



Not seeing the forest for the trees? A systems approach to the entrepreneurial university

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Abstract The idea and practice of the entrepreneurial university has emerged in response to growing expectations of universities contributing to economic development and has, in turn, been subject to a growing body of research. However, much of the work is focused on individual activities or institutions, typically overemphasising commercialisation activities and certain types of universities. Furthermore, much of this research is de-contextualised and does not consider the systems in which universities operate. As a result, we have a variety of unit theories of constituent parts of the entrepreneurial university without considering the wider (feedback) effects and implications — in other words: we are, in effect, not seeing the forest for the trees. Drawing on in-depth quantitative and qualitative field work and the literature, we develop a programmatic theory of the entrepreneurial university and the institutionalised entrepreneurial activities. Using causal loop diagrams, we capture the systemness and the interdependencies between universities' entrepreneurial activities and their dynamic capabilities. The model highlights how universities are part of a

larger system and how this influences their external engagement activities. The result is a more holistic understanding of entrepreneurial universities that reconciles existing work and guides future research. We discuss practical implications and policy levers derived from this systemic perspective.

Plain English Summary We provide a systemic model for understanding and diagnosing the capabilities of entrepreneurial universities based on in-depth qualitative and quantitative work. Universities are expected to contribute to society and the economy through activities that go beyond the traditional missions of research and teaching. Academic research on entrepreneurial universities tends to focus on discrete activities in universities or case studies at the cost of a wider understanding of the concept. The result is a limited understanding of how these activities and the university's capabilities influence each other and co-evolve. We thus propose a new way of understanding how entrepreneurial universities behave, engage, and develop in a systematic fashion. For future research, new methodological approaches are required to operationalise this systemic view including the need to harmonise datasets covering entrepreneurial universities. For policy and practice, understanding the interconnectedness of activities and missions highlights the trade-offs and helps mitigate unintended consequences from different policy actions. The model developed in this

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paper serves as a tool for thinking and diagnosis for university managers and policy makers that can be applied to different contexts.

Keywords Entrepreneurial universities · Academic entrepreneurship · Dynamic capabilities · System dynamics · Causal loop diagrams

JEL Classification I230 · L140 · O310 · O340 · O36

1 Introduction

Universities engage with external partners, both for-profit and non-profit, in a variety of ways (Abreu & Grinevich, 2013; Guerrero et al., 2014; Perkmann et al., 2021; Zhang et al., 2016). This has been the subject of a vast body of research that has focused on different missions, i.e. research, teaching, engagement, and commercialisation (e.g. Guerrero et al., 2015; Perkmann et al., 2021) or individual capabilities of universities within these missions (Heaton et al., 2019; Leih & Teece, 2016; Pugh et al., 2018). We have a good understanding of the antecedents, processes, and consequences of activities such as licensing, spin-offs, consulting, contract and collaborative research which, in turn, indicates their capabilities in these areas. This includes the most relevant internal and external factors of entrepreneurial universities (Guerrero & Urbano, 2012) and how they can drive different aspects of their external environment (Guerrero et al., 2016).

However, progress regarding our understanding of the dynamics of entrepreneurial universities is almost stagnating (Klofsten et al., 2019; Siegel & Wright, 2015). Most studies ignore the interrelatedness and interdependencies within and between entrepreneurial universities, in favour of narrower and methodologically simpler analyses which comprise investigations of discrete activities that occur within their confines. Furthermore, there is a lack of integration of external context into studies of entrepreneurial universities (Klofsten et al., 2019). A more recent approach is the ecosystem perspective that sees universities either at the heart of their own ecosystem (Miller & Acs, 2017; Siegel & Wright, 2015) or part of a regional entrepreneurial ecosystem (e.g. Wurth et al., 2022, 2023). To date, reconciling these two approaches with the

organisational-level resources and capabilities from a systemic perspective has remained relatively elusive to academics.

Most of the published work has still not incorporated or addressed the ‘systemness’, i.e. how ‘large networks of components with no central control and simple rules of operation give rise to complex collective behaviour, sophisticated information processing, and adaptation via learning or evolution’ (Mitchell, 2011, p. 13), which is required to fully benefit from this perspective. Typically, research focuses on peripheral issues which limits the explanatory power of the entrepreneurial university concept and how it can help support policy and practice. The literature around entrepreneurial universities and university ecosystems is in an ‘intermediate state’ and is missing an understanding of the changing nature of entrepreneurial universities (Edmondson & Mcmanus, 2007). We have several explanatory concepts and studied individual activities (going back to the work by Slaughter & Leslie, 1997, and Etzkowitz et al., 2000). These form ‘unit theories’, ‘which [frame] empirical work on specific aspects of a phenomenon’ (Cronin et al., 2021, p. 667). We lack an overarching theory and empirical framework that connects existing work, incorporating the interdependencies, and explaining the dynamics of entrepreneurial universities and the wider context (Audretsch, 2014; Heaton et al., 2019). As a result, we are not seeing the forest for the trees and understanding entrepreneurial universities requires seeing both perspectives. If we accept these considerations, then we cannot understand entrepreneurial universities without understanding the systems in and through which they operate (Carayannis et al., 2022; Kast & Rosenzweig, 1972).

The aim of this paper is to provide insights into the dynamics of entrepreneurial universities, internally and within the wider ecosystem, hereby integrating the individual ‘unit theories’. More precisely, we address the question ‘How can we reconcile the interdependencies between capabilities and activities within the entrepreneurial university?’ This approach is distinct to prior research as consistent within this is the recognition of complexity as a prerequisite and not a limitation. Universities with their individual capabilities are part of a larger, interconnected system. Based on a mixed method research design, we reconcile the core activities and capabilities of entrepreneurial universities as relational (as opposed to

studying them in isolation), their strategic orientation within the respective context (as opposed to a de-contextualised view of characteristics and strategies without links to the activities), and how they are linked through ecosystems (as opposed to studying individual organisations). We demonstrate that such activities are not static, but dynamic in terms of the capabilities of entrepreneurial universities to undertake and develop them accordingly.

The result is a ‘programmatically theory’, ‘which orients scholars and practitioners toward what the unit theories collectively support’ and provides structure and direction for future research (Cronin et al., 2021, p. 667). Reconciling solid ‘unit theories’ of entrepreneurial activities and capabilities enables a systemic analysis, which is a novel means for diagnosing and facilitating the development of universities’ core and dynamic capabilities across their three missions. By taking this systems perspective on the entrepreneurial university, we help clarify the concept in a more holistic way that comprises measurable, practical, and theoretical terms.

2 Background

The importance of the Third Mission of universities has evolved over time, and so has the way in which it is implemented by universities and understood by academics. The initial conceptualisation of the entrepreneurial university was based on the system as a whole and how universities more generally develop further economic outcomes from their core missions of teaching and research (Slaughter & Leslie, 1997). This gave way to work looking at individualised mechanisms such as technology transfer and commercialisation. The results were ‘overly mechanistic national and regional policies that seek to commercialize those ideas and transfer them to the private sector’ (Florida, 1999, p. 67). Subsequently, this trend reversed to a degree through the evolution from technology transfer to knowledge exchange, which provides a more appropriate account for the two-way flow of information in university-industry interactions but still focusing on distinct activities (Abreu & Grinevich, 2013; Meyer-Krahmer & Schmoch, 1998; Perkmann et al., 2021).

With the aim of reconciling this more recent trend with the original work on entrepreneurial universities, we define entrepreneurial activities as ‘any activity that occurs beyond the traditional academic roles of teaching and/or research, is innovative, carries an element of risk, and leads to financial rewards for the individual academic or his/her institution. These financial rewards can occur directly or indirectly via an increase in reputation, prestige, influence or societal benefits’ (Abreu & Grinevich, 2013, p. 408). Academic entrepreneurship, both at the individual and organisational level, describes the sum of all entrepreneurial activities to promote innovation, entrepreneurship, and growth within the university ecosystem (Klofsten & Jones-Evans, 2000; Siegel & Wright, 2015).

This more inclusive definition is especially relevant since universities are expected to contribute to economic development and solutions for complex social issues in both global and local contexts, which requires them to constantly evolve and adapt (Abreu & Grinevich, 2013; Grimaldi et al., 2011; Hayter & Cahoy, 2018; Perkmann et al., 2021; Philpott et al., 2011; Siegel & Wright, 2015). Lehrer et al. (2009) differentiate between ‘dynamic’ (based on Clark, 1998; Etzkowitz, 2003) and ‘commercial’ (based on Siegel et al., 2003b; Lockett et al., 2005) interpretations of the entrepreneurial university. However, successful universities must combine both aspects to be able to align strategies and resources to this end (Hayter & Cahoy, 2018; Heaton et al., 2019). Entrepreneurial universities are also driven by a combination of ‘the invisible hand of market forces and the visible hand of public R&D funding’ (Lehrer et al., 2009, p. 269), the latter referring to a bidding system that is supposed to increase the societal return by directing public funding to the most promising projects (David, 2004).

Entrepreneurial universities involve a greater number of internal and external stakeholders in addition to industry partners, such as government programmes, agencies to support entrepreneurship and economic development (external), and new generations of researchers and academics (internal) (Siegel & Wright, 2015). This involves complex processes that bring together the project, individual, and support dimension (Castillo Holley & Watson, 2017) as well as complex interactions among different entrepreneurial activities, and between entrepreneurial

and scientific activities (Carayol, 2003; Owen-Smith, 2003; Van Looy et al., 2006). In addition to supply-side issues, it includes the demand side and issues such as partnering and trust, experience in working with academia and vice versa, absorptive capacity, and a collaborative culture, among others (Baycan & Stough, 2013; Bruneel et al., 2010; Fabrizio, 2009; Rajalo & Vadi, 2017; Santoro & Bierly III, 2006; Tartari et al., 2012; de Wit-de Vries et al., 2019).

When these constituent parts of entrepreneurial universities are combined, a complex system of interdependencies appears both within and beyond individual universities. Entrepreneurial universities are an integral part of their region and actively engaged in a variety of other networks, clusters, and ecosystems (Asheim & Coenen, 2005; Wurth et al., 2022). A university ecosystem is, therefore, defined as a multi-level ecosystem that is centred around the university as the focal organisation and combines providing services and support to the local entrepreneurial ecosystem, but also leveraging these connections for entrepreneurial means. These include student start-ups and faculty spin-offs; supporting commercialisation in business ecosystems through scientific input and business model innovation; collaborating with public and private organisations in innovation ecosystems and clusters to co-create value for customers and users (particularly to solve societal, environmental, or economic problems from the university's point of view). Entrepreneurial universities closely engage with other universities and non-academic partners in knowledge ecosystems to push the boundaries of the scientific frontier and enable breakthroughs. An entrepreneurial university is then inseparable from its ecosystem and vice versa.

The treatment of the concept of the entrepreneurial university is an inherently positive one as it has necessarily focused on additionality over and above the traditional missions of universities of research and teaching to highlight the economic contribution made by engaging in entrepreneurial behaviour. However, most of the literature focuses either on individual universities (supporting a narrative of 'winners' and 'losers') or individual activities, thereby neglecting the relational nature of the interdependencies between them and the core mechanisms (O'Shea et al., 2007) relating to how embedded entrepreneurial universities are within their ecosystems (Heaton et al., 2019). What has therefore emerged is a growing recognition

of the entrepreneurial potential of universities and concomitant foci on the different facets of this, albeit typically in discrete analyses of individual constituent activities rather than holistic analyses of combined activities and their interdependencies.

As a result, we are predominantly looking at the *trees* and there is a gap in our understanding of entrepreneurial universities and the (eco)systems that they are comprised of and embedded in (the *forest*). We are lacking models and frameworks that integrate what we know about different parts of entrepreneurial universities and, equally important, the interdependencies and potential synergies and trade-offs between them. Meaningful knowledge accumulation is limited without reconciling entrepreneurial universities in a relational and dynamic manner through a systemic understanding of their operations, impact, and changing performance over time.

3 Method and data

3.1 Research design

To address this gap in the literature, we apply an inductive and explorative approach to develop a theory of the interdependencies between established and emerging concepts and mechanisms (Edmondson & Mcmanus, 2007). More specifically, we deploy a mixed methods approach encompassing both quantitative data comprising multiple datasets collected at a national level in the form of surveys, and qualitative data from interviews with university decision-makers. Through a triangulation of insights from these data sources, we operationalise the entrepreneurial university concept, including their embeddedness within their ecosystem, predominantly through a systemic and relational approach that explicates the interdependencies between the relevant constituent elements.

