University of Reading

CONCEPTUALISING ENTREPRENEURIAL UNIVERSITY:

CASE OF THE UNITED KINGDOM

Doctor of Philosophy in Management

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Abstract

This thesis contributes to the growing body of literature on entrepreneurial university and the role stakeholders play within the universities. It develops a framework for conceptualising the entrepreneurial university from stakeholders' perspective by interrogating literature, as well as secondary and primary sources. Despite the increasing body of literature on the concept of the entrepreneurial university, it is still under-theorized.

The literature on the entrepreneurial university, starting from the first publications of B. Clark up until recent studies, most were focused on case studies that have not been analytically driven and have not analysed different types of universities and their attributes and stakeholders they collaborate with. This gap in the literature of entrepreneurial universities inspired this study aim, which is to develop the analytical framework that can be applied as a tool to recognise entrepreneurial patterns in different university types.

An entrepreneurial university is considered as an institution that has three missions simultaneously or teaching, research and entrepreneurship. This has been developed as a "compass" to characterise an ideal type of entrepreneurial university. This study argues that universities apply different business models to pursue entrepreneurship and get different entrepreneurial outcomes via collaborating with a diverse range of stakeholders. University business models towards entrepreneurship have been initially developed by Etzkowitz and Leydesdorff (2000) and applying stakeholders' perspective have been tested within this study where availability of different actors seems to play a significant role for universities to achieve particular entrepreneurial outcomes. Our results show that while some universities (research-oriented) are getting entrepreneurial outcomes performing three missions simultaneously (teaching, research and entrepreneurship) others (teaching-oriented) can still have entrepreneurial outcomes fulfilling two university missions (teaching and entrepreneurship). This adds a new development to the entrepreneurial university as a phenomenon.

The case of the analysis for the purpose of this research has been the UK higher education system as a good example of universities which has utilised university missions to different extents. Applying mix method approach (quantitative and qualitative), the framework developed is shown to reveal characteristics of different universities within one country which can be used to develop policy actions. The results of this study show that the UK higher education system has both classic and entrepreneurial universities which achieve particular entrepreneurial outcomes while collaborating with different actors. To achieve higher entrepreneurial outcomes the role of Business Incubators and nurturing of business as well as commercialisation skills in faculty seems to be playing a key role.

First, this study utilised secondary data at the organisational level to build the architecture of entrepreneurial universities within different university types in the UK. Second, individual level data have been collected by the means of a survey to test the concept and was supported by in-depth interviews with academics and university managers. This approach improves the validity of the research and provides a rich overview of universities and their environment.

Finally, the study provides a framework that characterises entrepreneurial universities along with many context-neutral dimensions which could take the research forward. The novelty of using case of the country higher education system as an empirical study added a new contribution to the field. In addition, this study contributes to a better understanding of policy actions with regard to entrepreneurial transformation.

Dedication

This thesis is dedicated to my mother, Natalya Radko,

To my father, Mikhail Radko, who passed away a decade before this thesis have been ready,

To any people, the future generation and policy makers of the UK and any other country which can benefit from results of this work.

Acknowledgement

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Declaration

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or another institute of learning.

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INTRODUCTION

Purpose and motivation for the research

Universities all over the globe are being forced to reconsider the role they play in society and to estimate their relationships with various stakeholders and the community (Jongbloed et al., 2008). It is expected universities assume a *third mission (entrepreneurship)* additionally to teaching and research and to engage with regional and industrial partners (Audretsch 2014).

Why do universities follow the entrepreneurial pathway? There is a consensus of the nature of pressure on institutions throughout the globe to become entrepreneurial. In most cases, they follow policy imperatives. There is an enhanced role for universities in fostering the international competitiveness of the economy via research commercialisation (Gibb, 2010; Saginova, 2005).

Entrepreneurial universities have incorporated entrepreneurship into the academic culture to attain economic returns generated from new knowledge via teaching and research, teams of teachers and students as well as businesspeople, networked enterprises occurred in university new venture (spin-offs and start-ups) activities. The entrepreneurial university mission is to facilitate an environment that promotes innovative activity and risk-taking. One of the main features of entrepreneurial universities is to explore innovative ideas for potential business opportunities.

There is a push for universities to prepare students for a life in uncertainty and complexity including global mobility, frequent occupation, job status changes, adjusting to different cultures; higher level of self-employment, higher responsibility in life (Jongbloed et al. 2008). There is also a lifelong learning concept devoted to preparing students to live in a constantly changing environment. Additionally, the concept of life-long learning pushed universities to be opened to learning from different stakeholders they are collaborating with.

This notion is aligning with an idea of stakeholder capitalism which acknowledges each stakeholder as essential to value creation and trade rather than preferring the interests of one group over another (Freeman et al., 2007). Stakeholder capitalism is fostering innovations. Thus, to successfully create, deliver and sustain value, universities must engage with stakeholders.

Globalisation and development of information technologies diversified the way intellectual property belongs when universities are no longer the only and the main source of it (Gibb, 2010; Perkmann et. al., 2021). To secure their status, universities would require developing a partnership with different stakeholders and the society (Gibb, 2010). Additionally, universities cannot be isolated from the society demands by the state funding what was the guaranty for

their autonomy forcing academia to earn this autonomy by other means. The necessity to look for external funding by building credibility with key stakeholders and facilitating the process of active engagement became a key in university mission (Cunningham & Miller, 2021).

Additionally, increasing market competition is forcing firms to investigate new directions of collaboration with universities to foster service and product innovations. The industry could benefit from greater knowledge and technology transfer by working together and developing strategic networks with the university. Gattringer et. al. (2014) showed that a university-industry collaboration network has many benefits for its various stakeholders and can overcome barriers in knowledge transfer.

Although recent literature on the entrepreneurial university has benefited from research on a stakeholders' pull (Miller et al., 2014), we argue that the distinctive types of entrepreneurial university stakeholders have not been categorized and their involvement in the commercialization of basic and applied research has not been investigated. Stakeholders' role across various levels of university engagement has also not been researched. In addition, studies on whether the entrepreneurial model is appropriate for all types of universities are limited. Furthermore, research that conceptualizes shareholder perspective and the multi-dimensional structure of the entrepreneurial university has been fragmented (Hayter, 2016). When it comes to academic engagement literature, there is a lack of studies and analytical and methodological approaches to evaluate the drivers and impediments of faculty engagement with different stakeholders on idea and/or new knowledge development and promotion stages (Iorio et al., 2017). This research will contribute to filling identified gaps.

The recognition of the main group of stakeholders is not simple (Jongbloed et. al., 2008). Thus, Bartell (2003) emphasized the high complexity of university as an organization with a variety of external and internal stakeholders. However, different customers and employees can have a diversified influence on organisations. Applying stakeholder framework to management may be a useful instrument assisting organizational actors while dealing with environments (Freeman 1984). It allows selectively to perceive, evaluate and interpret stakeholders' attributes and main actors' attitudes towards collaboration. For instance, Mitchell et al. (1997) applied Freeman's stakeholder concept and developed an approach assisting to recognise "who or what really counts" and evaluate the extent to which managers should pay attention to their stakeholders.

The **aim** of this study is to develop conceptual and methodological recommendations helping to facilitate the engagement of universities with stakeholders around following their specific role to contribute to better outcomes of the academia.

The specified aim requires execution of the following **objectives**:

- to generalise and systematize the main scientific and methodological approaches to the definition of an entrepreneurial university and its stakeholders;

- to analyse the existing case studies on entrepreneurial university and identify the role different actors have within the knowledge and technology transfer process;

- to explore and describe the current state and the contribution of different stakeholders into achieving university outcomes;

- to identify factors contributing to achieving university entrepreneurial outcomes;

- to define factors impacting the willingness of academics to engage with other actors for commercialisation;

- to determine stakeholders having the strongest contribution to the willingness of academics to engage with others for commercialisation and identify why they are the most important;

- to develop practical recommendations on facilitating the engagement of academics with stakeholders around the university.

Following the aim and objectives the following main **research questions** are guiding this research with the supporting questions provided in Table 1 (p. 18 of this thesis):

- What is the role of stakeholders in facilitating entrepreneurial outcomes of universities?
- What factors shape entrepreneurial outcomes of different types of UK universities?
- What factors impact the interest of academics to engage with other actors for commercialisation?
- What university managers can do to facilitate the engagement of academics with stakeholders for knowledge and technologies transfer?

The object of the research.

The object of this research is an entrepreneurial university. For the purpose of this study, we define the entrepreneurial university as any university that has the ability to innovate, recognise and create opportunities (Kirby, 2002) and can produce and disseminate knowledge (Etzkowitz, 2003). It can also develop a comprehensive internal system for knowledge commercialisation (custom-made further-education courses, consultancy services, contract research) (Jacob et al., 2003) and commoditisation (patenting, licensing; both staff and student spin-offs and start-ups) (Chrisman et al., 1995; Jacob et al., 2003) by providing a support structure, as a "natural incubator" (Etzkowitz, 2003), through different stakeholders.

The subject of the research.

This research explores the entrepreneurial university from the perspective of the role different stakeholders play for knowledge and technologies transfer out of university boundaries. Firstly, the process has been conceptualized and explored from the organizational point of view considering the final outcomes of academic entrepreneurship (new ventures creation (spin-offs and start-ups) and IP revenues generation). Secondly, individual faculty perspective on engagement with others have been explored to identify factors facilitating and exhibiting the engagement of academics with different stakeholders.

Thus, this research set an objective to conduct a comprehensive review of the current literature on entrepreneurial university and academic entrepreneurship to develop multidimensional conceptual and empirical models of the object of the study based on the UK example. In particular, we apply a stakeholder approach to identify the role different stakeholders play for knowledge and technologies as well as to find out what university managers can do to facilitate the engagement of academics with others to reach entrepreneurial outcomes. Using the example of the UK, we test multidimensional conceptual and empirical model to develop university and public policy recommendations applied to entrepreneurial universities.

Based on Jongbloed et al. (2008), the variety of traditional and emerging communities with whom universities are engaging now requires a clearly articulated strategy to understand stakeholders and manage collaboration with them. According to Freeman (2010), the effectiveness and efficiency of the organization largely depend on the stakeholders' characteristics and their interconnection.

From the theoretical perspective, the instrumental approach to the stakeholder concept could be vital in higher education while explaining the connection among the academia and its various stakeholders. The approach is discussed in Chapter 1 of this thesis.

Chronology of this research.

This research cover data from Higher Education Business and Community Interaction Survey in the UK since 2010 based on the time when the first survey has been conducted by Higher Education Statistics Agency. In addition, by the means of a survey and interviews, primary data have been collected for the purpose of this research from October 2020 to March 2021.

The philosophical foundation of the study.

This research is based on ideas of social constructivism which claims that sociological analysis of scientific knowledge and science is crucial and discloses the social nature of science. Scientific knowledge development is determined by the social forces which are independent

and contingent of rational methods and could be analysed from the perspectives of causal processes of formation of any beliefs (Latour & Woolgar, 2013).

Until the 1980s, academic thoughts about science, technology and innovation (STI) were based on ideas of differentiation, ordering, and contractual relationships between science and society. Against this background, STI policy researchers came to a common understanding that there was a social contract in the sense of "a map of the institutional arrangements and their intellectual foundations that dominated in science policy from the end of World War II until about 1980" (Guston, 2000, p. 39).

From a historical point of view, the idea of a social contract for science has never been existed on its own but required institutional and symbolic support. For example, after World War II, the language of technology transfer and innovation has become increasingly important to support the social contract in science and arguments for sustainable spending on R&D.

Ideas of transferring research outcomes to civilian use were presented in concepts such as “spin out”, “spill over” and “spinoffs” (Geiger, 1993, pp. 71, 77). In terms of metaphorical support for the social contract, these early concepts of technology transfer were functional in maintaining a kind of “protected space” for scientists (Rip, 2011).

They did not question the relevance of the production of scientific knowledge but advocated auxiliary means that make scientific knowledge available for transfer to the region and society. Reflections and arguments for concepts related to technology transfer models have been accompanied, if not overlapped, by what scholars have in retrospect called the “linear innovation model” (Godin, 2006).

Since the 1950s, the linear model has promoted the idea that innovation can be planned in different sequences of actions. While economists and STI policy researchers challenge their failure to grasp the complexities of innovation (Fagerberg, 2005), the linear model remains dominant in STI discourses around the world, albeit more as an idea than as a model in the technical and economic sense (Godin, 2017).

For several decades (from about 1950 to 1980), reconciling the contract metaphor with technology transfer and innovation models has been quite successful in codifying some of the problems and implicit premises of research policy. These issues have been reflected in debates about contested concepts such as “basic research” and “applied research” (Kaldewey & Schauz, 2018), or more recently in terms of “excellence”, “interdisciplinarity” and translational research”.

Sometimes such concepts act as boundary objects; through their interpretable flexibility, they can facilitate consensus building or generate and fuel controversy. The important thing here is

that scientists and politicians need to use a common conceptual language. Historically, such a common language has been used either to challenge the importance of basic research conducted by researchers or to defend its relevance to innovation processes.

In other words, the social contract for science, as well as models of technology transfer and innovation, have been useful strategies in the day-to-day "frontier work" of scientists and policymakers (Gieryn, 1983). However, constraint and adaptation (Calvert, 2006) - especially when integrated into broader narratives of scientific and social progress - are more than strategic games: they provide participants in different institutional settings with different roles in an imaginary innovation process and, thus a sense of identity (Kaldewey, 2018). They can help build consensus or create and build controversy (Jacob, 2005, p. 198).

This brief discussion should be enough to illustrate that concepts, models and metaphors are powerful not necessarily because of their analytical accuracy, but rather because of their symbolic function in STI policymaking. Against this backdrop, STI research may benefit from examining more closely their role in managing the science-policy interface. To do this, we rely on a combination of conceptual history and metaphorical analysis.

Conceptual history traces the origins and trajectories of concepts, and the modifications that occur in their meanings, thereby helping to reveal the "layered meanings contained in the actual use of the concept" (Steinmetz & Freeden, 2017). With regard to the actual use of concepts in communication policy in the field of STI, the conceptual history should be complemented by the findings of cognitive linguistics.

Following Lakoff and Johnson (1993), participants from different social spheres are likely to be attracted if they can associate themselves with common, analogous and figurative language - especially with metaphors. In other words, social conventions and - ultimately - legitimacy can only be achieved if complexity is reduced through language. We build on these ideas and argue, that following ideas of *social constructivism*, neither expert academics nor politicians can achieve an overarching and identical imagination or representation of (social) phenomena, but rather deal with historically and contextually random sets of concepts, models and metaphors.

With this in mind, we argue that STI policy discourses in the 1990s were not based on popular and therefore familiar metaphors that easily conveyed ideas and images within and between social contexts: while academic concepts Post-normal science (Funtowicz & Ravetz, 1993), Mode 1 and 2 knowledge production models (linear knowledge production culture) (Gibbons et al., 1994), and the triple helix model (Etzkowitz & Leydesdorff, 2000) reflect the search a new contract between science and society (Hessels et al., 2009), they remain the offspring of

their very expert communities (see Table 1 for more details). As a consequence, these concepts have not resulted in STI policy discourses becoming as influential and sensible as the supposedly outdated models of technology transfer and linear innovation. The fact that, in the meantime, we are confronted with semantic aberrations such as "third mode (Mode 3) knowledge production in innovation systems with four helixes (quadruple helix)" (Carayannis & Campbell, 2012) demonstrates that STI policies in the 21st century are still haven't learned to speak in believable, memorable language.

Table 1. Knowledge production modes.

Type	Mode 1	Mode 2	Mode 3
Knowledge production method	Academic interests of specific groups set the knowledge problems and their solutions.	Production of knowledge is in the context of an application.	Production of knowledge and innovations are aligned with the socio-ecological transition of economy, society, and democracy.
Knowledge production capabilities	Discipline based	Cross-disciplinary	Trans-disciplinary
Configurations for knowledge creation, diffusion, and use	Homogeneity	Heterogeneity	Multi-layered, multimodal, multi-nodal, and multilateral
Interaction mode	Bilateral interactions among academia, industry, and government.	Triples Helix model of innovation among universities, industry, and government.	Quadruple and quintuple helix model of innovation among universities, industry, government, civil society, and natural environment.

Thus, Mode 1 and Mode 2 models that were put forward by Gibbons in 1994 have been among the first knowledge production functions and were linear in nature. Based on Gibbons ideas other authors put forward relevant concepts with the current research agendas including the Triple Helix by Etzkowitz et al. (2008), The Engaged University (Watson, 2011), Mode 3 knowledge production model (Carayannis & Campbell, 2012), The Question of Conscience (Watson, 2011).

The Mode 3 culture value research impact on society and region and emphasis the coexistence and co-development of knowledge and innovations at individual, organisational and system levels (Carayannis & Campbell, 2012). It values collaboration of the university with a diverse set of stakeholders in a non-linear manner with an overlap of basic research, its application and further development. According to this model, research (or new knowledge production) is not independently concerned with the university and technologies is not solely exploited by

industry but "socially distributed knowledge" (Gibbons, 1994) or a Mode 3 knowledge creation and distribution model (Carayannis & Campbell, 2012).

Thus, policies around the world are pushing universities towards Mode 2 and Mode 3 knowledge production models to collaborate with a broader set of stakeholders and benefit societies.

This research follows the Mode 3 model of universities approach in knowledge production and dissemination.

The theoretical and methodological basis of the study.

This research is based on the theoretical concepts developed previously including the concept of the entrepreneurial university by Clark B., Kirby D., Audretsch D., Etzkowitz H., Guerrero M. and its role in the entrepreneurial society through collaboration with other actors. We described the phenomenon as an organisation that develop a supportive structure while collaborating with others to facilitate knowledge dissemination and application.

This research integrates logic from instrumental approach to stakeholder theory developed by Freeman E. (1984) and Donaldson & Preston (1995) to conceptualise the framework to explain the role different stakeholders within the university domain play for knowledge and technology transfer. In addition, we expanded the application of the stakeholder approach to the entrepreneurial university as a phenomenon and applied it previously to the university domain by Miller K., McAdam M., McAdam R. as well as Bischoff K. and Gianiodis P. (the latter applied it exclusively to the entrepreneurial education). The inspirational methodological work for this thesis was research proposed by Bradley et al. (2013) who described technology commercialisation as a process within the university. This work also incorporated the academic entrepreneurship phenomenon following Kalar & Antonic (2015) and expanded it integrating the stakeholder approach.

Theoretical contribution.

This thesis contributes to the knowledge spillover theory of entrepreneurship (Audretsch, 1995; Acs et al., 2004, 2013) arguing that the theory misses the support and skills domains that academics and students as entrepreneurs need to make a decision to pursue entrepreneurship. This thesis incorporates the stakeholder concept and academic entrepreneurship approach applied to the university domain to explain the contribution to the theory.

Practical contribution.

