

The roles of universities in knowledge-based urban development: A critical review

JOHNSTON, Andrew <<http://orcid.org/0000-0001-5352-9563>>

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The Roles of Universities in Knowledge-Based Urban Development: A Critical Review

Abstract

Universities are increasingly recognised as key actors in the knowledge-based urban development process, occupying a crucial role of knowledge creators and transmitters. This paper takes a critical view of these roles and reviews the extant literature to present a synopsis of relevant work examining universities and open innovation, the uncertainties involved in the process of knowledge transfer, and the spatial scope of university-industry links. The paper proposes a number of areas for future development: understanding the heterogeneity of universities and how this influences their potential roles in knowledge-based urban development; a better understanding of how uncertainties in the partner selection process may prevent efficient university-industry collaboration to promote knowledge based urban development; further exploration of the micro-level processes involved in knowledge transfer between universities and firms; and a broader understanding of the roles of proximities in facilitating these links.

Key words: university-industry links; knowledge-based urban development; innovation; collaboration

1: Introduction

Urban growth is increasingly conceptualised as the ability of actors in a city or region to access and utilise knowledge. Increasingly, the concepts such as ‘knowledge cities’ (Carrillo 2004; Carrillo 2006; Yigitcanlar & Velibeyoglu 2008) and ‘knowledge-based urban development’ (Knight 1995; Knight 2008; Kunzmann 2008; Yigitcanlar & Lönnqvist 2013; Yigitcanlar 2009) have emerged as key conceptualisations of how inter-organisational knowledge networks can drive development. Thus, the characterisation of urban areas as innovative milieux positions these as important territories in which knowledge-based development can abound (Vazquez-Barquero 2007). For example, the knowledge city concept places knowledge as the key to promoting urban development (Yigitcanlar 2009), explicitly focussing on highlighting and exploiting the knowledge assets of urban environments (Kunzmann 2008; Lönnqvist et al. 2013). Knowledge-based urban development extends this by providing a broader framework through which to understand how knowledge production, distribution, and use play a central role in economic development (Carrillo et al. 2014; Yigitcanlar et al. 2012).

Universities are increasingly recognised as central to knowledge-based urban development, performing the key roles of knowledge creation and transfer (Edvardsson & Durst 2017). Thus, the process reflects the prominence of the open innovation paradigm, which characterises development of urban areas as resulting from an innovation process that is increasingly systemic (Chesbrough 2017a). Consequently, knowledge-based urban development is reliant on inter-organisational networks as catalysts of innovation and conduits of knowledge, with universities portrayed as the central nodes or ‘anchors’ within these networks (Goddard et al. 2012; Goddard et al. 2014). As a result, policymakers have been increasingly focussed on formalising the role of universities in the innovation system (Wilson 2012), resulting in so called ‘third mission’ activities becoming to be regarded as important as their primary functions of teaching and research (Thursby & Thursby 2002). Consequently, in the context of knowledge-based urban development, universities are seen as forming the key pillars of the innovation landscape (Yigitcanlar 2011; Sarimin & Yigitcanlar 2012; Benneworth & Ratinho 2014; Andrew Johnston & Huggins 2016).

This paper presents a critical literature review of the role of universities in the KBUD in order to highlight the current state of the extant literature, as well as extending current debates in this area and provide an outline and overview of the contemporary focus on the role of universities. In order to accomplish this aim, the literature review was focused on three key themes: 1) the potential roles fulfilled by universities; 2) the barriers to university-industry collaboration; and 3) the spatial scope of university ties. The motivation for this approach was to synthesize the extant literature in order to produce to a timely contribution to knowledge in this field through following what Guiliana et al (2008) have termed a ‘critical perspective’ that considers the benefits of collaborating with universities while highlighting some unanswered questions.