3.2 Context

This study utilises data from Scottish universities and their interactions with businesses within their ecosystems. Scotland is representative of a developed, Western democracy with mature institutions and technology systems. The strong higher education sector plays a key role in its economic development efforts (Brown, 2016; Lyall, 2007). Scotland has 19 higher

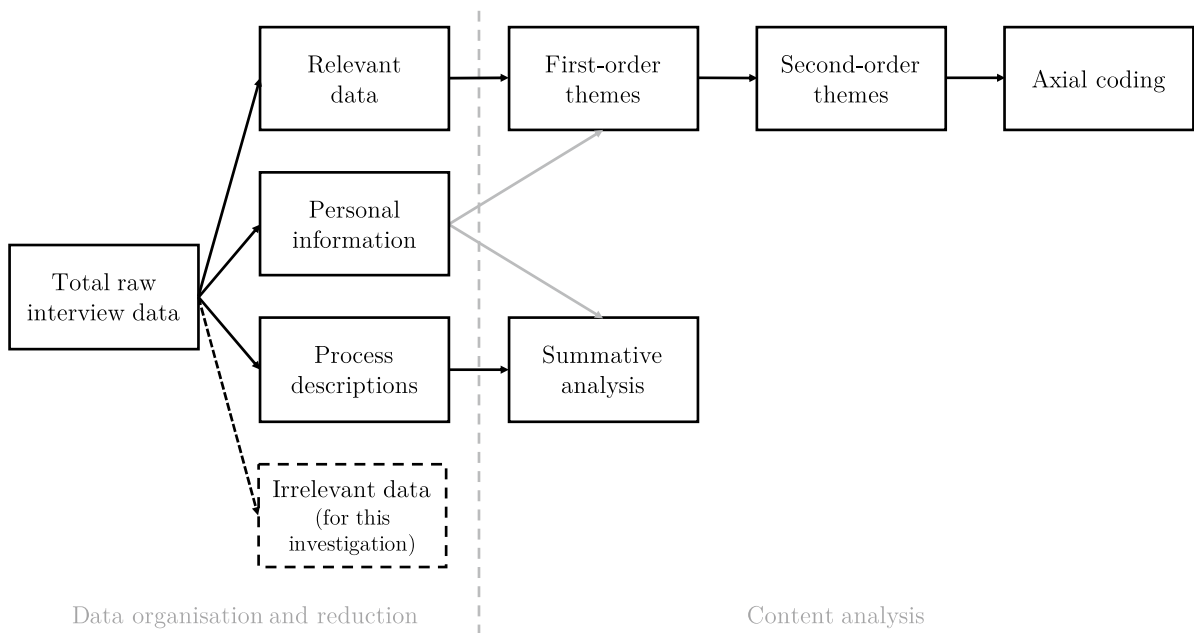


Fig. 1 Qualitative data organisation, reduction, and analysis. Source: Adapted from Graneheim and Lundman (2004); Huberman and Miles (1994)

education institutions in total, with 15 campus based institutions. These characteristics of the environment must be considered to develop a ‘contingent or context-specific perspective’ (Acs et al., 2014; Eun et al., 2006). While there are challenges in generalising insights from single cases, the nature and composition of Scotland’s higher education sector with a high level of attention from government and policy dedicated to innovation and (academic) entrepreneurship; a range of universities from world-class research-focused to teaching-led institutions with a regional focus; as well as both rural and urban areas provide insights that are relevant for other regions around the world.

3.3 Interviews

3.3.1 Sampling and data collection

Interviews were planned and conducted with representatives from Scottish universities that are involved in both initiating and facilitating entrepreneurial activities as well as the university’s strategic position in this area. The questions, mostly open and ‘how’ questions (Gioia et al., 2012), are structured around

the most common five formal entrepreneurial activities, namely licensing, spin-offs, consulting, contract, and collaborative research (Castillo Holley & Watson, 2017; Philpott et al., 2011; Wright et al., 2008). Two sets of additional questions regarding the personal background and experience of the interviewee as well as more holistic questions were included. We reached out to all 15 campus-based universities. In total, we conducted 13 semi-structured interviews with representatives from seven Scottish universities (one associate principal, seven technology transfer office¹ directors, and five TTO staff) over a period of four months between May and September 2016. This covers nearly half of the relevant population, spanning universities with a variety of strategic foci, resources, and capabilities. The interviews lasted between 42 and 93 min, with an average duration of 71 min.

¹ For simplicity and consistency, we use the term ‘technology transfer office’ (TTO), explicitly acknowledging that most universities have changed the name and branding as well as responsibilities of their TTO.

3.3.2 Data analysis

The interviews were transcribed, and the data organised and subsequently analysed using a combination of content and summative analysis as illustrated in Fig. 1 (Creswell, 2009; Huberman & Miles, 1994). Summative content analysis was used for the process descriptions to explore whether universities have similar processes in place for the five entrepreneurial activities and identifying potential discrepancies between process descriptions in the academic literature and the practices at Scottish universities (Hsieh & Shannon, 2005). Content analysis of the remaining relevant data is done through creating initial first order ('interviewee-centric') codes, followed by second order ('theory-focused') codes, and finally axial coding that will lead to dynamic relationships (relating them to the literature and other data sources). The aim of this part is to uncover further insights into the mechanism and dynamics of entrepreneurial universities. This is a variation of the grounded theory approach (Glaser & Strauss, 1967) and follows the structure and strategies outlined by Gioia et al. (2012, p. 26) and Luna-Reyes and Andersen (2003).

An overview of the data structure and the emergent themes from the content analysis is provided in Fig. 2. The analysis has shown that even a relatively small number of 13 interviews has uncovered a variety of different perspectives, opinions, and experiences. This is consistent with findings from Baker & Edwards (2012, p. 5) that it might 'only take a few interviews to demonstrate that a phenomenon is more complex or varied than previously thought'.

3.4 Survey data

To supplement the interview data, we analysed four nationally collected, survey-based datasets on entrepreneurial university activities to understand the role and impact of these behaviours on and among universities. The primary data source is the Higher Education-Business and Community Interaction survey (HE-BCI), which is collected annually by the Higher Education Funding Council for England (HEFCE). HE-BCI includes self-reported information on Third Mission activities, funding sources, and university resources. This data is complemented by institutional level data from the Higher Education

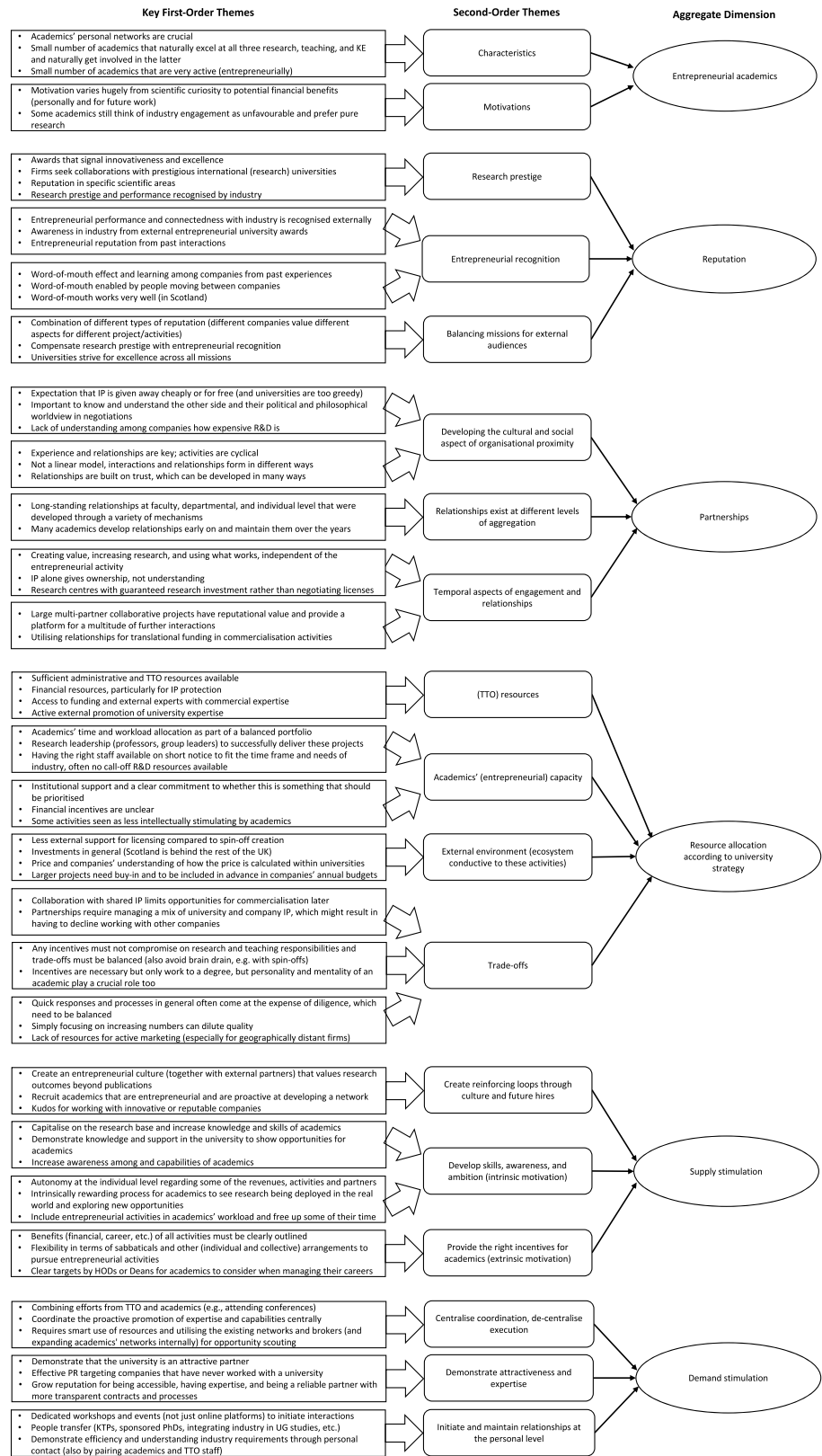
Statistics Agency (HESA). HESA collects data annually regarding staff and student numbers of all universities, their financial information, and other aspects of the UK higher education sector. This data provides important institution-specific characteristics. Lastly, results from the 2014 Research Excellence Framework (REF14), the most recent UK university research performance survey that covers a similar period of time to other data that was collected and analysed for this study, were used to rank universities based on their quality of research in the process of understanding university reputations and performances. An organisational-level overview of the 15 campus-based Scottish universities, ordered by their REF14 results, with regard to the five entrepreneurial activities that are considered in this study is provided in the Appendix Figure.. 10.

Lastly, we analysed data from the University of Cambridge's Centre for Business Research Survey of Knowledge Exchange Activity by United Kingdom Businesses 2005-2009 ('CBR Business Survey') with responses from 2530 businesses from across the UK based on a sample size of 25,015 firms (one-stage stratified or systematic random sample) and the Neyman optimal allocation method to distribute the sample across twelve UK regions, 23 sectors and five company size classes (Hughes et al., 2010; Hughes & Kitson, 2013). This cross-sectional data allows us to understand general drivers, constraints, and the behaviour of companies, i.e. how and through which activities different types of companies (in this case firm size and innovativeness, which is also correlated to a firm's absorptive capacity) work with universities. An exemplary overview for licensing, consulting and contract research is provided in Fig. 3.