This thesis provides an overview of the contribution of different types of stakeholders to achieving different entrepreneurial outcomes based on the university type (e.g., research or

teaching-oriented) (more details are provided in Table 1). In general, our results show that no matter of university type, all the universities do benefit from having or collaborating with Business Incubator and the Government. In addition, faculty acquired and developed business and commercialisation skills would be more inclined to collaborate with others for knowledge and technologies transfer. This research provides methodological recommendations helping to facilitate the engagement of universities with stakeholders which could be used by university managers in making justified managerial decisions. In addition, those developments might be used and applied by relevant ministries.

Viva statements:

1. Based on the literature, available definitions of the entrepreneurial university have been analysed and it was identified that there is no common definition that integrated stakeholder approach to understanding the phenomenon and thus should be explored both from academic as well as practical points of view.

2. This research has shown that universities as entrepreneurial do collaborate with a broad range of stakeholders who play four main roles including knowledge enabling (government and industry), knowledge production (university faculty and students, managers), knowledge codification (technology transfer and intellectual property offices), knowledge facilitation (science parks, business incubators, venture capitalists).

3. When it comes to the organisational level of analysis, this research has shown that different stakeholders contribute to different entrepreneurial outcomes of the university. However, one feature has stand-out that no matter of university type they would always benefit from having or collaborating with Business Incubators and Government while much attention within the academic research as well as government policy has been given to TTOs.

When it comes to collaboration with technology transfer offices, those universities which are more research-oriented would benefit much when it comes to IP revenues generation while this stakeholder might cause a negative effect for teaching-oriented universities when it comes to new companies' creation. The effects of venture capitalists and science parks are different across universities and types of entrepreneurial outcomes. As an example, higher investment into start-ups might negatively affect IP revenues generation at Russel Group universities. Investment into one type of company (e.g., in staff start-ups) might cause a negative effect on the creation of other types of companies (e.g., student start-ups).

4. When it comes to the individual level of analysis or university faculty, this research has justified that, academics would be more inclined to collaborate with others for the purpose of knowledge and technologies transfer if they are more confident in their business skills and

knowledge about commercialisation. Academics would expect Business Incubators to contribute to enhancing their business skills.

Publications.

Following the dissertation topic, four papers have been published, including 1 publication in journal indexed in Scopus, as well as 2 publications in local peer-reviewed journals, recommended by the Ministry of Education in Russia. In addition, 1 book chapter has been accepted for publication by Edward Elgar publisher. The structure of the dissertation is followed the objectives set. Research findings have been presented at the local and international conferences on the topic.

Publication list:

1. Radko N. (2021) Income generation activities from academics at universities and engagement with stakeholders, Mezhdunarodnye protsessy.
2. Радько Н. Скиба М.А. (2021), Предпринимательский университет: влияние государства на построение предпринимательской экосистемы. Наука Красноярья, Vol. 10 (4), pp. 27-52.
3. Radko N., Korzhova N.A., Skiba M. (2022), The impact of university collaboration with stakeholders on employment and turnover of university new ventures, Economic Sciences, Vol. 9 (202), pp. 297-304.
4. Radko N. (2022), Entrepreneurial university stakeholders and their contribution to knowledge and technologies transfer, in Developments in Entrepreneurial Finance and Technology. Edward Elgar.
5. Radko N., Belitski M., Kalyuzhnova Y. (2022), Conceptualising Entrepreneurial University: The Stakeholder Approach. The Journal of Technology Transfer. (Accepted)

Thesis overview.

Each Chapter of this thesis contributes to the relevant literature and area of knowledge.

Chapter 1 is conceptual and is the first attempt to utilise stakeholder perspective to represent entrepreneurial university applied to technology transfer domain and education. It explains the role of different actors by structuring four different groups of entrepreneurial university stakeholders based on their contribution to achieving university goals. Within the following Chapters, the phenomenon has been evaluated from both organisational and individual perspectives.

We have structured and described the role each stakeholder has for the generation and transfer of new knowledge via systemically evaluating existing case study papers on the entrepreneurial university. This helped us to conceptualise stakeholder perspective and the multi-dimensional structure of entrepreneurial university which has been fragmented.

Literature on the entrepreneurial university has covered different features of the phenomenon and connections of university with different stakeholders which are scattered around the university with no empirical evaluation of the actual role of each stakeholder applying a holistic approach.

Chapter 2 is the first attempt in the literature and practice to test theoretical concept of the entrepreneurial university via providing in-depth insight into the organisational structure of university and its connection with different stakeholders.

Within this Chapter, we build the architecture and analysed the organisational structure of the university as well as evaluated the contribution of each stakeholder to achieving entrepreneurial outcomes. Applying secondary data, we identified which stakeholders contribute to which entrepreneurial outcome applying to different university types in the UK.

This research unfolds the complexity of different types of entrepreneurial universities. This is beneficial for theory and practice to describe interdependent processes and mechanisms for knowledge transfer among different stakeholders to understand their role in achieving university entrepreneurial outcomes.

Chapter 3 contributes to the academic entrepreneurship literature. Within the framework of this research, we have evaluated the impact of engagement of academics with relevant stakeholders at and/or around the university on the decision of academics to interact for knowledge and technologies commercialisation. This Chapter brings more clarity on which factors facilitate and/or inhibit the decision of academics to engage with others for knowledge and technologies transfer.

This study is an advanced step to contribute to a better understanding of the academic entrepreneurship phenomenon within the entrepreneurial university from the perspective of support universities provide to individuals. In particular, applying primary data (survey and interviews) this research has evaluated the feedback of academics on actual engagement with other actors on their interest to engage with others for achieving entrepreneurial outcomes. By analysing data gathered this study tries to identify what can be done by university managers and actors engaged to facilitate knowledge and technologies sharing.

Table 2 provide an overview of the thesis according to each Chapter.

Table 2. Thesis overview according to each chapter.

	Chapter 1 Literature review and development of the concept	Chapter 2 Analysis of the phenomenon at the organisational level	Chapter 3 Analysis of the phenomenon at the individual level
Title	Entrepreneurial university and collaboration with stakeholders: background and conceptualisation	The context of entrepreneurial universities in the UK (organisational level of analysis)	The role of stakeholders for academic entrepreneurship within entrepreneurial university
Study objectives	To develop two conceptual models based on the case studies available: - a conceptual model of entrepreneurial university and stakeholders around; - a conceptual model of academics' engagement with stakeholders.	To test the conceptual model of the entrepreneurial university across different types of universities in the UK from the organisational point of view (applying secondary data).	To identify what facilitate and provide impediments in academics' engagement with stakeholders via testing the conceptual model from individual point of view (applying primary data).
The research question for each Chapter	- Who are the stakeholders and what is their role in facilitating entrepreneurial outcomes of the university? - What motivates academics to engage with other actors?	- In which way do different types of universities within the UK engage with stakeholders? - What factors shape the entrepreneurial outcomes of UK universities?	- What impact academics' decision to engage with different stakeholders? - What university managers can do to facilitate the engagement of academics with stakeholders for knowledge and technologies transfer?
Methodology	Conceptual Chapter to conduct a comprehensive review of the literature on entrepreneurial university and academic entrepreneurship.	Empirical Chapter to test the conceptual framework of university engagement with others from the organisational point of view. A quantitative study applying Pooled OLS regression and interaction analysis.	Empirical Chapter to test the conceptual framework from individual point of view. Mixed method study applying Factor analysis and multinomial logistic regression, structured analysis of interviews.
Data source	All the available studies for this research have been accessed via the following databases: EBSCO, ABI Inform, Science Direct, Taylor and Francis, Wiley and Blackwell, JSTOR, Springer, Sage journals, Books Google, ProQuest.	University-business collaboration survey (Higher Education Business and Community Interaction Survey (HE-BCIS)) collected by the Higher Education Statistics Agency (HESA).	Survey and interviews developed for the purpose of this research.

Research outcomes	RO1 - Through analysing the literature, the following main stakeholders who contribute to new knowledge and technologies generation and transfer have been identified: industry, government, faculty, students, technology transfer office, intellectual property office, business incubator, science park, a venture capitalist. RO2 Identified stakeholders have been grouped into four main groups following the role they perform: - knowledge enablers (Government and Industry - organisations and individuals that facilitate knowledge manipulation); - knowledge providers (university faculty and students - organisations and individuals that produce and spillover knowledge within the entrepreneurial university); - knowledge codifiers (organisations and individuals that actively seek new channels and forms of knowledge transfer, and facilitate knowledge spillovers outside the university level - Technology transfer and intellectual property offices); - knowledge facilitators (organisations that facilitate entrepreneurial incentives and encourage knowledge spillovers within the university and into the ecosystem; these stakeholders may also raise finance - research and science parks,	RO1 Based on the UK higher education sector, we have been able to see the following patterns on universities engagement with stakeholders: - engagement with a broader set of stakeholders (all stakeholders included in the framework) is inherent to more research-oriented universities for achieving entrepreneurial outcomes (both IP revenues generation and new companies' creation) while teaching-oriented universities might less benefit from collaborating or having technology transfer offices; - for Russel Group universities most of the negative interactions associated with VC what have been explained as once the VC support is secured, universities may want to cut down on other forms of collaborations with external stakeholders and prioritising VCs; - Business Incubators seem to be the stakeholder which provides a positive effect on the generation of different entrepreneurial outcomes both in research and teaching-oriented universities (but IP revenues for Polytechnic universities); - as for the Polytechnic universities, the more university faculty interact with Government as well as Science Parks and Business incubators, the better chances are for the TTO to bring a positive contribution to university entrepreneurial outcomes; - when it comes to Rest Teaching universities, this type of universities mostly	RO1 - business and commercialisation skills as well as time are the two main factors contributing to the willingness of academics to collaborate with others and commercialise new knowledge and technologies. - readiness of industry to implement new technologies is also very important for academics to proceed for commercialisation. RO2 - encourage faculty to take CPD courses to develop their business and commercialisation skills.

	business incubators, accelerators; venture capitalists, business angels).	benefit if they set up or collaborate with Business incubators and Venture Capitalists. RO2 - renting university facilities is not exactly beneficial for universities and only teaching universities do benefit significantly out of that; - having a plan for engagement with business is positive for new companies' creation while is negative for IP revenues generation (except for Polytechnics) - the contribution of universities to graduates retention to the region is positive for graduate start-ups creation; - university's contribution to regional skills development has a positive effect on graduate start-ups creation for teaching-oriented universities.	

CHAPTER 1. ENTREPRENEURIAL UNIVERSITY AND COLLABORATION WITH STAKEHOLDERS: BACKGROUND AND CONCEPTUALISATION

1.1. Entrepreneurial university as a concept.

This section is aimed at describing what the entrepreneurial university as a phenomenon is and how we should understand it.

Over the last two decades, the field of entrepreneurship has expanded, incorporating the concept of entrepreneurial university (Kirby et al. 2011; Guerrero and Urbano 2012). In the literature, this phenomenon has been described as the "Evolution of the ivory tower" (Etzkowitz et al. 2000), the rise of the entrepreneurial university (Guerrero et al. 2016) and the new "Humboldt University" phenomenon (Audretsch 2014).

In recent years, universities have become key stakeholders of the entrepreneurial society, which reflects the central role played by them as conduits of knowledge that spillover to entrepreneurship (Bradley et al. 2013; Braunerhjelm et al. 2010; Acs et al. 2013). Moreover, universities are an important source for regional economic development and the main driver of local content policy (Kalyuzhnova et. al 2016). At the same time, there has been a lack of systemic literature review and empirical evidence of entrepreneurial university, in particular through knowledge spillover of entrepreneurship and a stakeholder perspective (Gianiodis et al. 2016; Abreu et al. 2016).

The entrepreneurial university is characterised by high organisational adaptation to the changes in the environment (Clark, 1998; Grishina et al., 2012) and by governance and managerial distinctiveness (Subotzky, 1999). Such a university implements new activities oriented towards the development and enforcement of entrepreneurial culture at all levels (Kirby, 2002), contributes to the economic development through the creation of new companies (Chrisman et al., 1995), as well as commercialises its research results (Jacob et al., 2003). Relying on these parameters, the entrepreneurial university has the capacity to innovate, recognise, and create opportunities, take risks, work in teams, as well as respond to challenges (Guerrero and Urbano, 2012). More concretely, the entrepreneurial university is required to fulfil three missions simultaneously: teaching, research and entrepreneurship, which otherwise might be at odds with each other.

Based on the endogenous growth theory and starting from Solow's model (Solow, 1956) university outcomes are transformed and served as determinants of the economic development of a region or city (Audretsch and Keilbach, 2004; Lucas, 1988; Romer, 1986). According to

Kirby et al. (2011), they later provide a positive impact on the society as well as the economy of the region.

Academia is accepted as the main provider of knowledge and technology (Romer 1986; Lucas 1988) having innovative context as an engine of economic growth. Furthermore, following the perspective of information and knowledge society development, the most valuable assets are both social and human capital with knowledge and creativity being key factors (Guerrero et al., 2016). According to Mian (2011), knowledge and innovation (which is an output of the former and creativity) are the key facilitators of economic growth, competitiveness and wealth creation in a competitive world.

There is a push for universities to prepare students for a life in uncertainty and complexity including global mobility, frequent occupation, job status changes, adjusting to different cultures (Ghoshal & Gratton, 2002); higher level of self-employment, higher responsibility in life. There is also a life-long learning concept devoted to preparing students to live in a constantly changing environment (Mayhew et al., 2008).

Based on this scenario, university education is considered a ticket into the working world. One of the components for this view is an encouragement of students to pursue a career in entrepreneurship with an emphasis on managing independence and the capacity to develop new ventures with high growth potential (one of the popular assumptions is that graduates are more ambitious segment of the population) (Gibb et al., 2013).

According to Lucas (1988), human capital is a factor of production, concerning knowledge, competencies, skills and abilities gained through education and trainings (Becker, 1993). Thus, teaching as universal university activity contributes to human capital development through educating students who later become jobseekers and job creators. The creation of jobs by graduates is contributed to the entrepreneurial mission of the university.

Research activity represents another legitimate function of the university in the knowledge-based economy. This function has been described as a generation, transfer and commercialization of new knowledge (Solow, 1956; Romer, 1986). The mechanism of knowledge commercialisation includes patents, licenses, trademarks and copyrights as main spillover indictors. According to the literature, this phenomenon is called academic entrepreneurship that occurs at the boundaries of scientific and professional backgrounds and requires a supporting mechanism to go beyond these boundaries (Urbano and Guerrero, 2013).

Since universities have seen that intellectual property rights can bring commercial wealth, they become more aggressive on the knowledge market (Jongbloed et al., 2008) and more active in

transferring its newly generated knowledge to the industry and established new structures that link universities with industry to spillover knowledge easily.

Background of the phenomenon

We analysed all the existing definitions of the entrepreneurial university to understand and evaluate how it has been understood and evaluated in the literature and conceptualised since its origin.

Universities are among the fundamental ancient institutes in history, and they require a comprehensive evaluation (Ropke, 1998). There are four main theoretical approaches used to describe the entrepreneurial university concept and they were developed by Clark (1998), Sporn (2001), Etzkowitz (2004) and Kirby (2006). Clark (1998) was among the first authors to describe the entrepreneurial university model, the mechanism and emergent structure (Etzkowitz 2000) as well as the one who described historical accounts was Etzkowitz (Etzkowitz 1983; 2003, Etzkowitz et al. 2000). According to Etzkowitz and Leydesdorf (2000) university is at the centre of the relationships between academia, industry and government and it plays a prominent role in innovation and economic development in the knowledge society.

The empirical papers from the period 1995-2019 have analysed universities as an entrepreneurial phenomenon within such countries as China, Canada, Singapore, Netherland, United States, Germany, Sweden, Australia, Italy, Spain, the UK (Table A1 Appendix A).

The growing literature on the entrepreneurial university have been fragmented including plural definitions, multiple theories the works were based on, as well as multiple methodological approaches. The definitions of the entrepreneurial university are presented in Table 3.

One of the first researchers who provided a conceptualisation of entrepreneurial university were Etzkowitz (1983) and Clark (1998). According to Etzkowitz (2003) entrepreneurial university is considered a classical research university having the Third Mission additionally to teaching and research. This third mission includes an active contribution to social and economic development (Perkmann et al., 2013; Schulte, 2004; Guerrero et al., 2016).

Table 3. Principal definitions of Entrepreneurial Universities

Year	Author	Definition	The measurement
1983	Etzkowitz	"Universities that are considering new sources of funds like patents, research under by contracts and entry into a partnership with a private enterprise"	A new source of funds like patents. Contract research, private enterprise partnership
1995	Chrisman, et al.	The Entrepreneurial University involves "the creation of new business ventures by university professors, technicians, or students"	Creation of new business ventures
	Dill	"University technology transfer is defined as formal efforts to capitalize upon university research by bringing research outcomes to fruition as commercial ventures. Formal efforts are in turn defined as organizational units with explicit responsibility for promoting technology transfer"	Commercial ventures from research outcomes
1998	Clark	An Entrepreneurial University, on its own, seeks to innovate in how it goes to business. It seeks to work out a substantial shift in organizational character so as to arrive at a more promising posture for the future. Entrepreneurial universities seek to become "stand-up" universities that are significant actors in their own terms"	Globalisation, Entrepreneurship
	Röpke	"An entrepreneurial university can mean three things: the university itself, as an organization, becomes entrepreneurial; the members of the university faculty, students, employees are turning themselves somehow into Entrepreneur; and the interaction of the university with the environment, the "structural coupling" between university and region, follows entrepreneurial patter"	The members of the university faculty, students, employees are turning themselves into Entrepreneur
1999	Subotzky	"The entrepreneurial university is characterized by closer university-business partnerships, by greater faculty responsibility for accessing external sources of funding, and by a managerial ethos in institutional governance, leadership and planning".	
2000	Etzkowitz and Leydesdorf	An entrepreneurial university is any university that undertakes entrepreneurial activities	
2000	Etzkowitz et al.	Entrepreneurial universities are those that engage in third mission activities to improve regional or national economic performance as well as the university's own financial position.	Engagement in third mission activities to improve …. the university's own financial position
2002a	Kirby	"As at the heart of any entrepreneurial culture, entrepreneurial universities have the ability to innovate, recognize and create opportunities, work in teams, take risks and respond to challenges".	
2003	Etzkowitz	"Just as the university trains individual students and sends them out into the world, the Entrepreneurial University is a natural incubator, providing support structures for teachers and students to initiate new ventures: intellectual, commercial and conjoint".	Support structures for teachers and students to initiate new ventures: intellectual, commercial and conjoint
	Jacob, et al.	"An Entrepreneurial University is based both on commercialization (customs made further education courses, consultancy services and extension activities) and commodification (patents, licensing or student-owned star-ups)". A university that has developed a comprehensive internal system for the commercialisation and commodification of its knowledge	Commercialization (customs made further education courses, consultancy services and extension activities) and commodification (patents, licensing or student-owned star-ups)".
2010	Guerrero & Urbano	A university that can meet the current requirements of the society through developing its organizational potentials, innovation, creating and identifying opportunities, team-work, risk-taking.	
2010	Heinonen and Hytti	The entrepreneurial university "encompasses teaching, research and services to society in terms of producing and diffusing new knowledge as well as applying it to industrial development".	Production and diffusion of new knowledge.
2016	Guerrero, M., Urbano, D., Fayolle, A. et al.	More specifically, an Entrepreneurial University is being considered as an organization that adopts an entrepreneurial management style, with its members (faculty, students, and staff) acting entrepreneurially and that intern interacts with its outside environment (community/ region) in an entrepreneurial manner (Clark 2001; Klofsten and Jones-Evans 2000).	Theoretical (networks, agency theory, institutional theory, internationalization) and methodological (multilevel, OLS).
2017	Gibson and Foss	… the entrepreneurial university is seen to be a result of complex processes by which institutional forces both shape and are shaped by, organizational and individual actions. In our conceptualization, universities tend to be entrepreneurial in two main ways. First, academic entrepreneurship focuses on the commercialisation of knowledge and research findings (Klofsten and Jones-Evans, 2000; Roessner et al., 2013). A second path toward being an entrepreneurial university is through entrepreneurial education (Gibb, 2010) encompassing the university's teaching mission and the building of entrepreneurial competencies in students and faculty (Altmann and Ebersberger, 2013).	1. academic entrepreneurship focuses on the commercialisation of knowledge and research findings 2. through entrepreneurial education and building of entrepreneurial competencies in students and faculty.