The starting point of the paper is that while the reasoning behind the promotion of universities as pillars of the innovation system appears well-motivated, i.e. the benefits of U-I links are well documented (Perkmann et al. 2013) as is the significant contribution to both innovation and GVA made by universities (R. Huggins & Johnston 2009), three significant questions require addressing:

- 1) What are the implications for knowledge-based urban development of the fact that some universities are more prone to collaborative engagement with firms than others (Laursen & Salter 2004; Huggins et al. 2012)? As such, if the open innovation process is skewed towards particular types of university does this undermine the arguments as to the isomorphic nature of universities as anchor institutions?
- 2) What are the implications for knowledge-based urban development of the existence of uncertainties in the process of collaboration between firms and universities, typically reflecting a lack of understanding and anticipation around the intentions and actions of their partners, suggesting that the process of collaborating with a university is not costless and frictionless (Lokshin et al. 2011)?
- 3). What are the implications for knowledge-based urban development of the importance of spatial proximity in the formation of U-I links (D'Este et al. 2013; A. Johnston & Huggins 2016; Johnston & Huggins 2017), which suggests that knowledge-based development involving universities may have to rely on those located in the same city or region? (Link this to roles of universities).

The paper is structured as follows; Section Two examines the role of universities in the knowledge-based urban development as underpinning the open innovation process. Section 3 discusses the barriers to collaborating with universities; and Section four examines the spatial scope of university links and the implications for university-led knowledge-based development. The paper, therefore, contributes to the extant literature through highlighting a number of areas for future development: understanding the heterogeneity of universities and how this influences their potential roles in knowledge-based urban development; the existence of uncertainties in the partner selection process may prevent efficient university-industry collaboration to promote knowledge-based development; a further exploration of the micro-level processes involved in knowledge transfer between universities and firms; and a broader understanding of the roles of different proximities in facilitating these links.

2. Knowledge-Based Urban Development and Potential Roles of Universities

The central premise of the paper's conceptual framework is that knowledge-based urban development relies on the transformation of society through harnessing innovation in order to promote development (Carrillo 2008). Fundamentally, urban growth is increasingly determined by capabilities of organisations to appropriate and utilise stocks of knowledge through relational assets (Storper, 1997). Thus, the knowledge-based urban development

concept has emerged as a means of examining the roles of both knowledge and networking as the central drivers of economic development (Knight 1995; Knight 2008; Kunzmann 2008; Yigitcanlar & Lönnqvist 2013; Yigitcanlar 2009). Knowledge-based urban development relies on identifying the knowledge assets of urban environments (Kunzmann 2008; Lönnqvist et al. 2013), of which universities and their collaborative linkages with firms have been identified as particularly important (Perry 2008). Therefore, the dynamic interrelation of universities and firms, driven by both proximity and networks, are crucial for promoting urban development (Benneworth and Ratinho (2014).

Underpinning the knowledge-based urban development concept is the idea that the innovation process has evolved into a more open and systemic undertaking that involves a interdependent and intertwined network of actors (Chesbrough 2003; Enkel et al. 2009; Carrillo & Batra 2012; Chesbrough 2017b). Thus, these arguments suggest that as firms become ever more reliant on external knowledge for the development of new products and processes, inter-organisational networks become an increasingly important resource for firms to augment their knowledge resources (Grant 1996; R Huggins & Johnston 2009). Consequently, over half of all firms now rely on external knowledge for developing new products, processes and technology, a pattern observed in both manufacturing and service sector firms (Mina et al. 2014; Theyel 2012).

Consequently, the increased interest among academics and policymakers in open innovation has seen actors such as universities increasingly recognised as significant sources of external knowledge (Audretsch et al. 2012; Mansfield 1995; Bok 2003; D'Este & Patel 2007; Huggins et al. 2012). Thus, academic knowledge is ever more considered as an important input in the development of new ideas within firms (Rutten et al. 2003; Mueller 2006; Huggins et al. 2012; Kauffeld-Monz & Fritsch 2013). Correspondingly, academic knowledge creation activities and their outputs are recognised as significant indicators of the extent to which an economy can be considered as knowledge-based (Grant & Chuang 2012; Titze et al. 2012), placing universities, and their knowledge creation and transfer abilities, at the centre of the process of knowledge-based urban development (Casaleiro 2011).