3.5 Data triangulation

The secondary data on universities and companies does not only show that a complex systems approach is needed (e.g. due to the heterogeneity among firms and universities) but also that universities must develop (and have, as the Appendix Fig. 10 shows) dynamic capabilities to deal with this complexity. The interviews we conducted provide a detailed account of the most common university engagement and commercialisation activities. While the

Fig. 2 Emerging themes from the interviews. Source: Authors



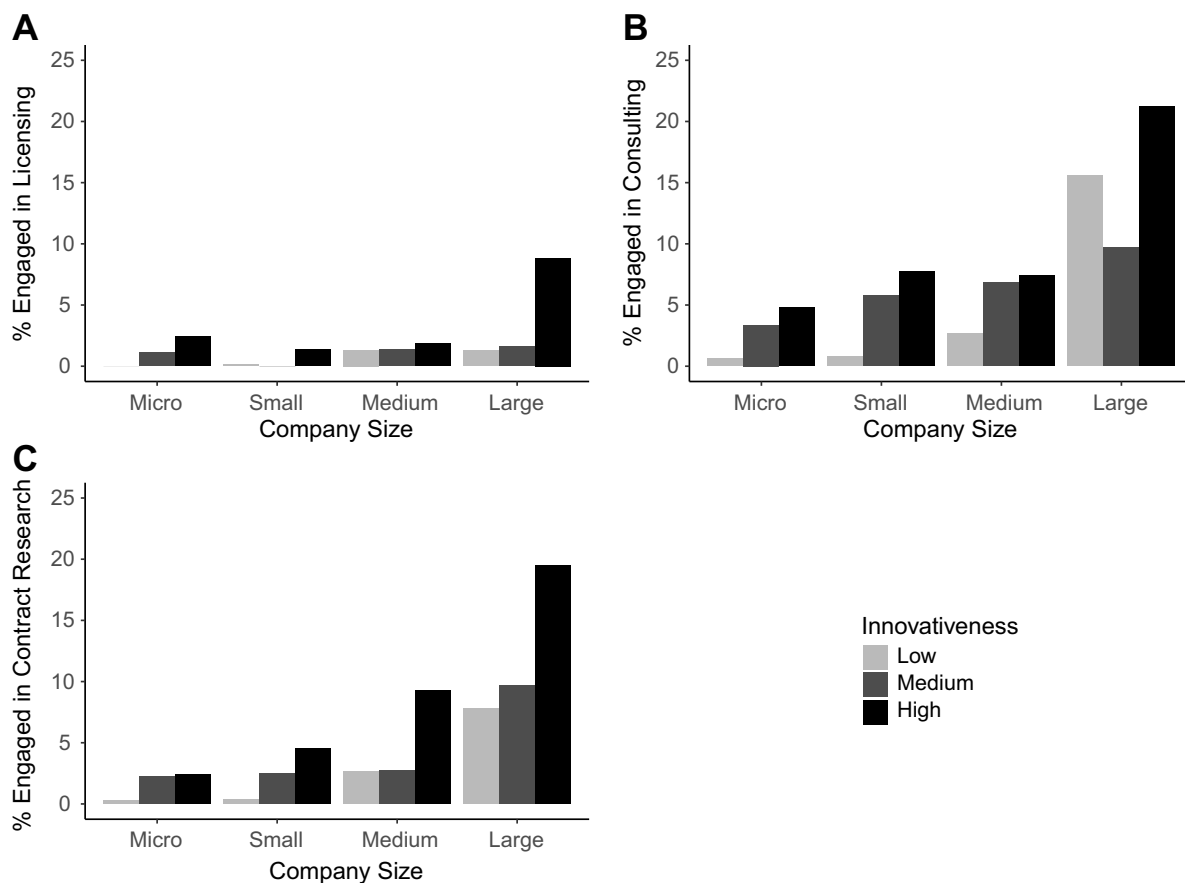


Fig. 3 Share of UK companies who licensed at least one technology from a university (A), received consulting services from a university (B), or engaged in contract research (C) in the period 2005–2009. Source: CBR Business Survey

processes are similar to what is documented in the literature, we interpret the results from a systemic perspective and tease out the mechanisms and interdependencies between activities and capabilities.

This is operationalised through the construction of a causal loop diagram (CLD) (Azoulay et al., 2010; Dattée et al., 2018; Luna-Reyes & Andersen, 2003). CLDs are comprised of concepts, arrows, and loops. Starting with the concepts and processes derived from the empirical work, we looked for links between them and to other concepts. By focusing on regularities (regarding processes and structures) as well as problematising key emerging themes and triangulating these insights with the academic literature, we work toward a programmatic theory (Cronin et al., 2021; Tsang & Williams, 2012). The links between

variables (concepts) are represented as arrows². This does, initially, not necessarily result in closed (feedback) loops. We turned to secondary data and the literature to both confirm those links and close the loops (Dattée et al., 2018; Vennix, 1996; Yearworth & White, 2013). Feedback loops are divided into reinforcing loops (no or an even number of negative links within one loop), leading to exponential growth, and balancing loops (an odd number of negative links within a loop), leading to goal-seeking behaviour.

² A positive or reinforcing link between two variables means that, all else being equal, an increase in one variable will lead to an increase in the other. A negative link means that, all else being equal, an increase in one variable leads to a decrease in the other one. For the sake of clarity, the '+' label for all positive links is left out and only negative links are labelled with a '-'.

Our results show that the dynamics of an entrepreneurial university and its interaction with the ecosystem can be understood as a set of coupled feedback loops. This way, we are reconciling multiple activities and capabilities of entrepreneurial universities. This is particularly relevant when thinking about how universities can grow their Third Mission and support the development of their ecosystem (Heaton et al., 2019). This is not the only way to operationalise the entrepreneurial university concept or an (eco)system approach, but the most appropriate to address our research question. It allows us to highlight the relational nature of different aspects of the entrepreneurial university and how they relate to the ecosystem without having to model the whole ecosystem and the university in detail. The usefulness of our model lies in its ability to address the gap in the literature and simplifies the overall system rather than trying to replicate the system with all details and its entire complexity (e.g. Sterman, 2000, p. 89, on the importance of purpose and problem articulation in the modelling process).

4 A systems model of entrepreneurial universities

In the following, we present the stepwise development of the model, including the rationales for the concepts (variables), their links, and the resulting feedback loops. Our programmatic theory is based on a dynamic explanation of entrepreneurial universities developed through establishing causal relationships between the themes from our empirical work and, therefore, the different processes, activities, and mechanisms (Kopainsky & Luna-Reyes, 2008; Lane & Schwaninger, 2008; Morecroft, 2007).

4.1 Research and commercialisation

Entrepreneurial activities are related to the quality and volume of university R&D (Link & Scott, 2005; O'Shea et al., 2005). A key aspect is the notion of 'independent research', which distinguishes universities from non-academic (contract) research organisations (Norn, 2016). Research performance

strengthens entrepreneurial performance over time, which, in turn, supports research 'through positive mediation between past and future research' (Sengupta & Ray, 2017, p. 881). In our model, 'research' is represented by the number of FTE staff involved in research activities because (1) research and entrepreneurial activities are inherently based on 'people' and (2) the model looks at what academics actually do; in terms of their salary costs a 'pure' researcher and an academic who engages with industry look the same, yet they perform different activities. Our model captures the differences in their activities, recognising the agency of academics in entrepreneurial universities and the dynamics therein.

Licensing, the traditional technology transfer process, has been the starting point and locus of attention for decades with regard to university-industry interactions (Friedman & Silberman, 2003; Siegel et al., 2003b). The general process of invention disclosure, patenting, licensing, and collecting financial returns is well documented in the literature (Siegel et al., 2003a; Bradley et al., 2013) and is illustrated in the CLD in Fig. 4. Summative content analysis of the interviews shows that all participants, who were asked about licensing, have confirmed this licensing process within their institutions.

The royalty income from licensing is typically split among the academic inventors, their department or faculty, and the university. Most of the profit after costs that have been deducted (e.g. IP protection, external legal support) get re-invested in research (Siegel & Wright, 2015), leading to reinforcing loop R1. In this model, the split among these parties is not included. The faculty will use the income to, for example, provide academics with a budget for travelling or equipment, academics typically keep the money in their university accounts for research support. While this money is not necessarily used to hire new staff, it does support their research and might even free up some of their time because they are able to hire research or teaching assistants. The relative income from licensing is marginal compared to the general staff budget, which makes it a reasonable simplification to model this increase in additional research time and research support as additional staff.

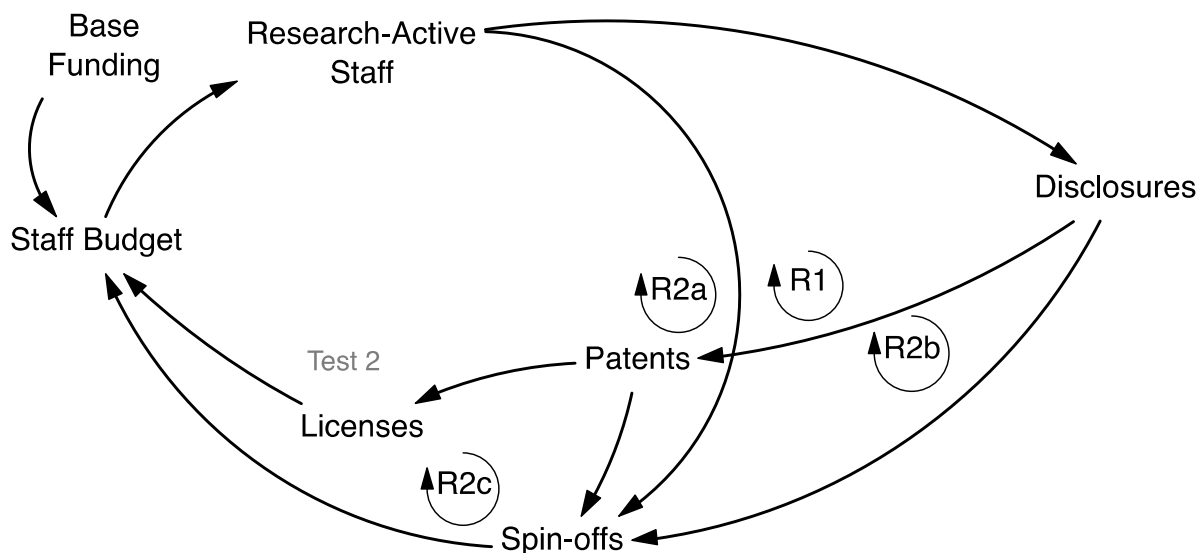


Fig. 4 CLD of commercialisation processes with reinforcing loops R1 (licensing), R2a (staff spin-offs), R2b (spin-offs with university shareholding), and R2c (spin-offs based on patents). Source: Authors

The typical process for spin-off generation is similar to the licensing process and follows an invention disclosure, patenting, and then license that patent to a spin-off, usually in exchange for equity (Shane, 2004). Recent studies have, however, shown that this is not how most spin-offs and staff start-ups are formed. Studies in different contexts have shown that only 33.3% of all new businesses are based on disclosed and patented inventions (Fini et al., 2010) and only 45% use codified knowledge from the parent university more broadly (Karnani, 2013). Spin-offs that are not based on codified knowledge are widely spread across all disciplines. In many universities, academics still need to file an invention disclosure, which is then reviewed by the TTO, and appropriate support is provided, regardless of whether there is codified IP involved. All interviewees who were asked about spin-offs described this process of spin-off creation within their respective university in a similar way. These routes are included in this model in three ways as illustrated in Fig. 4, which reflects the common definitions of spin-offs used in the literature (Hayter et al., 2018) and the data collection by HESA and HEFCE. Spin-offs can be based on patents (corresponding to formal spin-off with partial university ownership in the HESA data) leading to loop R2c, disclosures (other formal spin-offs) in loop R2b, or academics (staff start-ups; the direct link from staff to spin-offs) in loop R2a.

4.2 Consulting, collaborative and contract research

Academics can apply their knowledge and skills via consultancy and contract research without having to acquire additional skills and taking on the burden of creating a spin-off company, yet still generate further income either personally or for their research (Klofsten & Jones-Evans, 2000). This also leads to complementarities between teaching, research, and consulting. Consulting has been described by different interviewees as an effective means for scoping out the potential larger collaborations between universities and businesses due to the clearly defined goals, the relatively short duration, and, by extension, the lower financial commitment.

