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**Developing University Innovation Capacity: How can innovation policy
effectively harness universities? capability to promote high-growth
technology businesses?**

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Abstract

Some universities and departments have been very successful in stimulating university spin-off firms (USOs). This has persuaded policy makers and university administrators to devote considerable resources to improve universities' capabilities to promote USOs, but with little tangible results. Related research has considered why some universities contribute more to business innovation than others, but whether the majority of universities can become innovation hotbeds remains an open question. This paper takes a novel interdisciplinary approach integrating insights from two separate literatures, academic entrepreneurship and university management. We start by taking the firm's perspective and seek to understand the challenges faced by USOs and how universities can assist these firms in developing their entrepreneurial competencies. The structure and main purpose of universities are very different from that of new technology businesses and the transition from being an academic research activity to become a commercial business activity poses challenges both for the university and the USO. Much research on universities' entrepreneurial capability focuses on 'what' universities can do to support USOs at the expense of 'why' universities might choose to promote

USOs when they are under many intense competing demands from outside. We explore not only what universities can do to support USOs, but also how universities experience USOs? support demands, and the circumstances under which universities can develop capability to promote USOs. We address the barriers that arise between universities and USOs and discuss mitigating factors which support the competencies of USOs whilst at the same time meet the different university stakeholders? needs.

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Abstract

Some universities and departments have been very successful in stimulating university spin-off firms (USOs). This has persuaded policy makers and university administrators to devote considerable resources to improve universities' capabilities to promote USOs, but with little tangible results. Related research has considered why some universities contribute more to business innovation than others, but whether the majority of universities can become innovation hotbeds remains an open question. This paper takes a novel interdisciplinary approach integrating insights from two separate literatures, academic entrepreneurship and university management. We start by taking the firm's perspective and seek to understand the challenges faced by USOs and how universities can assist these firms in developing their entrepreneurial competencies. The structure and main purpose of universities are very different from that of new technology businesses and the transition from being an academic research activity to become a commercial business activity poses challenges both for the university and the USO. Much research on universities' entrepreneurial capability focuses on 'what' universities can do to support USOs at the expense of 'why' universities might choose to promote USOs when they are under many intense competing demands from outside. We explore not only what universities can do to support USOs, but also how universities experience USOs' support demands, and the circumstances under which universities can develop capability to promote USOs. We address the barriers that arise between universities and USOs and discuss mitigating factors which support the competencies of USOs whilst at the same time meet the different university stakeholders' needs.

1 Introduction

Universities are important producers of new knowledge, with many examples of universities contributing strongly to the creation, development, and growth of technology businesses (Shane 2004). Strengthening universities' innovation capacity has been a key area of most countries' innovation policy via a diverse set of initiatives ranging from legislative changes, altered university funding and incentives, and different funding and support arrangements for research commercialization (Slaughter and Leslie 1997). These initiatives have had mixed effects: the degree to which universities and departments create and develop high-growth businesses remains extremely uneven beyond a handful of exemplars (Bercovitz and Feldman 2008; O'shea et al. 2005).

Historical policy efforts to make universities more entrepreneurial developed through establishing science parks adjacent to universities. Although this had some effect on universities (Link and Scott 2003), this approach's major shortcoming was in failing to incentivise universities and academics to increase commercialization activities (Henrekson and Rosenberg 2001). A second policy aimed to facilitate university engagement through legislative changes and funding universities' internal innovation activities. Creating successful policies on the basis of good practices requires understanding their underlying mechanisms, and a re-examination of universities' organizational structures and practices is urgently required (Siegel et al. 2007).

One often-cited example is the US Bayh-Dole Act, which gave the intellectual property rights to universities, and spurred similar legislative changes in most European countries, including Norway (Mowery and Sampat 2005). The rapid diffusion of infrastructure initiatives, such as technology transfer offices (TTOs), proof of concept programmes, and incubators, now can be found in most universities, represent largely unsuccessful 'policy borrowing' (Rasmussen et al. 2006; Siegel et al. 2007). Mowery and Sampat (2005) assert that "Efforts at "emulation" of the Bayh-Dole policy elsewhere in the OECD are likely to have modest success at best without greater attention to the underlying structural differences among the higher education systems of these nations."

Some observers noted difficulties in introducing top-down policies and initiatives (Goldfarb and Henrekson 2002; Rasmussen 2008). Policies may fail because they assume that the purpose of universities is exclusively to work with innovative business, or assume that firms working with universities are sophisticated, well-resourced large firms. Policy borrowing is symptomatic of a deeper problem, the simplifications necessary to deal with the fact that relationships between universities and firms are highly complex. One clear simplification visible in both policy and academic research has been 'siloesation' of policy-making responsibility between different Ministries responsible for their own innovation policy-making areas (OECD 2007; OECD 2011). The net effect has been to completely ignore the tensions and problems that emerge when institutions as complex as universities interact with partners as diverse and heterogeneous as 'businesses' (Harrison and Leitch 2010).

Understanding how universities can promote the establishment and growth of spin-offs requires detailed knowledge about how these firms develop and the type of conditions and support that facilitate their success. At the same time it requires equally detailed understanding of how universities are managed and can develop relevant capabilities for supporting new ventures. This paper addresses this complexity by synthesising two important, yet to date largely separate, literature fields, organisational sociology and academic entrepreneurship. Both literatures have dealt extensively with the challenges of entrepreneurship, but although occupied with the same issue of how academic research can be

commercialized through new firm creation in academic institutions, these literatures have effectively ignored one another or cherry-picked supportive arguments.