Consequently, the central casting of universities in this process has led to increased interest are termed 'coupled-innovation' projects involving firms and universities (Enkel et al. 2009). These projects are characteristically collaborative endeavours, typically arranged through formal means as they involve an element of public funding, and are ultimately designed to leverage in particular skills, knowledge and resources into a firm in order to enhance competitiveness (Bishop et al. 2011; Huggins et al. 2014). These university-industry (U-I) linkages have been shown to have a positive impact on the firms involved; the evidence highlights a number of benefits to the firms involved through increasing sales, research productivity, and level of patenting, through facilitating access to a broader range of external resources, promoting learning within the firm, and broadening the scope of their activities (Hagerdoorn et al. 2000; Fontana et al. 2006; Lööf & Broström 2006; Abreu et al. 2008). In light of these findings, policymakers worldwide are increasingly pushing universities towards

developing industry linkages and commercialising their knowledge (Huggins et al. 2008; Goddard et al. 2012; OECD 2007; Wilson 2012; European Commission 2011).

As a result of these developments, the university as an organisation has been re-purposed as a 'transceiver' of knowledge, simultaneously creating, receiving and transmitting knowledge (Huggins et al. 2012). As such, the university cannot be viewed merely as a knowledge generator, although this may be its key function, but as a catalyst for knowledge creation. Thus, the transceiver role involves absorbing knowledge for use and creating new knowledge as well as working collaboratively with external organisations. Therefore, the contemporary view of universities sees them as focussed on both Mode 1 type knowledge creation, exploratory knowledge creation focused on new ideas, and Mode 2 knowledge creation, problem focused exploitative projects aimed at commercialising an idea, type knowledge creation (Gibbons et al. 1994).

Thus, the innovation systems that underpin knowledge-based urban development are increasingly based around a collaborative nexus of state-industry-university relationships, developments that have been formalised in the Triple Helix model, laying the foundations of economic development through the university led innovation system (Ranga & Etzkowitz 2013). Thus, while universities may be key anchors in the knowledge-based urban development process, the types of knowledge creating activity in which they engage may determine their value to the system and locale. Therefore, through encompassing Mode 2 knowledge creation alongside the more traditional mode 1 activities, i.e. their move towards what have been described as 'third mission' activities which move beyond a focus on teaching and research towards including and prioritising industry engagement, is crucial for the success of the process (Thursby & Thursby 2002).

This last point highlights one key issue; implicit in these theoretical conceptualisations of the innovation process is that all universities are treated as equal. Thus, universities are conceptualised as a generic resource within innovation systems, contrary to evidence that universities are far from homogenous (Mowery & Sampat 2004; Huggins et al. 2012). This homogeneity is manifested in various ways: firstly, some universities may be more research intensive than others, with a keener focus on the capture of grant income and the production of academic outputs, characteristics which have been found to have an influence on the formation of U-I links (Hewitt-Dundas 2012; Huggins et al. 2012; A. Johnston & Huggins 2016).

There is evidence that universities undertaking world-leading research may be members of more extensive knowledge networks (Bathelt et al. 2004), thus institutions and departments that perform well in ranking metrics typically attract more distant partners (Hewitt-Dundas 2011; Laursen et al. 2011). Other scholars have examined the influence of these rankings on technology transfer activity by focussing on so called 'mid-ranking' universities. This work suggests that these institutions typically offer a narrower scope due to their focus on a smaller number of departments with significant reputations, as well as developing links with larger

firms (Wright et al. 2008). Therefore, depending on characteristics and the ethos towards research and technology transfer, a university's behaviour can vary significantly.

