

## **The Emerging Role of University Spin-off Companies in Developing Regional Entrepreneurial University Ecosystems: The Case of Andalusia**

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### ***Abstract***

#### **Purpose**

To understand the role of University-focused Venture Capital firms (UVCs) in developing Entrepreneurial Universities.

#### **Design/methodology/approach**

We followed the approach of *regional entrepreneurial university ecosystems* and analysed interview data from twenty University Spin-Off companies (USOs) and knowledge intermediaries, including UVCs.

#### **Findings**

Based on regional, network, and knowledge spillover perspectives, our study reveals the emerging role of UVCs in sustaining dynamic relationships between universities and USOs in the ecosystem, thus developing the entrepreneurial nature.

#### **Research limitations/implications**

This is an exploratory study that investigates the different ways of approaching academic entrepreneurship promotion involving UVCs and other knowledge intermediaries. The sample can be considered small, so a larger number of observations coming from more regions and countries might improve the generalization of its results.

#### **Practical implications**

Policymakers should bear in mind that UVCs can have a proactive role at the centre of an *entrepreneurial university ecosystem*. The identification of the ongoing interactions

between USOs and UVCs have a significant role in reconnecting USOs with Universities, thus providing further opportunities for university IP commercialisation.

### **Originality/value**

We explain a long cycle or *boomerang effect*, as a metaphorical way of explaining how USOs keep their relationships with universities, by using UVCs support as strategic tool, long after they have started, which thus sustains the *entrepreneurial university ecosystem* over time.

**Keywords:** University venture capital firms, Entrepreneurial University, Knowledge Intermediaries, Regional Entrepreneurial University Ecosystems.

## **1. Introduction**

There are a number of prominent papers devoted to the study of the relationship between universities, industry, knowledge and regional development (Pugh, 2017). Different approaches are evident, such as the *Triple Helix* approach of university–government–industry relations (Etzkowitz and Leydesdorff, 2000), the *Quadruple Helix* (Carayannis and Campbell, 2009), the *national innovation system* (Freeman, 1987), the *regional innovation systems* (Benneworth *et al.*, 2017), and the *ecosystem* approach (Spigel, 2017). Among these, the *entrepreneurial ecosystem* has generated increasing interest in the literature in recent years (Autio *et al.*, 2014; Harrison and Leitch, 2010) with two major streams of research being developed (Clarysse *et al.*, 2014), *business* or *innovation ecosystems* and *knowledge* or *regional ecosystems* (Agrawal and Cockburn, 2003; Graham, 2014).

In this vein, universities have been the focus of several policies due to their ability to stimulate the production and diffusion of new knowledge and their acting as catalysts of innovations across their regions (Audretsch, 2014; Pugh, 2017). Universities have been identified as good anchor tenants in the development of *knowledge ecosystems* (Agrawal and Cockburn 2003) and the concepts of the *entrepreneurial university* (EU) (Etzkowitz, 1983, 2017; Clark, 1996) and the *entrepreneurial university ecosystem* (EUE) (Graham, 2014) have emerged.

University Spin-off companies (USOs) are a much used mechanism for universities to exploit the new knowledge generated from their research results (Grimaldi *et al.*, 2011), as an application of its third mission (Secundo *et al.*, 2017), in the formation of *regional*

EUE (Graham, 2014). Subsequently, recent research has shown that the contribution of universities to their ecosystem, in terms of USOs success, depends on the existence of interrelated and well-coordinated knowledge intermediaries guided by the strong collective ethos to encourage and support academic entrepreneurship (Hayter, 2016a, b). The intermediaries' organizational resources provide a strong foundation, however, they are not sufficient to make the network a success, and key individuals also perform vital functions (Larty *et al.*, 2017). In this vein, among the knowledge intermediaries, venture capitalists have been highlighted as important financial intermediaries (Munari and Toschi, 2010; Yusuf, 2008) for the development and success of USOs in EU (Lawton-Smith and Bagchi-Sen, 2012). In fact, Graham (2014) identified the emergence of new *venture capital teams* interested in investing in new technologies emerging from university research. Additionally, investment capital has been included as one of the social attributes of entrepreneurial ecosystems (Spigel, 2017). We refer to these financial intermediaries as *University-focused Venture Capital firms* (UVCs) which are located close to universities, have a strong focus on research exploitation and are continually looking for new potential technology in which to invest. Little is known about these new financial intermediaries as knowledge intermediaries (Hayter, 2016a) and more work is needed to understand the emerging role of UVCs (Graham, 2014) and their relationship in sharing knowledge and resources for supporting new successful ventures in the context of *regional EUEs* (Siegel and Wright, 2015). In addition, there is a call for more research related to the identification of the determinants of the overall performance of USOs in the long run, and of variations in that performance, for example, regarding their access to adequate resources in terms of finance, skilled personnel and advice and business development support, crucial to venture development (Harrison and Leitch, 2010) as crucial elements for the success of the EU.