The interviews have highlighted that collaborative research is seen as more intellectually stimulating by academics compared to contract research and consulting, which is consistent with previous studies (Meyer-Krahmer & Schmoch, 1998). Many of these projects are considered ‘pre-competitive’ and they are typically supported by additional public funding (Perkmann et al., 2011). In contrast to contract research, they are usually multi-actor collaborations and of a much larger financial volume. While commercialisation activities have received disproportionate attention in the literature, contract research for individual firms as well as consulting are the most frequently used types of university-industry interaction whereas collaborative research accounts for

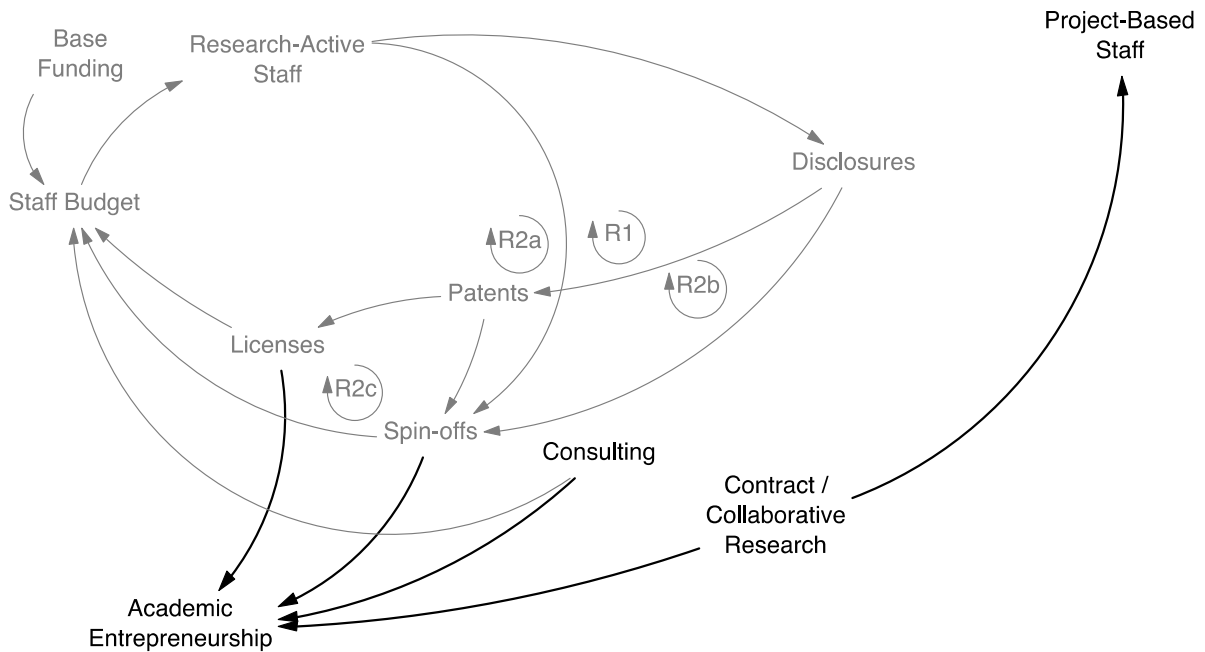


Fig. 5 CLD extension with consulting, contract, and collaborative research. Source: Authors

the largest volume in monetary terms according to data from HESA (see Appendix for the university perspective and Fig. 3 for the industry perspective).

The interviews have revealed that income from contract and collaborative research is treated as regular research income (hence, we combined them into one variable in Fig. 5) and is typically used for equipment and staff costs. Contract and collaborative research depend on the availability of research assistants and, in some scientific fields, technicians to operate the equipment. While a small percentage might be used to buy out time of the leading academic, this is neglected for the simplicity of the model considering the marginal gains in accuracy. Consulting income goes toward the general staff budget, whereas contract and collaborative research allow hiring project-based staff such as research assistants. The sum of these five entrepreneurial activities is the total amount of ‘academic entrepreneurship’ that the university is involved in at any point in time. This cumulative recognition of all entrepreneurial activities is crucial as the currently prevailing focus on individual activities means missing out on relevant dynamics, ranging from potential trade-offs (e.g. where do academics focus their attention and time, where to allocate university resources and time of TTO staff, what are the desired outputs/outcomes) to missed synergies (e.g.

building reputation and brand for the university, combined organisational learning from different activities, increasing social capital, bridging cognitive distance with industry), when developing dynamic capabilities.

4.3 Entrepreneurial academics and capacity

Entrepreneurial academics are defined as ‘academic faculty members who adopt an entrepreneurial outlook, seeking opportunities to support their research objectives by engaging with commercial partners in a range of formal and less formal modes of engagement’ (adapted from Miller et al., 2018).³ For the model, it is therefore not the amount of research-active staff but the entrepreneurial share of research active staff who are disclosing inventions and get involved in entrepreneurial activities in general. There is consensus among the interviews and the literature that there is usually a small number of academics who are involved in a large number of activities (Agrawal & Henderson, 2002; Balconi et al., 2004).

³ Miller et al. (2018) distinguish between entrepreneurial academics (with a focus on informal activities, based on the distinction made in this thesis) and academic entrepreneurs (with a focus on formal activities). Here, entrepreneurial refers to all activities involving commercial partners.

The total number of entrepreneurial academics and the workload allocation for these activities and research at their respective institutions define the entrepreneurial capacity of each university. If the amount of academic entrepreneurship exceeds this capacity at an aggregate level, there are potential detrimental effects on other missions of the university. Further entrepreneurial opportunities can also not be pursued due to time constraints of the available academics. This is represented in the CLD in Fig. 6 through balancing loops B1a, B1b, B2, and B3. If universities want to grow their entrepreneurial activity and industry engagement, they must increase the number of entrepreneurial academics. Academics must balance where they direct their attention to in line with their contracts and their university's priorities (Johnson et al., 2017). This 'lack of time to fulfil all university roles' is the most substantial constraint to working with external organisations as reported by academics in Scotland (Hughes et al., 2016). Academics

are typically fully workload, which means there is very little room for exploring opportunities for external collaboration. This is driven by the universities' strategy which reflects the wider (national) environment and influenced by how universities are evaluated (e.g. through the REF in the UK) (Audretsch et al., 2022).

4.4 Research prestige and entrepreneurial reputation

The literature has traditionally focused on the overall university reputation and its 'halo effect' on entrepreneurial activities in general (Mansfield & Lee, 1996) as well as particular activities such as collaborative research (Schartinger et al., 2001) or licensing (Sine et al., 2003). Research excellence, either at the institutional level (mainly for research-intensive universities) or in specific scientific areas or even for individual labs (mostly for less research-intensive and more teaching-focused universities), is an important

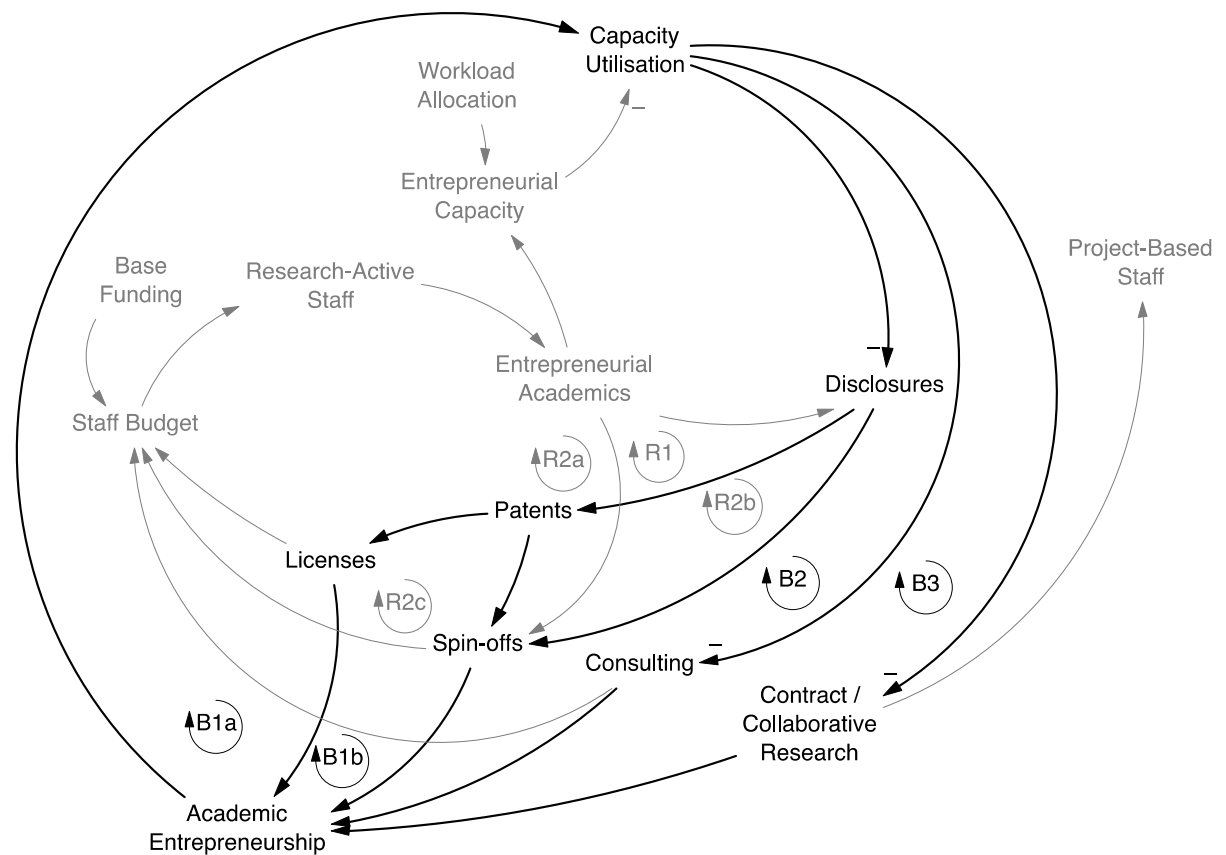


Fig. 6 CLD extension with entrepreneurial academics and entrepreneurial capacity that enable balancing loops B1a (capacity limitations from licensing), B1b (capacity limita-

tions from spin-offs), B2 (capacity limitations from consulting), and B3 (capacity limitations from contract / collaborative research). Source: Authors

criterion for companies before approaching a particular university. This has been extensively highlighted throughout the interviews across the university sector (Fig. 6).

In addition to research prestige, companies also consider the entrepreneurial reputation of a university. The interviews have shown that research-intensive universities are very aware of their (global) reputation, whereas interviewees from other universities focused more on their entrepreneurial reputation, and how the university is strategically trying to use it to complement its research prestige in particular areas to attract companies.

The entrepreneurial reputation will not necessarily influence the need for external input among companies, but their preference with which university they want to work. This is mainly influenced by past experiences of working with a particular university and the

word-of-mouth effect among companies. The interviews have highlighted that most universities are aware of these effects and try to actively influence their reputation to the best of their ability. Often being included implicitly in research and practice, our feedback-based model makes this link explicit. The interdependencies of both research prestige and entrepreneurial reputation with other parts of the system are presented in Fig. 7. Their effects go beyond the direct links to ‘industry demand’. The resulting feedback loops drive the behaviour of the entrepreneurial university by reinforcing change, such as more entrepreneurial activities making the university more attractive for future industry engagement. These dynamics have previously been neglected in the literature.