Compared to traditional academia, an entrepreneurial university have different values and aims (Rinne & Koivula, 2005) considering that building a responsive and dynamic university demanded strong strategic changes in its operations (Clark, 1998; Etzkowitz, 2003). Such

redesign towards the third mission of university has been implemented in UK policies for 20 years. These policies are directed towards institutional changes as well as increasing funding for university partnerships with businesses and society.

Guerrero et al. (2016) described a university as a process that evolves and changes in terms of structure, strategy, content and governance where several stakeholders are shaping the university on a constant base (Miller et al. 2014; Bischoff et al., 2018). Such development of a university was described as a "evolution of ivory tower to entrepreneurial paradigm" (Etzkowitz et al. 2000, 325).

According to Culkin, N. and Mallick, S. (2011), to be truly entrepreneurial, universities should have various income streams with no more than 40% of funding is forming by HEFCE funds and the rest is by entrepreneurial activities.

The discussion of an entrepreneurial university has moved away from the focus on the commercialization of intellectual property (Gibb et al. 2013). Entrepreneurship for entrepreneurial universities is now concentrated on organizational, behavioural, development and individual response to complexity and uncertainty what is relevant to the different organisations including public, private and autonomous.

The concept of entrepreneurialism was discussed by Etzkowitz (2003) as a natural process of university development. However, Leslie and Slaughter (1997), characterized it as a transformation of Research University. Based on Clark (1998) the term "genetic entrepreneurialism" is relevant to the dynamism and was applied in the best US universities.

We see that there are plenty of definitions exists in the literature and they look at different perspectives and characteristics of an entrepreneurial university as well as factors within the ecosystem that impact university development. For the purpose of this research, we look at stakeholders perspective to understand with whom entrepreneurial universities collaborate to disseminate knowledge. In this study, we define the entrepreneurial university as any university that has the ability to innovate, recognise and create opportunities (Kirby, 2002) and which can produce and disseminate knowledge (Etzkowitz, 2003). It can also develop a comprehensive internal system for knowledge commercialisation (custom-made further-education courses, consultancy services, contract research) (Jacob et al., 2003) and commoditisation (patenting, licensing; both staff and student spin-offs and start-ups) (Chrisman et al., 1995; Jacob et al., 2003) by providing a support structure, as a "natural incubator" (Etzkowitz, 2003), via different stakeholders.

The diversity of entrepreneurial universities

To evaluate universities as entrepreneurial institutions based on the different entrepreneurial outcomes while illustrating what groups of universities share similar portfolios with respect to these outcomes, it is vital to first categorise universities (Fuller et al., 2017).

While Etzkowitz et al. (2000, p. 313) stated that "the 'entrepreneurial university' is a global phenomenon with an isomorphic developmental path", recent research shows that no best type of entrepreneurial university model exists (Bronstein and Reihlen, 2014; Kitagawa et al., 2016). There are significant differences across the higher education systems of different countries, as well as between universities in the same education system (Bonaccorsi et al., 2007; Philpott et al., 2011; Sánchez-Barrioluengo, 2014; Pickernell et al., 2019). Based on the analysis of 27 case studies of entrepreneurial universities across different countries, Bronstein and Reihlen (2014) identified that universities might be categorised into several types based on their primary focus.

UK universities are often categorised as new vs. old, research-oriented vs. teaching-oriented, and Russel Group vs. non-Russel-Group universities. The research-oriented group usually has higher research outputs than the teaching group (Abreu et al., 2016). It is thus expected that universities have different resources and capabilities influencing their engagement with third stream activities or entrepreneurship additionally to teaching and research (Liu et al., 2018).

Universities can adopt both broad and focussed strategies to collaborate with stakeholders for knowledge spillovers (Kitagawa et al, 2016). We consider the broad strategy of engaging with stakeholders as more entrepreneurial, as it allowed universities to use the outcomes of both teaching and research activity to generate third-stream income. Firstly, a broad strategy allows universities to gain income through multiple channels and via both research and teaching activities. Everything being equal, universities that use a wide range of knowledge exchange channels are usually in a better position to address the needs of the individual organisation and gain better entrepreneurial outcomes from diverse sources (Olmos-Peñuela et al., 2014; Ramos-Vielba et al., 2016). Secondly, using a broad strategy enables universities to diversify their knowledge base and bridge the gap between theoretical research and its practical applications (D'Este & Patel, 2007). Thirdly, this approach allows universities to strengthen their research base and might lead to the development of new knowledge (D'Este & Patel, 2007).

Some universities would prefer to adopt a narrower strategy for knowledge spillovers. This means by focusing on the knowledge exchange activities based on the relative advantage, universities increase the likelihood they will achieve above-average growth in third stream

income. In addition, the disciplinary mix at universities might influence their strategy to focus more on one activity rather than another. As universities have diverse disciplinary mixes determined by faculties and schools (Bonaccorsi et al., 2007), they have different educational activities and research outputs. This diversity impacts the range and forms for third income activities of universities. On a different note, the strategy of focusing on smaller sets of knowledge exchange channels may be a result of resources and capabilities constraints (Liu et al., 2018).

University third-stream activities include at least four key blocks: the range of third-stream activities with which universities engage, the emphasis they place on each activity, the variety of partners they engage with and the area (regional, national, international) they focus on when engaging with stakeholders (Pickernell et al., 2019). These show us that universities do engage with different stakeholders based on their types and activities and the outputs they want to achieve.

Entrepreneurship at university and entrepreneurial ecosystem.

Universities are broad in their activities and play different roles in the entrepreneurial ecosystem and following Florida (2014) they provide novel science-based ideas, entrepreneurship education, technical and scientific training, different facilities etc. Like large organisations, universities have different touch points within the entrepreneurial ecosystem.

Entrepreneurship is a separate observable phenomenon that can be captured by measures like companies created, jobs created by young ventures (less than 5 years old), venture capital (VC) funding available (measured as a per centage of GDP), and IPOs or acquisitions. In this sense entrepreneurship within the university is a widespread phenomenon that required a wide ecosystem and connection with other stakeholders to reach those outcomes. The world ecosystem in this sense is quite deliberate and is used to capture the organic, inter-dependent and evolving nature of the phenomenon.

Ecosystem characterised by a network of connected and interdependent stakeholders who have a range of formal and informal ties within the geographically proximate area (Schrank and Witford, 2011; Sorenson, 2018). Such an ecosystem has a hierarchical structure that denotes different power dynamics and diverse resources while these dynamics need to be overcome for collective actions to enable a strongly connected network and more resources sharing. In addition, a successful entrepreneurial ecosystem is socially coherent and is driven by collective action (Owen-Smith & Powel, 2006).

The most successful ecosystems arise from the systematic dynamics of stakeholders' engagement. To understand the systemic roles of stakeholders it is critical to get more accurate and nuanced perspectives on their contribution to the university ecosystem development. Taking a more purposeful and accelerated approach to stakeholders for building an ecosystem can help to shift the odds more swiftly and clearly in favour of the success of the university.

The role that stakeholders play in building the ecosystem around the university is well-researched area. However, what role do they play within the university ecosystem is a not sufficiently studied area (Miller et al. 2014). The following parts of the thesis will further discuss different areas of research that considered diverse stakeholders of a university and classify stakeholders in terms of their contribution to university development.

1.2. University business models and stakeholder approach to the entrepreneurial university

As a unit of analysis, business models are an emerging phenomenon (Zott et al., 2011) despite being explored around a century (Osterwalder et al., 2005). The literature says that the term is often used without its complex understanding of defining features (Osterwalder et al., 2005; Teece, 2010). At the simplest level of understanding, a business model is defined as a tool that "describes the rationale of how an organisation creates, delivers and captures value" (Osterwalder and Pigneur, 2010). According to Amit and Zott (2001), the business model "defines the content, structure and governance of transactions designed so as to create value through the exploitation of business opportunities".

From the theoretical point of view, literature on business models is under-developed with some parts existing with the relevance of its conceptualisation and definition (Nenonen & Storbacka, 2010). However, the general features of business models state that they consist of interdependent activities (Zott et. al., 2011) transcending organisational boundaries and cocreated by different actors (Chesbrough & Schwartz, 2007).

From the conceptual point of view, business models express the resources and capabilities as well as design principles that are interdependent in nature but together convert knowledge into a unique competitive advantage (Nenonen & Storbacka, 2010).

When it comes to academia, university business models have changed significantly over the last three decades (Etzkowitz, 1998; Etzkowitz & Leydesdorff, 2000). These changes happen in part due to the emergence of the knowledge-based economy where universities play a core role in the development of the region (Perkmann et al., 2013).

The business model of academia is in a transition state where knowledge and technologies transfer in academia are evolving into the open innovation process (Chesbrough, 2010) via commercialisation. The open innovation process requires the collaboration of multiple stakeholders, both internal and external to the university, such as companies, technology transfer offices, government, venture capital firms etc., who are making an influence on achieving university goals (Alsos et al., 2011).

Zott et al., (2011) stated that there is a need for studies to investigate in which way different actors around academia shape the structure, content and administration of organisational business model and how transactional and social dimensions of the business model stakeholders can affect the design of the business model.

The university business model can be defined as an outline of actions where their value proposition is dependent on the different activities of multiple boundary-spanning stakeholders centred to the university (Zott et al., 2011). The architecture of the activities system "capture how the focal firm is embedded in its ecology" (Amit & Zott, 2001).

According to Etzkowitz & Leydesdorff (2000), the business models of university interaction with external stakeholders might be described as traditional, transitioning and evolving (see Figure 1).

It’s assumed that the traditional business model of academia was implicit in its nature and comprised several activities for achieving a primary mission of research, teaching and the transfer of knowledge to society (Gibb, 2010). According to Carayannis et al. (1998), academia also indirectly contributed to the transfer of technologies by providing qualified and highly educated human resources to the industry. Even though the links between academia, government and business were from the early 1900s (Gibb, 2010), the connections were ad hoc, and each stakeholder was independent with the government being a regulator of the business model of the university (Miller et al. 2014).

One of the key documents that fundamentally changed the traditional university business model was the Bayh-Dole Act (1980). The Act promoted the transfer of Intellectual Property Rights (IP) from Federal-funded research to the university (Sharma et al., 2006). While the Bayh-Dole Act (1980) was implemented in the US context, it caused similar legislation within areas outside the United States. For example, universities in the UK were authorized to share the revenues from academic disclosures that led to such activities as patenting and licensing (Campbell et al., 2004; Bercovitz and Feldman, 2006).

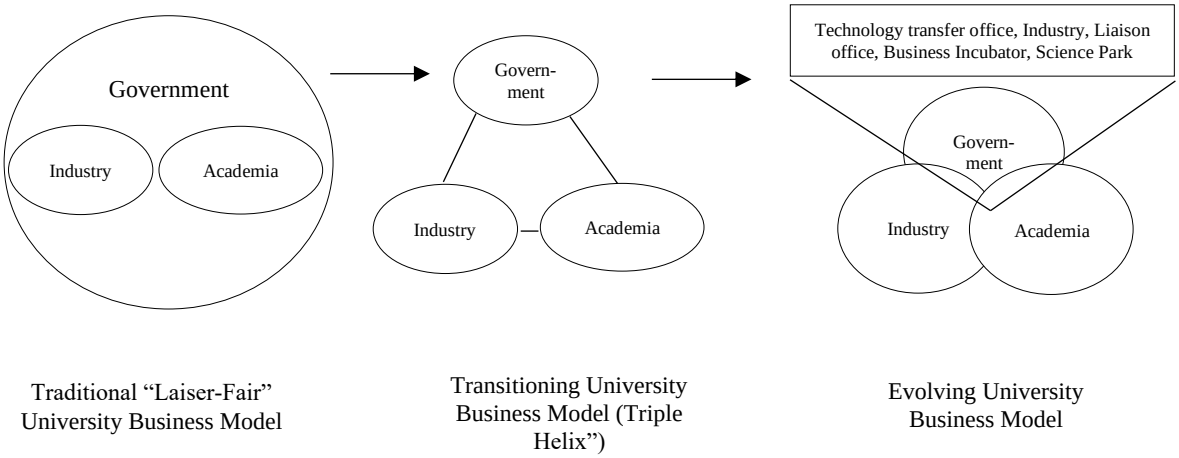

Figure 1: The evolving university business models

Source: Adapted from Etzkowitz and Leydesdorff (2000, p. 4); Cunningham & Miller, 2021.

All these activities initiated the cooperation between three main stakeholders which are academia, business and government in the framework of a triple helix (Etzkowitz, 1998; Etzkowitz and Leydesdorff, 2000). The framework pushed the changes in the governance of the university with the latter taking a "more prominent role . . . in innovation, on par with industry and government" (Etzkowitz and Klofsten, 2005, p. 245).

Based on this idea, Etzkowitz et al. (2000) state that academia started to perform a more "entrepreneurial role". These changes resulted in a new way of teaching (integrating entrepreneurship skills and training), research (basic and applied) as well as commercialisation, which exists in creative conflict and tension, as well as leads to normative changes, compromises and legitimisation (Suchman, 1995).

Thus, the next stage or an evolving business model of the university is dependent on relationships with multiple stakeholders as the new area of activity is based on the transfer of knowledge and skills among academia, the community and the business (Lambert, 2003; Wilson, 2012). Additionally, Tankhiwale (2009) reveals that the pressures from external regulations and stakeholders are considered as drivers of business model innovation.

The role that stakeholders play in the development of business activities is well researched. However, what impact they do provide on the university activity is a not sufficiently studied area (Zott et al., 2011; Miller et al. 2014). This work will further discuss different areas of research that considered diverse stakeholders of a university.

1.3. Conceptualisation of entrepreneurial university and stakeholders' collaboration at organisational and individual levels.

The recognition of the main group of stakeholders is not necessarily simple (Jongbloed et al., 2008). Bartell (2003) emphasised the particular complexity of the university as an organisation with a variety of external and internal stakeholders. However, different customers and employees can have diverse forms of influence on organisations. Applying stakeholder framework to management may be a useful instrument that assists organisational actors when dealing with environments (Freeman, 1984). It allows one to selectively perceive, evaluate and interpret stakeholders' attributes. For instance, the stakeholder approach assists one in recognising "who or what really counts" and evaluating the extent to which managers pay attention to stakeholders around their organisation.

According to Freeman (1984), originally, the stakeholder was determined as "those groups without whose support the organisation would cease to exist" and the definition dates to 1963 to Stanford Research Institute (SRI).

A more commonly used statement of who or what stakeholders are was introduced by Freeman (1984) and who defined stakeholders as "any group or individual who can affect or is affected by the achievement of the firm's objectives" (Freeman 1984, p. 16). According to the author, any business organisation should be concerned about what their stakeholders' interest is while making strategic decisions or choices.

Based on Burrows (1999), university stakeholders are divided by specific groups that are accepted as having an influence on the universities' behaviour, policy and actions. Burrows (1999) presented a list of actors to which universities supposed to pay attention stating that the degree of attention is not similar in each case.

Stakeholder theory characterises stakeholders from three different perspectives, which are the normative (why the interests of stakeholders should be considered), the instrumental (the effect that stakeholders have on organisational performance) and the descriptive (whether stakeholder interests are considered by a firm) (Alsos et al., 2011).

The instrumental understanding of stakeholders is linked to their contribution to the creation of entrepreneurial value by the university (San-Jose et al., 2017). The instrumental parts of the theory are applied in this research to identify the connection between stakeholders and their contribution to the achievement of the university's goals. This approach has a prescriptive nature. It categorises stakeholders as a tool to maximise profit and increase an efficiency of the university. As following Donaldson & Preston (1995), the instrumental approach helps to

examine the *ceteris paribus* connection and is hypothetical. It helps to answer the question "if you want to achieve particular result X then adopt (or don't) practices Y". Applying this logic to the entrepreneurial university concept, we might answer the question "If a university wants to achieve particular entrepreneurial results, it should collaborate (or not) with a certain set of stakeholders who facilitate or inhibit the process of knowledge creation and dissemination".

Thus, from the stakeholder perspective, the entrepreneurial university intentionally develops a network of contacts that helps to obtain resources and later assists to convert these resources for added value (Redford & Fayolle, 2014). Based on the entrepreneurial viewpoint, the factors used to determine the relevance of a stakeholder are vital in a practical sense since entrepreneurs have to decide which group, they need to deal with at any given stage during the knowledge transfer process (Redford & Fayolle, 2014). Thus, from a theoretical perspective it is vital to analyse and conceptualise a framework for application to this task (Redford & Fayolle, 2014). The classification of stakeholders at various levels of the university could help to identify the impact stakeholders have on the performance of an entrepreneurial university (Rowley, 1997). It shows configurations of stakeholders to represent an entrepreneurial university with classification making the conceptualisation possible (Bailey, 1994).

Independently of the type of entrepreneurial university, we recognise the combination of several groups of stakeholders that engage within the university in a complex way (Jongbloed et al., 2008). Bartell (2003) emphasised the particular complexity of universities as an organisation in the way they engage with a variety of external and internal stakeholders. Thus, expanding the stakeholder categorisation proposed by Yusef (2008) and aligning it with the entrepreneurial university model (Audretsch 2014), we propose to distinguish four categories of entrepreneurial university stakeholders:

(1) knowledge enablers: organisations and individuals that facilitate knowledge manipulation (Jaziri-Bouagina & Jamil, 2017) (industry and government);

(2) knowledge providers: organisations and individuals that produce and spillover knowledge within the entrepreneurial university (university students and faculty; managers) (O'Gorman et al. 2008);

(3) knowledge codifiers: organisations and individuals that actively seek new channels and forms of knowledge transfer, and facilitate knowledge spillovers outside the university level (technology transfer and IP offices);

(4) knowledge facilitators: organisations that facilitate entrepreneurial incentives (Fayolle and Linan 2014) and encourage knowledge spillovers within the university and into the ecosystem

(research and science parks, business incubators, accelerators) (Link & Scott, 2006; Autio et al., 2014). These stakeholders may also raise finance (e.g., venture capitalists, angel investors, crowd investors, banks and financial groups).