This paper seeks a more systematic integration of key insights from these literatures to map the current state-of-the-art regarding how policy can transform universities to become better in promoting high-growth technology firms. The next section takes the spin-off venture's perspective, using an entrepreneurial competency framework highlighting the specific types of contributions a university can offer at firm level. Section 3 takes a university capability perspective, using a stakeholder approach to outline the capabilities that universities require in order to mobilise activities which augment USOs' entrepreneurial capabilities. Section 4 presents a conceptual framework linking the competency needs at the firm level with the capabilities at the university level via the idea of entrepreneurial stakeholder network capabilities, concluding with policy implications and suggestions for further research.

2 Entrepreneurial competencies for the development of university spin-off ventures (USOs)

University spin-off ventures (USOs) are sometimes narrowly defined as firms exploiting university-generated intellectual property (Di Gregorio and Shane 2003), or more broadly as firms taking advantage of all types of university generated knowledge. In this paper we define USOs as new ventures initiated within a university setting, based on technology derived from university research (Rasmussen and Borch 2010). The relationship to university context is very important for this type of new ventures and it is clear that the extent of venture creation and the type of ventures created is influenced by university-level factors.

Some university characteristics associated with USO formation are well established in the literature: spin-off activity relates to universities intellectual eminence (Di Gregorio and Shane 2003), faculty quality (Powers and McDougall 2005), or scientific productivity (Van Looy et al. 2011). What is less clear is *how* different university-level factors lead to USOs' establishment and subsequent performance. Understanding the mechanisms of how university conditions influence USO creation and development is far more relevant for deriving policy implications than a list of characteristics.

Characteristics are typically difficult to change in the short run, while well-understood processes can be managed to compensate for particular university contextual disadvantages. Star scientists founding a USO may overcome both geographic distance to venture capitalists and the absence of affiliation to a top research university (Fuller and Rothaermel 2012). Hence, eminent research universities' better performance in creating USOs (Di Gregorio and Shane 2003) may not only be linked to university characteristics but rather to individual level influence. The following section explores how universities support USOs from the firm perspective, facilitating separating university capabilities from other contextual factors and highlighting priorities for policy makers seeking to expand universities' USO promotion activity.

2.1 The USO and the need for resources and competencies

By definition, new ventures lack track record and must assemble and develop a range of different input factors into an operating organization. A new organization must establish operating routines, secure affordable inputs from suppliers, and develop a customer base willing to pay for its products and services. This takes time and creates urgency given steep learning curves and an organization's limited resources.

Stinchcombe (1965) noted that new organizations are imprinted with characteristics their specific founding environment. Internal and external characteristics at the point of founding have long term effects on new ventures' development, survival and performance (Ganco and Agarwal 2009). The many competencies needed to transform scientific findings from a traditionally non-commercial university context into viable products and services create specific problems for USOs in their initial development phases (Vohora et al. 2004). USOs created by academics are likely to inherit characteristics different from other technology firms. Relating to the type of technology commercialized this is more often embryonic technologies developed in a university context with some distance to the market (Jensen and Thursby 2001), or firm's endowed resources at start up (Clarysse et al. 2011b; Moray and Clarysse 2005). There may also be cultural differences between academic and business environments granting university-originating firms more limited access to the competencies needed to start and grow a business (Colombo and Piva 2012).

To analyze how university context influences venture creation and development, a further examination of new venture creation within the university setting is warranted. Entrepreneurship scholars have theorized on the properties that constitute the central aspects of emerging organizations (Brush et al. 2008; Katz and Gartner 1988), suggesting that developing a specific set of entrepreneurial competencies is central to initial venture success for USOs. Three entrepreneurial competencies provide a framework to analyze how different actors provide different contributions to USO venture evolution (Rasmussen et al. 2011). These entrepreneurial competencies are related to three core processes necessary to develop a new venture;

- 1) developing a viable business opportunity (opportunity development),
- 2) championing individuals that provide meaning and energy to the entrepreneurial process (championing), and
- 3) accessing resources necessary to develop the new venture (resource leveraging).

These three competencies provide a useful analytical framework highlighting how different actors play different roles in a venture's development. The framework can be elaborated to highlight the different challenges faced by young USOs and how the ventures can overcome these challenges. Identifying the sources and processes behind these entrepreneurial competencies discloses how the university can facilitate USO creation and development.

2.2 Opportunity development competency

All new ventures exploit a business opportunity: USOs' business opportunity are typically based on new technological knowledge that potentially can lead to highly innovative products or services. Technological innovations are fungible (Penrose 1959) and new inventions can lead to different market applications depending on their commercialisation process (Shane 2000), with USOs often pursue several business models simultaneously (Clausen and Rasmussen 2012). Technological inventions' market applications are rarely clear from the outset (Gruber et al. 2008) with business models being modified as entrepreneurs gain more knowledge about resources and potential opportunities (Chesbrough and Rosenbloom 2002).

A key challenge for USO initiation and development is the ability to transform scientific knowledge into a commercially viable product or service. This ability of seeing a potential business opportunity and developing it into a viable business is a cognitive act, with different individuals playing different roles throughout the entrepreneurial process (Eckhardt and Shane 2003). Initially, business opportunity perception is related to individual scientists' knowledge and experience: academics' 'opportunity recognition capacity' has been found to be the most important explanation for scientist's engagement in USOs (Clarysse et al. 2011a).