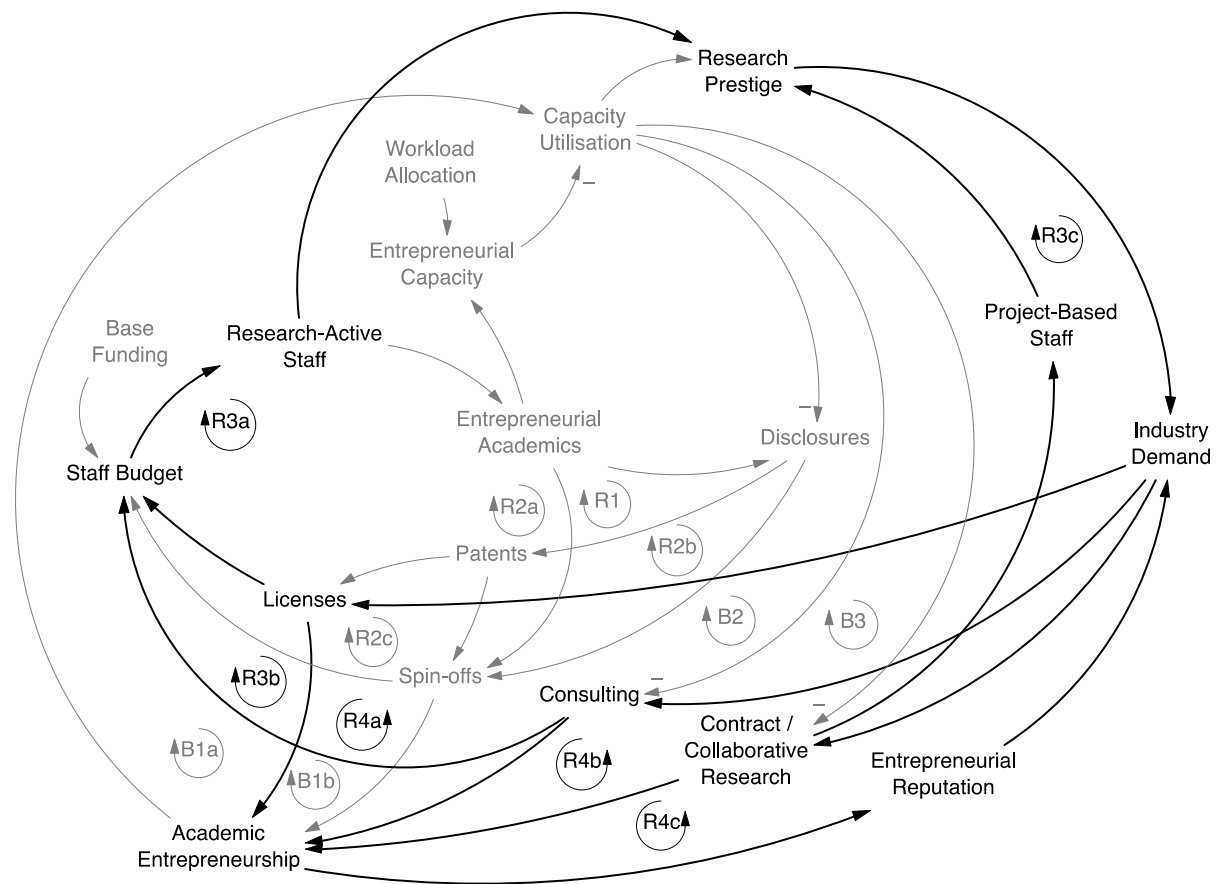


Fig. 7 CLD extension with research prestige leading to more demand for licensing (reinforcing loop R3a), consulting (R3b), and collaborative and contract research (R3c) as well as

increased demand through increased in entrepreneurial reputation for licenses (R4a), consulting (R4b), and collaborative and contract research (R4c). Source: Authors

4.5 Supply and demand stimulation

Through the interviews, we identify two main levers for universities to grow their entrepreneurial activities: supply (internal) and demand (external) stimulation. Internally, growing entrepreneurial activities requires increasing the entrepreneurial capacity of universities by increasing the number of academics that are involved in extant activities. This requires a mix of incentives, developing skills, awareness and appetite, and the right hiring policies, to name a few of the mechanisms that emerged from the interviews. However, growing this also represents a paradox. Academics chose academia in the first place instead of working for private companies or in other non-academic jobs (Grimaldi et al., 2011). Therefore, not every academic can or should be encouraged to become more entrepreneurial. Internal marketing is the combination of a reinforcing loop R5 (increased rate of academics becoming more entrepreneurial due to peer effects, incentive structures, and active marketing) and a balancing loop B4 (it gets increasingly hard to recruit

academics the smaller the share of non-entrepreneurial academics) as shown in Fig. 8.

Demand stimulation involves all means to increase the demand from industry. This includes both stimulating the need for input among companies as well as increasing the likelihood to be the preferred academic partner for companies. While universities might have an intrinsic motivation to pursue external marketing to grow their ‘academic entrepreneurship’, there have previously also been calls for more incentivisation of this behaviour and to re-focus and increase the Higher Education innovation funding in the UK (Witty, 2013). Externally, this is further emphasised by the increased weighting of ‘impact’ as part of the REF (Audretsch et al., 2022). Particularly non-top-tier institutions (from a research perspective) must be more proactive in reaching out to external organisations as highlighted by our interviewees and the literature (Siegel et al., 2004). This requires an understanding of the state of the university ecosystem and the economic landscape more broadly. The analysis of the CBR Business Survey

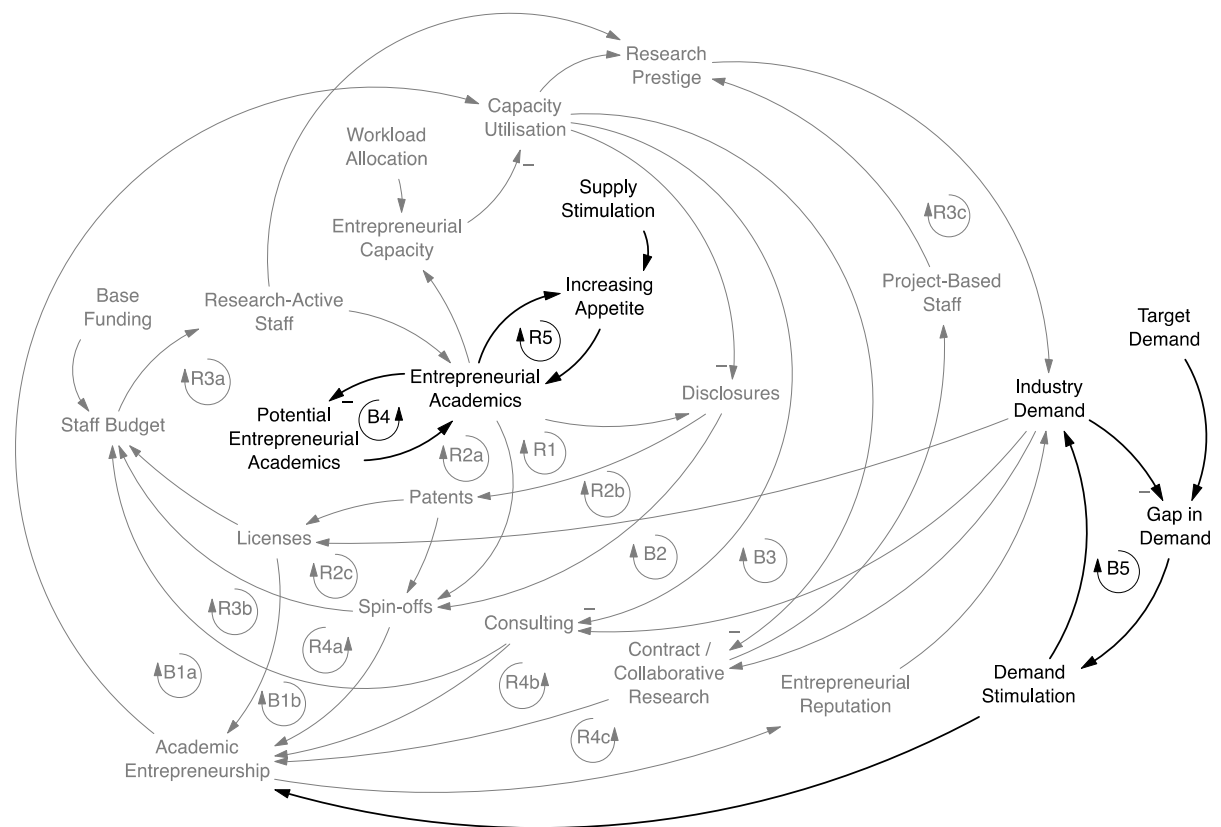


Fig. 8 Complete CLD including additional reinforcing loop for an increased appetite, peer support, and motivation (R5), and a balancing loop based on limited academic to recruit (B4) as well as a balancing loop for demand stimulation (B5). Source: Authors

highlights the heterogeneous nature of companies and their demand for working with universities. More specifically, universities must demonstrate that they are the most suitable partner for collaboration. This requires highlighting their industry-friendliness and experience in working with businesses, i.e. increasing the likelihood of being the preferred partner. The effort that universities put into this is typically adjusted based on the current amount of demand, resulting in balancing loop B5. A suggestion that emerged from the interviews was to pair commercial business developers with academics in the first place, try to engage with businesses collaboratively, and attend conferences, among others. Consequently, demand stimulation increases ‘academic entrepreneurship’ as academics spend more time working with external partners.

While different aspects of supply and demand stimulation have been recognised in the literature, Fig. 8 makes the interdependencies between them explicit and tangible. Universities need to simultaneously consider both supply and demand stimulation. Focusing on one at the expense of the other will lead nowhere in most cases as it only shifts the bottleneck for universities’ external engagement. The model allows universities to trace interdependencies. By monitoring the relevant data and evaluating the feedback over time, it also provides a new perspective on the dynamics of entrepreneurial universities and allows them to evaluate possible strategies or changes in policies or incentives.

5 Discussion

Our CLD illustrates the importance of studying entrepreneurial universities from a systemic perspective, accounting for feedback loops and trade-offs. Figure 9 highlights how the aggregate themes from the interviews are embedded within this the model. We discuss the implications of this relational perspective in the following, highlighting both the opportunities as well as the challenges for individual entrepreneurial universities and the academic sector. We emphasise the contribution of this systemic approach and the additional insights from synthesising ‘unit theories’ of the entrepreneurial university into a ‘programmatically theory’.

5.1 Strategic focus and resource allocation

The strategic orientation of universities has implications for resource endowments and allocation, with significant differences between local teaching-oriented and world-leading research universities (Siegel & Wright, 2015). Our results highlight two crucial, yet related aspects. First, we cannot understand entrepreneurial universities without recognising and understanding the systems in which they operate. Rather than focusing on ‘winners’ and ‘losers’, we propose a model that shows *how* universities can engage with the (eco)system and the interactions present within doing so.

Second, recognising the spectrum of entrepreneurial universities across their characteristics and strategic foci means, by extension, that entrepreneurial universities cannot be equally good at everything (see Appendix Fig. 10) and the potential impact of focusing on key areas of entrepreneurial activity. This impact is not limited to trade-offs among entrepreneurial activities but involves other activities and missions of the university too. Sengupta and Rossi (2023, p. 1) show that ‘universities whose share of blue-sky research income is higher relative to others, are associated with greater diversification in [entrepreneurial activities and stakeholder types]’. This is linked to core and dynamic capabilities. Teaching and research, the first two missions, can be seen as sets of core capabilities of any university. Third Mission activities are often based on dynamic capabilities, which allow universities to better sense changes in the environment and react to them (Tece et al., 2016).

For example, the CLD in Fig. 9 shows how universities’ engagement with one mission impacts other missions and capabilities (e.g. ‘capacity utilisation’ impacting balancing loops B1a, B1b, B2, and B3) and a means to understand what changes in different capabilities and activities would look like (Ambrosini et al., 2009). Another example is how research prestige and entrepreneurial reputation are connected and part of several feedback loops. Increasing entrepreneurial activities in the absence of a balanced approach risks an unintended, yet likely, reduction in performance across the other two missions.

