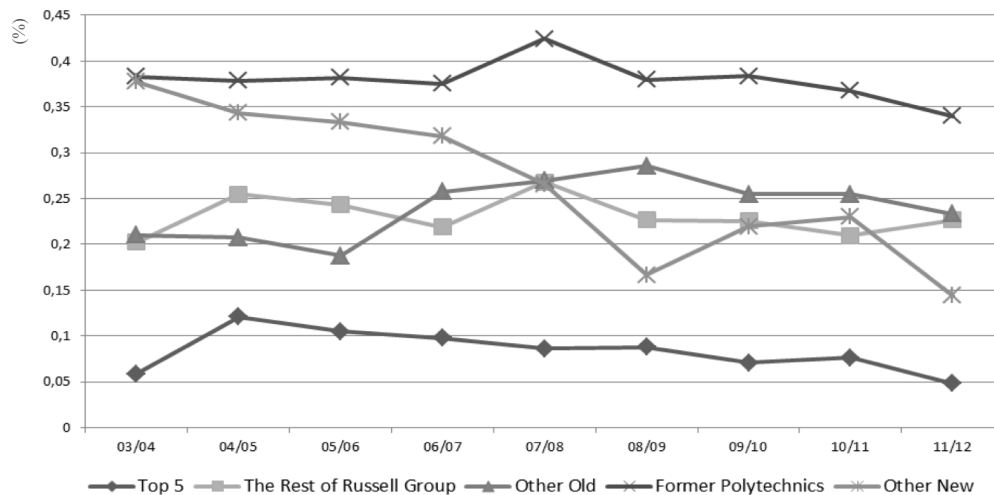
However, within this broad picture we can observe stark differences across institutional types. KE income increased in the period for all groups, particularly for 'Top 5' and 'The Rest of Russell Group' universities (on average the annual growth has been 10.3% and 5.5% respectively). Russell group universities ('Top 5' and 'The rest of Russell Group') exhibit the biggest growth in income from KE activities with non-commercial organizations (16% and 7.2% respectively) whilst 'Former Polytechnics' experienced the greatest increase in income from SMEs (7.5% compared with less than 2.5% for other universities). 'Top 5' universities benefited from the largest increase in income from large firms (5%), whilst 'Other New' universities experienced the biggest drop in KE income from large firms (-4.2%).

Whilst growth patterns in KE income remained positive for Russell group universities after 2007/08 (particularly for the group of 'Top 5'), the rest display low (for 'Other Old' universities) or even negative income growth (for post-92 universities). This slow or negative growth is explained mainly by a drop in income from large firms (particularly in the case of 'Other New' and 'Other Old' universities) and from SMEs (particularly for 'Former Polytechnics'). 'Other New' universities also experienced a significant reduction in the income they derive from non-commercial organizations (-4% compared with an 11% increase in the previous period considered).

Finally, and in order to understand the geographical dimension of triple helix interactions, the evolution of the regional share of KE income (from KE activities such as contracts, consultancy, facilities and licences) is presented in Figure 11. In addition, the AGR is estimated for the total regional funding (see also Table 2). General patterns show a clear reduction of the regional share of income for HEIs of around 2.3%, particularly in the second period (with a reduction of 5.4%). Within this broad trend, differences can be observed for the group of 'Other New' and 'Top 5' HEIs, which have decreased their income from regional KE activities by 10.4% and 5.1% respectively for the whole period. This decline has been sharper in recent years. Looking at the figures before and after the economic crisis, whilst before 2007/08 all groups of universities have positive growth (except 'Other New' that is negative),

after this year all groups reduced their interaction with regional actors, particularly ‘Top 5’ universities (-11.8%).

Figure 11. Evolution of regional Knowledge Exchange activities across HEIs



5.2 Beyond one-size-fits all: the differentiation of triple helix interactions

Our empirical results presented above highlight the variety of actors, different scopes of both geographies and types of activities that constitute triple helix interactions within the English higher education system. By analysing five distinctive clusters of HEIs we indeed observed a very diverse picture. In general all Russell Group universities are more focused on research-oriented activities such as collaborative research, contract research and generation of IPs, particularly with large firms and non-commercial organisations, which distinguishes them from the rest of HEIs. Other universities are either not specialised, or focused on activities closer to training and consultancy. Within the latter, former polytechnic HEIs have more focused on engagement with SMEs, particularly within the home region.