Based on the categorisation presented above, we identified that while some papers on the entrepreneurial university have analysed one level of stakeholder engagement (e.g., knowledge providers), others addressed several levels, for instance examining the links between two, three or four of identified levels (e.g., knowledge enablers, providers and codifiers) (Table 4).

Table 4. Four extinct types of entrepreneurial university stakeholders

No	Stakeholders' categorisation	Stakeholders	Literature
1	Knowledge enablers	Government	Keast, 1995; Chrisman, et al., 1995; Ryu, 1998; Schmoch, 1999; Klofsten & Jones-Evans, 2000; Bernasconi, 2005; De Zilwa, 2005; Lazzeretti & Tavoletti, 2005; Kirby, 2006; Wong et al., 2007; Bramwell & Wolfe, 2008; Hu 2009; Guerrero & Urbano, 2012; Culkin & Mallick, 2011; Goddard et al., 2012; Hewitt-Dundas, 2012; Sterzi, 2013; Miller et al., 2014; Graham, 2014; Banal-Estanol et al., 2015; Guerrero et al., 2015; Czarnitzki and Delanote, 2015; Bischoff et al., 2017; Miller & Acs, 2017; Fuller et al., 2017; Etzkowitz et al., 2019; Fuster et. al., 2018
		Industry	
2	Knowledge providers	Teaching staff	Keast, 1995; Chrisman, et al., 1995; Ryu, 1998; Schmoch, 1999; Klofsten & Jones-Evans, 2000; Jacob, et al., 2003; Bernasconi, 2005; De Zilwa, 2005; Lazzeretti & Tavoletti, 2005; Kirby, 2006; Wong et al., 2007; Bramwell & Wolfe, 2008; Hu 2009; Guerrero & Urbano, 2012; Goddard et al., 2012; Hewitt-Dundas, 2012; Sterzi, 2013; Graham, 2014; Miller et al., 2014; Kalar & Antoncic, 2015; Banal-Estanol et al., 2015; Guerrero et al., 2015; Czarnitzki and Delanote, 2015; Bischoff et al., 2017; Fuller et al., 2017; Miller & Acs, 2017; Etzkowitz et al., 2019; Fuster et. al., 2018
		Research staff	
		Students	
		Managers	Keast, 1995; Etzkowitz et al., 2000; Philpott et al., 2011; Beresford & Michels, 2014; De Silva, 2016; O'Kane et al., 2017; Forliano C. et al., 2021; Perkmann et al. 2021
3	Knowledge codifiers	Technology transfer office (TTO)	Keast, 1995; Chrisman, et al., 1995; Schmoch, 1999; Klofsten & Jones-Evans, 2000; Jacob, et al., 2003; De Zilwa, 2005; Lazzeretti & Tavoletti, 2005; Wong et al., 2007; Bramwell & Wolfe, 2008; Hu 2009; Guerrero & Urbano, 2012; Hewitt-Dundas, 2012; Sterzi, 2013; Graham, 2014; Miller et al., 2014; Banal-Estanol et al., 2015; Guerrero et al., 2015; Bischoff et al., 2017; Fuller et al., 2017; Etzkowitz et al., 2019; Fuster et. al., 2018
		Patenting office (IPO)	
4	Knowledge facilitators	Science or technology parks	Ryu, 1998; Jacob, et al., 2003; Lazzeretti & Tavoletti, 2005; Kirby, 2006; Wong et al., 2007; Guerrero & Urbano, 2012; Hewitt-Dundas, 2012; Graham, 2014; Guerrero et al., 2015; Bischoff et al., 2017; Fuller et al., 2017; Miller & Acs, 2017; Etzkowitz et al., 2019; Fuster et. al., 2018
		Venture capitalists	
		Accelerators	
		Business incubators	
* Most of the literature included into the table are not represented in the reference list due to the word's limitations			

According to Table 4, papers that empirically investigated the way universities are linked with industry and have spilled over knowledge have thus advanced considerably since the mid-

1990s. Currently, more sophisticated methods and robust measures are used to explore the phenomenon. The unit of analysis has also expanded, from single-case-study research (Chrisman et al., 1995) to the regional (Guerrero et al., 2015; Fuster et al., 2018) or ecosystem approach (Hewitt-Dundas, 2012; Miller and Acs, 2017), as well as multi-country studies (Bischoff et al., 2018).

The main focus of these studies was university-industry collaboration issues, rather than the ecosystem approach towards understanding the entrepreneurial university. Authors have investigated different outputs and means of university collaboration with stakeholders and the role of other factors in facilitating this collaboration. As an example, some authors have analysed the role of management and university strategy in facilitating entrepreneurship and connections with other stakeholders (Keast, 1995; Kirby, 2006; Kalar and Antoncic, 2015); others have studied the impact of research collaboration between university and industry on knowledge commercialisation (Banal-Estanol et al., 2015). Some have studied the mechanisms for knowledge transfer and engagement with stakeholders within the process (Bramwell and Wolfe, 2008); or the results of re-orientating university business models towards stakeholders (Miller et al., 2014); or the role of technology transfer offices (hereafter referred to as TTOs) in knowledge spillovers (Hu, 2009) (Table A1 Appendix A).

In the next part of the paragraph the author provides a detailed explanation for the classification of stakeholders presented.

Classification and conceptualisation of stakeholders around the entrepreneurial university.

Types of university stakeholders (knowledge enablers; knowledge producers; knowledge codifiers; knowledge facilitators)

Knowledge enablers

Government

The role of the government is controversial while critical in its role in ecosystem building. The government must be engaged in building the ecosystem even though it not necessarily should be a leader of these activities. While government do not play a keynote in the social networks of the ecosystem its presence and interaction with different organisations and individuals can be critical in shaping appropriate policy, rules and norms within the networks of the ecosystem (Budden and Murray, 2019).

The debate on the role of the government in the ecosystem is diverse. In the book "Boulevard of Broken Dreams", Lerner (2012) argued that while the government can set the table and create conditions for innovation-driven growth, it cannot lead these efforts. Brad Feld (2012) in the book "Start-up Communities" suggested that entrepreneurs are the only individuals to meaningfully lead the ecosystem as they are the leaders on the frontline. In her book "Entrepreneurial state" Mazzucato (2013) has positioned a strong central role government played in building the ecosystem. Thus, various research showed that the government played different roles in building the ecosystem while it is agreed that its role has been critical.

The government as an external stakeholder facilitates the knowledge and technology transfer process. Initially, the government develop appropriate policies and is the most common funding source. The government played a pivotal role that led to the growth of universities economic activities. Governments' explicit policy is directed at increasing the responsibility of academia for ensuing funding for research and its commercialisation (Guerrero et al., 2016).

The government also provides the political incentives that encourage entrepreneurship in universities that are focused both on research and teaching by enacting legislation designed to stimulate R&D-based entrepreneurial activities (e.g., tax incentives). One of the most prominent political instruments is the Bayh-Dole Act (1980), which became a law in the US with the purpose of facilitating the commercialisation of research outputs and impacted the introduction of relevant legislation in other countries throughout the world.

Additionally, in another document which is the Lisbon strategy a lot of attention has been paid to the incentives and government policies that encourage universities to pursue an entrepreneurial pattern and develop tight links with the ecosystem stakeholders, thereby facilitating the innovative capacity of the region and country (Jongbloed et al., 2008).

Industry

When it comes to external stakeholders, besides the government, universities engage with the industry. Via providing funding for the research industry is considered a significant boosting factor for ideas generation and development. Both parties form relationships through contract research which is considered an effective tool or channel to transfer knowledge (Cohen et al., 2002).

Contracts with industry positively affect direct commercialization of research outputs from university, the involvement of academics in entrepreneurial activities as well as building an entrepreneurial culture at the university (Powers and McDougall, 2005). Furthermore, contract research facilitates the creation of spin-offs, complements other knowledge exchange activities, offers benefits to regions.

From the outputs of academic research, academia provides different services to industry as a return. Such services are known as knowledge transfer channels and can be in the form of additional trainings for business (Ferreira and Ramos, 2015) or consultancy (Perkmann et al. 2013). As for the consultancy, it is driven by the motive of learning together with industry and is a potential stream for the third-stream revenues for academia (Druckman 2000). When it comes to training, this channel helps to transfer tacit knowledge and build skills (Ferreira and Ramos, 2015).

Thus, the engagement of knowledge facilitators can be explained as follows. The government holds a responsibility to set up formal rules and policies that regulate the higher education sector. In addition, it provides funding to support research, stimulate links with industry as well as develop community. As an outcome, this facilitates the creation of an entrepreneurial environment as well as infrastructure to promote technology transfer. Collaboration with industry and business provides financial support to university researchers, thus boosting R&D, patents and licensing activities, facilitating knowledge exchange via direct knowledge transfer.

Knowledge providers

Researchers

Scholars represent an important group of internal stakeholders. Academics are the hard core of any scientific production (Jongbloed et al. 2008). They are also considered as a basic internal nucleus without which the higher education establishment is not able to be functioning properly.

According to Belitski and Heron (2017) academics are the main force for knowledge transfer (e.g., via selling IP rights as well as creating spin-offs and start-ups) that impose the interaction with other stakeholders. Much of such transfer of knowledge are originating in a local region and within the community, including entrepreneurial, that is linked to academia.

Academic researchers are pivotal for the university as owning or having access to new technology facilitates the partnership with other stakeholders (including government and business) to launch the new company as a form of technology commercialization thus facilitating monetization of new technology (Audretsch et al. 2006).

Nelles and Vorley (2010) pointed to “star scientists” as being crucial leaders for the entrepreneurial turn. According to the authors, prominent researchers are key to attracting quality faculty who is key to winning competitive research grants and attracting top students for building world-class research centers and education excellence.

Given researchers’ central role in the university entrepreneurial ecosystem, their voice is critical for building the ecosystem. Without this voice on the frontline of knowledge

production and innovations, efforts for building an ecosystem might be undertaken in vacuum. Instead, efforts might simply provide what other stakeholders imagine that researchers' needs. Research shows that the important factor is to emphasize the needs and wants of those at the core stage of the entrepreneurial ecosystem (Budden and Murray, 2019). Instead, research shows that when present at the table, researchers as well as entrepreneurs are willing to give back to their ecosystem, share their views and represent their perspective of a wider entrepreneurial community.

Students

Students are another key stakeholder for the university. According to Rothschild and White (1995), education is a customer-input service. Students as customers of universities are a pivotal input into the teaching (Jongbloed et al., 2008). In classes, students are educated not only via lecture or professor but also through ideas or experience sharing as well as the interaction with other students. In this process, the quality of fellow students contributes to the learning outcomes.

Additionally, students play a pivotal role while engaging with external community (Jongbloed et al., 2008; Saginova and Maksimova, 2017) and are considered as one of the vital spillover mechanisms to facilitate new ventures creation (spin-offs and start-ups) (Acosta et al., 2011) and served as a measure of the demand for labour (Qian and Acs, 2013). The higher the human capital outputs of university, the lower the distance between academia and companies regarding knowledge transfer. As for the research activities, university students, especially PhD and postdoctoral researchers are important participants in research projects and IP rights generation. This knowledge is used for academic spin-off (Hayter et al., 2018) or based on identified market opportunities (Belitski and Heron, 2017). After graduation students become either job seekers or job creators. Students also play a crucial role in building entrepreneurial culture at the university.

University management

University managers play a huge role in developing a relevant supportive environment of the organisation and the entrepreneurial mindset of people to turn universities to become entrepreneurial (Forliano et al., 2021). This is because university entrepreneurs (e.g., academics and students) face many barriers while exploiting opportunities around (O'Kane et al., 2017) and often have the expertise, competence, and skills gap. That is why they need a variety of both formal and informal support to overcome obstacles of existing gaps (De Silva, 2016).

The way universities are managed and governed provide a crucial insight to understanding the role of academia in a knowledge-based society and developing innovations (Etzkowitz et al., 2000). Thus, university management and university faculty should have a similar understanding

of entrepreneurial mindset as any controversy between both can cause a negative effect on university entrepreneurial activities (Philpott et al., 2011).

University middle managers at the meso level (e.g., heads of departments and deans) are crucial actors to influence and support entrepreneurship and innovations within the entrepreneurial architecture, especially considering unidirectional and top-down approaches relevant to entrepreneurial university (Beresford & Michels, 2014).

Both university academics and students are thus able to generate new knowledge by exploring knowledge that existed and act on market opportunities. These stakeholders are identifying opportunities and experimenting with new ideas in order to commercialise knowledge and/or create new ventures to address market demand.

Before entering the public domain and being transferred into the economy, the knowledge produced by academia might follow either a traditional or formal (licensing) route, or alternative (non-linear) (new ventures creation, direct contracts with industry, etc.) route to commercialisation (Bradley et al., 2013). The former process requires the invention to be codified and protected before engaging with the knowledge codifier stakeholders' domain, namely the technology transfer offices (hereafter TTOs) (or any relevant department) and intellectual property offices (hereafter IP office). The latter involves knowledge facilitator stakeholder groups or science parks (hereafter SPs) and business incubators (hereafter BIs). Both of these stakeholder subgroups might be either internal or external to the university.

Knowledge codifiers

TTOs and IP offices

To ensure appropriate protection of the research invention (intellectual property (IP) rights, including patents, copyright, trademarks and designs), universities usually work with IP offices.

Patents and licences serve as a codified visible method and channel to transfer knowledge via the traditional route of research commercialisation (Fisch et al., 2016). They facilitate the commercialisation of university inventions and the creation of new ventures (e.g., spinoffs) contributing to the third mission of the university. They also contribute to start-ups raising external funding (Farre-Mensa et al., 2015). Patenting serves as a strong, robust research-based predictor for academics to participate in setting up a firm (Stuart and Ding, 2006). Thus, patents are a promising starting point for entrepreneurial activities by academics, or an initial step for research commercialisation via traditional way.

The licencing of patents is also one of the channels to transfer knowledge from universities to industry. This channel helps to facilitate the empirical study of knowledge (Agrawal, 2006) and is a proxy for contributions of university research to innovations.

Since universities have seen that intellectual property right can bring commercial wealth, they become more aggressive on the knowledge market (Jongbloed et al., 2008) and established new structures that connect universities with industry. From 1980 onwards more formal, contract-based relationships (spin-offs, patents, public-private venture) become more common. Universities started to establish technology transfer offices (TTOs) or intellectual property offices to professionally govern their intellectual property rights (Jongbloed et al. 2008). TTOs have been in the center of the research as they act as a key transaction point and foster the link between the academia and business as well as commercialize university's knowledge (Perkmann et al. 2013). Additionally, according to Walshok et. al. (2014), university entrepreneurship is considered as productivity of their TTOs.

TTO plays a crucial role in transferring the technologies from the university and its labs to the start-up firms and the business acting as a "technologies intermediary" by facilitating the expansion of research, teaching and extracurricular activities (Belitski and Heron 2016).

However, researchers might sometimes bypass the TTO and directly explore their inventions on the market (Guerrero et al., 2016).

Thus, in the entrepreneurship ecosystem literature, the role that TTOs play in the facilitation of spin-offs and knowledge commercialization is unclear (Belitski and Heron, 2017). There are still doubts about which structure of TTO and engagement strategy with industry and business are most efficient to facilitate the spin-offs growth and commercialization.

Along with TTOs, IP offices can help to bridge the gap between research commercialisation at the university and industry development through issuing patents being more actively at research-oriented universities where new knowledge is a breakthrough. TTOs, on the other hand, are intermediaries, gap-fillers as it were, in the process of research commercialisation. In addition, engaging in patenting activities enables researchers to delegate the function of searching for commercialisation opportunities with industry to TTOs and knowledge protection to IP offices while focusing mainly on developing new ideas (Aldridge and Audretsch, 2010).

Summing up, TTO and IP offices are an important conduit to bridge the information asymmetry between university and industry as well as to develop business skills to support the faculty in starting a business.

Knowledge facilitators

Science parks and business incubators

In those cases when knowledge created by academia is not formally commercialised through a TTO, alternatively it might be used for the new companies' creation. The creation of new ventures requires a supportive infrastructure and stakeholders who would facilitate knowledge

spillover outside the university, contributing to local economic development. Within the entrepreneurial university ecosystem, science parks and business incubators play a role in knowledge facilitation (Audretsch and Belitski, 2019).

The initial goal of science parks and business incubators is to facilitate transfers of knowledge from university and research institutions and provide support to create new companies (Hayter, 2016). They also are boundary spanners and network platforms between academia and industry (Audretsch et al., 2016). This strategy works very well for research-oriented universities because by collocating with other companies, new research-based start-ups can benefit from the localised knowledge spillovers for innovation and production.

According to the International Association of Science Parks (IASP, 2002), Science and Technology Parks (STP) are institutions that aim to facilitate and manage the technology and knowledge flow among academia, companies, market, R&D institutions and stimulate the formation and growth of new ventures based on innovations through the incubation and spin-offs.

In practice, there is a variety of patterns, stakeholders and founders of science parks (SP) (Phan et al., 2005) which have facilitated the creation of a very heterogeneous organization (Westhead, 1997) with a prominent role of academia in the park. Thus, e.g., all the STPs in the UK are the initiatives of the universities (Siegel et al., 2003), in a majority of countries (the US (Link and Scott, 2007), China (Wright et al., 2008), Australia (Phillimore, 1999), Spain and Italy (Albahari et al., 2013), Japan (Fukugawa, 2006), Portugal (Ratinho and Henriques, 2010), France (Chorda, 1996)), the degree of which universities are involved in STP is varied. According to Jongbloed et al. (2008), SPs facilitate the establishment of start-ups and licensees of university patterns.

The main idea behind science parks is to develop the infrastructure and provide administrative, technical, and logistic help to new companies, including those driven by university research (e.g., creating spin-offs utilising IP right). This objective is more effective for the research-led universities (Hayter et al., 2018) as new start-ups can participate in joint R&D projects and develop innovation clusters for knowledge commercialization. Newly established companies need this support to compete with established companies on the market. The debate about the effectiveness of science parks in supporting new firms (Hobbs et al., 2017) suggests that locating new ventures in science parks have a positive effect on company employment and sales.

According to Murphy and Dyrenfurth (2019), the support provided by incubators helps people to conceptualise their ideas (which do not necessary based on research outputs and thus might

be more effective within teaching-led universities) and launch businesses successfully. For the same reasons as for spin-offs from research-based universities, new firms from teaching-based universities seeking to explore market opportunities may enrich their ideas with a solid knowledge background and technologies of other firms co-located in science parks and incubators (Audretsch and Belitski, 2019). Such support to new firms may include workshops, mentorship, access to investors, and access to networks of entrepreneurs (Abduh et al., 2007). In addition, business incubators offer support services in the form of equipment such as fax machinery, photocopiers, computers, facilities (office space), knowledge and management support (Hobbs et al., 2017).