To answer these research gaps, we need to provide insight about the network formation to better understand how actors interact (Hoang and Antoncic, 2003) and how knowledge dissemination occurs (Acs *et al.*, 2009; Hayter, 2013a). Light also needs to be shed on the dynamics of the connectivity between the participants in an EUE (Clarysse *et al.*, 2014; Hayter, 2016a) and on the interaction that creates a supportive regional environment that increases the competitiveness of new ventures (Spigel, 2017). For this, a recent review of the empirical entrepreneurship network literature suggests investigating entrepreneurship

networks employing the *Knowledge Spillover Theory of Entrepreneurship* (KSTE) (Hayter, 2013a).

Consequently, the aim of this paper is to understand the intermediary role of the UVCs in developing EUs, as determinant of the USOs success in the long run, in the context of *regional* EUEs. We seek to contribute to this afore-mentioned gap, by providing evidence on the role of UVCs in the emergent ecosystem approach. We employ a knowledge-spillover conceptual lens (Acs *et al.*, 2009; Hayter, 2013a) in combination with a social network approach (Hoang and Antoncic, 2003; Nicolaou and Birley, 2003; Kauffeld-Monz and Fritsch, 2013). In doing so, we seek to answer the Research Question (RQ): *What is the role of UVCs, as knowledge intermediaries, in developing and sustaining entrepreneurial universities in the context of regional EUEs?*

To answer with this research question, we carried out an exploratory study based on in-depth interviews of key agents of the ecosystem, a relevant population of academic entrepreneurs (AE) and key stakeholders in England. Our study make a relevant contribution, as it reveals, from a regional, network and KSTE perspective, the emerging role of UVCs in developing and sustaining EUs in the context of *regional EUEs* through maintaining dynamic relationships over time between universities and USOs.

## **2. Theoretical background**

### ***2.1. Entrepreneurial university and Entrepreneurial university ecosystems***

We define an EU (Etzkowitz, 1983, 2017; Clark, 1996) as a university which is, in addition from teaching and research, also focused on the support of entrepreneurial activities by researchers and graduates, with strong connections with R&D centres (RDC), incubators (I), firms, science and technological parks, governments, and institutions. The EU acts as a natural incubator providing a supportive *ecosystem* to the university community and its surroundings in order to produce, diffuse, absorb, and use new knowledge that can become entrepreneurial initiatives (Guerrero *et al.*, 2014). These entrepreneurial initiatives are usually developed using USOs as mechanisms (Siegel and Wright, 2015).

USOs are for-profit firms based on university research (Philpott *et al.*, 2011) and they are the mechanism most used by universities to exploit the new knowledge generated from their research (Grimaldi *et al.*, 2011). However, in order for these USOs to be successful,

the existence of an interrelated and well-coordinated network of knowledge intermediaries is needed (Hayter, 2016a), bearing in mind that universities are one of the most relevant knowledge brokers in regional innovation systems (Kauffeld-Monz and Fritsch, 2013), particularly University Technology Offices (UTTOs) (Berbegal-Mirabent *et al.*, 2012).

*Knowledge ecosystems* are defined as a network of interconnected firms located around universities, public research organizations, or large firms with an established R&D department as focal institutions that co-evolve over time to generate, diffuse, and use new knowledge (Clarysse *et al.*, 2014). A EUE is a knowledge ecosystem where the network of interconnected organizations are located around an EU as the anchor tenant (Agrawal and Cockburn, 2003; Graham, 2014).

### **2.2. Dissemination of knowledge in the context of KSTE**

In order to understand how actors interact (Hoang and Antoncic, 2003) and how knowledge dissemination occurs (Acs *et al.*, 2009), it is fundamental to know the dynamics of EUEs (Clarysse *et al.*, 2014). For this, a recent review of the empirical entrepreneurship network literature suggests investigating entrepreneurship networks employing KSTE lens (Hayter, 2013a). KSTE focuses on the individual “agent of knowledge” and their role in knowledge spillover (Acs *et al.*, 2009). It embraces the assumption that new knowledge is the source of innovation, productivity and economic growth. However, it takes issue with traditional theoretical assumptions that all knowledge is economically useful or spills over “automatically” to other organizations. Knowledge is instead subject to institutional, geographic, and cost constraints known as the *knowledge filter*, defined as *the gap between the investment in new knowledge and its commercialization* (Audretsch *et al.*, 2014: 316), which leads to innovative activity and growth of the economy. Knowledge is generated usually by research organizations, such as universities or RDCs - however it often goes unexploited.