Over time, English HEIs seem to be intensifying this degree of selectivity and specialization through particular sets of KE activities. Research intensive universities have, in the period studied, increased their share of income from KE activities that are closely related to research activities such as collaborative and contract research, as well as ‘harder’ commercial activities such as licensing. New and generally less

research-intensive universities have increased their share of KE income from ‘softer’ activities such as consultancy and facilities.

The picture of an increasingly differentiated higher education sector is reinforced when we analyse the evolution of KE activities with different types of triple helix partners. Our analysis shows a significant drop in income growth from all actor types, namely, SMEs, large firms and non-commercial organisations, from 2007/08 onwards. The decline in income from KE interactions with firms (industry helix) and non-commercial organisations (the government helix) reflect the effects of the economic crisis and public sector funding cuts. This reduction is particularly severe for newer universities, which seem to be more reliant on KE income from SMEs and public sector organizations (e.g. CPD and consultancy), particularly at the local level. This selectivity and differentiation amongst different types of institutions has intensified particularly since 2007/08 onwards, coinciding in time with the economic slowdown as well as a series of policy changes influencing regional development and higher education in England as described in Section 3.

Older and more research-intensive universities seem to exhibit greater resilience and adaptation to these policy changes and economic conditions. They have been able to diversify their funding sources away from the public sector and towards private sector opportunities, for example, through strategic partnerships with large private firms. Newer, less research intensive universities are doubly affected by public spending cuts, which translate into diminished resources to fund KE (particularly with SMEs) and lower demand for KE by the public sector, and by changes in the governance mechanisms of local economic development in England. This has in turn affected the geographical scope of the triple helix interactions. For instance, ‘Former Polytechnics’ are more locally oriented and face greater vulnerability to the disappearance of RDAs whilst research-intensive universities may be able to rely on other sources within and beyond regional boundaries (Charles et al., 2014). A decline in public funding is indeed driving universities to reach for new partners and diversify activities, for example, explore overseas markets for research collaboration and consultancy (see Coates-Ulrichsen, 2014; Sánchez-Barrioluengo et al., 2014). On the demand side, firms and the public sector are, due to the economic crisis, arguably refocusing their knowledge sourcing strategies and being more selective in their

interactions with a fewer number of universities, even reducing their KE activities altogether, particularly SMEs (see Coates-Ulrichsen, 2014).

6 Discussion

Recent public policy pressures and macro environments seem to have pushed universities to follow the model of ‘entrepreneurial university’ including ‘triple helix’ university–industry–government interactions as ‘isomorphic institutions’ (DiMaggio and Powell, 1983). However, in response to wider policy environments, empirical evidence presented in this work confirms that each university and individual academics have recognised their own entrepreneurial opportunities and heterogeneous set of activities and pathways (see also, Hayter, 2015; Abreu et al., 2016; Kitagawa et al., 2016).

Focusing on HEIs in England and their third mission activities, this paper set off by asking: how have the dynamics of the third mission changed over time? In order to address our research question the paper articulated Leydesdorff’s (2010) conceptions of the micro foundations of the triple helix by analysing different types of knowledge exchange (first dimension in Leydesdorff’s model) across different institutional types, multiple partners and spatial dimension of triple helix interactions (second dimension) over time (third dimension). The micro-foundations of triple helix perspective developed in this paper highlights the complex (multi-activities) and multi-layered nature of universities’ third mission activities. This allows us to make two contributions to the existing literature by: a) shedding light on universities’ different positioning in their triple helix relationships in order to respond to external challenges and pressures; and b) incorporating a temporal dimension into the analysis where triple helix interactions change over time throughout different economic conditions.