This is reflected in entrepreneurial universities’ efforts to support and promote entrepreneurial activities. In the past, entrepreneurial activities, and licensing in particular, have been seen as a way of creating revenues for universities. Accordingly, their IP policies and entrepreneurial strategies in general are perceived by academics

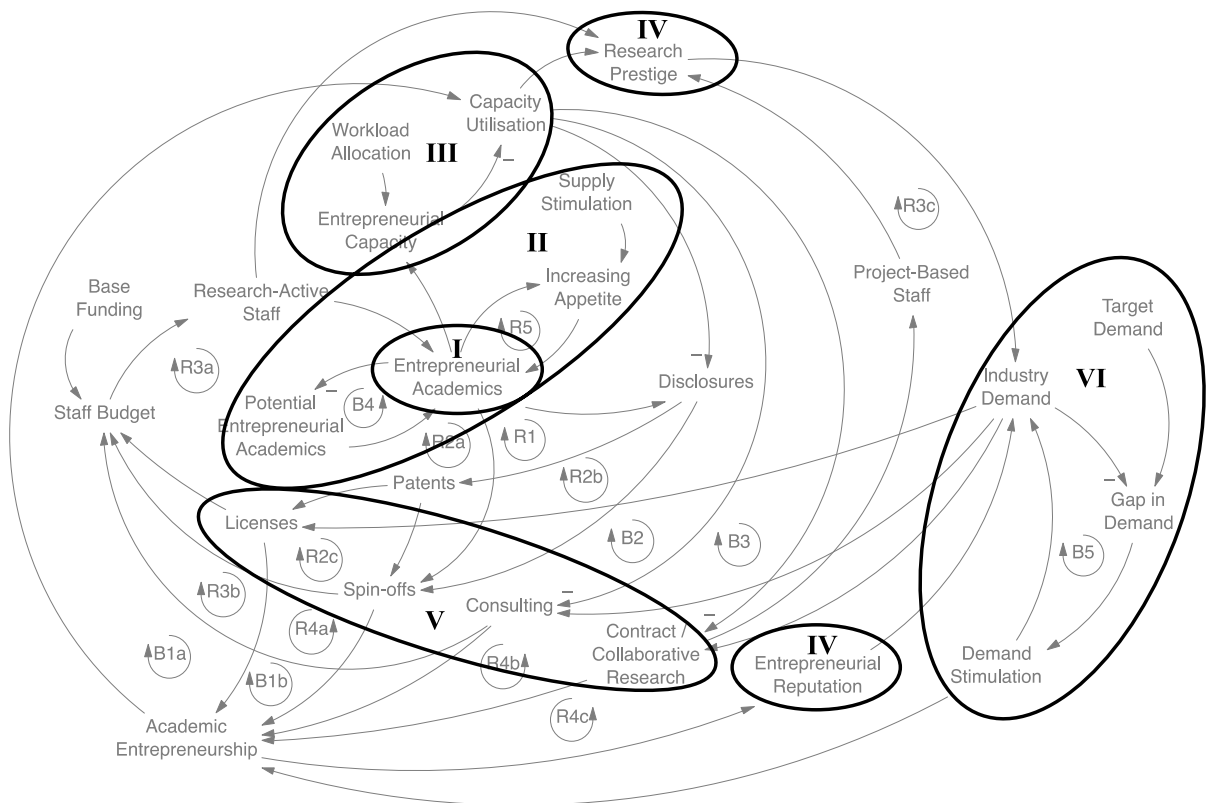


Fig. 9 Complete CLD with references to the aggregate themes from the interviews overlaid: ‘entrepreneurial academics’ (I), ‘supply stimulation’ (II), ‘resource allocation according to uni-

versity strategy’ (III), ‘reputation’ (IV), ‘partnerships’ (V), and ‘demand stimulation’ (VI). Source: Authors

to focus on revenue generation rather than providing societal benefits first (Welsh et al., 2008). Changing this requires widening the approach to entrepreneurial universities, including a broader view on what constitutes *valuable* external engagement beyond commercialisation. This is a first step in engaging more academics in these activities. Our interviews have highlighted that there is also uncertainty among academics about the incentives and rewards for themselves. To increase the number of entrepreneurial academics, universities must develop models that institutionalise the risk as opposed to leaving it with the academic (through reinforcing loop R5).

5.2 Partnerships

Most universities used to rely on ad hoc interactions with companies (Frølund et al., 2018) and behaved like a contractor, offering ‘knowledge on a market basis’ (Fey & Birkinshaw, 2005, p. 601). The result is often a high volume of evanescent collaborations that come at a

price. There are seldom any synergistic effects between these collaborations and, overall, more support is needed from the TTO. The idea is to change from a contracting approach to a partnering approach of repeated interactions with the same external partners. This has been identified as an underdeveloped concept in the literature (Belderbos et al., 2015). Universities engage in many rather superficial activities with different partners as a search mechanism to identify those companies that they want to form long-term relationships with (Dahlander & McFarland, 2013). The most common examples are consulting and contract research, as previously described, but essentially all collaborations with universities improve performance once firms have been persistently engaged with universities (Belderbos et al., 2018).

Partnerships cannot be represented explicitly in the CLD in Fig. 9 but are included in the five main activities considered in this study and the reinforcing loops R3a, R3b, R3c, R4a, R4b, and R4c (i.e. more engagement leads to more future engagement). Ties emerge from the

many ad hoc interactions based on ‘long-term strategies and substantive assessments of a relationship’s worth to draw extended rewards from the association’ and persist, ‘when familiar people reflect on the quality of their relationship and shared experiences’ (Dahlander & McFarland, 2013, p. 69). There is also a certain endogeneity involved in the partnership development process (Mindruta, 2013). If both parties are concerned with their partner’s research capabilities, ‘endogeneity arises when top faculty teams with firms whose qualities reinforce their expertise and effort in innovation (i.e. scientists and firms match on complementary attributes)’ (Mindruta, 2013, p. 645). Collaborating on R&D over an extended time span usually leads to the co-creation of very specific and often tacit knowledge (Fey & Birkinshaw, 2005). Long-term, strategic partnerships also show that universities cannot only support industry with current problems but also address grand challenges in a more ambitious, uncertain, and exploratory setting (Frølund et al., 2018). This can have a signalling effect, especially when working with leading companies, and attract new collaborators or potential licensees due to the perceived research excellence of the university. It will also, therefore, have an effect on the dynamic capabilities of universities engaged in such activities.

5.3 Nested university ecosystems and the ‘commons’

Beyond the relationships with individual companies, the model also shows the interdependencies between universities through the ecosystem more broadly. Data from the CBR Business Survey shows that the most important constraints on interaction with universities are, in descending order, insufficient internal resources, identifying partners, insufficient rewards, bureaucracy and perceived inflexibility of university administration, and lack of experience in dealing with universities (Hughes & Kitson, 2013). These issues are more crucial than, for example, (perceived) cultural differences which feature predominantly in the academic literature (e.g. de Wit-de Vries et al., 2019; Feldman & Desrochers, 2004).

The asymmetry of what is known inside a university and externally leaves many companies, who consider engaging with a university, to rely on what they know or sense rather than what is ‘knowable’ (Teece et al., 1997). Building an entrepreneurial reputation (‘strategic signalling’ through demand stimulation) and active engagement with the ecosystem must, therefore, be a key priority for universities. The entrepreneurial reputation

reflects information about a university and is an intangible asset that universities can use to achieve certain goals (Teece et al., 1997) and cannot be easily substituted or traded (Dierickx & Cool, 1989).

A company’s decision to engage with a university can be seen as a nested decision process that starts with the identification for a need for external input (‘need’) and subsequently choosing the preferred partner (Laursen et al., 2011). Industry demand for engaging with a particular University A can, therefore, be summarised as the combination of how many companies have a need for collaboration/external input and prefer to work with this university. We formalise this through the following stylised equation (Guerrero & Urbano, 2012, p.47):

$$\text{Demand for University A} = f(\text{Aggregate Need, Reputation of University A}).$$

By pro-actively engaging with companies and other external organisations, universities are not only building their own entrepreneurial reputation (though reinforcing loops R3a, R3b, R3c, R4a, R4b, and R4c), but also support the university sector by demonstrating the benefits of working with them and how to go about it. While applied at the organisational level, our model makes these feedback effects explicit. Rather than looking at individual activities limited strictly to their own institution, universities should treat this as a ‘commons’ problem (Ostrom, 1990). This also aligns with previous policy calls. For example, in the UK, there have been repeated calls and recommendations for broadening the scope of entrepreneurial activities, re-focus funding mechanisms, more accessible government support, coordination, and new schemes and forms of engagement, among others (e.g. Lambert, 2003; Wilson, 2012; Witty, 2013).

6 Conclusion

Within the extant literature on entrepreneurial universities there has been a disproportionate focus on the *trees* (‘unit theories’ of individual activities or universities) as opposed to understanding the *forest* (the relational system in which they operate). What is often ignored then is the interconnectedness and feedback between different activities and the core and dynamic capabilities of entrepreneurial universities. Through a combination of qualitative and quantitative empirical work and insights drawn from the academic literature, we present a systemic

perspective of the concept of the entrepreneurial university. We reconcile a number of ‘unit theories’, whose value is ‘not merely contained in that unit theory, [but] it is contingent upon its meaning for the programmatic theory’ (Cronin et al., 2021, p. 680).

More specifically, this paper shows that we are missing out on crucial dynamics, including potential synergies, trade-offs, and unintended consequences when isolating different aspects of activities of entrepreneurial universities. We contribute to the literature by providing a means for understanding the structure and intensity of the internal and external interactions of the entrepreneurial university. This does not downplay or dampen the individual academic entrepreneurs’ agency, but instead provides a model of the structures in which they operate. This forms the basis for new theoretical framing, policy support, and further research avenues that will yield productive support and help us unlock the potential of entrepreneurial universities for society.

This paper has two key implications for future research on entrepreneurial universities. First, this paper is an initial step toward a more systemic re-conceptualisation of the entrepreneurial university. External engagement of universities is a means, not an end in itself, and there is a need to further re-view and re-interpret entrepreneurial activities, missions, and capabilities for a better understanding of the co-creation of the ecosystem by universities and other actors. This includes re-viewing and integrating non-institutionalised entrepreneurial activities that can have a significant effect on both the university and the ecosystem in which it operates. There is further scope to re-view the relationship of the university with different parts of its ecosystem more broadly and how entrepreneurial universities react to challenges that the ecosystem or sub-systems face. Future research should also re-view the role of teaching and how educating highly skilled and entrepreneurial graduates is both affected by and shapes the university ecosystem as well as the possible linkages to entrepreneurial activities. Teaching is a fundamental mechanism for how entrepreneurial universities are constantly re-building core capabilities in a changing world (e.g. ‘enterprise for all’ initiatives, adapting curricula to industry demands). Through embracing this ‘systemness’, future research can lead to a better understanding of the levers and the potential growth trajectories by shedding light on what individual universities are and are not good at and the trade-offs that come with strategic choices.

Second, new approaches are required to embrace and operationalise this systemic perspective on entrepreneurial universities. Studying interdependencies and feedback across different activities, missions, and, by extension, different universities require methodological approaches such as system dynamics, agent-based modelling, and network approaches that can capture the feedback within the system. These should also be applied to different geographies, accounting for varieties in the institutional fabric in which universities are embedded, and make use of existing data and stimulate new data collection. The systemic nature of this line of research also marks a call to combine and harmonise datasets across missions rather than continually initiating new data collection efforts that impede wider comparison and learning. This will advance the field and get us closer to the real promise of the entrepreneurial university.

From a practical perspective, entrepreneurial universities must play the ecosystem ‘game’ to build a sustainable culture and practice of entrepreneurial activities and external engagement. Furthermore, the ‘entrepreneurial university’ will not be realised until structural issues such as including entrepreneurial activities in academics’ workload are addressed; otherwise, academics are disinclined to engage. The model allows the diagnosis of core capabilities, and which dynamic capabilities universities might want to develop by focusing on key strategic areas and leverage points (Ambrosini et al., 2009). By providing this systemic perspective, we offer the opportunity for university managers and policymakers to better understand the structural impediments to entrepreneurial action by academics and their interdependencies with the dynamic capabilities of the university.

Lastly, policy makers should widen their focus beyond commercialisation and engagement activities and support pro-active capacity and network building. This is particularly relevant for entrepreneurial universities with a less mature regional ecosystem. Effective support for universities is also limited by the absence of insights into entrepreneurial university performance as a whole, including capturing the financial and non-financial value of entrepreneurial activities and how these are balanced with the other missions of the university. Our systems perspective explicitly shows the potential synergies and trade-offs as opposed to discrete targets and isolated policies. It provides a new approach to benchmarking through assessing universities and their impact in a relational way. By

keeping a bird's eye view of the *forest*, we can ensure the *trees* are growing in the right way.