The likelihood of starting a spin-off company to commercialize research is much higher for faculty members that have received industrial support (Louis et al. 1989). Whilst work experience from private sector is not necessarily significant, joint research projects with private firms is clearly related to firm formation (Krabel and Mueller 2009). This indicates that the knowledge needed to establish USOs is developed in an academic-industrial interplay, rather than within one or other sector.

USOs' founders' and managers' networks and experiences are usually more technologically oriented than market oriented: when exploring possible technology applications, USOs may limit their search to familiar knowledge areas or a few alternative uses (Zahra et al. 2007). Conversely, considering alternative applications more broadly and synoptically increases the chances of developing a high performing business. This ability to improve and alter the opportunity according to new insights can be regarded as an opportunity development competency (Rasmussen et al. 2011). This competency is dependent on high technology expertise combined with industry or market knowledge.

While technological expertise abounds within universities, commercial expertise is often in short supply. Hence, for USOs initiated by academics, industrial interaction is often crucial to be able to conceive and modify a viable business concept based on scientific knowledge. There can be many sources of industry interaction and market knowledge that provide opportunity development competency: USO creation and industry collaboration are not substitutes but rather reinforce each other (Di Gregorio and Shane 2003; Powers and McDougall 2005; Van Looy et al. 2011). USOs set up by scientists with personal or research group experience and networks with industry seems better able to integrate technological and market knowledge.

In USOs' later developmental stages, the university can be an important partner for further technology development: USOs are more inclined than other technology ventures to keep their connections with the academic environment (Colombo and Piva 2012). Academic scientists may play a crucial role in connecting the entrepreneurial firm to scientific networks both within the laboratory/ research group and more widely to the scientific community (Murray 2004). But at the same time the university lacks market and commercially oriented knowledge, therefore USOs face a challenging in benefiting from their university relationship while also accessing industry-specific and managerial competences from other sources.

2.3 Championing competency

New ventures are started and developed by an entrepreneur or an entrepreneurial team that takes a championing role in the venturing process (Gupta et al. 2006). The 'champion' role inducing others' commitment to the new venture by providing emotional meaning and energy (Howell and Higgins 1990). USOs are usually championed by academics or by mixed teams consisting of academics and external entrepreneurs. Entrepreneurial teams often change over time: USOs typically develop by dynamic interaction of different individuals with different competencies throughout the start-up process (Clarysse and Moray 2004; Vanaelst et al. 2006). It is often difficult to clearly separate team members' contributions from other key supporters that promote the new venture, with many persons both within and outside the university potentially playing a championing role at some stage in the venturing process (Rasmussen et al. 2011).

The perceived viability of commercialization activity will influence the involvement and support of university scientists in USO creation. Professors' attitudes towards the dissemination of knowledge has been identified as the most significant factor influencing their entrepreneurial behavior (Renault 2006). Studies indicate that the perceived viability to act

entrepreneurially is to a high degree influenced by the local environment: scientists trained or working in an environment where entrepreneurial behavior is common are more likely to themselves become entrepreneurs (Bercovitz and Feldman 2008; Kenney and Goe 2004). Conversely, potential entrepreneurs are discouraged where current local work environments are not actively entrepreneurial (Bercovitz and Feldman 2008).

The role of the local work environment is particularly important for USOs because these firms are usually developed by teams where several persons play an active championing role (Vanaelst et al. 2006). Support from champions such as colleague scientists, university managers, TTO staff, and people in the external network of the university is often critical, particular in early stages (Rasmussen et al. 2011). Few USOs start without significant involvement from the inventors or scientists behind the technology: the university environment can facilitate or hinder such involvement. Moreover, it is crucial for emerging USOs that new individuals with industry and business experience become involved in developing the venture. In early stages, the university environment may be an important catalyst for attracting champions with relevant expertise to join or support the venture.

The lack of growth and financial success in many USOs may relate to entrepreneurs' motivations: individual academic entrepreneurs' motivation seem related to a variety of factors including technology diffusion, technology development, financial gain, public service and peer motivations (Hayter 2011). The inherent tensions between the academic and the commercial values and norms seems to be a possible impediment for USO development (Ambos et al. 2008; Gurdon and Samsom 2010). These tensions are likely to be more keenly felt lower in the university organization (Bienkowska and Klofsten 2012), particularly at the individual level (Ambos et al. 2008). However, scientists involved in commercial activities may adopt a hybrid role identity that preserves the academic identity alongside their commercial role (Jain et al. 2009).

2.4 Resource acquisition (leveraging) competency

Establishing a new venture requires access to resources such as financial capital, physical assets, technological resources, human capital, and organizational resources. Intangible 'soft' resources are more useful than tangible resources in the early stage of venture development (Lichtenstein and Brush 2001). Successfully creating a new venture depends on both the ability to assemble and organize resources (Brush et al. 2001). The cornerstone of the third entrepreneurial competency is the resource leveraging needed to develop and integrate the internal and external resources necessary to establish and grow a USO.

Creating a new business activity based on research is typically extremely resource demanding because of parallel needs for technological, market and organizational development along lengthy development paths. In addition to resources needed for technological and organisational development, new ventures must build legitimacy in relationships with their operational partners (Delmar and Shane 2004; Zimmerman and Zeitz 2002). This is particularly important for USOs because their new innovations may be unfamiliar to both partners and customers.

A key resource for early stage USOs is the university scientists behind the commercialised technology. Unsurprisingly many studies confirmed that academics with access to more resources are more likely to form USOs (Landry et al. 2006). Several studies have emphasised the role of academics' social capital and networks (Murray 2004; Nicolaou and Birley 2003). Where new venture founders have relationships with venture investors they are most likely to receive venture funding and are less likely to fail (Shane and Stuart 2002).