The extant literature highlights the existence of many different types of university each with differing strengths and strategies and, consequently, a varied commitment to the development of collaborative links with firms and that this equates to different impacts on and benefits for firms (Perkmann and Walsh, 2008). Furthermore, others have proposed that some universities may be more entrepreneurial than others, with an ethos that is more focussed on industrial collaboration and commercialisation activities (D. Siegel et al. 2007). Some universities may focus their entrepreneurial activities on 'softer' activities such as offering lectures to the business community or engaging in consultancy work, whereas others focus on 'harder' activities such as technology licensing and the creation of spin-off firms (Philpott et al. 2011; Caldera & Debande 2010). In addition, universities may also vary according to the types of technology transfer activities in which they engage (Fuller et al. 2017; Rossi & Rosli 2015).

in terms of knowledge-based urban development, these findings suggest that development opportunities may be influenced, and bound, by the universities that are anchoring the innovation system and the activities in which they engage. For example, innovations systems which are anchored by research intensive universities that engage in 'harder' entrepreneurial activities will offer different opportunities to those that are anchored by more teaching focused institutions offering 'softer' support activities. Therefore, the profile and strategy of the university or universities within the system may be crucial to the development path taken. As such, knowledge-based urban development policies and programmes may benefit from an *a priori* understanding of the assets of their universities.

As well as the diversity of universities, we must also consider the types of linkage that exist. If the systemic nature of the contemporary innovation process is accepted, characterised by collaborative innovation projects between with universities and firms, a clear understanding of the mechanisms through which this occurs and the factors that drive it are required. The extant literature, however, is not always clear on process, with studies focussed on what has been termed the 'out the door' criterion in that successful knowledge transfer is assumed once a collaborative link between a firm and university is established (Bozeman et al. 2015). For example, while knowledge spillovers from universities have been highlighted as important sources of knowledge for innovation, they are generally characterised as unintended, with knowledge, in the words of Alfred Marshall, considered to be 'in the air' (Jaffe 1989; Marshall 1890; Glaeser et al. 1992). In this account, knowledge is considered to share the characteristics of a public good in that it is non-rival and non-excludable. Similarly, the Knowledge Spillover Theory of Entrepreneurship follows this approach, assuming that knowledge is easily accessible and absorbed in the creation of entrepreneurial opportunity (Acs et al. 2013).

Yet, the weaknesses inherent in these conceptualisations are a lack of understanding of *how* knowledge from universities is transferred to firms, or the reasons behind the collaboration of particular firms with an individual university. Academic engagement is broad in scope,

typically covering activities such as consultancy, contract research and collaboration (D'Este & Patel 2007; Huggins et al. 2012). Thus, as it has been argued that universities with higher levels of engagement will possess higher levels of commercialisation activities and have a greater effect on its local milieu (Perkmann et al. 2013; Breznitz & Feldman 2012). Thus, it follows that these activities provide a signal to outside organisations that the university is more 'engaged' and connected to industry in terms of the ability not just to create knowledge but to also exploit it (Chang et al. 2016).

Thus, as it is argued that it is not always useful to assume that the transfer of knowledge and technology from universities to other organisations is straightforward in nature, it must be understood as a process of communication *and* understanding, which also requires absorptive capacity on the part of actors in order to be successful (Rajalo & Vadi 2017). Therefore, if universities are to play a key role in the knowledge-based urban development, a clear understanding of how the knowledge transfer process works, particularly the micro level processes involving the interaction of individuals and the exchange of knowledge (Bjerregaard 2009), is required.

3. Uncertainties, University Collaboration, and KBUD?

Another theme that is relatively under-examined in the context of building collaborative links with universities is the problem of uncertainty. Thus, while universities may be regarded as significant actors in the knowledge-based urban development process, and U-I links provide substantial gains to firms, the facilitation and development of these links may not always be costless and frictionless (Thanasopon et al. 2016; Johnston & Huggins 2018).