KSTE suggests filling this gap through the process of starting a new firm, which commercializes knowledge as a conduit for the spillover of new knowledge, suggesting entrepreneurship as an important vehicle for the spillover of new knowledge and therefore critical for economic growth (Acs *et al.*, 2009; Hayter, 2013a). Consequently, investment alone in research universities is not sufficient to generate innovative activity and economic growth due to this *knowledge filter*. Universities need to become more

entrepreneurial to facilitate knowledge spillovers for commercialization out of the universities (Audretsch *et al.*, 2014), as the interactive flow of knowledge between the different stakeholders in the regional knowledge ecosystem is not guaranteed. We apply this theory to link the micro-level (the entrepreneurial behaviour of the ecosystem participants), with the macro-level (the dynamics of the connectivity between the participants in a EUE) (Hayter, 2013a).

### **2.3. UVCs as *Knowledge intermediaries***

*Knowledge intermediaries* are defined as *organizations that facilitate knowledge exchange between universities and external stakeholders through the creation of bidirectional, value-added network relationships* (Hayter, 2016a:636). Four categories of knowledge intermediaries can be differentiated (Hayter, 2016a; Yusuf, 2008): *general purpose, specialized, financial, and institutional*. *Financial* intermediaries have been highlighted as key elements in the EU structure for the USOs success (Lawton-Smith and Bagchi-Sen, 2012). Examples of financial intermediaries are venture capitalists, angel investors, or governments.

The link to venture capital companies has been found as one significant predictor of the performance of academic spin-offs (Lee *et al.*, 2001) and, given the success of this new agent as USOs developer in the USA, this model was rapidly replicated in many other countries in Europe, such as the UK (Wright *et al.*, 2006) and Spain (Ortín-Ángel and Vendrell-Herrero 2010). Since then, the role of Venture Capitalists (VCs) has been increasingly shown in the literature to be an important element of the infrastructure required for entrepreneurial universities (Lawton-Smith and Bagchi-Sen 2012). The VC investors not only provide financing, but also mentoring, expertise, and industry contacts improving the chances of the firm to succeed, and are also seen as catalysts for commercialisation because they help to develop the pool of entrepreneurial talent in an area (Samila and Sorenson, 2010). They attest how investing firms go from basic existing research to commercial products with increased R&D expenditures, ensuring a path of continuous innovation.

In addition, recent literature identified the emergence of a new type of venture team, which was created to invest in technology developed by universities (Graham, 2014), termed as UVCs, located close to universities and actively seeking new technologies in which to invest, working as both investors and surrogate entrepreneurs for the

development of new USOs. However, little is known in the literature about these new agents and more research is needed to clarify their role in developing EUs in the dynamics of EUEs (Graham 2014). In fact, in spite of the existence of VCs involved in *regional* EUEs, many USOs still lack the financial means to acquire the resources and develop the capabilities they need in order to fully exploit the commercial potential of their technologies (Harrison and Leitch, 2010). One of the reasons for this is that the nascent technology of USOs is characterized by uncertainty and information asymmetry (Widding *et al.*, 2009), which makes it difficult for investors to evaluate the profitability of that technology. Additionally, previous research has shown that early-stage VC funds use also the business experience and the commitment of the entrepreneurial team as the main criterion when considering investment (Mueller *et al.*, 2012). However, AEs frequently lack business knowledge and experience (Franklin *et al.*, 2001). Regarding the commitment, once an AE decides to run a USO, they have two options: first, leave the university to run the company or, alternatively, run the company in parallel with their academic responsibilities. In this second option, they have to share their time with their core functions of researching, teaching, and administration; so, they are not full-time entrepreneurs (Franklin *et al.*, 2001). Consequently, many USOs have attracted a *surrogate entrepreneur* (Lundqvist, 2013) into the new venture to fill these gaps (Mosey and Wright, 2007), acting as an individual (or organization) from outside the university who assumes the role of entrepreneur while the technology originator, the academic, maintains their position at the university.

According to this review, this RQ is proposed: *What is the role of UVCs, as knowledge intermediaries, in developing and sustaining entrepreneurial universities in the context of regional EUEs?*

## **2. Data collection and research methods**

### ***2.1. Research approach***

To address the proposed RQ, this study investigates social networks and the knowledge spillover process of entrepreneurship in one context of critical economic and scientific importance, England (UK). The reasons for selecting it were twofold. Firstly, because it was in UK where these intermediaries were first identified in the context of EUE (Graham, 2014). And secondly, because the researchers had access to different agents of

the ecosystems, which were different contexts that would provide enough rich data to analyse the phenomenon. This selection of the context could be considered a limitation of this study. However, it was intentionally decided to use this context as a way of better answering the aim of the research and thereby exploring the emerging role of UVCs in relation to different *entrepreneurial universities*.