In addition to academic scientists' roles, the resource acquisition process is highly iterative involving many different actors with appropriate competencies (Rasmussen and Clausen 2012). Most USO projects cannot access many resources required: those who succeed may be better at leveraging those required resources. This may explain why successful USOs also emerge in resource deficit contexts: USOs located outside the UK's venture capital hotspots may through their entrepreneurs compensate for this disadvantage (Mueller et al. 2012).

3 University capabilities to promote USO creation and development

With entrepreneurial competencies consisting of three elements, opportunity development, championing, and resource acquisition, university capability can be defined in terms of what universities do to support these elements. However, understanding university capability is hindered by a substantive disconnect between universities and USOs: USOs have a strong resource dependency on these competencies – without these competencies, the firm will not survive and grow. By contrast, universities' venturing activities are peripheral to their core missions around teaching & research. Universities may be positive towards these activities, or neutral or antipathetic – but that is an emergent property of university perceptions of those activities' value.

Much research on universities' entrepreneurial capability focuses on 'what' universities can do to support USOs (Bruneel et al. 2010; Rothaermel et al. 2007) at the expense of 'why' universities' might choose to use their scarce resources on supporting USOs at a time when they are under many intense competing demands from outside (Ćulum et al. 2013; Damme 2009; Enders and Boer 2009; Jongbloed et al. 2008). University management literature (Clark 1998a; Powell and Dayson 2013) has been at best rather normative, describing supporting entrepreneurship and venturing as something that university leaders can insert into their institutions' organisational DNA. To address the why question, we explore not only what universities can do to support USOs entrepreneurial competencies (3.1), but also how universities experience USOs' support demands USOs (3.2), and the circumstances under which stable entrepreneurial architectures (Nelles and Vorley 2010) might emerge around universities.

3.1 Defining university capability to promote USOs

The first step in defining university USO promotion capability is specifying how universities might contribute to USOs' entrepreneurial competencies. We have already defined three entrepreneurial competencies, opportunity development, championing and resource acquisition/ leverage (Rasmussen et al. 2011). In each of these, university support may be active or passive (Bozeman 1993; Coursey and Bozeman 1993). Active support may come through technology transfer offices' activities aiming to actively place resources at USOs disposal (Auten et al. 1984; Bozeman and Landsbergen 1989; Di Gregorio and Shane 2003; O'shea et al. 2005). Passive support involves providing an environment where many resources are freely available for firms to access including research, knowledge, demand for services, complementary firms and human capital (Benneworth 2007; Bozeman et al. 1986; Clark 1998b; Moray and Clarysse 2005; Rothaermel et al. 2007).

The capacity to support opportunity development is the most difficult or unusual for a university, because opportunity development involves explicitly transporting the idea from the academic to the commercial domain (Clausen and Rasmussen 2012; Rasmussen et al. 2011). University contact with industry correlates with strong track record in supporting USOs (Di

Gregorio and Shane 2003; Powers and McDougall 2005; Van Looy et al. 2011). But this is not that universities themselves help USOs generate and screen new technology applications, but university industrial contacts facilitate that process. This may come through a strong network of industrial partners, the presence of companies co-located with the university (for example in technology centres or science parks) and other industrial linkages. We hypothesise the underpinning process is universities encouraging USOs to stop research and seek industrial/ commercial technology applications.

A key distinction in terms of championing is between individual (academic) and institutional (university) capability for championing. Many university individuals from the university may be involved in championing firms (Rasmussen et al. 2011). If the key challenge of USO venturing is translating resources from an institutional environment of the university into a self-sustaining business, then we can distinguish those elements on the basis of where they end up. Academic contributions are those which end up in the USO after its success and for which there is an individual motivation for engagement (Vestergaard 2007): this may relate to a desire to create something useful such as a future employer for their graduates, partners for research projects or customers for consultancy (D'Este and Perkmann 2011; Zomer et al. 2010). University capabilities are elements which provide championing but which reside outside the firm's fuzzy resource space (Lam 2010), including university senior managers who enthusiastically encourage venturing and their own stakeholders to support USOs (Braun 2011).

The third university capability relates to resource acquisition/ leveraging, building up relationships of trust with suppliers, financiers and customers. Given that USOs are seeking a space to transform academic knowledge into commercially viable applications, universities' most valuable resource leveraging capacities come in terms of intangible resources. Universities may directly recommend USOs to investors, or signal their belief in the technology's commercial viability through investing their own resources in them (Etzkowitz and Klofsten 2005). Universities may also indirectly facilitate resource leverage by their USO associations, whether through a formal recognition of 'parentage', or through a USO's location on a university-owned high-technology site, which may function as quality marks for potential stakeholder (Smith and Bagchi-Sen 2012). Thirdly, universities' own networks may also help USOs to access resources, for example directly organising events to sell into the university's strategic partners, or a cluster of industrial partner firms – with technology needs capable of providing sophisticated demands to USOs – on site (Benneworth and Hospers 2007a; Benneworth and Hospers 2007b).

3.2 A stakeholder approach to understanding university capability

Although universities *can* offer these capabilities to firms, there is no automatic reason why they would choose to support USOs. For all those areas, it is possible to think of reasons why universities might choose to support their USOs; opportunity development could potentially lead to discussions with businesses leading to applied or joint research projects. But it is likewise possible to think of reasons why universities might choose to avoid supporting USOs – recommending USOs to industrial partners could potentially undermine industrial partners' trust in the academics if those USOs failed to perform. This reframes the problem of university capability as an emergent outcome of the locus between positive and negative reasons for universities supporting USOs (Guerrero and Urbano 2012).