The source of the uncertainty surrounding university engagement is that, at the point of initiation, their outcome is largely unknown due in part to the fact that U-I linkages focus on new knowledge, ensuring that the project is focussed the 'fuzzy front end' of the innovation process which is often inexact or unfocused (Alam 2006; Montoya-Weiss & O'Driscoll 2000). This may also be compounded due to uncertainties with collaborative partnerships, where actors must also tackle the problem of asymmetric information regarding the likely knowledge and capabilities possessed by their potential partner. Thus, while participation in inter-organisational knowledge networks is viewed as addressing the uncertainties faced by the firm in terms of development and, ultimately, survival (Beckman et al. 2004), the actual process network creation is itself an uncertain practice (Debackere & Veugelers 2005).

Previous research on inter-organisational collaboration highlights a high failure rate, with around half being unsuccessful; accordingly (Park & Ungson 2001). Indeed, collaborative partnerships based around technology development have been held up as exemplars of particularly unstable linkages and described as a 'bumpy road' to travel on for firms, typically reflecting their lack of an ability to predict or anticipate the intentions and actions of their partners (Lokshin et al. 2011). For these reasons, universities have been cited as 'safer' actors with which to collaborate (Powell et al. 1996), as their role is clearly defined and

understood. Furthermore, the development of collaborative links with public institutions such as universities is perceived as less risky as they focus more on 'basic' research rather than commercial application (Miotti & Sachwald 2003), seemingly validating their roles as anchors.

Despite their perception as 'safer' partners, there is evidence that collaborating with universities can increase the probability of a 'cooperation failure', i.e. the failure of the collaboration (Lhuillery & Pfister 2009). In addition the extant literature features a number of studies where collaboration with universities has not had a significant effect on the level of R&D or innovation within firms (Miotti & Sachwald 2003; Okamuro 2007). Despite the perceived benefits of collaboration with universities there is no guarantee that they will be successful. A lack of information regarding capabilities and trustworthiness of partners has been cited as a potential explanation for the lack of engagement in open innovation in general (Hewitt-Dundas & Roper 2017), and this may be true in the case of U-I links. Thus, uncertainties may act as a barrier to the formation of U-I links.

A number of reasons for the existence of these uncertainties are posited; firstly that the actors involved have different motivations, for example, firms are seeking commercial gain whereas universities are focused on novel research rather than attempting to commercialise an idea, thus responding to different incentives (Garman 2011; D'Este & Perkmann 2010; Lam 2011). Secondly, tensions between the actors have been identified, arising from differing logics and methods of working (Beech et al. 2010; Bartunek & Rynes 2014). Thirdly, it has been observed that actors within firms and universities work to differing time scales, with firms operating to a stricter timescale dictated by commercial demands (Walsh et al. 2007). Fourthly, it has been observed that each of the actors can use different communication styles (Wasserman & Kram 2009). Finally, others question the relevance of academic research to the private sector (McGahan 2007; Rasche & Behnam 2009). Thus, if universities are to play a central role in knowledge-based development, these uncertainties must be tackled.

The existence of uncertainties suggests that both costs and benefits to collaborative links with universities exist; firms then face a dilemma with respect to guaranteeing that they reap the benefits of these links while also minimising the costs. However, the issue of uncertainties, particularly technical uncertainty focused around the design and implementation of an idea plus the compatibility of partners, ensures that costs are present and there is friction in the process (Thanasopon et al. 2016).

This friction may result from the existence of asymmetric information arising from the fact that firms do not possess the means through which to either observe or understand any potential signals as to the university's suitability as a partner. Accordingly, firms require a method to circumvent these information asymmetries in order to choose an appropriate partner (Das & Teng 2001; Das 1998; Lokshin et al. 2011).