A mixed-method approach was used (Creswell, 2013) based on a quantitative exploratory Social Network Analysis (SNA) (Borgatti *et al.*, 2002; Borgatti and Foster, 2003), to show the general structure of the network and the relationships among the agents, and a deeper and relevant qualitative analysis of in-depth interviews with key participants (Eisenhardt and Graebner, 2007; Yin, 2011). Then, we used the concurrent triangulation strategy to cross-validate the two databases (Creswell, 2013; Jick, 1979).

## **2.2. Instrument design**

Two different tools were used to interview the same participants: a SNA survey and an interview protocol. The initial theoretical framework informed the questions proposed in the survey (Eisenhardt and Graebner, 2007), investigating the starting year of the company, the activity sector, and a brief description of their job and main responsibilities. Subsequently, additional open questions were used to encourage respondents to talk about their relationships with other agents in the knowledge sharing process and about the frequency of these contacts. A list of the main intermediaries and agents involved in the *EUE* previously identified in the literature was included in the survey (UTTO, R&D Centre, USOs, I, UVCs). In doing so, we looked to ensure the interviewee did not forget about any contact of their network (Yin, 2011).

## **2.3. Research setting**

According to Universities UK (2018), in 2016–17, there were 162 higher education institutions in the UK and 2.32 million students studying at UK higher education institutions. Moreover, in 2014–15, the UK university sector contributed £21.5 billion to GDP, representing 1.2% of the UK's GDP. Regarding working with business and industry, in 2015–16 new university-owned or part-owned spin-off companies were 150, up from 133 in 2014–15 (Universities UK, 2018).

Higher education (HE) in England shares a number of characteristics and structural features with HE in Wales, Northern Ireland and Scotland. In all four parts of the United



Kingdom, Higher Education Institutions (HEIs) are autonomous self-governing bodies that offer degrees by virtue of their own degree awarding powers or the degree awarding powers of another institution, recognised by the UK authorities (Eurydice, 2018). Grants for specific research projects and programmes are administered on a UK-wide basis; until March 2018 through the seven UK research councils and, from April 2018, by a new body, UK Research and Innovation (UKRI). Operating across the whole of the UK with a combined budget of more than £6 billion, UK Research and Innovation brings together the seven Research Councils, Innovate UK and a new organisation, Research England (UKRI, 2018).

As will be detailed later, the interviewees were located in Leeds, London, Sheffield, Southampton and Oxford, with universities members of the Russel group (Russel Group, 2018), a group of 24 research-intensive, world-class universities, committed to maintaining the very best research, an outstanding teaching and learning experience and unrivalled links with business and the public sector.

The interviewees from the UK were mainly from the regions of Yorkshire and Oxford. The Leeds City Region is a functional economic area, it is the largest city region in the UK, home to 3 million people and 100,000 businesses, and generating 4% of the UK's economic output. The White Rose University Consortium is a strategic partnership between three of the UK's leading research universities located in Leeds, Sheffield and York.

Regarding Oxfordshire, it is one of Europe's leading centres of enterprise, innovation and knowledge. The county's growth rate in high-tech employment remains one of the highest in the UK and many of its 1,500 high-tech companies have links to Oxford University. Oxford University external research grants and contracts continue to be the University's largest source of income. In 2011-12, 40% (£409 million) of income came from external research sponsors.

#### **2.4. Data selection**

All the participants interviewed were selected using pre-determined criteria. There is no official database of the agents (however, there are some private ones of USOs, e.g., Spin Outs, 2018), and the exact number of existing USOs is unknown. Consequently, a database of companies, including USOs, was developed in consultation with regulatory bodies from the public sector (UTTOS), as well as with owners and managers from USOs.

We contacted the UTTOs of all English Universities. Consequently, a snowball convenient sample of USOs was developed. 30 agents were identified and contacted in England (20 were finally interviewed, response rate 66.6%). The selection criteria were based on these USO characteristics (see Table 1): (i) USO creation as a formal mechanism (this means having signed a contract with the university); (ii) coming from a variety of technological fields; (iii) having different funding sources; and (iv) have existed for at least one year at the time of the interview. Regarding the last criterion, we collected data from USOs in different stages of development. This way, we represented the dynamics of a EUE, and enriched the study taking consideration of the role of knowledge intermediaries at different stages in the USOs development, which is key for their success. In addition, key knowledge intermediaries involved in the EUE were also identified and interviewed. In doing so, we compared and completed the data collected from the USOs ensuring the correct interpretation was used for data analysis (Yin, 2011). In addition to interviews, archival data (web pages, *LinkedIn*, etc.) was searched until a point of saturation was reached (Yin, 2011), guaranteeing the depth and relevance of the data required (Jick, 1979; Stake, 2010; Yin, 2011).