Fig. 10 Entrepreneurial activities for selected Scottish universities (2008/09-2014/15). Source: HE-BCI and HESA

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Appendix

References

- Abreu, M., & Grinevich, V. (2013). The nature of academic entrepreneurship in the UK: Widening the focus on entrepreneurial activities. *Research Policy*, 42(2), 408–422. <https://doi.org/10.1016/j.respol.2012.10.005>
- Acs, Z. J., Autio, E., & Szerb, L. (2014). National systems of entrepreneurship: Measurement issues and policy implications. *Research Policy*, 43(3), 476–494. <https://doi.org/10.1016/j.respol.2013.08.016>
- Agrawal, A., & Henderson, R. (2002). Putting patents in context: Exploring knowledge transfer from MIT. *Management Science*, 48(1), 44–60. <https://doi.org/10.1287/mnsc.48.1.44.14279>
- Ambrosini, V., Bowman, C., & Collier, N. (2009). Dynamic capabilities: An exploration of how firms renew their resource base. *British Journal of Management*, 20(S1), S9–S24. <https://doi.org/10.1111/j.1467-8551.2008.00610.x>
- Asheim, B. T., & Coenen, L. (2005). Knowledge bases and regional innovation systems: Comparing Nordic clusters. *Research Policy*, 34(8), 1173–1190. <https://doi.org/10.1016/j.respol.2005.03.013>
- Audretsch, D. B. (2014). From the entrepreneurial university to the university for the entrepreneurial society. *The Journal of Technology Transfer*, 39(3), 313–321. <https://doi.org/10.1007/s10961-012-9288-1>
- Audretsch, D. B., Belitski, M., Guerrero, M., & Siegel, D. S. (2022). Assessing the impact of the UK's research excellence framework on the relationship between university scholarly output and education and regional economic growth. *Academy of Management Learning and Education*, 21(3), 394–421. <https://doi.org/10.5465/amle.2021.0240>
- Azoulay, P., Repenning, N. P., & Zuckerman, E. W. (2010). Nasty, brutish, and short: Embeddedness failure in the pharmaceutical industry. *Administrative Science Quarterly*, 55(3), 472–507. <https://doi.org/10.2189/asqu.2010.55.3.472>
- Baker, S. E., & Edwards, R. (2012). How many qualitative interviews is enough? *National Centre for Research Methods Review Paper*. Available at: https://eprints.ncrm.ac.uk/id/eprint/2273/4/how_many_interviews.pdf
- Balconi, M., Breschi, S., & Lissoni, F. (2004). Networks of inventors and the role of academia: an exploration of Italian patent data. *Research Policy*, 33(1), 127–145. [https://doi.org/10.1016/S0048-7333\(03\)00108-2](https://doi.org/10.1016/S0048-7333(03)00108-2)
- Baycan, T., & Stough, R. R. (2013). Bridging knowledge to commercialization: The good, the bad, and the challenging. *Annals of Regional Science*, 50(2), 367–405. <https://doi.org/10.1007/s00168-012-0510-8>
- Belderbos, R., Carree, M., Lokshin, B., & Sastre, J. F. (2015). Inter-temporal patterns of R&D collaboration and innovative performance. *The Journal of Technology Transfer*, 40(1), 123–137. <https://doi.org/10.1007/s10961-014-9332-4>
- Belderbos, R., Gilsing, V., Lokshin, B., Carree, M., & Sastre, J. F. (2018). The antecedents of new R&D collaborations with different partner types: On the dynamics of past R&D collaboration and innovative performance. *Long Range Planning*, 51(2), 285–302. <https://doi.org/10.1016/j.lrp.2017.10.002>
- Bradley, S. R., Hayter, C. S., & Link, A. N. (2013). Models and methods of university technology transfer. *Foundations and Trends in Entrepreneurship*, 9(6), 571–650. <https://doi.org/10.1561/03000000048>
- Brown, R. (2016). Mission impossible? Entrepreneurial universities and peripheral regional innovation systems. *Industry and Innovation*, 23(2), 189–205. <https://doi.org/10.1080/13662716.2016.1145575>
- Bruneel, J., D'Este, P., & Salter, A. (2010). Investigating the factors that diminish the barriers to university–industry collaboration. *Research Policy*, 39(7), 858–868. <https://doi.org/10.1016/j.respol.2010.03.006>
- Carayannis, E. G., Grigoriadis, E., & Wurth, B. (2022). OR for entrepreneurial ecosystems: A problem-oriented review and agenda. *European Journal of Operational Research*, 300(3), 791–808. <https://doi.org/10.1016/j.ejor.2021.10.030>
- Carayol, N. (2003). Objectives, agreements and matching in science–industry collaborations: Reassembling the pieces of the puzzle. *Research Policy*, 32(6), 887–908. [https://doi.org/10.1016/S0048-7333\(02\)00108-7](https://doi.org/10.1016/S0048-7333(02)00108-7)
- Castillo Holley, A., & Watson, J. (2017). Academic entrepreneurial behavior: Birds of more than one feather. *Technovation*, 64–65, 50–57. <https://doi.org/10.1016/j.technovation.2017.07.001>
- Clark, B. R. (1998). *Creating entrepreneurial universities: Organizational pathways of transformation*. Pergamon Press.

- Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed method approaches* (3rd ed.). Sage Publications, Inc.
- Cronin, M. A., Stouten, J., & van Knippenberg, D. (2021). The theory crisis in management research: Solving the right problem. *Academy of Management Review*, 46(4), 667–683. <https://doi.org/10.5465/amr.2019.0294>
- Dahlander, L., & McFarland, D. A. (2013). Ties that last: Tie formation and persistence in research collaborations over time. *Administrative Science Quarterly*, 58(1), 69–110. <https://doi.org/10.1177/0001839212474272>
- Dattée, B., Alexy, O., & Autio, E. (2018). Maneuvering in poor visibility: How firms play the ecosystem game when uncertainty is high. *Academy of Management Journal*, 61(2), 466–498. <https://doi.org/10.5465/amj.2015.0869>
- David, P. A. (2004). Understanding the emergence of ‘open science’ institutions: Functionalist economics in historical context. *Industrial and Corporate Change*, 13(4), 571–589. <https://doi.org/10.1093/icc/dth023>
- de Wit-de Vries, E., Dolfsma, W., van der Windt, H. J., & Gerkeema, M. P. (2019). Knowledge transfer in university–industry research partnerships: A review. *The Journal of Technology Transfer*, 44(4), 1236–1255. <https://doi.org/10.1007/s10961-018-9660-x>
- Dierickx, I., & Cool, K. (1989). Asset stock accumulation and sustainability of competitive advantage. *Management Science*, 35(12), 1504–1511. <https://doi.org/10.1287/mnsc.35.12.1504>
- Edmondson, A. C., & Mcmanus, S. E. (2007). Methodological fit in management field research. *Academy of Management Review*, 32(4), 1155–1179. <https://doi.org/10.5465/amr.2007.26586086>
- Etzkowitz, H. (2003). Research groups as ‘quasi-firms’: The invention of the entrepreneurial university. *Research Policy*, 32(1), 109–121. [https://doi.org/10.1016/S0048-7333\(02\)00009-4](https://doi.org/10.1016/S0048-7333(02)00009-4)
- Etzkowitz, H., Webster, A., Gebhardt, C., & Terra, B. R. C. (2000). The future of the university and the university of the future: Evolution of ivory tower to entrepreneurial paradigm. *Research Policy*, 29(2), 313–330. [https://doi.org/10.1016/S0048-7333\(99\)00069-4](https://doi.org/10.1016/S0048-7333(99)00069-4)
- Eun, J.-H., Lee, K., & Wu, G. (2006). Explaining the “University-run enterprises” in China: A theoretical framework for university–industry relationship in developing countries and its application to China. *Research Policy*, 35(9), 1329–1346. <https://doi.org/10.1016/j.respol.2006.05.008>
- Fabrizio, K. R. (2009). Absorptive capacity and the search for innovation. *Research Policy*, 38(2), 255–267. <https://doi.org/10.1016/j.respol.2008.10.023>
- Feldman, M. P., & Desrochers, P. (2004). Truth for its own sake: Academic culture and technology transfer at Johns Hopkins University. *Minerva*, 42(2), 105–126. <https://doi.org/10.1023/B:MINE.0000030019.99709.a0>
- Fey, C. F., & Birkinshaw, J. M. (2005). External sources of knowledge, governance mode, and R&D performance. *Journal of Management*, 31(4), 597–621. <https://doi.org/10.1177/0149206304272346>
- Fini, R., Lacetera, N., & Shane, S. (2010). Inside or outside the IP system? Business creation in academia. *Research Policy*, 39(8), 1060–1069. <https://doi.org/10.1016/j.respol.2010.05.014>
- Florida, R. (1999). The role of the university: Leveraging talent, not technology. *Issues in Science and Technology*, 15(4), 67–73.
- Friedman, J., & Silberman, J. (2003). University technology transfer: Do incentives, management, and location matter? *The Journal of Technology Transfer*, 28(1), 17–30. <https://doi.org/10.1023/A:1021674618658>
- Frølund, L., Murray, F., & Riedel, M. F. (2018). Developing successful strategic partnerships with universities. *MIT Sloan Management Review*, 59(2), 1–16.
- Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2012). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods*, 16(1), 15–31. <https://doi.org/10.1177/1094428112452151>
- Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Aldine.
- Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today*, 24(2), 105–112.
- Grimaldi, R., Kenney, M., Siegel, D. S., & Wright, M. (2011). 30 years after Bayh–Dole: Reassessing academic entrepreneurship. *Research Policy*, 40(8), 1045–1057. <https://doi.org/10.1016/j.respol.2011.04.005>
- Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities’ activities: An exploratory study of the United Kingdom. *Research Policy*, 44(3), 748–764. <https://doi.org/10.1016/j.respol.2014.10.008>
- Guerrero, M., & Urbano, D. (2012). The development of an entrepreneurial university. *Journal of Technology Transfer*, 37(1), 43–74. <https://doi.org/10.1007/s10961-010-9171-x>
- Guerrero, M., Urbano, D., Cunningham, J. A., & Organ, D. (2014). Entrepreneurial universities in two European regions: A case study comparison. *Journal of Technology Transfer*, 39(3), 415–434. <https://doi.org/10.1007/s10961-012-9287-2>
- Guerrero, M., Urbano, D., Fayolle, A., Klofsten, M., & Mian, S. A. (2016). Entrepreneurial universities: Emerging models in the new social and economic landscape. *Small Business Economics*, 47(3), 551–563. <https://doi.org/10.1007/s11187-016-9755-4>
- Hayter, C. S., & Cahoy, D. R. (2018). Toward a strategic view of higher education social responsibilities: A dynamic capabilities approach. *Strategic Organization*, 16(1), 12–34. <https://doi.org/10.1177/1476127016680564>
- Hayter, C. S., Nelson, A. J., Zayed, S., & O’Connor, A. (2018). Conceptualizing academic entrepreneurship ecosystems: A review, analysis and extension of the literature. *The Journal of Technology Transfer*, 43(4), 1039–1082. <https://doi.org/10.1007/s10961-018-9657-5>
- Heaton, S., Siegel, D., & Teece, D. J. (2019). Universities and innovation ecosystems: A dynamic capabilities perspective. *Industrial and Corporate Change*, 28(4), 921–939. <https://doi.org/10.1093/icc/dtz038>

- Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, *15*(9), 1277–1288. <https://doi.org/10.1177/1049732305276687>
- Huberman, A. M., & Miles, M. B. (1994). *Qualitative data analysis: A sourcebook of new methods*. Sage.
- Hughes, A., & Kitson, M. (2013). *Connecting with the Ivory Tower: Business perspectives on knowledge exchange in the UK*. University of Cambridge and Imperial College London.
- Hughes, A., Kitson, M., Abreu, M., Grinevich, V., Bullock, A., & Milner, I. (2010). *Cambridge centre for business research survey of knowledge exchange activity by United Kingdom businesses 2005–2009*. UK Data Archive Study No. 6464. <https://doi.org/10.5255/UKDA-SN-6464-1>
- Hughes, A., Lawson, C., Salter, A., Kitson, M., Bullock, A., & Hughes, R. B. (2016). *The changing state of knowledge exchange: UK academic interactions with external organisations 2005–2015*. NCUB.
- Johnson, M., Monsen, E., & MacKenzie, N. (2017). Follow the leader or the pack? Regulatory focus and academic entrepreneurial intentions. *Journal of Product Innovation Management*, *34*(2), 181–200. <https://doi.org/10.1111/jpim.12355>
- Karnani, F. (2013). The university's unknown knowledge: tacit knowledge, technology transfer and university spin-offs findings from an empirical study based on the theory of knowledge. *The Journal of Technology Transfer*, *38*(3), 235–250. <https://doi.org/10.1007/s10961-012-9251-1>
- Kast, F. E., & Rosenzweig, J. E. (1972). General systems theory: Applications for organization and management. *Academy of Management Journal*, *15*(4), 447–465. <https://doi.org/10.5465/255141>
- Klofsten, M., Fayolle, A., Guerrero, M., Mian, S. A., Urbano, D., & Wright, M. (2019). The entrepreneurial university as driver for economic growth and social change - Key strategic challenges. *Technological Forecasting and Social Change*, *141*, 149–158. <https://doi.org/10.1016/j.techfore.2018.12.004>
- Klofsten, M., & Jones-Evans, D. (2000). Comparing academic entrepreneurship in Europe – The case of Sweden and Ireland. *Small Business Economics*, *14*(4), 299–309. <https://doi.org/10.1023/A:1008184601282>
- Kopainsky, B., & Luna-Reyes, L. F. (2008). Closing the loop: Promoting synergies with other theory building approaches to improve system dynamics practice. *Systems Research and Behavioral Science*, *25*(4), 471–486. <https://doi.org/10.1002/sres.913>
- Lambert, R. (2003). *Lambert review of business-university collaboration*. London: HM Treasury.
- Lane, D. C., & Schwaning, M. (2008). Theory building with system dynamics: Topic and research contributions. *Systems Research and Behavioral Science*, *25*(4), 439–445. <https://doi.org/10.1002/sres.912>
- Laursen, K., Reichstein, T., & Salter, A. (2011). Exploring the effect of geographical proximity and university quality on university–industry collaboration in the United Kingdom. *Regional Studies*, *45*(4), 507–523. <https://doi.org/10.1080/00343400903401618>
- Lehrer, M., Nell, P., & Gärber, L. (2009). A national systems view of university entrepreneurialism: Inferences from comparison of the German and US experience. *Research Policy*, *38*(2), 268–280. <https://doi.org/10.1016/j.respol.2008.11.007>
- Leih, S., & Teece, D. J. (2016). Campus leadership and the entrepreneurial university: A dynamic capabilities perspective. *Academy of Management Perspectives*, *30*(2), 182–210. <https://doi.org/10.5465/amp.2015.0022>
- Link, A. N., & Scott, J. T. (2005). Universities as partners in US research joint ventures. *Research Policy*, *34*(3), 385–393. <https://doi.org/10.1016/j.respol.2005.01.013>
- Lockett, A., Siegel, D. S., Wright, M., & Ensley, M. D. (2005). The creation of spin-off firms at public research institutions: Managerial and policy implications. *Research Policy*, *34*(7), 981–993. <https://doi.org/10.1016/j.respol.2005.05.010>
- Luna-Reyes, L. F., & Andersen, D. L. (2003). Collecting and analyzing qualitative data for system dynamics: Methods and models. *System Dynamics Review*, *19*(4), 271–296. <https://doi.org/10.1002/sdr.280>
- Lyall, C. (2007). Changing boundaries: The role of policy networks in the multi-level governance of science and innovation in Scotland. *Science and Public Policy*, *34*(1), 3–14. <https://doi.org/10.3152/030234207X190568>
- Mansfield, E., & Lee, J. Y. (1996). The modern university: Contributor to industrial innovation and recipient of industrial R&D support. *Research Policy*, *25*(7), 1047–1058. [https://doi.org/10.1016/S0048-7333\(96\)00893-1](https://doi.org/10.1016/S0048-7333(96)00893-1)
- Meyer-Krahmer, F., & Schmoch, U. (1998). Science-based technologies: University–industry interactions in four fields. *Research Policy*, *27*(8), 835–851. [https://doi.org/10.1016/S0048-7333\(98\)00094-8](https://doi.org/10.1016/S0048-7333(98)00094-8)
- Miller, D. J., & Acs, Z. J. (2017). The campus as entrepreneurial ecosystem: The University of Chicago. *Small Business Economics*, *49*(1), 75–95. <https://doi.org/10.1007/s11187-017-9868-4>
- Miller, K., Alexander, A. T., Cunningham, J. A., & Albats, E. (2018). Entrepreneurial academics and academic entrepreneurs: A systematic literature review. *International Journal of Technology Management*, *77*(1-3), 9–37. <https://doi.org/10.1504/IJTM.2018.091710>
- Mindruta, D. (2013). Value creation in university–firm research collaborations: A matching approach. *Strategic Management Journal*, *34*(6), 664–665. <https://doi.org/10.1002/smj.2036>
- Mitchell, M. (2011). *Complexity: A Guided Tour*. Oxford University Press.
- Morecroft, J. D. W. (2007). *Strategic modelling and business dynamics: A feedback systems approach*. John Wiley & Sons, Ltd.
- Norn, M. T. (2016). *What lies beneath the surface? A review of academic and policy studies on collaboration between public research and private firms*. DEA.
- O'Shea, R. P., Allen, T. J., Chevalier, A., & Roche, F. (2005). Entrepreneurial orientation, technology transfer and spinoff performance of US universities. *Research Policy*, *34*(7), 994–1009. <https://doi.org/10.1016/j.respol.2005.05.011>
- O'Shea, R. P., Allen, T. J., Morse, K. P., O'Gorman, C., & Roche, F. (2007). Delineating the anatomy of an entrepreneurial university: The Massachusetts Institute of Technology experience. *R&D Management*, *37*(1), 1–16. <https://doi.org/10.1111/j.1467-9310.2007.00454.x>

- Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.
- Owen-Smith, J. (2003). From separate systems to a hybrid order: Accumulative advantage across public and private science at Research One universities. *Research Policy*, 32(6), 1081–1104. [https://doi.org/10.1016/S0048-7333\(02\)00111-7](https://doi.org/10.1016/S0048-7333(02)00111-7)
- Perkmann, M., King, Z., & Pavelin, S. (2011). Engaging excellence? Effects of faculty quality on university engagement with industry. *Research Policy*, 40(4), 539–552. <https://doi.org/10.1016/j.respol.2011.01.007>
- Perkmann, M., Salandra, R., Tartari, V., McKelvey, M., & Hughes, A. (2021). Academic engagement: A review of the literature 2011–2019. *Research Policy*, 50(1), 104114. <https://doi.org/10.1016/j.respol.2020.104114>
- Philpott, K., Dooley, L., O'Reilly, C., & Lupton, G. (2011). The entrepreneurial university: Examining the underlying academic tensions. *Technovation*, 31(4), 161–170. <https://doi.org/10.1016/j.technovation.2010.12.003>
- Pugh, R., Lamine, W., Jack, S., & Hamilton, E. (2018). The entrepreneurial university and the region: What role for entrepreneurship departments? *European Planning Studies*, 26(9), 1835–1855. <https://doi.org/10.1080/09654313.2018.1447551>
- Rajalo, S., & Vadi, M. (2017). University–industry innovation collaboration: Reconceptualization. *Technovation*, 62–63, 42–54. <https://doi.org/10.1016/j.technovation.2017.04.003>
- Santoro, M. D., & Bierly, P. E., III. (2006). Facilitators of knowledge transfer in university–industry collaborations: A knowledge-based perspective. *IEEE Transactions on Engineering Management*, 53(4), 495–507. <https://doi.org/10.1109/TEM.2006.883707>
- Schartinger, D., Schibany, A., & Gassler, H. (2001). Interactive relations between universities and firms: Empirical evidence for Austria. *The Journal of Technology Transfer*, 26(3), 255–268. <https://doi.org/10.1023/A:1011110207885>
- Sengupta, A., & Ray, A. S. (2017). University research and knowledge transfer: A dynamic view of ambidexterity in british universities. *Research Policy*, 46(5), 881–897. <https://doi.org/10.1016/j.respol.2017.03.008>
- Sengupta, A., & Rossi, F. (2023). The relationship between universities' funding portfolios and their knowledge exchange profiles: A dynamic capabilities view. *Technovation*, 121, 102686. <https://doi.org/10.1016/j.technovation.2022.102686>
- Shane, S. (2004). *Academic entrepreneurship: University Spinoffs and Wealth Creation*. Edward Elgar.
- Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2003a). Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration. *Journal of High Technology Management Research*, 14(1), 111–133. [https://doi.org/10.1016/S1047-8310\(03\)00007-5](https://doi.org/10.1016/S1047-8310(03)00007-5)
- Siegel, D. S., Waldman, D. A., & Link, A. N. (2003b). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: An exploratory study. *Research Policy*, 32(1), 27–48. [https://doi.org/10.1016/S0048-7333\(01\)00196-2](https://doi.org/10.1016/S0048-7333(01)00196-2)
- Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2004). Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: Qualitative evidence from the commercialization of university technologies. *Journal of Engineering and Technology Management*, 21(1–2), 115–142. <https://doi.org/10.1016/j.jengtecman.2003.12.006>
- Siegel, D. S., & Wright, M. (2015). Academic entrepreneurship: Time for a rethink? *British Journal of Management*, 26(4), 582–595. <https://doi.org/10.1111/1467-8551.12116>
- Sine, W. D., Shane, S., & Di Gregorio, D. (2003). The halo effect and technology licensing: The influence of institutional prestige on the licensing of university inventions. *Management Science*, 49(4), 478–496. <https://doi.org/10.1287/mnsc.49.4.478.14416>
- Slaughter, S., & Leslie, L. L. (1997). *Academic capitalism: Politics, policies, and the entrepreneurial university*. Johns Hopkins University Press.
- Sterman, J. D. (2000). *Business Dynamics*. McGraw-Hill/Irwin.
- Tartari, V., Salter, A., & D'Este, P. (2012). Crossing the Rubicon: exploring the factors that shape academics' perceptions of the barriers to working with industry. *Cambridge Journal of Economics*, 36(3), 655–677. <https://doi.org/10.1093/cje/bs007>
- Teece, D. J., Peteraf, M. A., & Leih, S. (2016). Dynamic capabilities and organizational agility: Risk, uncertainty, and strategy in the innovation economy. *California Management Review*, 58(4), 13–35. <https://doi.org/10.1525/cm.2016.58.4.13>
- Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509–533. [https://doi.org/10.1002/\(SICI\)1097-0266\(199708\)18:7%3C509::AID-SMJ882%3E3.0.CO;2-Z](https://doi.org/10.1002/(SICI)1097-0266(199708)18:7%3C509::AID-SMJ882%3E3.0.CO;2-Z)
- Tsang, E. W. K., & Williams, J. N. (2012). Generalization and induction: Misconceptions, clarifications, and a classification of induction. *Management Information Systems Quarterly*, 36(3), 729–748. <https://doi.org/10.2307/41703478>
- Van Looy, B., Callaert, J., & Debackere, K. (2006). Publication and patent behavior of academic researchers: Conflicting, reinforcing or merely co-existing? *Research Policy*, 35(4), 596–608. <https://doi.org/10.1016/j.respol.2006.02.003>
- Vennix, J. A. M. (1996). *Group model building: Facilitating team learning using system dynamics*. Wiley.
- Welsh, R., Glenna, L., Lacy, W., & Biscotti, D. (2008). Close enough but not too far: Assessing the effects of university–industry research relationships and the rise of academic capitalism. *Research Policy*, 37(10), 1854–1864. <https://doi.org/10.1016/j.respol.2008.07.010>
- Wilson, T. (2012). A review of business–university collaboration. *Department for Business, Innovation & Skills BIS/12/610*. Available at: <https://www.gov.uk/government/publications/business-university-collaboration-the-wilson-review>
- Witty, A. (2013). Encouraging a British invention revolution: Sir Andrew Witty's review of universities and growth: Final report and recommendations. Department for Business, Innovation and Skills BIS/13/1241. <https://www.gov.uk/government/calls-for-evidence/universities-and-growth-the-witty-review-call-forevidence>

- Wright, M., Clarysse, B., Lockett, A., & Knockaert, M. (2008). Mid-range universities' linkages with industry: Knowledge types and the role of intermediaries. *Research Policy*, 37(8), 1205–1223. <https://doi.org/10.1016/j.respol.2008.04.021>
- Wurth, B., Stam, E., & Spigel, B. (2022). Toward an entrepreneurial ecosystem research program. *Entrepreneurship Theory and Practice*, 46(3), 729–778. <https://doi.org/10.1177/1042258721998948>
- Wurth, B., Stam, E., & Spigel, B. (2023). Entrepreneurial ecosystem mechanisms. *Foundations and Trends in Entrepreneurship*, 19(3), 224–340. <https://doi.org/10.1561/03000000089>
- Yearworth, M., & White, L. (2013). The uses of qualitative data in multimethodology: Developing causal loop diagrams during the coding process. *European Journal of Operational Research*, 231(1), 151–161. <https://doi.org/10.1016/j.ejor.2013.05.002>
- Zhang, Q., MacKenzie, N. G., Jones-Evans, D., & Huggins, R. (2016). Leveraging knowledge as a competitive asset? The intensity, performance and structure of universities' entrepreneurial knowledge exchange activities at a regional level. *Small Business Economics*, 47(3), 657–675. <https://doi.org/10.1007/s11187-016-9759-0>

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