Implicit in these arguments is that it is possible for firms to observe the signals such as research intensity, commercialisation activities, and patents possessed, and interpret and act

upon them in the process of selecting a suitable partner. Yet, it is not clear how they may do this; therefore, the existence of uncertainty may mean that blindly promoting a central role for universities in the knowledge-based urban development may be unwise. It must be acknowledged that there are costs, benefits, and uncertainties in the formation of U-I links; as a result, these links do not necessarily represent a panacea for promoting innovation within firms (Giuliani & Arza 2009; A. Johnston & Huggins 2016). Instead, policy may be better directed at identifying suitable methods for circumventing uncertainties, costs, and information asymmetries in order to promote successful collaboration (Plewa, Korff, Baaken, et al. 2013; Plewa, Korff, Johnson, et al. 2013; Barbolla & Corredera 2009). Here it may be useful to highlight previous work which suggests that in the partner selection process, the credibility of academic partners, i.e. the extent to which a firm believes their university partner will deliver on the promises made, is judged at the individual rather than institutional level (Johnston & Huggins 2018). Thus, these uncertainties may be best tackled at the individual level, examining the behaviours and capabilities through focussing on the micro-level processes of the actors involved rather than the university as an organisation (Bjerregaard 2009).

The issue of uncertainty raises an important question around the roles of universities in knowledge-based urban development, namely as interaction with universities is not costless and frictionless for firms, and does not necessarily guarantee success, how does this affect potential collaboration between firms and universities? Thus, work is required to understand not only the reasons for firms' collaboration with universities, but also their motivations for not engaging in this way. In addition, it may also be of use to think of the development of university links as a series of stages; no contact, indirect contact, direct contact but no collaboration, unrealised collaboration, part-successful collaboration, successful collaboration, and unsuccessful collaboration.

4. The Spatial Scope of University-Industry Networks

The final area the paper discusses is the spatial scope of university links and the implications for knowledge-based urban development. The role of universities in this process is typically examined at the regional level (Huggins et al. 2008; Harrison & Turok 2017; Kitagawa & Robertson 2011), thus scholars typically focus on this unit of analysis. (Goddard et al. 2012; Goddard et al. 2014; Huggins et al. 2008; Goldstein & Drucker 2006; Pugh et al. 2016). While this may be motivated by the importance of spatial proximity in the formation of U-I links, i.e. the transfer of knowledge from universities observed to be more locally focussed than those from firms (Morgan 2004; Sonn & Storper 2008; Ponds et al. 2007; Muscio 2013; Adams 2002), scholars and policymakers are increasingly interested in smaller geographic units such as city-regions (Harrison 2007).

The spatial scope of university-industry links is important as the physical closeness of the actors is posited as facilitating greater levels of interaction. Firstly, spatial proximity allows the actions of partners to be observed, and an assessment to be made as to their effectiveness and probable contribution to a collaborative venture to be made (Wood & Parr 2005; Gulati

2007). secondly, spatial proximity typically promotes the development of localised linkages through social networks which encourage interaction among agents and the subsequent spillover of knowledge within a locality (Singh 2005). Finally, spatial proximity may also increase the intensity of collaborative links through enabling greater face-to-face interaction (Capello & Faggian 2005; Storper & Venables 2004) and ‘communication externalities’ (Charlot & Duranton 2004; Charlot & Duranton 2006; Gittelman 2007). Indeed, there is plentiful empirical evidence to support the importance of spatial proximity on the formation of U-I linkages (D’Este et al. 2013; A. Johnston & Huggins 2016; Crescenzi et al. 2017; Andrew Johnston & Huggins 2016).

Yet, some scholars have suggested that spatial proximity is neither a sufficient nor necessary condition for the successful formation of collaborative links between firms and universities (Torre & Rallet 2005). Indeed, the increasingly global nature of inter-organisational networks suggests that the importance of spatial proximity to collaborative relationships (Bathelt et al. 2004; Bathelt 2005; Maskell et al. 2006; Teixeira et al. 2006). In addition, the dynamics of spatial proximity are changing, with temporary proximity increasing as actors are able to travel to the same place for a short time period (Bathelt & Schuldt 2008). indeed, this ability to develop spatial proximity when necessary suggests that it has become more fluid and flexible in nature as location becomes less sticky (Markusen 1996).