**2.5. Data collection**

All interviews were recorded and each one lasted between 45-90 minutes, which gave us a total of 85 hours interviewed. Data were collected in person or over the phone. For the phone interviews, we ensured that the participants met the environmental conditions so the dynamics of the interview were not affected. The transcriptions of the interviews resulted in 415 simple line spaced pages. Table 1 provides information about the 20 interviews in England (the UK, located in five different cities, Leeds, London, Sheffield, Southampton and Oxford).

**Table 1. Summary**

| City         | Type of participant |           | Year of USOs start up | USOs mentioning the funding source<br><i>(multiple answer allowed)</i> |                    |          |
|--------------|---------------------|-----------|-----------------------|--|--------------------|----------|
|              | Intermediaries      | USOs      |                       | Own resource   | University founded | UVC      |
| England      |                     |           | Range                 |  |                    |          |
| Cardiff      | 0                   | 1         | 2004                  | 1  | 1                  | 0        |
| Leeds        | 5                   | 2         | 2000-2010             | 2  | 2                  | 1        |
| London       | 1                   | 1         | 2004                  | 1  | 0                  | 1        |
| Oxford       | 2                   | 2         | 2000-2009             | 2  | 2                  | 2        |
| Sheffield    | 2                   | 3         | 2001-2012             | 3  | 2                  | 3        |
| Southampton  | 0                   | 1         | 2003                  | 1  | 1                  | 0        |
| <b>TOTAL</b> | <b>10</b>           | <b>10</b> |                       | <b>12</b>  | <b>9</b>           | <b>8</b> |

| Type of participant | N         | Sector of the USOs     | N         |
|---------------------|-----------|------------------------|-----------|
| USOs                | 10        | IT                     | 1         |
| RDC                 | 1         | Health and Biomedicine | 6         |
| Incubators          | 3         | Services               | 0         |
| UTTOs               | 2         | Engineering            | 2         |
| UVCs                | 4         | Defence                | 1         |
| <b>TOTAL</b>        | <b>20</b> | <b>TOTAL</b>           | <b>10</b> |
| Gender              |           | Method of interview    |           |
| Female              | 3         | Face to face           | 18        |
| Male                | 17        | Phone                  | 2         |
| <b>TOTAL</b>        | <b>20</b> | <b>TOTAL</b>           | <b>20</b> |

### 2.6. Data analysis

According to Wolcott (1990), the key to good qualitative work is to identify and reveal the essences that contain enough contextual information to allow the reader to understand the situations in which the individuals are immersed. Following this principle, we used the five-phase cycle proposed by Yin (2011) for the analysis of the qualitative interviews: compiling, disassembling, reassembling, interpreting and concluding.

Firstly, all responses were recorded and transcribed, compiling them into a formal database, together with the archival data. In doing this, we ensured the triangulation of the different data sources used (Jick, 1979; Yin, 2011). Secondly, all responses were coded inductively. For each participant, we composed a list of the benefits and challenges related to the relationships mentioned in the SNA survey. Then, all of them were compared yielding multiple emergent themes and different perspectives were discovered regarding the contribution of the network contacts and the context in which the ecosystem was embedded (Miles and Huberman, 1994). In addition, four researchers discussed the interpretation of the reassembled data. The different researchers' backgrounds and countries of origin enriched the data analysis. Finally, we carefully agreed upon selected quotations that supported each finding. A narrative approach was chosen for presenting the results of the qualitative data (Wolcott, 1990).

### 2.7. Data coding

We used SNA (Borgatti and Foster 2003) to explore the complex network structures and the cross-network alignment of their participants in both *regional* EUEs. Akin to previous studies (Clarysse *et al.* 2014), UCINET (version 6) bundled with NetDraw was used;

firstly, to visualise the network structure, and then, to calculate some relationship indexes (Borgatti *et al.*, 2002).

### 3. Findings

The empirical section is divided into two parts, social network analysis and interviews analysis.

#### 3.1. Social network analysis: Connectivity between participants and role of UVCs

As previously mentioned, the UCINET software (version 6) bundled with NetDraw (Borgatti *et al.*, 2002) was used, first, to visualise the network structure (see Figure 1), and then, to calculate the relationship indexes.