University pressures can be interpreted in terms of a stakeholder model: stakeholder notions in higher education emerged as part of late 20th century discussions concerning the modernisation of universities (Amaral and Magalhaes 2002). Freeman (1984) defined an

organisation's stakeholders as those with a stake in the outcome of an organisation's activity. This interest in outcome became important with the rising importance of new public management pioneered in many countries' higher education systems (Kickert 1995; Landsbergen et al. 1992). In this context, universities were formalised into managerial organisations, shifting autonomy towards managers to manage their resources to best achieve goals set by public actors (Fried 2006). For universities, this shift in managerial culture moved away from collective decision-making towards hierarchies in universities (Deem et al. 2007). Universities' stakeholders maybe internal as well as external, and Jongbloed *et al.* produce a comprehensive taxonomy of these stakeholder set as follows.

Table 1 Stakeholder categories and constitutive groups

Stakeholder category	constitutive groups, communities, etc.
Governing entities	state & federal government; governing board; board of trustees, buffer organisations; sponsoring religious organisations
Administration	president (vice-chancellor); senior administrators
Employees	faculty; administrative staff; support staff
Clienteles	students; parents/spouses; tuition reimbursement providers; service partners; employers; field placement sites ...
Suppliers	secondary education providers; alumni; other colleges and universities; food purveyors; insurance companies; utilities; contracted services
Competitors	direct: private and public providers of post-secondary education potential: distance providers; new ventures substitutes: employer-sponsored training programmes
Donors	individuals (includes trustees, friends, parents, alumni, employees, industry, research councils, foundations,...)
Communities	neighbours; school systems; social services; chambers of commerce; special interest groups...
Government regulators	Ministry of Education; buffer organisations; state & federal financial aid agencies; research councils; federal research support; tax authorities; social security; Patent Office
Non-governmental regulators	foundations; institutional and programmatic accrediting bodies; professional associations; church sponsors
Financial intermediaries	banks; fund managers; analysts
Joint venture partners	alliances & consortia; corporate co-sponsors of research and educational services

Source: (after Burrows 1999; Jongbloed et al. 2008).

A stakeholder's importance to an actor is defined as 'salience', possession of attributes important to that actor (Mitchell et al. 1997). Mitchell *et al.* define salience as the consequence of three variables, power (coercive, utilitarian, and normative), legitimacy (individual, organisational, societal) and urgency (time sensitivity, mission criticality). USOs do not feature particularly strongly in this list of stakeholders, and indeed their various problems and limitations clearly reduce their salience to universities (Auerswald and Branscomb 2003). With universities facing pressures from a variety of sources, as well as potential resistance internally, supporting USOs could be far from universities' wider interests (Dill 1995; Enders and Boer 2009).

Bjørkquist argues networks of relationships between stakeholders can institutionalise what she calls 'stakeholder regimes' (Bjørkquist 2009), charting how USO support became

important in two Norwegian HEIs stakeholder regimes, albeit in slightly different ways. It was the pressure from more salient stakeholders such as government regulators and research funders that encouraged universities to shift to become more supportive of USOs. Each of the stakeholder classes defined above could encourage universities to be supportive of USOs under particular circumstances, set out in the table below.

Table 2 How key university stakeholders might promote USO interests

Stakeholder category	How groups encourage USO interests in universities
Governing entities	Government policies encouraging spin-off programmes; HEI policies facilitating risk-taking, share-owning, contracting, leasing
Administration	Steering core with mandate to promote USOs with participating from direction of extended development periphery (TTO)
Employees	Internal policies that allow staff to 'benefit' from USO activity – bringing in money to group, spending time, supporting T&R
Clienteles	USOs provide a means for HEI to enrich teaching experience via placements, guest lectures, employment opportunities etc.
Suppliers	Suppliers develop strategic links with university to 'tap into' USO networks as technology suppliers, partners, takeovers etc.
Competitors	Competitors also taking USOs seriously and acquiring a competitive edge, forcing HEI SMT to respond
Donors	Entrepreneurs invest in HEI to create chairs, sponsor research, lecture series, promoting high-technology entrepreneurship
Communities	Supportive of local land reclamation, regeneration developments for USOs; new members for business networks and 'clubs'
Government regulators	Tax breaks for investors in USOs, support for the finance gap, innovation support agencies, business-research schemes
Non-governmental regulators	Professional bodies willing to accredit time in USOs; foundations supportive of USO activity
Financial intermediaries	University financiers acceptive of risks/ liabilities of USO involvement, willing to securitise university investments
Joint venture partners	Consortia lead partners promote USO presence & involvement in research consortia; non-exclusivity, open innovation activities.