The important point to note is that collaborative linkages between firms and universities do occur in the absence of geographic proximity; while a smaller distance between partners increases the likelihood of a linkage developing, its absence does not preclude its creation. Indeed, the arguments stating the importance of geographic proximity do not necessarily illustrate *why* it is important, only that it is. Indeed, the spatial reach of a university has been shown to differ according to the type of institution and its location (Huggins et al. 2012; Laursen et al. 2011). Furthermore, endowments of universities may differ by location, with urban regions typically possessing a greater endowment of institutions than their rural counterparts (Charles 2016).

Finally, the extant literature has begun to move beyond simply focussing the spatial when looking at proximity (Aguilera et al. 2012; Balland et al. 2015). Thus, non-spatial proximities have come to the fore in terms of explaining the determinants of U-I linkage formation, suggesting that the process is more nuanced than simply selecting a partner that is located close by (D’Este et al. 2013; Aguilera et al. 2012). These non-spatial proximities are typically conceptualised in terms of organisational or technological factors (Knoben & Oerlemans 2006). Organisational proximity has been conceptualised in terms of the similarities between agents based on shared knowledge, methods of working, relationships, and culture (Aguilera et al. 2012; Knoben & Oerlemans 2006).

Thus, organisational proximity typically captures the ease with which agents are able to interact due to utilising similar languages, routines, and behaviours (Torre & Rallet 2005). Technological proximity refers to the similarity of knowledge, expertise, experiences, know-how of particular processes, machinery, or tools (Knoben & Oerlemans 2006), and a sign that

other actors may possess similar absorptive capacities in that they understand the same technological field (Cohen & Levinthal 1990), while also utilising a similar knowledge base (Tether et al. 2012).

These findings raise questions for knowledge-based urban development around the extent to which urban regions may rely on the universities with which they are endowed to anchor the innovation system. Thus, to what extent do the universities located within an urban region represent the limits of the collaborative potential within the area? If spatial proximity was paramount, then urban regions would be well placed to facilitate the creation of knowledge networks between universities and firms and promote their relational assets. Alternatively, if spatial proximity is in fact more fleeting and flexible in nature, urban regions would not necessarily have to rely on their own universities to provide the anchor within the system but can effectively draw from the outside. Furthermore, the importance of non-spatial proximity to the process of U-I link formation may also mean that university links do not form merely through the interaction of the closest actors but those that make the most appropriate partners. Thus, the pertinent question is the extent to which firms pursue links with local universities as a strategy, and whether other proximities, other than spatial, are key drivers of this process?

5. Conclusions and Future Research Agenda

This paper presents a critical overview of the role of universities in knowledge-based development. In summary, the arguments presented in this paper suggest that universities are rightly positioned at the centre of the knowledge-based development process. As centres of knowledge creation, absorption, and transfer they are uniquely placed to boost innovation through engaging with organisations outside of academia (Thursby & Thursby 2004; Huggins et al. 2008; Goddard et al. 2014). As such, the broad policymaking focus on promoting the development of U-I linkages appears to be well motivated (OECD 2007; European Commission 2011; Wilson 2012).

Yet, while the policy focus on universities is well motivated, the paper highlights several factors that require further examination in order to clearly understand the roles of universities in the knowledge-based urban development process and assess the effectiveness of their knowledge transfer activities to the innovation activities of firms. Firstly, the open innovation concept, while a useful theoretical framework for understanding inter-organisational networks and knowledge transfer in the course of knowledge-based urban development tends to frame the process as frictionless and costless. Secondly, while knowledge spillover theories suggest that the knowledge is in the air (Jaffe 1989), this conceptualisation merely posits that universities are creating knowledge in order for firms to utilise. Instead, the role of universities in knowledge-based development may be better understood through a micro-level examination of the process talking to the actors involved. Thus, this would allow a further examination of both the technology *and* productivity spillovers that may occur as a result of U-I links (Hermannsson et al. 2016).