The observed evolution in the triple helix interactions is arguably both the result of macro-level external pressures but also micro-level institutional practices and strategic prioritising of individual universities recognising their own entrepreneurial opportunities (Hayter, 2015). Universities have different strengths, and at the same time, different types of universities in different geographical contexts have been exposed to different degrees of ‘vulnerability’ (Goddard et al., 2014). Further

consideration therefore needs to be given to the spatial as well as institutional strategic dimensions of triple helix interactions. For example, internally, universities are nurturing their own strengths and, over time, changing their structures and incentives to improve legitimacy and better align third mission activities with research and teaching missions (Sánchez-Barrioluengo et al., 2014). This would improve access to resources and capabilities and help ease internal tensions and resistance to third mission activities within the university (O’Kane et al., 2015). Externally, HEIs are adapting their activities in order to leverage funding from several partners, both in terms of their mix of activities and changing their structures to exploit complementarities across activities and working towards long-term partnerships. There are also learning processes among actors in networks, including universities and their partners building up and capitalizing on existing relationships and capabilities (Charles et al., 2013).

From a temporal perspective, such organisational evolution can be seen as the product of universities’ cumulative experiences and conscious efforts over the years to improve capabilities and build up resources for specific KE activities, and relationships with selected partners around these activities. Each university is a ‘path dependent’ product of a distinct process of social, economic and institutional development. Universities adopt distinct configurations of activities, which can be seen as the result of changes in their internal capabilities, traditional trajectories and surrounding structural and functional changes (Wittrock, 1993). Our findings echo previous studies confirming that there is no one model of triple helix interactions (e.g. Hewitt-Dundas, 2012; Hussler et al. 2010; Philpott et al., 2011; Sánchez-Barrioluengo, 2014), but further complements them by taking a longitudinal view of third mission performance over time.

Some policy implications emerge from the empirical study for the UK and beyond. First, although the UK government stresses that universities should voluntarily choose appropriate functions (for example, Sainsbury, 2007), in reality, the third mission policy seems to leave little room for choice. This is largely due to the distribution of third mission funding based on formulae which are highly skewed in favour of a few elite research intensive universities (see Coates-Ulrichsen, 2014). Combined with other higher education policies such as increased concentration of research funding,

and recent changes in the student tuition fees, there are intended and unintended consequences for the financial sustainability of some institutions. Consequently, certain universities' third mission strategies and practices may be compromised, as they are not well positioned to diversify their income base.

Second, increased concentration of funding in particular institutions, combined with the reduction of incentives for regional and SME engagement, may constrain universities' capability and resources to address specific economic and social needs, particularly in their local areas. This could involve a risk of aggravating regional disparities in innovation and economic growth. A worrying trend can be observed in terms of engagement with SMEs and in terms of local and regional engagement, which has diminished substantially in the last period, coinciding with the economic crisis and the abolition of the RDAs.

Third, more generally, a key reflection relates to the need to balance the multiple expectations regarding universities' roles within increasingly differentiated higher education systems. The conceptualisation of third mission policy (see also Molas-Gallart et al., 2002; Molas-Gallart and Casto-Martinez, 2007) needs reconsideration from a broader perspective of HEIs' strategies, their engagement with a variety of partners, and links to both research and teaching. Current third mission policies have relied too much on the 'research- third mission nexus' with its narrow conception of triple helix interactions, with insufficient focus upon the 'teaching/education- third mission nexus' (Sigel and Wright, 2015).

7 Concluding remarks

Micro-foundations research has been concerned with how actors, their interactions, and the mechanisms and contexts that influence such interactions, produce organisational level and collective heterogeneity (Felin et al., 1995). By adopting a 'micro foundations as levels' (Felin et al., 2012; 2015) approach, and by focusing on the analysis of the university as an actor, this paper contributes to this special issue by shedding light on the heterogeneity and dynamics of the triple helix interactions between academia, industry and the government (Etzkowitz and Leydesdorff, 2000). Using this approach, we are able to contribute to the extant literature by articulating

empirically the three sub-dimensions of Leydesdorff (2010) model (types of KE activities, partners and geography) and including the temporal dimension in the classic static view of triple helix interactions.