Source: after Burrows (1999), authors' own modifications

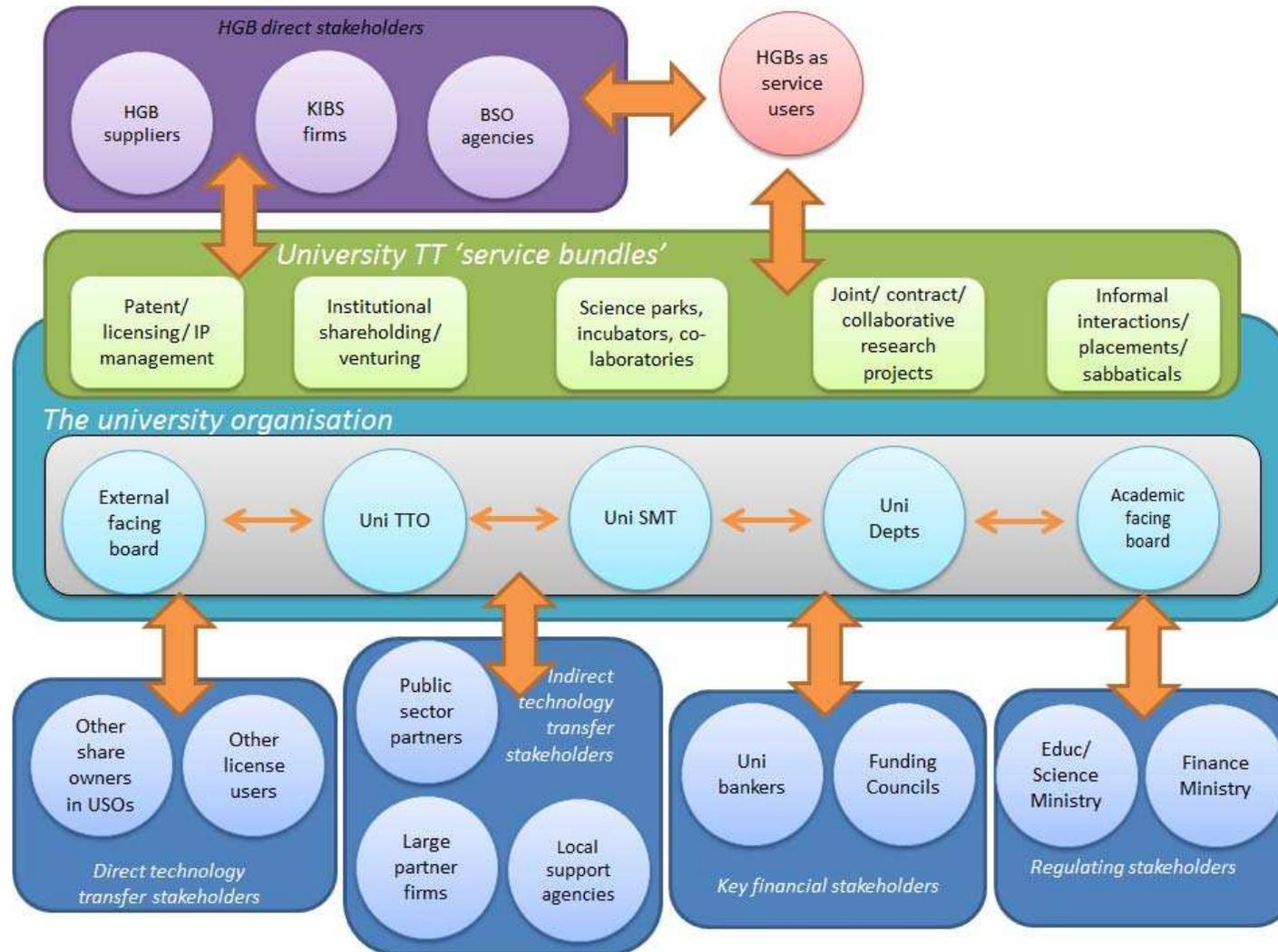
Six classes of stakeholder *for the university* can be distinguished who influence developments around technology transfer and business support.

- Internal actors, whether governance (decision-making boards) or operational units (teaching, research, technology transfer), as well as between internally-facing (examination boards, promotion committees, accreditation activities and consultative bodies) as against externally-facing governance structures concerned with the university's business model.
- University technology transfer stakeholders who may also be shareholders in university spin-off or partner companies, working with the university as license holders for existing technologies, or investors in companies that have licensed university technologies.
- Technology and innovation policy actors, those indirectly interested in technology transfer, including local and regional policy-makers, innovation support organisations, and partner businesses, whose activities are affected by technology transfer activities.

- Core university funders, including Funding Councils, Research Councils, University bankers (investing in risky activities like USOs and licensing might potentially raise borrowing costs which science parks and real estate development are potentially profitable).
- University regulators, including science and education ministries responsible for sectoral oversight make decisions with differential effects, or may negotiate individual contracts with HEIs; regulatory changes may make USOs more or less attractive, make it easier or harder for universities to offer USO support activities, and legal changes may permit or hinder active IP strategies (Etzkowitz and Klofsten 2005).
- Other companies and agencies that provide services to USOs, whether those selling innovation services (Benneworth and Dawley 2005), competitors for university services, university approved partners for commercialisation services, and those (such as patent lawyers) that sell to universities prior to USO formation.

We conceptualise university commercialisation activity as technology transfer service 'bundles' which universities build up to support USOs (Benneworth et al. 2004; Crow and Bozeman 1987; Miles 2005). These bundles create activities which make resources available to USOs and facilitate their entrepreneurial journey. But at the same time, these service bundles are also activities which diverse groups of stakeholders come together to support, expressing to the university that they value these activities. Although USO support comes through the dyadic relationships between service bundles and USOs, university capability in that area comes through the way that stakeholders compel universities to deliver these activities. These relationships are shown in the diagram below.

Figure 1 A stakeholder model of the university capacity to support USOs via supporting service bundles



Source: authors' own design after Benneworth & Jongbloed (2010):

3.3 Four elements of university capability to promote USOs

Our definition of university USO capability therefore is

“the capability to provide service bundles which support the development of USOs’ entrepreneurial competencies in a sustainable way within the university structure.”