Venture capitalists (VCs)

The availability of risk capital is vital for the success of a company. Under conditions of resource constraints at universities with regard to creating successful new ventures, VCs (or Angels investors and their syndicates) are considered an important source of the associated funding. Universities which are research active and are able to commercialize knowledge by starting new firms and acquiring property rights on the invention will be more successful in securing venture capital. Access to venture capital is the second-most important channel for facilitating knowledge and technology transfer in the UK (after government support through University Challenge Funding) (Wright et al., 2006). However, their measure is more than simply a measure of their presence in the ecosystem as funders.

Additionally, to financial capital, VCs provide academic entrepreneurs with managerial and technical advice on running a business and allow access to their business networks (Bock et al., 2018). In addition, VC adds credibility to a start-up and connections to markets and industry. Moreover, the coaching effect of VCs and their active involvement positively affects company sales and employee growth (Bertoni et al., 2011), but will be more relevant to start-ups without prior expertise in the market and limited business networks.

To summarise, science parks and business incubators are mechanisms that help to foster the creation of knowledge-based spin-offs including via utilisation of IP rights (more for research-oriented institutions) and university-based start-ups (more for teaching-oriented institutions). Science parks are characterised as a traditional supply-side tool that promotes infrastructure and networking among academic and business actors. This enhances community-building and industrial clusters both in and outside the park. Business incubators are organisations that are involved at all stages of company development from idea generation to launching an enterprise and are used as tools to facilitate knowledge transfer in universities of both types.

In Figure 2, we conceptualised how the process of collaboration between stakeholders and entrepreneurial universities occurs. The process accounts for both traditional (linear) and alternative (non-linear) routes of knowledge transfer from universities. For both approaches, the process begins with the knowledge-enabling stakeholders, who create the opportunities to facilitate discovery (e.g., by providing funding for the research or market needs that should be solved). These stakeholders also contribute to idea generation and exchange. Besides, the government provides a legal framework with which to stimulate technology transfers (Perkmann et al., 2013). Knowledge providers then use these opportunities to work on developing new knowledge through research projects and teaching (Jongbloed et al., 2008).

In the next stage, newly developed ideas follow traditional or alternative routes and might take one of three different paths. The former process engages knowledge codifiers when the invention is disclosed to TTOs for evaluation in terms of its market potential. This set of stakeholders also provides other support services for the promotion of the invention on the market (Siegel, 2018). The latter process involves knowledge facilitators who enable knowledge transfer and the creation of new firms. These stakeholders provide support to ensure the successful launch of ideas on the market (Albahari et al., 2019; Hobbs et al., 2017).

Also, via the alternative way, newly developed knowledge might turn into services that are subsequently provided back to the industry in the form of consultancies and/or professional development courses (Perkmann, 2013). All stakeholders promote knowledge and technology commercialisation, contributing to the third-stream income generation by the university.

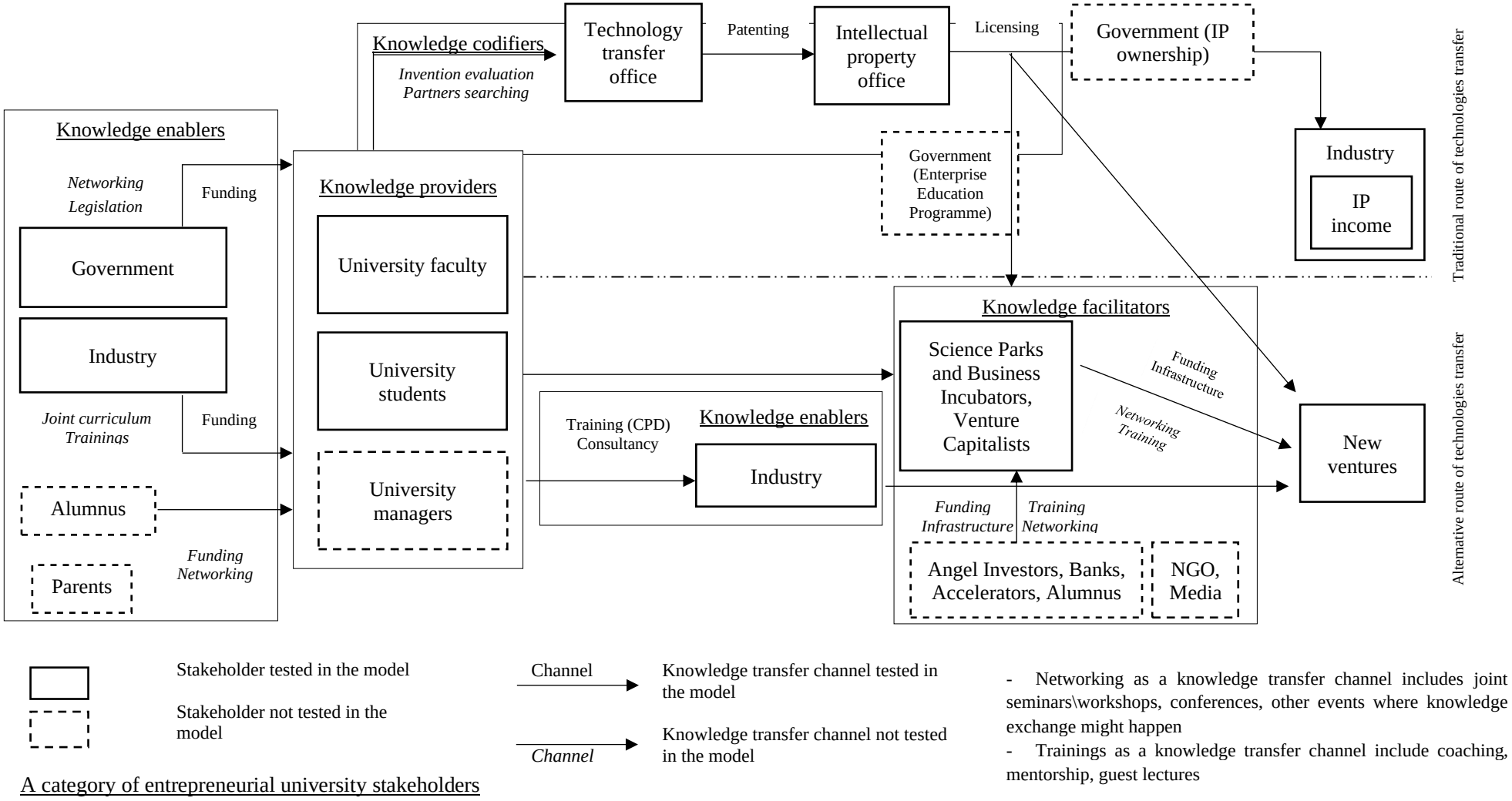

Figure 2: Conceptualisation of the university and stakeholder collaboration process to facilitate knowledge spillover (general conceptualisation)

The conceptual background of academics' collaboration with stakeholders (individual level of analysis)

Following the literature and conceptualisation of university collaboration with stakeholders provided before, university faculty is at the centre of the university as a stakeholder who generates new ideas and knowledge. Being able to understand the possible facilitators and impediments for academics to engage with others at different stages of new knowledge generation would help university managers to build appropriate policies to facilitate entrepreneurial outcomes.

There are two main aspects of academics' engagement with relevant stakeholders around or at the university which are attitudinal and motivational (Iorio et al., 2017). With respect to the attitude of researchers for engagement e.g., in the US, the majority of academics are supportive of commercialisation and other forms of knowledge transfer activities while is objected to the support and/or assistance provided by university (Lee, 1996). Academic engagement with other actors is viewed by faculty as a natural extension of publication or agreement-based research while commercialisation per se is a distinct activity type (Iorio et al., 2017). Traditional scientific norms are not necessarily contradicting academic engagement especially for active academics (Boardman and Ponomariov, 2009). As for the motivational approach, faculty usually has one of the three motivations, including intrinsic (e.g., competencies), extrinsic (e.g., monetary rewards), pro-social (society impact) while participating in knowledge exchange with other actors (Iorio et al., 2017).

When it comes to the entrepreneurial university, patenting and IP licences are one of the ways to transfer academic research to society hence the role of technology transfer offices has always been at the heart of academic engagement to foster knowledge transfer (Landry et al., 2010; Belitski et al., 2019). However, there are multiple ways stakeholders and academics engage to transfer knowledge and technologies to the society also before the actual development and transfer happens (Salter and Martin, 2001). For the purpose of this research, we focus on academic engagement which we define as an interaction of faculty with different stakeholders representing entrepreneurial university (including government, industry, intellectual property office, TTO, science park, business incubator, venture capitalist or business angel) and facilitating technology and knowledge (or knowledge relating collaboration) transfer out of the university boundaries. Such interactions include formal and informal interaction on the pre- (idea) and post- (patent, licence, spin-off or start-up) knowledge generation stages (e.g. contacting TTO on available business partners university is collaborating or seeking for advice from the business supporting department; networking with practitioners in science park or

business incubator), promoting new knowledge via building formal collaboration (legal agreement or contract with government or industry to conduct research), or new technologies via selling IP licences or setting-up a spin-off (Abreu et al., 2009; Bonaccorsi and Piccaluga, 1994; Perkman and Walsh, 2008; D'Este and Patel, 2007).

Research shows that academics while engaging with stakeholders adopt two different strategies: either they engage with a diverse range of stakeholders (knowledge transfer breath) or they focus on relatively narrow stakeholders with higher frequency (knowledge transfer depth). This idea is resonating with literature on social networks and knowledge and technologies transfer showing that variety and intensity of relationships bring higher exchange and creation of new knowledge and as a consequence leads to more effective entrepreneurial outcomes (Iorio et al., 2017).

Most research show that engagement of academics with others are driven by intrinsic or learning (self-esteem, competencies, personal satisfaction) and extrinsic or financial (monetary rewards or career progression) motivations while participating in knowledge exchange with other actors (D'Este and Perkmann, 2011; Ramos-Vielba, et al., 2016; Iorio et al., 2017). The literature on extrinsic motivation mainly focuses on learning and financial motivations. Learning motivation is expressed in the possibility to get access to the external competences and expertise as well as exchange ideas and new knowledge with the external environment in a more informal way. Financial motivation refers to the direct and indirect financial gains. In addition, academics interested in academic progression and promotion would engage more with other actors (Perkmann et. al., 2021). Another type of motivation is pro-social motivation and is related to the possibility to contribute to society and the development of organisation academics work in (Iorio et al., 2017). This motivation has an extrinsic component comprising of prospects for improvements and progression in a career at the individual level that derive from activity on science dissemination.

In general, research shows that most academics have different types of motivation and a strong *interest* to contribute to society at large and favour collaboration with a broader set of actors via different channels (Iorio et al., 2017).

However, our distinct review of the literature has shown that studies on academic engagement lack research and analytical and methodological approaches to synthesise and evaluate what are the drivers and impediments for academics to engage with diverse range of stakeholders (beyond government, industry and TTO) (Iorio et al., 2017) at different stages of the idea and/or new knowledge and technologies generation and transfer. Such a wide coverage in one study does not appear to have been previously reported in the literature, as most studies have been

concentrated on only one or two of these areas (e.g., support of the government at idea generation stage (Czarnitzki and Delanote, 2015) and/or following codification of knowledge via patenting or licensing while engaging with TTOs (Keast, 1995). We portrait findings from the literature on the motivation of academics for engagement and try to show within the process framework in which way motivation for collaboration with stakeholders could lead to engagement with different actors and move into different knowledge transfer channels and subsequently result in different entrepreneurial and commercialisation outcomes (Figure 3).

Thus, our broad literature review has identified that there is a number of definitions of the entrepreneurial university while there is no common statement that integrated stakeholder approach to understanding the phenomenon. Furthermore, this research has identified that within the entrepreneurial university phenomenon at the organisational level stakeholders play different roles for the knowledge and technologies transfer including knowledge enabling (government and industry), knowledge codification (technology transfer and intellectual property offices), knowledge production (university faculty and students), knowledge facilitation (science parks, business incubators, venture capitalists). In addition, from the individual point of view research should be done to understand what are the factors that facilitate and/or inhibit academics to collaborate with stakeholders around for the purpose of knowledge and technologies transfer.

The next Chapters of this thesis are testing the concepts developed by applying secondary data at the organisational level of analysis (Chapter 2) and primary data at the individual level of analysis (Chapter 3).

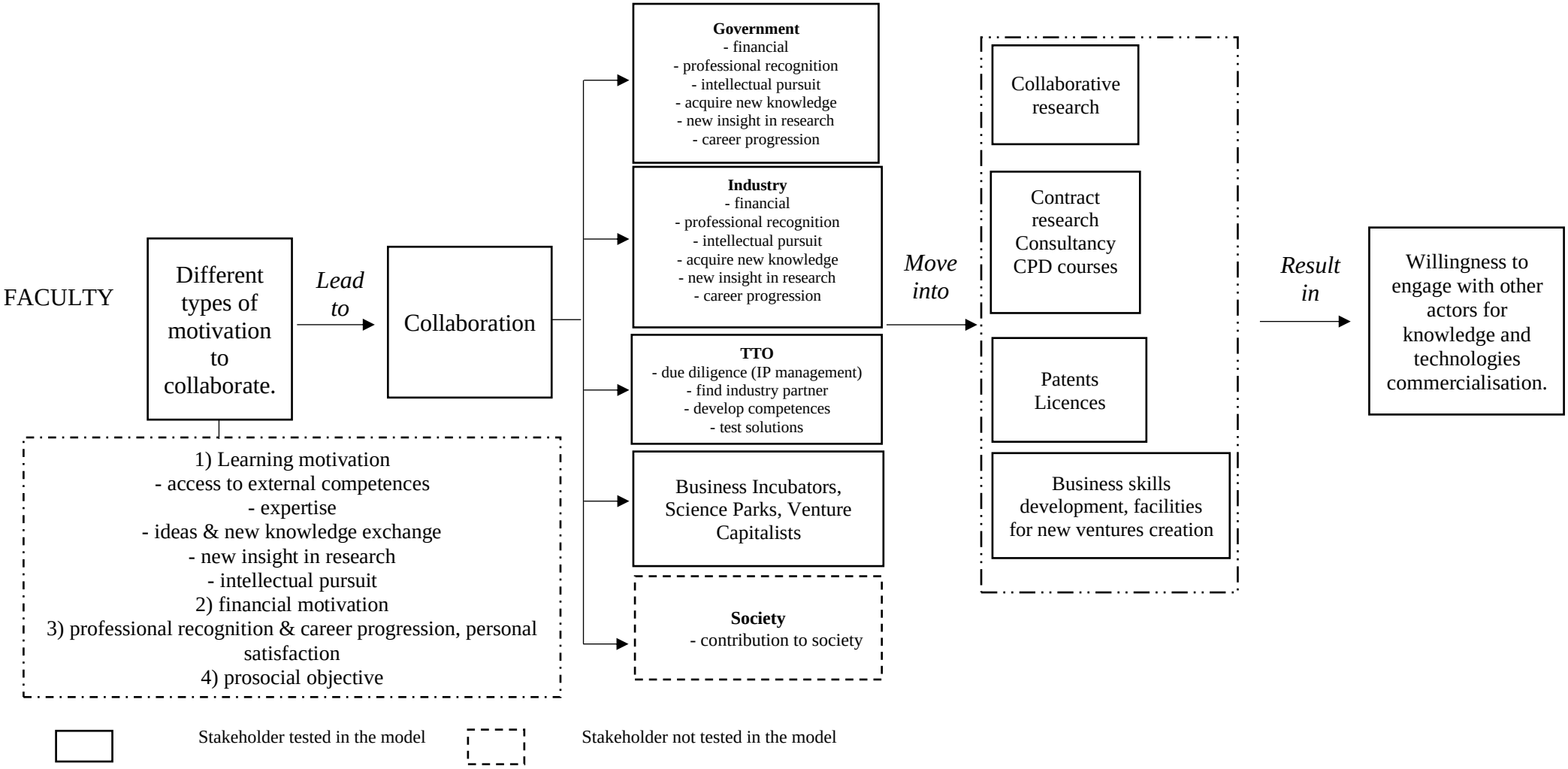

Figure 3: Conceptual process framework for university faculty engagement with stakeholders: an integrative view

CHAPTER 2. THE CONTEXT OF ENTREPRENEURIAL UNIVERSITIES IN THE UK (ORGANISATIONAL LEVEL OF ANALYSIS)

The field of entrepreneurship has expanded considerably over the last two decades, incorporating the concept of the "entrepreneurial university" (Kirby et al., 2011). Based on this concept, universities have become key stakeholders in entrepreneurial society (Audretsch, 2014), which reflects the central role they play as conduits of knowledge that spills over into entrepreneurship (Braunerhjelm et al., 2010).

In this study, we define the entrepreneurial university as any university that has the ability to innovate, recognise and create opportunities (Kirby, 2002) and which can produce and disseminate knowledge (Etzkowitz, 2003). It can also develop a comprehensive internal system for knowledge commercialisation (custom-made further-education courses, consultancy services, contract research) (Jacob et al., 2003) and commoditisation (patenting, licensing; both staff and student spin-offs and start-ups) (Chrisman et al., 1995; Jacob et al., 2003) by providing a support structure, as a “natural incubator” (Etzkowitz, 2003), through different stakeholders.

The entrepreneurial university model suggests the existence of multiple interactions between a variety of stakeholders (Miller et al., 2014; Miller and Acs, 2017), such as governments, students, businesses, entrepreneurs and incubators (Clauss et al., 2018) that cross organisational boundaries. The university plays a leading role in these interactions, which can facilitate the flow of knowledge and promote regional economic development (Feldman and Desrochers, 2003; Etzkowitz et al., 2008; Miller and Acs, 2017). This is supported by empirical research that is largely based on observations in both developed (Liu et al., 2018) and developing (Belitski et al., 2019) countries.

The research question on what constitutes an entrepreneurial university with respect to stakeholders who facilitate and encourage knowledge creation and spillovers at different levels of engagement remains unanswered.

Universities can be considered a complex phenomenon due to their divergent strategic goals, as well as the internal and external stakeholders they deal with (Bartell, 2003; Bercovitz and Feldman, 2008; O’Kane et al., 2015). However, research on entrepreneurial universities lacks the complexity of models needed to explain the interdependent processes amongst the different stakeholders involved (Rothaermel et al., 2007; Foss and Gibson, 2015) and their impact on university entrepreneurial outcomes.

Besides, current research on university engagement with other actors has a number of drawbacks. First, there is no clear explanation of who the entrepreneurial university's stakeholders are. Little research exists that conceptualises the structure, mechanisms and links such universities build while engaging with external stakeholders (Hayter, 2016) during the knowledge creation and transfer processes. Secondly, research is missing into entrepreneurial universities that adopt a static perspective with dynamic interactions between the various stakeholders (Hayter, 2016). Thirdly, it is important to further investigate the key elements of the entrepreneurial university: the resources needed to help develop commercialisable knowledge, e.g., human capital and know-how, or knowledge hubs, patenting and incubators (Youtie and Shapira, 2008). An entrepreneurial university creates a system of incentives to encourage internal and external stakeholders to interact with each other (e.g., missions of the entrepreneurial university) (Fugazzotto, 2009).