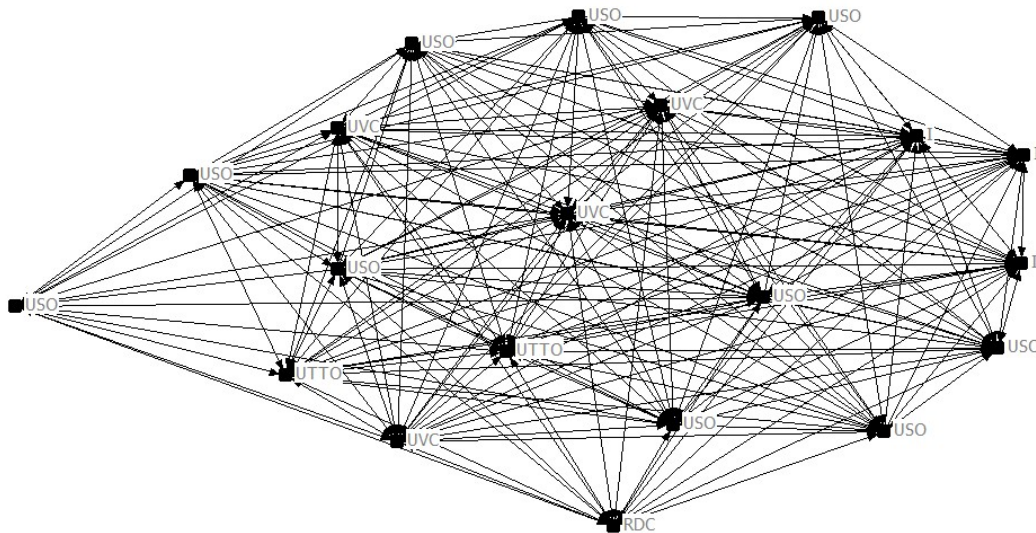
The indexes calculated were: *centrality degree* and *betweenness degree* (Borgatti *et al.*, 2002; Kauffeld-Monz and Fritsch, 2013), both are commented on next. The *centrality degree* indicates the number of individuals to whom an actor is directly attached. If the agents of the network are ranked from the greatest to the lowest centrality, an order of the best-connected individuals in the network is obtained. In the network, the first positions are occupied, regarding the Indeg, by the four UVCs (Indeg 50.0 and 48.0) and I analysed, followed by UTTOs (Indeg 47.0, 44.0). And concerning the Outdeg, by one USO (Outdeg 54.0), I (48.0), and UVCs (48.0).

The *centrality index* of a network shows how close a network is to being a ‘*star*’ (centralization index as proportion closes to 1). Consequently, it shows the existence of an intermediate agent that connects the other agents in the network. In this case, the centralization index is 0.0760 (out) and 0.0514 (in), both closed to 0, which means that in such networks the agents are well connected between them and there is not a *star*.

The *betweenness degree* shows the ability of an actor to mediate communications between pairs of other agents, which is known as *agent communication control*. In the network the agent communication control were the UTTOs (4.243; 3.940), one USO (3.533) and UVCs (the four with 3.372). This means that, the UTTOs could be an excellent intermediary to connect agents of the network in terms of knowledge sharing activities. However, as shown in the *centrality degree* calculated above, it occupies a more passive position with respect to connectivity.

To conclude, in the network, the UVCs occupy a central location in the social network and, as the index shows, they are key participants in connecting agents of the network in terms of entrepreneurship activities.

**Figure 1. Social network**



### **3.2. Interviews analysis**

#### **3.2.1. The role of UVCs**

Regarding the UVCs, we summarise the most relevant information from the interviews analysis into two main categories: concept of UVC and functions (knowledge transfer, EU support, opportunity recognition, university-market gap, surrogate entrepreneurs, incubation, and financial support).

#### ***Concept***

As *concept*, as one UVC expressed, ‘*We, as a company, are a way to exploit and develop university knowledge*’. According to the interviews, the main role of UVC is to provide external support to universities looking for entrepreneurial opportunities. UVCs were set-up by people with experience in technology and business development. Once they identified a good opportunity, they helped academics to develop it as a USO, providing them business support as well as investment for the first stages of development. They are considered strategic partners in developing *entrepreneurial universities*.

#### ***Knowledge transfer***

Concerning the functions, the first one is related to the main idea of academic entrepreneurship: contributing to *knowledge transfer* from Universities. UTTOs were found to be very efficient in the knowledge sharing process for developing USOs, '*many universities have a commercialisation business function - maybe a department of the university or a separate company which works in the market*' (USO). Regarding the external companies, we identified the role of UVCs who were interested in investing in potential technologies developed in universities (Graham, 2014). They worked closely with UTTOs continually looking for new emerging technologies in which to invest, creating new USOs. One of the UVCs said, '*we invest in early stage technologies, particularly technologies that come out from the universities*' (UVC).