Service bundles are assembled in response to stakeholder pressures and therefore meet a wider set of stakeholder needs than just those USOs. Service bundles must fit with internal stakeholders’ needs, both fitting with the universities’ own governance style as well as supporting core activities around teaching & research. Therefore, in response to this, we suggest that there are four areas of **university capability** as defined above:

Sustaining management commitment: the first capability is sustaining management commitment to entrepreneurship and supporting USOs. This is about more than just stating a desire – rather, it is about steering the institution to make management commitment more achievable and hence more sustainable. There is an institutionalisation dimension to this - sustaining management commitment involves building USO support into universities’ formal structures and informal cultures. What begin as experimental and peripheral projects become more widely valued, influence the internal communities across the university, and persuade external parties to value and/or reward the university for its pro-activity in stimulating USO support.

Creating attractive technology transfer infrastructure: the second capability is creating university activities that correspond to service bundles useful to USOs. There is the risk that this service bundle creation process is captured by the supply-side, where the university and key stakeholders deem a particular set of activities useful, and construct a project to deliver those activities. There is also a corresponding demand-side risk, in universities focusing on working with established, well-configured R&D intensive corporations whose own interests align much more closely to the university’s interests. If the university does not provide access to the kinds of resources that firms need in managing the transition process, then although there may be a diverse technology transfer infrastructure, it will not

Demonstrating institutional benefits of USO support: the third university capability is acknowledging the benefits which working with USOs brings to the university. This facilitates university-USO cooperation becoming a solution to individual problems faced by internal university constituencies in achieving their own goals. Managers must demonstrate to staff that USO support is valued is for the enrichment that it brings their work. This may come via altering tenure or sabbatical criteria, allowing work with USOs not immediately connected to research or teaching to count towards promotion, or allowing staff to spend sabbaticals working in applied development in USOs. There is also an important element in persuading other external stakeholders to state that they value universities’ USO support activities not just that they value USOs because they create new jobs and industries.

Balancing with other commercial interests: the final capability is balancing the USOs with the university’s other commercial interests. At the highest level, this might involve finding a suitable university risk profile allowing different kinds of risks to be managed, comparing and balancing the potential risks of USO involvement against other risks¹. At the meso-level,

¹ For example the University of Salford uses a risk matrix to bring potential problems into perspective and set out acceptable risk levels http://www.education-benchmarking.org/images/stories/Benchmarking_Project_presentation_11_June_2010_ROLLINSONFINAL.pdf

the university must balance USOs' future interests against existing partners' current needs in its strategies and policies, to avoid created unintended barriers to USO support. At the micro-level, particular commercial decisions taken by the university must ensure that possible consequences for USO relationships are considered within the university's wider decision-making process.

4 Where do the firm meet the university? Integration of the literatures

To understand the issue of universities supporting USOs, we draw on Bruneel *et al.*'s concept of barriers in the University-company interaction (UCI): both differences in outlook between universities and firms, and problems in transactions, undermine universities supporting USOs' entrepreneurial capabilities (Bruneel *et al.* 2010). Bruneel *et al.* further argue that three characteristics facilitate university-company interactions, mitigating these barriers' effects: experience of collaboration, breadth of interaction channels and inter-organisational trust. But we have noted that within these dyadic UCI relationships, there are barriers corresponding to both the university side and the firm side: what the firm experiences as a lack of application oriented research is experienced by university research groups as a lack of sophisticated demand for knowledge.

Our diagnosis of the conceptual impasse is a failure to deal with the duality of the characteristics of these relationships and consequently the turbulent dynamics of those barriers, and by logical extension, the factors that ameliorate those barriers. Better understanding those barriers and what reduce them requires incorporating these dyadic relationships' duality. We previously noted that these dyadic UCI relationships are embedded within wider stakeholder networks supporting entrepreneurial activity (Harrison and Leitch 2010). This model has a single logic for relationships, support for particular concrete activities on the basis of their correspondence to actors' and salient stakeholders' goals.

We therefore propose modifying Bruneel *et al.*'s conceptualisation by shifting the emphasis from dyadic co-operations to entrepreneurial stakeholder networks. Both barriers as well as mitigating factors can be reformulated in terms of entrepreneurial stakeholder network characteristics. This generates novel explanations of USOs' problems faced by USOs, and what can solve those problems, in terms of network properties. These new conceptual tools likewise provide insights which can be extended and applied to generate new policy insights, focusing on outcomes in these networks rather than incentives for heavily embedded transactions.

4.1 From university-USO relationships to university entrepreneurial networks

Bruneel *et al.* distinguish between orientation-related and transaction-related barriers. Orientation-related barriers relate to a mismatch between the orientations of firms and academics hindering the effective acquisition of 'collective' assets around the university into USOs. But we also highlight that USO entrepreneurs must separate their role as entrepreneurs from that as academics and create the firm as an entity distinct from the university (Lam 2010; Vestergaard 2007). The issue is proximity – on the one hand sufficient proximity to facilitate knowledge exchange but on the other hand sufficient distance between actors to validate different roles in the network allowing USO entrepreneurs to play distinct roles from universities and their other stakeholders. Therefore, we define the first barrier in university USO systems as a **proximity** barrier, either being too close to progress beyond lifestyle businesses or too remote to allow overspill.

Transaction-related barriers relate to different valuations between universities and USOs in terms of various resources. USOs are unable to pay the full market cost of resources and reliant on leveraging collective resources to survive, whilst universities acquire the full opportunity cost of providing those resources. The issue here is firms being able to benefit from spill-over effects (research in both tacit and codified forms as well as human capital) whilst at the same time ensuring there is not an excessive individual private benefit being derived from university assets which the university could manage more commercially (Audretsch et al. 2005). Therefore, we define the second barrier in USO systems as a **spillover** barrier, in which the network is excessively individualised in ways that prevent those spillover effects from being derived.