Based on this research gap, this study improves our understanding of a variety of entrepreneurial universities as a complex phenomenon in connection with other actors. It further informs us regarding the potential outcomes of university activities with different stakeholders.

In order to investigate the heterogeneity of the entrepreneurial university phenomenon, this study categorises UK universities into three main groups. This is based on their historical involvement in research and teaching and their historical development (Hewitt-Dundas, 2012; Abreu et al. 2016).

Using longitudinal data on 139 UK universities (2009-2016) collected by the Higher Education Statistics Agency (HESA), the purpose of this study is to theoretically develop and empirically test the concept of the entrepreneurial university. It demonstrates how collaboration between a variety of stakeholders on knowledge spillovers can change university outcomes across universities of different types.

While previous studies have provided interesting insights into university collaboration with stakeholders, the literature indicates a lack of holistic systems perspectives across different levels of analysis that might be representative of different types of entrepreneurial universities.

The following contributions address this theoretical gap.

First, we review the prior research in order to develop a theoretical model of an entrepreneurial university and its engagement with other actors to explain how it operates. We introduce the structure of an entrepreneurial university and describe the channels it uses for knowledge commercialisation.

Second, we introduce the mechanism which describes how the entrepreneurial university is organised to create and facilitate knowledge transfers outside of university boundaries through multilevel external stakeholders (Bradley et al., 2013). We also consider the role that the university entrepreneurial ecosystem (Guerrero et al., 2016, 2019) plays in these relationships, distinguishing between three types of entrepreneurial universities in the United Kingdom (UK) (the Russel Group, former polytechnics, and teaching-based universities).

Third, we develop an organisational structure of the entrepreneurial university that enables the recognition of the main stakeholders promoting entrepreneurial inputs and outputs (Adner, 2017). Specifically, we intend to address the gap in the current research by considering how interactions between stakeholders affect university entrepreneurial outcomes as well as to examine how a university's structure and resources (Teece et al., 1997; Audretsch, 2014) are combined by exploring the role that the university plays within the entrepreneurship ecosystem (Rice et al., 2014; Heaton et al., 2019).

Within this chapter, we describe the context of the UK higher education sector and apply the conceptual framework developed for the universities in the UK. The chapter discusses the data and methodology as well as provided results and discussions. Conclusions are provided in the final Chapter.

2.1 The context of the UK higher education system

The UK Higher Education system is very diverse (Scott, 2014). The historical differences started from the establishment of Cambridge and Oxford Universities in the medieval era. Later, civic universities were created during the Victorian period in the industrial cities. The following reforms included the creation of the red-brick universities (during the inter-war period) and of a number of new universities in the 1960s, as well as the incorporation of the Colleges of Advanced Technologies into the university sector (Goddard et al., 2012).

Considering all the reforms, there is a general binary divide in the UK Higher Education sector (Morgan, 2002; Hewitt-Dundas, 2012; McCormack et al., 2014) between the older (founded before 1992), more research-oriented universities, and those which gained university status after 1992 following the introduction of the Further and Higher Education Act (HMSO, 1992), and university colleges that became universities later on. The latter group is divided into two which will be described below.

The research-oriented universities constitute Russel group universities and comprise 24 institutions including the oldest research higher education establishments from the medieval era. The top-5 oldest research universities include Oxford University, Cambridge University, Manchester University, Imperial College London, University College London. Due to the heterogeneity among the Russel Group universities (Boliver, 2015) and the dominance of the top-5 universities, a fine-grained distinction exists between the two groups.

The Russel Group represents less than 15% of all universities, yet its members receive around 75% of the research funding granted by the Higher Education Funding Council (HEFCE) annually. The top-five universities are usually represented separately from the Russel Group, as they receive the biggest share of government funding (around 30% every year) inside of the group.

The teaching-oriented group comprises of pre- and post-1992 universities or former polytechnics which offered degrees in more technical subjects and other teaching universities gained university status after 2004 (those that previously were further education colleges). In general, both pre- and post-1992 universities and those gained status after 2004 are more teaching-oriented, providing vocational education and trainings. Meanwhile, their third mission is locally focused and engagement in basic research is relatively low (Charles et al., 2014; De la Torre et al., 2018).

The polytechnics group (pre- and post-1992) consists of the higher education institutions originally established as polytechnics under the funding and control of the local authorities and which received their university status since 1992. Boliver (2015) identified a significant difference between pre- and post-1992 universities in terms of the resources they possessed, their teaching and research activities, and the selectivity of students and academics. In general, these universities carry out a large portion of tertiary education and they make up a quarter of the UK higher education system. The purpose of polytechnics from their origin was to provide professional training and especially in STEM subjects, engineering, applied and life sciences (Schimank & Winnes, 2000) but soon after they gained university status, they developed schools of journalism, humanities, architecture, law and other professional practices. The adoption of the university status built a link with the community making polytechnics as semi-autonomous bodies responsible only to a central government. Polytechnics were primarily located in urban areas to support industry or commerce and they usually have a city name.

The other teaching universities are higher-education institutions that gained university status after 2004 and include former further and higher education bodies, along with specialist and current higher education colleges. The government allowed those institutions with their own taught degree to get university status provided they have at least 4000 students with not least than 3000 should be on degree level courses including two-year foundation degrees (Boliver, 2015). This move has not been supported by existing universities stating that it would break the nature of the university in terms of the link between teaching and research which was vital for higher education. Under the new criteria all the teaching staff in the institution applied to get a university degree have to demonstrate understanding and knowledge of current research in their discipline and show how it directly inform and enhance teaching.

Thus, teaching and research together became integrated into all universities and their infrastructure and capacity have been supported and developed across all higher education establishments beyond their concentration in older universities (Shattock, 1994).

Therefore, this research categorises universities into three main groups (Russel group – research-oriented; Polytechnics and Rest teaching universities – teaching-oriented) based on their research intensity and historical development while all of them do have the diverse infrastructure for knowledge transfer (Table A2 Appendix A). Our research-intensive universities are Russel Group universities. The teaching domain included former polytechnics and teaching-led universities (not included in any of the groups described before).

Boliver (2015) showed that a binary division exists between pre-1992 universities, characterised by their greater wealth, higher quality research, greater academic success and larger socioeconomically advantaged student intakes, and the post-1992 universities. McCormack et al. (2014) conclude that research universities are competing more on the international and national levels (for both staff and students) while newer universities are more focused on local markets. These findings are consistent with those of De la Torre et al. (2018), who showed that division exists between traditional universities and former vocational institutions in terms of research and teaching intensity, specialisation and stakeholder's engagement.

The proposed groups of universities capture the historical differences between different universities, and they represent the UK higher education sector. Our categorization is consistent with other research which has emphasised the institutional differences in the sector (Abreu et al. 2016; Sanchez-Barrioluengo et al, 2016).

Legally, all the universities in the UK are private non-profit corporations (incorporated by the Oxford and Cambridge Act in 1571). However, their receipt of public funds means they are treated as public bodies for various legal purposes, including the Equality Act, the Human Rights Act and the Freedom of Information Act, and there is a cap on how much they can charge home students. All the universities could theoretically, turn down the government funding and become fully private. The government theoretically has no say in how universities run themselves, in who they admit, or in how they teach.

This study argues that all stakeholders affect the development and outcomes of entrepreneurial universities, while the results of the university-stakeholder collaboration are likely to be different between universities with different orientations (teaching, research or polytehnic) and between different stakeholder types. In the next part of the paragraph, we are trying to describe our arguments in more detail.

2.1.1 Stakeholders' classification and conceptualisation within the entrepreneurial university in the UK

The classification of stakeholders at different levels of the entrepreneurial university could help us to identify the impact stakeholders have on entrepreneurial university performance (Rowley, 1997), as well as show how multiple configurations of stakeholders can represent an entrepreneurial university. In addition, classification makes conceptualisation possible (Bailey, 1994). Relying on the theoretical chapter and conceptualisation presented before, below we provide a detailed explanation and build a hypothesis for the classification of stakeholders applying to the UK higher education sector.

Types of university stakeholders (knowledge enablers; knowledge producers; knowledge codifiers; knowledge facilitators)

Knowledge enablers

Government

As an external stakeholder, government facilitates the technology transfer process. Initially, the government will develop appropriate university operating policies and is considered to be the most common source of funding (e.g., Innovate UK programme in the UK). The government's explicit policy is directed at devolving responsibility to academia for ensuing research funding and its subsequent commercialisation (Guerrero et al., 2016).

Universities have a strong public responsibility to society (Neave 2000). Consequently, academia usually receives a generous amount of public funding and, in some countries, academic autonomy. Collaborative research officially forms the relationship between two stakeholders and, unsurprisingly, is a knowledge transfer channel.

In addition, collaborative research contributes to the increasing awareness of the commercial exploitation of research results. It also promotes a better understanding of market needs, thus facilitating academic engagement in the patenting and commercialisation processes (Shane, 2001; Siegel et al., 2003).

The government also provides the political incentives that encourage entrepreneurship in universities that are focused both on research and teaching by enacting legislation designed to stimulate R&D-based entrepreneurial activities (e.g., tax incentives) in teaching led universities and stimulate patenting own research in research-oriented universities (e.g. Knowledge transfer partnership programme). One of the most prominent examples of political instruments is the Bayh-Dole Act, which became law in the US to facilitate the commercialisation of research outputs.

Industry

Besides the government, universities engage with the industry as an initial external stakeholder. By providing funding for research projects, the industry represents a significant input into idea generation and development. The relationships between the two parties are formed through contract research, which is an effective tool and channel through which to transfer knowledge from university to industry (Cohen et al., 2002). The existence of contracts with industry positively affects the propensity for direct commercialization of university research, but also researchers' involvement in entrepreneurial activities, and helps to create an entrepreneurial culture at the university (Powers and McDougall, 2005). This is important as collaboration with industry benefits both research- and teaching-oriented universities in direct research

commercialization via contracts and creating an entrepreneurial culture at research and teaching universities.

In addition, contract research supports the creation of spin-offs (van Looy et al., 2011), complements other knowledge exchange activities, and offers benefits to local regions (Schartinger et al., 2002). Contract research can also advance university research by helping academics to gain access to materials, equipment and data that might otherwise have been impossible to obtain.

Once the knowledge has been created at the universities, academia provides various services to the industry in return. Such services are also knowledge transfer channels and can be provided in the form of consultancy (Perkmann et al. 2013) or additional training (Ferreira and Ramos, 2015), for instance. Consultancy is driven by the motive of learning with industry and is considered to be a potential means of third-stream revenue for academia (Druckman 2000). As for training, this knowledge transfer channel helps to transfer tacit knowledge and build skills (Ferreira and Ramos, 2015).

Stakeholder engagement across teaching and research-led universities can be explained as follows. Government support is adopted to various extents for knowledge spillover on both types of universities. The government is responsible for setting the formal rules and policies under which the higher education sector operates. It is also a principal provider of research funding for research-led universities, as well as community development and collaboration with industry for knowledge spillover in teaching-led universities (e.g. Innovate UK programme). This creates a flourishing entrepreneurial environment and the infrastructure needed to promote technology transfers. Collaboration with industry provides financial support to university scientists, therefore boosting the development of R&D, patents in research-led universities as well as facilitating the exchange of knowledge via direct knowledge transfer in teaching led universities. We thus hypothesise that:

H1a: Knowledge enablers have a positive effect on university start-up activity and the licencing of technologies in research-oriented universities.
H1b: Knowledge enablers have a positive effect on university start-up activity and the licencing of technologies in teaching-oriented universities.

Knowledge providers

Researchers

Once the opportunities exist and institutional conditions have been established, knowledge creation for the following transfer occurs internally within the university. Within the knowledge transfer process itself, scholars represent an important group of internal stakeholders (Bercovitz and Feldman, 2008; Clauss et al., 2018; Jongbloed et al., 2008) and influence the emergence of knowledge spillovers in both teaching- and research-oriented universities. They transfer knowledge vis selling IP rights as well as creating spin-offs and start-ups (Belitski and Heron, 2017). Academics are the main internal nucleus that generates new knowledge, allowing both university types to function properly.

Students

Students are another group of internal stakeholders within the knowledge transfer process. Acosta et al. (2011) demonstrated that the total number of university graduates is one of the vital spillover mechanisms that explain the creation of new ventures in both teaching- and research-led universities. Higher education is a customer-input service and students, as customers of universities are a pivotal input into its teaching. Taking classes, students are educated not only via lecturers or their professors but also through interacting and sharing ideas or experiences with their peers. In this process, the quality of their fellows contributes to the outcomes of their learning. When it comes to research activities, graduates and PhD or postdoctoral students are important participants in research projects and IP rights generation. This knowledge can be used for academic spin-off formation based on new knowledge in research-oriented institutions (Hayter et al., 2018) or based on identified market opportunities for teaching-led universities (Belitski and Heron, 2017). After graduation of any university type students become either job seekers or job creators (Saginova and Maksimova, 2017).

University students are important to the transfer of tacit knowledge in the form of start-ups or spin-offs (in particular, for the research-led universities), and also serve as a measure of the demand for labour (Qian and Acs, 2013). The higher the human capital outputs of academia, the lower the distance between academia and firms with regard to the transfer of knowledge.

Both researchers and students are thus able to generate new knowledge by exploring new knowledge and exploiting new market opportunities with both are vital to the initial stages of conducting and commercialising the associated research. They identify opportunities and experiment with new ideas in order to proceed to knowledge commercialisation (mostly faculty

and postgraduate students within the research-oriented universities) and the creation of new ventures to address market demand (both university faculty and students within teaching- and research-led universities). This leads us to hypothesise that:

H2a: Knowledge providers have a positive effect on university start-up activity and the licencing of technologies in research-oriented universities.

H2b Knowledge providers have a positive effect on university start-up activity and no effect on licencing of technologies in teaching-oriented universities.

Before entering the public domain and being transferred into the economy, the knowledge produced by academia might follow either a traditional or formal (licensing) route, or alternative (non-linear) (new ventures creation, direct contracts with industry, etc.) route to commercialisation (Bradley et al., 2013). The former process requires the invention to be codified and protected before being transferred through the knowledge codifier stakeholders' domain, namely the TTOs (or any relevant department) and intellectual property offices (hereafter IP office). The latter involves knowledge facilitator stakeholder groups or science parks (hereafter SPs) and business incubators (hereafter BIs). Both of these stakeholder subgroups might be either internal or external to the university.

Knowledge codifiers

TTOs and IP offices

To ensure appropriate protection for a given invention, academia usually works with IP offices that are responsible for protecting intellectual property (IP) rights, including patents, copyright, trademarks and designs.

Patents and licences are a visible method and channel for knowledge transfers via the traditional route (Fisch et al., 2016), especially for research-focused universities. They facilitate the commercialisation of inventions and the creation of new ventures contributing to the university's third mission. They also enable start-ups to raise external funding (Farre-Mensa et al., 2015). Patenting is a strong, robust research-based predictor for the decision by academics to participate in founding a firm (Stuart and Ding, 2006). Patents can thus be seen as a promising starting point for entrepreneurial activities by researchers, or otherwise an initial step towards a traditional way of research commercialisation.

The licencing of patents is also one of the channels through which knowledge can be transferred from universities to industry. This channel generates a trail that facilitates the empirical study

of knowledge (Agrawal, 2006) and serves as a proxy for innovation-based contributions from university research (Gulbrandsen and Rasmussen, 2012).

The sale of licenses to companies is one way by which university patents can be exploited, providing an additional and often substantial income and more profoundly for research-led universities (Siegel and Leih, 2018). Licensing income is one way of measuring knowledge transfers from universities, along with their economic success (Siegel, 2018).

The licensing of patents occurs through the TTO, which facilitate communication with other actors, fostering links between science and industry (Perkmann et al. 2013) and formalising the knowledge transfer process (Siegel, 2018). TTOs encourage scholars to share their inventions and evaluate their potential for commercialisation. They also provide diverse support services, including searches for partners, intellectual property rights management, etc. When it comes to new ventures creation, TTOs are usually helpful for business development skills including conducting workshops on business skills, helping with business plans, etc. for both research- and teaching-led universities (Aldridge and Audretsch, 2010).

TTOs play a crucial role in facilitating and transferring technologies where these technologies exist, mainly in research-led universities to the industry, while in universities with the paucity of scientific knowledge, TTO's activity will focus on supporting knowledge spillover via spin-offs from universities and their laboratories (Balven et al., 2018; Siegel, 2018). In this role, TTOs act as "technology intermediaries" by facilitating the expansion of research to the industry while commercialising research and market ideas by supporting start-ups from teaching-led universities.

Along with TTOs, IP offices can help to bridge the gap between research commercialisation at the university and industry development through issuing patents being more active at research-oriented universities where new knowledge is a breakthrough. TTOs, on the other hand, are intermediaries, gap-fillers as it were, in the process of research commercialisation. In addition, engaging in patenting activities enables researchers to delegate the function of searching for commercialisation opportunities with industry to TTOs and knowledge protection to IP offices while focusing mainly on developing new ideas (Aldridge and Audretsch, 2010). Summing up, TTO and IP offices are an important conduit to bridge the information asymmetry between university and industry as well as to develop business skills to support the faculty in starting a business. This discussion thus leads us to hypothesise that:

H3a: Knowledge codifiers have a positive effect on the licencing of technology and no effect on university start-up activities in research-oriented universities.

H3b: Knowledge codifiers have no effect on the licencing of technology while having a positive effect on university start-up activities in teaching-oriented universities.

Knowledge facilitators

Science parks and business incubators

In those instances where the new knowledge created by universities is not commercialised formally through a TTO, it might alternatively be used for the creation of new companies. The creation of new ventures requires a supportive infrastructure and stakeholders who facilitate knowledge spillover outside the university domain, contributing to local economic development (Feldman and Desrochers, 2003). Within the entrepreneurial university context, science parks and business incubators play this role of knowledge facilitation (Audretsch and Belitski, 2019).

The primary goal of science parks and business incubators is to facilitate knowledge transfers from academia and research institutions and create new firms (Hayter, 2016). They also act as boundary spanners and network platforms between universities and businesses (Audretsch et al., 2016) bringing both together and helping academics to develop networks for commercial exploitation of new knowledge (e.g. selling IP rights). This strategy works very well for research-oriented universities because by collocating with other companies, new research-based start-ups can benefit from the localised knowledge spillovers for innovation and production (Audretsch and Feldman, 1996a).