### ***Entrepreneurial university support***

UVCs work together with universities in order to promote an entrepreneurial culture and create an environment where university research can be developed through USOs. It was stated that, '*When you think that the brightest ideas are inevitably often in universities, the challenge is to pull it out the universities and creating spin-offs that can actually take form into the economy to have an impact*'. (UVC)

### ***Opportunity recognition***

Once the opportunity is identified, the UVC invests in this early stage of technology, for example, a UVC manager stated, '*my main responsibility is working within the universities, to identify IP that we feel has the potential to become a USO and really incubating and developing that IP to build the business case*' (UVC). '*I think UK is very rich in ideas, but there is a gap in terms of translating these ideas into the real solution for the industry... So, for our point of view that is a good opportunity*' (UVC).

Once the new company is formed, the UVC carries out all the management activities involved in developing the research opportunities. That includes incubation and directing the research, bringing the commercial people to validate the technology, bringing in management teams, getting the technology out of the university, making the agreement with universities and employing people in the USO. Thus, they bring to the USO all the skills that academics may not have but need for running the company.

### ***University-market gap***

UVCs recognise the difficulties of taking this research into the real market, *'there is a gap in terms of translating these ideas into real solutions in the market'* (UVC). UVCs work within the universities identifying IP that have the potential for exploitation in a new company. *'[In England] I think we should be a lot better because if you look at the science base, it's probably one of the best in the world and surely we are doing less perfect in terms of commercial success turning in the entrepreneurial success'*. (UVC)

### ***Surrogate entrepreneur***

It was mentioned that *'Universities and academics don't have the experience and the skills for running companies... We are within the university trying to provide that help. That is the way in which we go'* (UVC). Regarding hiring an experienced CEO, also known in literature as a surrogate entrepreneur (Mosey and Wright 2007). However, not all the USOs had access to this choice, *'because of the maturity of the company did not have the resources to hire managers'* (USO). The other one was to connect with UVCs. These UVCs brought to the USO all the skills that academics did not have but were badly needed for running the company, *'my main responsibility is working within the universities to identify IP that we feel has the potential to become a spin-off and really incubating and developing that IP to build the business case'* (UVC). Once the investment was made and the company was established in the market, they still sat on the board of the company to ensure that it was developed. Therefore, in this way, the USO keeps the contact with UVCs and UTTOs over time. By doing so, they ensure they are linked to the revenues of the company established, which will be invested back again in new emerging technologies at universities. Therefore, UVCs in England are key in sustaining university IP commercialisation.

### ***Incubation***

As one UVC interviewee stated, *'Our activities regarding incubation are: bringing commercial people to validate the technology, bringing management teams, getting the technology out to the university, making the agreement with universities, and employ people into the spin-off company'*. (UVC)

### ***Financial support***

This was also mentioned: '*Our UVC has a number of venture capital investment try to get funds that come out of some government initiatives to create enterprise within the university sector*' (UVC).

#### 4. Discussion

This paper has addressed the RQ: *What is the role of UVCs, as knowledge intermediaries, in developing and sustaining entrepreneurial universities in the context of regional EUEs?* Our research shows distinct contributions, regarding the role of UVCs in the emergent ecosystem approach.

Firstly, this paper provides evidence of the role of UVCs in developing *entrepreneurial universities*, in the emergent ecosystem approach and expands it within the existing literature. It shows what is their role in regional development (Larty *et al.*, 2017), and how USOs access to adequate resources in terms of finance, skilled personnel, advice, and business development support (Harrison and Leitch, 2010). We also contribute to the entrepreneurship literature in the area of social networks and knowledge spill-over approaches. This study empirically analyses the social network interactions among participants in *EUEs* and shows how actors interact (Hayter, 2013b) and how the knowledge dissemination occurs for USO success (Acs *et al.*, 2009; Hayter, 2013a), shedding light on the dynamics of both *regional EUEs* and the role of UVCs. The results highlight the importance of building a connected ecosystem with a variety of participants for new venture success (Hayter, 2013b). In this sense, the agents mentioned in the academic entrepreneurship literature, such as UTTOs, R&D Centre, advisers, incubators, and financial intermediaries, such VC or business angels (Audretsch *et al.*, 2014; Hayter, 2016a) were identified, as well as their role in sharing knowledge process.