It is likewise possible to transpose Bruneel *et al.*'s three mitigating factors, namely experience of collaboration, the breadth of interaction channels and inter-organisational trust, from dyadic relationships into capabilities of the wider entrepreneurial stakeholder network. We consider these to be the entrepreneurial stakeholder network capabilities, the characteristics of the network which support the competencies of USOs whilst at the same time meeting other stakeholders' needs.

The first of these is the experience of collaboration. This variable has a dual nature, both experience of groups working together, which helps in subsequent mutual co-operations, but also experience more generally of working with others with different world perspectives, which helps with new co-operations. Critical here is facilitating the appropriate level of proximity but also critical distance between actors. Therefore, our first proposed mitigating network factor is **social capital** in the entrepreneurial stakeholder network, in terms of the capability of actors when approached by others to develop partnerships with a strong level of role differentiation, and the ability of these roles to adapt over time, as the main USO actors move out of Lam's 'fuzzy zone' back to their respective organisations.

The second is the breadth of interaction channels, which is a broad range of interaction channels at a range of different levels, which provide multiple contacts and redundancy in connections if particular interactions or relationships fail to facilitate interactions. These correspond to the diversity of the service bundles which universities offer, but also the way these service bundles operate as spaces where communities come together and interact. Our second proposed mitigating network characteristic is **community activity**, in terms of the scale (number of participants), scope (number of activities) connectivity (inter-relation of service bundles) and salience (importance to stakeholders) of the service bundles.

The third mitigating factor is inter-organisational trust, which Bruneel *et al.* define in terms of the certainty that partners have that the other party in the relationship will not behave opportunistically. The issue of opportunism is critical in knowledge exchange relationships because of the pricing problem of knowledge. An actor cannot value whether the knowledge is useful without acquiring the knowledge, at which point the originator cannot exact a price – so prices have to be set using signals other than the known utility (Zomer and Benneworth 2011). In opportunistic behaviour, deviants make a choice to create a market benefit by disadvantaging their non-market capitals. It is the existence of collective norms and an expectation of punishment for deviant behaviour within stakeholder networks that mitigate against opportunism: opportunism still takes place but it carries a cost for opportunists in terms of corroding their network capital. Therefore, our third proposed mitigating network characteristic is **shared norms** within the stakeholder network which provide stability and undermine the potential benefits from deviant behaviour (Jordan and Schubert 1992).

4.2 Implications for policy and further research

The transition from being an academic research activity to become a commercial business activity poses challenges both for the university and the USO. The structure and main purpose of universities are very different from that of new technology businesses. The contribution made by our paper is to argue that addressing the challenge of the tensions that arise between universities and USOs during this transition it is necessary to take a broader view of the wider networks of (non-market, quasi-market and hybrid) relationships within which those market relationships (the vectors for the tensions) are embedded.

Hence, a key challenge in the process of creating a USO is to find the balance between what could realistically be organized within the university and what should be organized outside the university. We have used a stakeholder approach to define and map a stylised stakeholder relationship for university entrepreneurship activities based around universities. This is admittedly based on set of assumptions of that stakeholder system that there is a typical north-west European model, with relatively munificent entrepreneurial systems, active national public regulators and somewhat underdeveloped private entrepreneurial services (such as venture capital and business advice).

But we believe the wider point holds – that these dyadic relationships are embedded within a wider set of relationships, and that universities relationships are so complex that they will inevitably shape the environment within universities interact with their USOs. Therefore, understanding this wider stakeholder network for university entrepreneurship is a vital precondition to understanding university entrepreneurship more generally.

We therefore argue that more work is needed to develop this network understanding of USO entrepreneurial competencies. Theoretical work is required to validate these three dimensions, specify and conceptualise these network capabilities along these three dimensions, as well as empirical work studying the functioning of these networks in practice. The logical extension of this would be to study non-USO high-growth firms in terms of the embeddedness of their non-market relationships (in terms of social capital, collective activities and shared norms) with key stakeholders.

This in turn is a precondition for developing the kinds of policies which can build entrepreneurial stakeholder network capacities (social capital, collective activities, shared norms) which best facilitate productive relationships between universities and their USOs. USOs are not to be a substitute for other channels of interaction with industry, but industry interaction and USO creation seems to be reinforcing activities and policy initiatives should therefore see different mechanisms in connection with each other. These interactions create network regularities, dependencies and interactions that shape and condition the relationships that USOs have with universities. At the highest level, this would suggest a shift in policy paradigm, from market mechanism interventions ('hard') towards stimulating non-market interactions ('soft'). A shift in paradigm brings with it a shift away from correcting market failures and optimising efficiency, towards correcting network gaps and optimising opportunity and interactivity.

Different kinds of instruments could work to promote activities in different ways, but typically involve hybridising existing instruments to achieve participants' different values. Social capital could be promoted through for example hybrid research-innovation instruments, in which researchers and USOs are each funded to do what matters to them (excellent research, quick commercialisation), and the proposals are evaluated on that basis. Likewise, community activity could be promoted by linking networking meetings and collaborative

innovation grants, encouraging participants to come together for a functional reason, but at the same time encouraging the socialised learning which facilitates other relationships. A more systematic categorisation of these hybrid network management policies is required before concrete recommendations can be made, and a key challenge is ensuring that USOs make their contributions to the emerging knowledge economy because of and not despite public interventions.

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