The main idea behind the establishment of science parks is to develop the necessary infrastructure and provide administrative, logistic and technical help to new firms, including those which are driven by university research (e.g. creating spin-offs utilising IP right) as well as to generate knowledge spillovers. This objective is more effective for the research-led universities (Hayter et al., 2018) as new start-ups can participate in joint R&D projects and develop innovation clusters for knowledge commercialization (Audretsch and Feldman, 1996b). New ventures need such support if they are to compete successfully with established companies on the market (Guy, 1996). The debate regarding the effectiveness of such parks in supporting new firms (Hobbs et al., 2017; Albahari et al., 2019) suggests locating firms in science and technology parks have a positive impact on company employment and sales.

According to Murphy and Dyrenfurth (2019), the support provided by incubators helps people to conceptualise their ideas (which do not necessary based on research outputs and thus might be more effective within teaching-led universities) and launch businesses successfully. For the

same reasons as for spin-offs from research-based universities, new firms from teaching-based universities seeking to explore market opportunities may enrich their ideas with a solid knowledge background and technologies of other firms co-located in science parks and incubators (Audretsch and Belitski, 2019). Such support to new firms may include workshops, mentorship, access to investors, and access to networks of entrepreneurs (Abduh et al., 2007). In addition, business incubators offer support services in the form of equipment such as fax machinery, photocopiers, computers (Hatten, 2006), facilities (office space), knowledge and management support (Hobbs et al., 2017).

Venture capitalists (VCs)

The availability of VCs is vital to the success of a company (Samilla and Sorenson 2010; Powers and McDougall 2005). Under conditions of resource constraints at universities with regard to creating successful new ventures, VCs are considered an important source of the associated funding. Universities which are research active and are able to commercialize knowledge by starting new firms and acquiring property rights on the invention will be more successful in securing venture capital. Access to venture capital is the second-most important channel in the UK (after government support through University Challenge Funding) (Wright et al., 2006). Additionally, to financial capital, VCs provide academic entrepreneurs with managerial and technical advice on running a business and allow access to their business networks (Bock et al., 2018; Hayter, 2016). In addition, VC adds credibility to a start-up (Fernández-Alles et al. 2015) and connections to markets and industry (Vohora et al., 2004). Moreover, the coaching effect of VCs and their active involvement positively affects company sales and employee growth (Colombo and Grilli, 2010; Bertoni et al., 2011), but will be more relevant to start-ups without prior expertise in the market and limited business networks.

To summarise, science parks and business incubators are mechanisms that help to foster the creation of knowledge-based spin-offs including via utilisation of IP rights (more often for research-oriented institutions) and university-based start-ups (more often for teaching-oriented institutions). Science parks are characterised as a traditional supply-side tool that promotes infrastructure and networking among academic and business actors. This enhances community-building and industrial clusters both in and outside the park. Business incubators are organisations that are involved at all stages of company development from idea generation to launching an enterprise and are used as tools to facilitate knowledge transfer in universities of both types. We thus hypothesise that:

H4a: Knowledge facilitators have a positive effect on the licencing of technologies and university start-up activities in research-oriented universities

H4b: Knowledge facilitators have no effect on the licencing of technologies while having a positive effect on university start-up activities in teaching-oriented universities

To sum up, considering the types of universities in the UK higher education system, not all universities are engaging with all of the various types of stakeholders described. We argue that the more entrepreneurial path with both traditional (licensing, spin-off creation) and alternative (start-up creation) routes for knowledge transfers appeal most to the Russel Group universities or research-oriented universities. Instead, teaching-oriented universities might not benefit so much from engaging in the traditional knowledge-exchange process or collaborating with TTO and patenting offices as well as science parks (e.g. due to the lack or less volume of commercialisable research outcomes). They might achieve higher entrepreneurial outcomes engaging with Business Incubators and establishing start-up companies.

In the next section, we test our hypothesis based on the UK higher education sector and describe the results of the evaluation.

2.2 Analysis of the UK higher education system through the lens of stakeholders at organisational level

2.2.1. Data and method

2.2.1.1 Sample

Our sample comprises 139 UK universities that have used knowledge through commercialisation, commodification or through both channels via university collaboration with stakeholders to perform such activities. The data was collected by the Higher Education Statistics Agency (HESA), specifically the university-business collaboration survey (Higher Education Business and Community Interaction Survey (HE-BCIS)). This is open-access data available at the university level. We supplemented the HE-BCIS statistics using other data from HESA (e.g. university establishment year, number of faculty and students). The information available from HESA also covers issues relating to the strategic priorities of universities and their entrepreneurial activities, income levels and other activities related to their social responsibilities.

From the total number of universities which had participated in the HE-BCI survey, we excluded those that had no outcomes related to third-stream income generation or social responsibility from both teaching and research missions.

For the sample of this research, we defined the "entrepreneurial university" as an institution that had entrepreneurial outcomes from teaching, and/or research missions, or both. We also required institutions to have established support structures to facilitate knowledge commercialisation and spillovers. From the teaching perspective, we considered entrepreneurial outcomes of a university such as a start-up creation (both staff and graduate). From the research perspective, we considered entrepreneurial outcome such as income generated from contract research, IP revenue generation and spin-offs creation. We also considered consultancy and training activities as the main factor in the dissemination of new knowledge (entrepreneurial mission) from both teaching and research activities.

Additionally, these results should be supported by the established internal system, either for the research dimension (mostly TTOs or licensing offices) or the teaching dimension (mostly business incubators or science parks), or both (see Table A2, Appendix A). According to Henrekson and Rosenberg (2001), the existence of the above-mentioned structures is one of the four key aspects required for the emergence of university-based entrepreneurship.

For example, in the case whereby University A has an entrepreneurial outcome from teaching activities (e.g. start-ups) but has not achieved entrepreneurial outcomes from research activities (e.g. IP revenues or spin-offs), University A will still be included in our sample. A university would be excluded from a sample should there be no evidence of entrepreneurial outcomes from teaching or research missions. Thus, from the total sample of UK higher education establishments, we excluded 29 universities that did not meet our requirements for the period covered (see Table A2, Appendix A for the sample details covered by this research).

The sample of 139 universities includes universities that displayed the features of an entrepreneurial university through entrepreneurial outcomes and internal supportive structures (see Table A2, Appendix A for more details). However, within the total sample, we have three distinct groups of universities which can be categorised based on specific features of their activities or historical development.

Table 5. General features of the sample by university subgroup (percentage of universities in a group that perform certain commercialisation activities and have supportive structures)

Indicator	University Type		
	Russel Group Universities	Polytechnic Universities	Rest Teaching Universities
Consultancy and CPD	100.00	100.00	100.00
Contract research	100.00	100.00	91.00
IP revenues	100.00	93.00	65.00
University staff start-ups	25.00	30.00	17.00
University graduates' start-ups	75.00	80.00	68.00
University spin-offs	87.00	43.00	36.00
Venture capitalists support	91.00	70.00	58.00
University Science park	37.00	16.00	14.00
External Science park	29.00	23.00	23.00
TTO exists at the University	79.00	46.00	45.00
TTO and other organisations	16.00	43.00	25.00
University Business incubator	79.00	66.00	63.00
External Business incubator	8.00	-	3.50
Number of universities in the sample	24	30	85

We divide the sample into a subgroup of Russel Group universities, polytechnic universities (previous polytechnics or less research-intensive universities) and other teaching-led Universities (institutions not included in one of the previous categories). We use a relative measure as the percentage of universities that participate in each specific activity type to visualise the differences between the three subgroups of universities (Table 5). Relative measures are applied because of the difference in university numbers in each group.

According to Table 4, for the period covered all universities in each subgroup were involved in consultancy courses for business. All Russel Group and polytechnic universities demonstrated 100% involvement in contract research, while only 91% of teaching-led universities were involved in contract research. All Russel Group universities have IP revenues, while 93% of polytechnic universities and only 65% of teaching-led universities have IP revenues. Interestingly, 75% of Russel Group universities have university graduate start-ups, while polytechnics have 80% and teaching-led universities have only 68% of graduate start-ups. Russel Group universities have achieved the highest level of VC support (91%) compared to 70% for polytechnics and 58% for teaching-led universities. Polytechnic universities have no business incubator support out of the university, while 8% of Russel Group universities collaborate with off-campus business incubators. A more detailed description of the differences in entrepreneurial outcome by teaching and research missions is presented in Table A2, Appendix A.

2.2.1.2. Variables

Dependent variable

In terms of measuring entrepreneurial capital at universities, researchers have paid more attention to two particular performance metrics, which are revenues from utilising patents (or licensing), as well as the creation of new ventures (Siegel and Wright, 2015; Siegel, 2018; Siegel and Leih, 2018). Audretsch and Keilbach's (2004) definition of university entrepreneurial capital consists of looking at the latter, while research conducted over the past decade has placed its emphasis on licensing revenues (Markman et al., 2005). These two metrics represent a certain status quo for accessing the entrepreneurial university within the framework of the profit-orientation model.

The benchmark of entrepreneurial capital is the number of new companies created by exploring university inventions (Markman et al., 2009). However, according to Siegel and Wright (2015), this measure does not capture the number of new ventures created by students, while

entrepreneurial activity usually originates from student-led start-ups supplemented by programmes and classes. According to Astebro et al. (2012), there is a lack of studies within the area examining new ventures created by students. This thesis should address this gap by including the measure of students' enterprise in the research.

The majority of new ventures are created by students, as compared to those created by faculties. This is because students open more ventures than faculty (Astebro et al., 2012) and students are more likely to be involved longer in the venture's life cycle. Hayter (2016) showed that students play a crucial role in convincing academics to start companies, and often lead the process. In addition, companies created by students are found to be more frequently of higher quality than those by faculty (Astebro et al., 2012).

The type of entrepreneurship education affects students' entrepreneurship outcomes (Guerrero et al., 2018, 2016; Bergman et al., 2018). Thus, utilisation of student start-up metrics, in addition to licensing activity and spin-offs creation, is an important contribution to the literature on entrepreneurial universities. Capturing these metrics is crucial not only for an elite but also other universities pursuing entrepreneurial activities (Wright et al., 2017).

Thus, our dependent variables represent IP revenues generation as well as the creation of three types of entrepreneurial university ventures, which are academic spin-offs and staff and graduate start-ups. We have provided definitions of all three types of companies as well as some other variables included in the modelling in Table A3. We used a natural logarithm for all the dependent variables (Siegel et al., 2003; Roessner et al., 2013).

Independent variables

We grouped independent variables based on the outcomes of activities with four different stakeholder types (see Table A3 in Appendix A).

Knowledge enablers.

The government is represented by the value of collaborative research contracts per staff member, or by the total funding that the government (both the UK and EU) provides to universities to conduct research (Bramwell and Wolfe, 2008; Guerrero et al., 2015). As a stakeholder, the industry is represented by the total value of consultancy per staff member and the training courses that universities provide for businesses (Hewitt-Dundas, 2012) (e.g., bespoke courses at business premises and courses for professional development), as well as the value of contract research. Both indicators should be considered as outcomes of the entrepreneurial mission or third-stream activities (Guerrero et al., 2015; Sengupta and Ray,

2017). Government and industry are of the knowledge enablers stakeholder group and represent the research and entrepreneurial missions of the university.

Knowledge providers.

Knowledge providers, as stakeholders, are represented by the total number of research staff, teaching staff and research and teaching staff together (Belitski and Heron, 2017; Acosta et al., 2011). We have also included the number of doctoral students and those studying other higher degrees (Hayter et al., 2018). Additionally, we have considered the share of undergraduates and postgraduates taking STEM, biology, medicine and physics, business and administrative courses, as well as university employment indicators per 1,000 students (Jongbloed et al., 2008; Pavone, 2019). This group of stakeholders represents the teaching mission of the university.

Knowledge codifiers.

TTO services are both internal and/or external to the university (Siegel et al., 2003). Along with the IPOs, as a stakeholder, which is represented by the number of patents granted per staff member (Hewitt-Dundas, 2012; Guerrero et al., 2015) we consider IPOs and TTOs as representatives of the knowledge codifier stakeholder group.

Knowledge facilitators.

Venture capitalists, as stakeholders, are represented by the total value of investment university spin-offs and staff and graduate start-ups receive. We measure collaboration between universities and science parks and business incubators by identifying whether universities provide such services, whether internally and/or through outsourcing (Kalahari et al., 2019). VCs, science parks and business incubators represent the knowledge facilitator stakeholder group. The last three groups of stakeholders represent both the research and entrepreneurial missions of the university.

In the final modelling, some of the variables described above have been excluded due to multicollinearity issues.

To check, whether the variables chosen do represent the stakeholder subgroup, we applied the Cronbach alpha approach. We have created seven distinctive types of stakeholders based on our four core subgroups (knowledge enablers, providers, codifiers and facilitators). Cronbach's alpha is a measure of scale reliability and might be written as a function of the number of tested items, the average inter-correlation among them and the cut-off point (Wooldridge, 2012).

In particular, for knowledge, facilitators we created two constructs using Cronbach alphas for two stakeholders, such as government (comprised of the collaborative contribution of the UK government, European governments, Other UK government as well as Other funding) and Industry (comprised of income from consultancy and courses for professional development, as well as contract research funding).
We created two constructs using Cronbach alphas for two stakeholders of knowledge providers comprised of human capital - university faculty (including doctoral students, university teaching capital, university research capital and university teaching and research capital) and human capital - university students (including STEM undergraduates and postgraduates; biology, medicine, physics undergraduates and postgraduates; business and administrative studies undergraduates and postgraduates; other degree students).
We created two constructs using Cronbach alphas for two stakeholders of knowledge codifiers representing TTOs (TTOs exist at university; TTOs and other organisations and IP revenues). We presented patenting offices separately because of the high correlation between TTO variables and the number of patents granted.

We created two constructs using Cronbach alphas for two stakeholders of knowledge facilitators comprised of two subgroups such as science parks and business incubators (external and university science parks; external and university business incubators) and venture capitalists (investment in spin-offs, staff and graduate start-ups). All new constructs have Cronbach alpha greater than 0.70, which is the reliability threshold for this analysis (Cronbach, 1951). The variables used to create Cronbach alphas are described in Table A3 (Appendix A). The created Cronbach alphas were used in the interaction analysis when testing for interdependence and collaboration between stakeholders in their effect on university entrepreneurial outcomes.

Control variables

With respect to the entrepreneurial university and its social responsibilities, and in specific reference to the UK context (Guerrero et al., 2015; Marzocchi et al., 2019), we included control variables as predictors of university entrepreneurial outcomes. Such variables account for university-specific features which were included in a model with a one-year lag to enforce a causality.

For university characteristics, we considered the following variables as controls: total value from renting facilities, a strategic plan for business engagement, incentives for the university

staff to engage with business, and whether the university was amongst the top five groups or otherwise. We also included university age as a proxy for university maturity.

As for facilities, academia can use its buildings and equipment and rent them to businesses, encouraging entrepreneurial behaviour and generating third-stream income (Etzkowitz, 2003) (contributing to the entrepreneurial mission). Table A4 (Appendix A) provides descriptive statistics for all variables used in our estimation for the overall sample of 139 UK universities, as well as descriptive statistics for each subgroup of the entrepreneurial university: the Russel Group, polytechnics and teaching-led universities. Means and standard deviations across the four samples allow us to compare the university-level characteristics for each group in the population. In addition, we provide a Pearson-type correlation matrix in Table A5 Appendix A. This provides a statistical adjustment to the correlations among the variables applied in the model using multiple regression (Wooldridge, 2010).

2.2.1.3. Method

We test our hypotheses using the pooled ordinary least squares (POLS) with university and time fixed effects.

The following model was estimated:

$$y_{it} = f(\beta x_{it,} \Theta z_{it,} \alpha_i, \lambda_t, \mu_{it}) \quad i=1 ,..., N; \quad t=1,..., T \tag{1}$$

where y_{it} is a set of dependent variables (represented by IP revenues as well as new ventures creation (including university spin-offs and staff and graduate start-ups)) of a university *i* at time *t*. β and Θ are parameters to be estimated, x_{it} is a vector of independent explanatory variables lagged 1 year (four groups of stakeholders), z_{it} is a vector of exogenous control variables lagged 1 year; α_i presents time fixed effects to capture potential changes over time for all universities (e.g. research assessment exercises for UK universities in 2014); and λ_t presents university fixed effects to measure the potential changes within each university over time (e.g. university-specific characteristics such as culture, traditions, informal institutions etc.); μ_{it} is a common intercept in the Model 1 (Wooldridge, 2010).

In addition to the Pooled OLS basic estimation we estimate (2) adding interactions between stakeholders (φ_{it}):

$$y_{it} = f(\beta x_{it,}\psi\varphi_{it}\Theta z_{it,}\alpha_i, \lambda_t, \mu_{it}) \quad \text{i=1 ,..., N;} \quad \text{t=1,...,T} \qquad (2)$$

where y_{it} is a set of dependent variables (represented by IP revenues as well as new ventures creation (including university spin-offs and staff and graduate start-ups)) of a university *i* at time *t*. β, ψ and Θ are parameters to be estimated, x_{it} is a vector of independent explanatory variables lagged 1 year (four groups of stakeholders), z_{it} is a vector of exogenous control variables lagged 1 year; φ_{it} is a vector of interactions between stakeholders lagged 1 year; α_i presents time fixed effects to capture potential changes over time for all universities (e.g. research assessment exercises for UK universities in 2014); and λ_t presents university fixed effects to measure the potential changes within each university over time (e.g. university-specific characteristics such as culture, traditions, informal institutions etc.); μ_{it} is a common intercept in the Model 2 (Bell and Jones, 2014).

Interaction effects were applied to check if the effect of one variable depends on the value of another variable (Bell and Jones, 2014).

We perform the estimation in the overall sample for 139 universities during 2010-2016 with all independent and control variables lagged one year. We also estimate model (1) and (2) for all three samples of entrepreneurial universities subgroups. To incorporate the potential non-linear relationship between the dependent and independent variables, we use logarithmic transformations of some variables. To address the concern of multicollinearity, we used a variance inflation factor (VIF) which was always less than 5 for each variable (Wooldridge, 2010).

2.2.2. Results

We start by reporting the results of Tables 6-9, which illustrate the role of stakeholders in the generation of the entrepreneurial outcomes including IP revenues and new ventures creation (university spin-offs, staff and graduate start-ups). The results are grouped by university type and include four different models of university collaboration with stakeholders. We report the main findings in this section and discuss them in the next section for all the university types.

While we have not hypothesized the general effects for all university types, we start our analysis by analysing pooled data for all the university types – the baseline model of the entrepreneurial

university (or the total sample of 139 universities). With respect to the conceptual model of an entrepreneurial university, all the groups of stakeholders have contributed to the university's IP revenues generation (Figure B1, Appendix B) as well as new companies' creation (Figure B2, Appendix B).

2.2.2.1. Baseline model of the entrepreneurial university

The results are presented in Table 6 (spec.1-4).

The role of knowledge enablers (Government and Industry) is significant as they positively contribute to the university's entrepreneurial outcomes including IP income and new companies' creation (Table 5). The government's contribution to the IP income generation is positive. As an example, an increase of Other Government funding by 1 percent increases the IP income by almost 0.13 percent (β=0.129, $p<0.01$). When it comes to funding from Other collaborative contribution from the government, its increase by 1 percent enlarges IP revenues generation by 0.07 percent (β=0.069, $p<0.01$), creation of university spin-offs by almost 0.02 percent (β=0.017, $p<0.05$) and graduate start-ups by 0.07 percent (β=0.073, $p<0.01$).