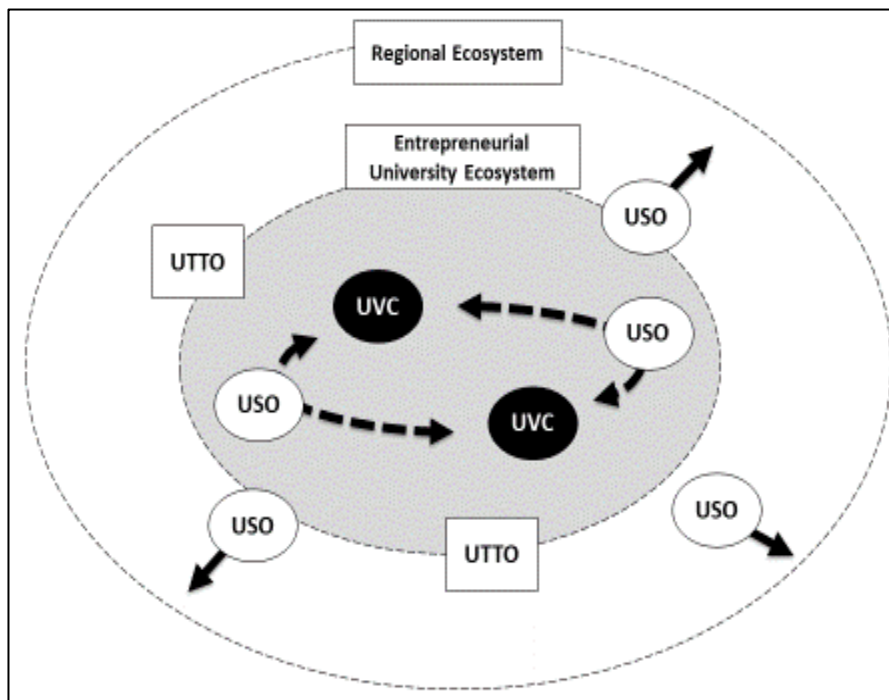
In addition, regarding the processes of USOs creation, universities act as facilitators, providing a supportive ecosystem in which the members of its community are able to start and develop entrepreneurial initiatives (Guerrero *et al.*, 2014, 2016). However, to fulfil their economic and social impact, they need the help of knowledge intermediaries (Guerrero *et al.* 2016; Siegel and Wright 2015). This study highlights the role of these knowledge intermediaries (Audretsch *et al.*, 2014) as promoting the development of *entrepreneurial universities* and as a relevant participant in *regional EUEs* for USOs success (Hayter, 2016a).



According to the conducted network analysis, our research shows the UVCs as central agents of the ecosystem. From the perspective of the KSTE, this research also shows the role played by UVCs, participating in the process of knowledge transfer, as support to the EU. They contribute to reduce the gap between the university and the market, with the recognition of opportunities, providing support for the creation of USOs, incubation, and financial funding.

In this vein, the major contribution of this study is the identification of the importance of UVCs (Graham, 2014) in developing and maintaining dynamic relationships between UTTOs (EUs) and USOs, providing support to the USOs as well as knowledge and resources during a long cycle that we call the *boomerang effect*, rather than a one-off event in *regional* EUEs. UVCs favour USOs relationships with UTTOs (EUs) and enable repeated access to emerging technologies within universities, thus acting as key participants for the ecosystem. There is a tendency for USOs to reduce their contact with UTTOs (EUs) over time. UVCs play a critical role beyond simply company formation. They maintain dynamic relationships between UTTOs (EUs) and entrepreneurs in USOs, giving rise to this *boomerang effect* that sustains university IP commercialisation in *regional* EUEs (see Figure 2). This effect means that the general investment made in research at universities returns to these institutions when the USOs commercialise the university IP, promoting the EUE. The generated revenues are reinvested in new technology in the university - metaphorically, as a *boomerang* that comes back.

**Figure 2. Boomerang effect**



## 5. Conclusion

This study highlights the role of venture capitalists and reveals the particular relevance of UVCs in developing and sustaining dynamic relationships between Universities and USOs, in *regional* EUEs, providing support, knowledge and resources to the USOs, during a long cycle (*boomerang effect*) rather than based on a one-off event. By doing this, UVCs contribute to the development of EUs. Our study make a relevant contribution, as it reveals, from a regional, network, and KSTE perspective, the emerging role of UVCs in developing and sustaining EUs. We provide evidence on the role of UVCs in the emergent ecosystem approach and expanding it within the existing literature (Pugh, 2017). In particular, we offer insight about understanding the role of these intermediaries in regional development (Larty *et al.*, 2017) and how USOs access to adequate resources in terms of finance, skilled personnel, advice and business development support (Harrison and Leitch, 2010).

As implications, policymakers in developed economies should bear in mind that UVCs have a proactive character and are at the centre of the *entrepreneurial university ecosystem*. The identification of the ongoing interactions between USOs and UVCs have

a significant role in reconnecting USOs with Universities, thus providing further opportunities for university IP commercialisation.

As limitations, this is an exploratory study that investigates the different ways of approaching academic entrepreneurship promotion involving UVCs and other knowledge intermediaries could be explored in a similar way. The sample can be considered small, so a larger number of observations coming from more regions and countries beyond Anglo-Saxon contexts might improve the generalization of the results.

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