Taking a micro-foundations lens, and using data from the Higher Education Business Community Interaction Survey (HEBCI) for the academic years 2003/4 to 2011/12, the paper analyses quantitatively the changing dynamics of the third mission in English HEIs, in relation to these sub-dimensions of third mission interactions. The paper confirms how, in the last decade, the entrepreneurial behaviour of universities in England is marked by increasingly differentiated patterns. As a result of micro-level interactions, and despite the top-down isomorphic policy and mimetic pressures acting upon them, institutional logics and learning dynamics arise that overtime diverge from the one-size-fits all model of the entrepreneurial university (see Kitagawa et al., 2016).

This study has some limitations. Firstly, from a theoretical point of view and in relation to third mission concept as discussed above, this work also suffers from a narrow conception as we only analysed a small set of KE activities constituting the triple helix model. Another limitation relates to the quality and consistency of our original data sources. Particularly issues were found regarding the quality of regional data, and lack of detail on partner types for some KE activities (such as training), which limits the extent of our comparative analysis. Furthermore, certain third mission activities such as individual consultancy income are difficult to be captured at an institutional level and the quality of data may be questionable. There is also limited understanding on the 'educational impact' (Healey et al., 2014) of university's collaborative relationships, including CPDs, placements and other training activities universities engage with. As we argued earlier, much emphasis of the existing data and literature on triple helix interactions has been placed on patent licensing and other IPR based transactions, which are considered to be 'easily measurable' forms of university-industry linkage (Gertner et al 2011; Rossi and Rosli, 2015). The nature of metrics and how to measure the impact of KE activities would require further studies (see Lockett et al., 2015). Finally, building on this study focusing specifically on English higher education, future extensions of the present study should incorporate

other regions and countries in the analysis to allow more generalizable results with a comparative perspective.

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Annex I. Universities included in each cluster

‘Top 5’	‘The Rest of Russell Group’	‘Other Old’	‘Former Polytechnics’	‘Other New HEIs’
Imperial College of Science, Technology and Medicine	King's College London	Aston University	Anglia Ruskin University	Bath Spa University
The University of Cambridge	London School of Economics and Political Science	Birkbeck College	Birmingham City University	Bishop Grosseteste University College Lincoln
The University of Manchester	Queen Mary University of London	Brunel University	Bournemouth University	Buckinghamshire New University
The University of Oxford	The University of Birmingham	Cranfield University	Coventry University	Canterbury Christ Church University
University College London	The University of Bristol	Goldsmiths College	De Montfort University	Edge Hill University
	The University of Exeter	Institute of Education	Kingston University	Harper Adams University College
	The University of Leeds	London Business School	Liverpool John Moores University	Leeds Trinity University College
	The University of Liverpool	London School of Hygiene and Tropical Medicine	London Metropolitan University	Liverpool Hope University
	The University of Newcastle-upon-Tyne	Loughborough University	London South Bank University	Newman University College
	The University of Nottingham	Royal Holloway and Bedford New College	Middlesex University	Roehampton University
	The University of Sheffield	St George's Hospital Medical School	Oxford Brookes University	Royal Agricultural College
	The University of Southampton	The City University	Sheffield Hallam University	Southampton Solent University
	The University of Warwick	The Institute of Cancer Research	Staffordshire University	St Mary's University College, Twickenham
	The University of York	The Open University	Teesside University	The University of Bolton
	University of Durham	The Royal Veterinary College	The Manchester Metropolitan University	The University of Chichester
		The School of Oriental and African Studies	The Nottingham Trent University	The University of Northampton
		The University of Bath	The University of Brighton	The University of Winchester
		The University of Bradford	The University of Central Lancashire	The University of Worcester
		The University of East Anglia	The University of East London	University College Birmingham
		The University of Essex	The University of Greenwich	University College Falmouth
		The University of Hull	The University of Huddersfield	University College Plymouth St Mark and St John
		The University of Keele	The University of Lincoln	University of Bedfordshire
		The University of Kent	The University of Northumbria at Newcastle	University of Chester
		The University of Lancaster	The University of Plymouth	University of Cumbria
		The University of Leicester	The University of Portsmouth	University of Derby
		The University of Reading	The University of Sunderland	University of Gloucestershire
		The University of Salford	The University of West London	York St John University
		The University of Surrey	The University of Westminster	
		The University of Sussex	The University of Wolverhampton	
			University of Hertfordshire	
			University of the West of England, Bristol	