Consequently, the paper highlights several areas which require addressing: Firstly, more attention needs to be paid to the diversity of universities and, accordingly, understanding the potential roles for different types of institution in knowledge-based urban development. Secondly, the role of uncertainty in the formation of U-I links could be more fully explored in order to identify and address potential barriers to the formation of these links. Thirdly, the micro-level processes involved in knowledge transfer require greater examination in order to understand the mechanisms through which it occurs within a project team and potentially increase the efficiency of knowledge-based development. Finally, the spatial scope of linkages requires further examination in order to consider how knowledge-based development may be achieved through more global networks, the establishment of temporary proximity, and non-regional and international linkages.

The arguments presented in this paper have several policy implications. The diversity of universities and the potential for them to play differing roles in knowledge-based urban development requires further examination. Consequently, this paper echoes previous calls to take into account the fact that the Higher Education sector is more heterogeneous than isomorphic when considering the roles of universities (Martin & Turner 2010; Philpott et al. 2011). As previously noted, research intensive universities may form the bulk of university knowledge creation, but these are not the only types of institution that exist (Hewitt-Dundas 2012; Wright et al. 2008).

Indeed, pure knowledge creation does not necessarily reflect 'third stream' or technology transfer activities, prompting scholars to propose new methods through which these activities within universities can be captured and understood (Fuller et al. 2017; Rossi & Rosli 2015). Consequently, the strengths and weaknesses of each institution in terms of technology transfer activities can be understood and benchmarked. Thus, when universities are discussed as anchors, a more precise understanding of the types of activity they actually 'anchor' is required. Thus, one university may be a patenting anchor, thereby promoting the development of novel knowledge, while another may be a CPD anchor and lead the development of workforce skills. Understanding and promoting these nuances can, therefore, lead to a better set of interventions.

In addition to the varying strengths of universities, the paper has suggested that their entrepreneurial ethos may also differ, along with motivations for and propensity to engage in knowledge transfer (Chang et al. 2016; D'Este & Perkmann 2010). Thus, some may be more focused on what have been termed 'soft' entrepreneurial activities, such as lectures and consulting, whereas others focus on licensing and the creation of spinoff firms (Philpott et al. 2011; Caldera & Debande 2010). However, the key point here is that *all* these activities may, potentially, contribute to knowledge-based urban development. The key, therefore, from a policy perspective is to understand these differences and implement interventions accordingly.

As such, policymakers may be advised to first identify the strengths of all local universities in order to determine where they may be useful to support development. Consequently, as multiple roles may exist for universities in the knowledge-based urban development process based upon their characteristics, it would pay to take this into account when discussing the potential role of universities. This would avoid over-reliance on universities that simply do not have the capacity to fulfil some functions. Thus, policymakers and university technology transfer offices must heed calls to work closely together to design and enact policies that are practicable and achievable (D. S. Siegel et al. 2007).

This last point is crucial; as the development of U-I Linkages is an uncertain process and the selection of an appropriate partner is important. Therefore, there is a need to understand how such uncertainty may be overcome; knowledge-based urban development is not just about highlighting universities as a medium of knowledge creation and transfer, but also breaking down the barriers between universities and firms to embed their relationships. When formulating policy aimed at promoting these links, consideration should be given to addressing these uncertainties. Thus, promoting university links could be best directed towards finding an appropriate partner rather than a convenient partner.

Finally, the recent move within the literature to move proximities beyond simply focussing on spatial issues enables a broader range of factors to be considered when the closeness of the firm and the university are examined (Aguilera et al. 2012; Balland et al. 2015). From a theoretical point of view, this has broadened the understanding of relationships between firms and universities so that the physical and relational aspects of proximity are considered. From a practical point of view this means it is no longer simply a matter of promoting local links, but a matter of developing links that are appropriate to the needs of the business. As such, policy could be directed towards the construction of epistemic communities of practice through which the networks between universities and firms can flourish.

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