Collaboration with industry and consultancy is positively associated with IP revenues generation and start-ups creation. Table 6 (spec. 1) illustrates that a 1 percent increase in income from this type of activity increases IP revenues by 0.16 percent (β=0.165, $p<0.001$) and the creation of staff start-ups by almost 0.03 percent (β=0.025, $p<0.01$).

Knowledge providers or human capital at university (Table 6, spec. 1-4) have both positive and negative effects on a university's entrepreneurial outcomes. In terms of faculty, an increase in teaching only capital by 1 percent reduces university spin-offs creation by 0.02 percent (β=-0.021; $p<0.01$). Furthermore, an increase in university research only capital by 1 percent increases IP revenues by 0.26 percent (β=0.256, $p<0.001$). As for the faculty represented by both teaching and research capital, their change by 1 percent causes a rise in IP revenues generation by 0.09 percent (β=0.091, $p<0.05$) while reducing graduate start-ups creation by 0.03 percent (β=-0.132, $p<0.001$). When it comes to postgraduate students, an increase of students with other high qualifications boosts the creation of university spin-offs by 0.06 percent (β=0.060, $p<0.05$) and graduate start-ups by 0.16 percent (β=0.160, $p<0.05$).

Turning to the undergraduate and postgraduate students, their effect varies between directions of study and outcome variables while the standard errors turn to be high enough evidencing a non-significant contribution of these types of students on the outcome variables (see Table 5, spec. 1-4).

With respect to the *knowledge codifiers* (Table 6, spec. 1-4), the fact if the university has a TTO at university enlarge IP revenues by almost 0.44 percent (β=0,438, p<0.05) and graduate start-ups creation by almost 0.35 percent (β=0,347, p<0.05). Collaboration with external TTO increases by 0.65 percent IP revenues (β=0,647, p<0.001) and by 0.31 percent graduate start-ups creation (β=0,312, p<0.05). When it comes to patenting offices, they do not affect outcome variables as the coefficients are not significant.

When it comes to *knowledge facilitators* (Table 6, spec. 1-4), science parks presence at the university facilitates spin-offs creation by 0.24 percent (β=0,235, p<0.001) as well as staff start-ups creation by 0.19 percent (β=0,199, p<0.001). However, this factor is negatively contributing to the graduate start-ups' creation reducing the factor by almost 0.30 percent (β=-0,291, p<0.05). Establishing a business incubator on campus increases staff start-ups by almost 0.08 percent (β=0,078, p<0.050) and graduate start-ups by 0.68 percent (β=0,682, p<0.001) supporting prior research of Murphy and Dyrenfurth (2019) and Audretsch and Belitski (2019).

Table 6. Results for Pooled OLS regression for the baseline model of entrepreneurial university and Russel group universities

Dependent variables	IP revenues	Uni spin-offs creation	Graduate s-ups creation	Staff s-ups creation	IP revenues	Uni spin-offs creation	Graduate s-ups creation	Staff s-ups creation
Specification	1	2	3	4	5	6	7	8
Independent variables	**Baseline model of entrepreneurial university**				**Russel group universities**			
Knowledge enablers (H1)								
Other government funding	0.129*** (-0.028)	0.007 (-0.009)	0.032 (-0.024)	-0.004 (-0.008)	-0.001 (-0.044)	0.060* (-0.034)	0.034 (-0.055)	0.002 (-0.023)
Other funding	0.069*** (-0.022)	0.017** (-0.007)	0.073*** (-0.018)	-0.005 (-0.006)	0.060** (-0.029)	0.045** (-0.022)	0.003 (-0.037)	-0.025 (-0.015)
Bespoke courses for business	15.178 (-31.045)	3.971 (-10.212)	-27.951 (-25.764)	-1.653 (-8.208)	4.567 (-755.492)	713.526 (-582.815)	986.99 (-952.185)	164.833 (-391.954)
Consultancy and CPD	0.165*** (-0.050)	-0.003 (-0.016)	-0.004 (-0.042)	0.025* (-0.013)	-0.117 (-0.185)	-0.003 (-0.142)	0.23 (-0.233)	0.111 (-0.096)
Knowledge providers (H2)								
Other high qualifications	0.086 (-0.075)	0.060** (-0.025)	0.160** (-0.062)	-0.007 (-0.020)	-1.244*** (-0.356)	-0.397 (-0.274)	0.527 (-0.448)	-0.109 (-0.185)
Teaching capital	0.055 (-0.033)	-0.021* (-0.011)	-0.032 (-0.028)	-0.004 (-0.009)	0.253* (-0.135)	-0.050 (-0.104)	0.020 (-0.170)	0.057 (-0.07)
Research capital	0.256*** (-0.070)	0.011 (-0.023)	0.041 (-0.058)	0.007 (-0.019)	0.836*** (-0.288)	0.415* (-0.222)	0.809** (-0.363)	0.022 (-0.149)
Teaching and research capital	0.091** (-0.043)	0.003 (-0.014)	-0.132*** (-0.036)	0.011 (-0.011)	0.334*** (-0.102)	0.132* (-0.078)	0.199 (-0.128)	0.018 (-0.053)
STEM UG	4.456*** (-1.371)	-0.027 (-0.452)	3.008*** (-1.137)	0.783** (-0.362)	19.683*** (-4.851)	1.597 (-3.742)	-6.577 (-6.114)	-0.072 (-2.517)
STEM PG	-0.461 (-1.660)	0.824 (-0.545)	-3.798*** (-1.378)	-0.189 (-0.439)	-8.572 (-6.813)	-4.928 (-5.256)	-7.071 (-8.586)	1.374 (-3.534)
Biology PG	-2.670**	-0.432	-2.150**	0.010	-0.774	3.232	3.958	-1.567

	(-1.104)	(-0.363)	(-0.916)	(-0.292)	(-4.087)	(-3.153)	(-5.151)	(-2.120)
Biology UG	-2.115** (-1.004)	-0.417 (-0.33)	-1.359 (-0.834)	0.132 (-0.266)	-12.309*** (-2.775)	1.151 (-2.141)	12.288*** (-3.498)	2.996** (-1.440)
Business PG	2.691** (-1.097)	-0.650* (-0.360)	2.670*** (-0.910)	-0.436 (-0.290)	-2.809 (-4.912)	-1.277 (-3.79)	-7.789 (-6.191)	-2.121 (-2.549)
Business UG	-6.053*** (-1.247)	-0.465 (-0.410)	-1.987* (-1.035)	-0.730** (-0.330)	-21.991*** (-5.858)	-5.812 (-4.519)	7.598 (-7.383)	2.288 (-3.039)
Employment rate	1.229*** (-0.120)	0.066* (-0.039)	0.149 (-0.099)	-0.023 (-0.032)	-0.071 (-0.538)	-0.243 (-0.415)	-0.887 (-0.677)	-0.393 (-0.279)
Knowledge codifiers (H3)								
Patents granted	197.380*** (-51.446)	49.525*** (-16.906)	-132.286*** (-42.694)	-1.991 (-13.602)	-81.022 (-266.562)	-315.645 (-205.636)	-372.161 (-335.961)	66.286 (-138.294)
TTO exist at university	0.438** (-0.200)	-0.044 (-0.066)	0.347** (-0.166)	-0.011 (-0.053)	0.538** (-0.219)	0.127 (-0.169)	0.138 (-0.276)	0.290** (-0.113)
TTO and other organisations	0.647*** (-0.190)	-0.045 (-0.063)	0.312** (-0.158)	-0.013 (-0.050)	0 (.)	0 (.)	0 (.)	0 (.)
Knowledge facilitators (H4)								
External Science park	0.087 (-0.157)	0.064 (-0.052)	-0.184 (-0.130)	0.023 (-0.042)	-0.063 (-0.302)	-0.272 (-0.233)	-0.449 (-0.380)	0.301* (-0.157)
University Science park	0.238 (-0.173)	0.235*** (-0.057)	-0.291** (-0.143)	0.199*** (-0.046)	0.496* (-0.258)	0.005 (-0.199)	0.077 (-0.326)	0.228* (-0.134)
University Business incubator	-0.103 (-0.138)	0.058 (-0.045)	0.682*** (-0.114)	0.078** (-0.036)	0.004 (-0.285)	0.204 (-0.219)	0.374 (-0.359)	0.122 (-0.148)
External Business incubator	0.990*** (-0.318)	-0.035 (-0.104)	1.059*** (-0.264)	-0.011 (-0.084)	0.889** (-0.411)	-0.460 (-0.317)	1.388*** (-0.518)	0.222 (-0.213)
Investment in spin-offs	0.147*** (-0.020)	0.034*** (-0.007)	-0.025 (-0.017)	-0.006 (-0.005)	-0.042 (-0.031)	0.025 (-0.024)	-0.110*** (-0.040)	0.002 (-0.016)
Investment in staff start-ups	0.008 (-0.034)	-0.005 (-0.011)	-0.079*** (-0.029)	0.101*** (-0.009)	0.049 (-0.037)	-0.031 (-0.028)	-0.036 (-0.046)	0.090*** (-0.019)
Investment in graduate start-ups	-0.003	0.007	0.189***	0.003	-0.067**	0.003	0.113***	-0.016

	(-0.024)	(-0.008)	(-0.020)	(-0.006)	(-0.028)	(-0.022)	(-0.036)	(-0.015)
Control variables								
Income from infrastructure	0.033 (-0.023)	-0.003 (-0.008)	0.020 (-0.019)	-0.007 (-0.006)	-0.103** (-0.049)	-0.076** (-0.038)	-0.086 (-0.062)	-0.075*** (-0.025)
Business engagement	-0.167** (-0.072)	0.009 (-0.024)	0.299*** (-0.060)	0.022 (-0.019)	0.022 (-0.127)	-0.059 (-0.098)	0.105 (-0.160)	0.014 (-0.066)
Incentives for business engagement	-0.073 (-0.076)	0.033 (-0.025)	-0.044 (-0.063)	0.037* (-0.020)	0.164 (-0.129)	0.089 (-0.099)	0.123 (-0.162)	0.037 (-0.067)
Regional strategy	-0.497*** (-0.121)	0.180*** (-0.04)	0.108 (-0.1)	0.067** (-0.032)	0.327 (-0.233)	-0.131 (-0.180)	-0.639** (-0.294)	-0.076 (-0.121)
Widening participation access	0.356*** (-0.135)	0.065 (-0.044)	-0.172 (-0.112)	0.015 (-0.036)	0.121 (-0.258)	0.073 (-0.199)	0.176 (-0.325)	0.033 (-0.134)
Graduates' retention into the region	-0.353** (-0.146)	-0.027 (-0.048)	0.395*** (-0.121)	0.009 (-0.039)	0.805** (-0.404)	-0.736** (-0.312)	0.372 (-0.510)	0.418** (-0.210)
Support for community	-0.332** (-0.158)	-0.054 (-0.052)	-0.071 (-0.131)	-0.017 (-0.042)	-0.679** (-0.291)	-0.133 (-0.225)	-0.146 (-0.367)	-0.053 (-0.151)
Developing local partnership	0.423*** (-0.160)	-0.027 (-0.053)	0.129 (-0.133)	0.049 (-0.042)	0.119 (-0.318)	-0.057 (-0.246)	-0.657 (-0.401)	0.088 (-0.165)
Meeting regional skills needs	-0.211 (-0.148)	-0.013 (-0.049)	0.378*** (-0.123)	-0.015 (-0.039)	-0.164 (-0.515)	0.933** (-0.398)	-0.091 (-0.65)	-0.626** (-0.267)
Knowledge exchange	0.271* (-0.162)	0.126** (-0.053)	0.324** (-0.134)	0.024 (-0.043)	-0.200 (-0.300)	-0.211 (-0.232)	0.561 (-0.378)	0.040 (-0.156)
Supporting SME	0.302** (-0.137)	-0.005 (-0.045)	0.348*** (-0.114)	0.044 (-0.036)	0.050 (-0.299)	0.225 (-0.230)	0.928** (-0.376)	-0.130 (-0.155)
Research collaboration	0.380*** (-0.145)	0.041 (-0.048)	-0.150 (-0.120)	-0.038 (-0.038)	-0.634 (-0.426)	-0.156 (-0.329)	0.551 (-0.537)	0.378* (-0.221)
University established year	-0.001** (-0.001)	-0.001 (-0.001)	0.001* (0)	-0.001 (-0.001)	-0.001 (-0.001))	-0.001 (-0.001)	-0.001 (-0.001)	-0.001 (-0.001)
University fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Top 5 universities	0.556 (-0.368)	0.572*** (-0.121)	-0.555* (-0.305)	-0.064 (-0.097)	1.758*** (-0.429)	0.836** (-0.331)	0.370 (-0.541)	0.378* (-0.223)
constant	-4.825*** (-1.299)	-0.212 (-0.427)	-3.283*** (-1.078)	-0.566* (-0.343)	10.584*** (-3.867)	0.606 (-2.983)	-8.761* (-4.874)	0.123 (-2.006)
R^2	0.694	0.383	0.369	0.235	0.799	0.528	0.684	0.574
F	47.76	13.07	12.308	6.476	11.102	3.133	6.047	3.763
Number of observations	995	993	995	995	168	168	168	168
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$								

Source: Higher Education Business and Community Interaction Survey, Higher Education Statistic Agency

Standard errors are in parenthesis

University collaboration with external business incubators increases IP revenues by almost 1 percent (β=0,990, p<0.001) and graduate start-ups creation by 1.06 percent (β=1,059, p<0.001). As for the investment into university spin-offs, its increase by 1 percent rises IP revenues by almost 0.15 percent (β=0,147, p<0.001) and spin-offs creation by 0.03 percent (β=0,034, p<0.001). Growth of investment into staff start-ups by 1 percent increases the creation of the type of this venture by 0.10 percent (β=0,101, p<0.001) whereas it reduces graduate start-ups creation by almost 0.08 percent (β=-0,079, p<0.001). An increase of investment into graduate start-ups leads to an increase in the creation of this type of new ventures by almost 0.019 percent (β=0,189, p<0.001).

Interaction effects that represent interrelationships between different stakeholders in the baseline model of the entrepreneurial university are illustrated in Table 7 (spec. 1-4). The following combinations of stakeholders are positive and significant for the entrepreneurial outcomes of the university: Science parks and Incubators with Government enable the creation of university spin-offs (β=0.175, p<0.050); Faculty with VC investments (β=0.181, p<0.050) increases spin-offs creation. These two combinations are the cornerstone of the baseline model of the entrepreneurial university.

An interaction between the government collaboration and VC investments reduces spin-offs creation (β=-0.102, p<0.010); Industry and VC investments reduce IP revenues (β=-0.407, p<0.010); TTOs with VC investments reduce staff start-ups rate (β=-0.061, p<0.010); university faculty with VC investments lead to a decline in IP revenues (β=-0.307, p<0.010) as well as staff start-ups (β=-0.140, p<0.050).

2.2.2.2. Russel group universities

With respect to the conceptual model of the Russel group universities (Figure B3 and B4, Appendix B), their model of collaboration with stakeholders follows the conceptual model of an entrepreneurial university presented in Figures 1B and 2B. Results are reported in Table 6 (spec. 5-8).

As for the *knowledge enablers*, the government contributes to both IP revenues and new companies' creation at university while industry contribution is only significant for new companies' creation. Table 6 (spec. 5-8) demonstrates that increase in other funding by 1 percent increases IP revenues generation by 0.06 percent (β=0,060, p<0.050) and spin-offs creation by 0.04 percent (β=0,045, p<0.050). In addition, an increase of 1 percent in the

financial support from other government departments boosts university spin-offs creation by 0.06 percent (β=0,060, p<0.010). Our findings support H1a that knowledge enablers (government and industry) positively affect university start-up activity and the licensing of technologies proxied by IP revenues in research-oriented universities.

Knowledge providers were found to be important to increase IP revenues generation and start-ups creation. However, Russel group universities with a large number of other high qualification students are less likely to increase their IP revenues compared to other Russel group universities with fewer "other students". An increase of 1 percent of such students reduces IP revenues by 1.24 percent (β=-1,244, p<0.001). An increase in teaching capital by 1 percent rises IP revenues by 0.25 percent (β=0,253, p<0.010). When it comes to the university research capital, its growth by 1 percent increases IP revenues by 0.84 percent (β=0,836, p<0.001), university spin-offs by 0.42 percent (β=0,415, p<0.010) and graduate start-ups by 0.81 percent (β=0,809, p<0.05). Turning to the undergraduate and postgraduate students, their effect varies between the type of study and the outcome variables (see Table 5, spec. 5-8). Our findings support H2a that knowledge providers positively affect university start-up activity and the licencing of technologies in research-oriented universities.

As for the *knowledge codifiers*, TTO set up at the university increases IP revenues generation by 0.54 percent (β=0,538, p<0.050) and staff start-ups creation by 0.29 percent (β=0,290, p<0.050) (Table 5, spec. 5-8). Our H3a is partly supported as knowledge codifiers have positively affected both licencing of technology and university start-up activities in research-oriented universities.

When it comes to *knowledge facilitators*, university collaboration with the external science parks increases the creation of staff start-ups by 0.30 percent (β=0,301, p<0.010) while on-campus science parks boost IP revenues generation by 0.5 percent (β=0,496, p<0.010) and staff start-ups creation by 0.22 percent (β=0,228, p<0.010). Business incubators do not affect our outcome variables except for the positive effect for IP revenues (β=0,889, p<0.050) and graduate start-ups (β=1,388, p<0.001). An increase in investment into the university spin-offs by 1 percent reduces graduate start-ups creation by 0.11 percent (β=-0,110, p<0.001), which may point to the competition for resources between start-ups and spinouts at university. An increase in investment into the staff start-ups by 1 percent increases staff start-ups by 0.09 percent (β=0,090, p<0.001). We also noticed that an increase in the investment into graduate start-ups by 1 percent increases the creation of this type of new venture by 0.11 percent (β=0,113, p<0.001) while reducing IP revenues generation by almost 0.07 percent (β=-0,067, p<0.050) (Table 6, spec. 5-8). Our findings support H4a that knowledge facilitators have a

positive effect on both the licencing of technologies and university start-up activities in research-oriented universities.

Interaction analysis for the Russel group universities model is illustrated in Table 7 (spec. 5-8). The following combinations of stakeholders are positive and significant for the entrepreneurial outcomes of this university type: Industry with TTOs for spin-offs creation (β=1,779, $p<0.010$); Government with TTOs for university spin-offs (β=0,696, $p<0.050$) and staff start-ups creation (β=0,317, $p<0.010$); VC investments and students for staff start-ups creation (β=0,427, $p<0.050$).

We also found that the following combinations of stakeholders will negatively affect the entrepreneurial outcomes of the university (Table 7, spec. 5-8). First, science parks and Incubators with VC investments (β=-0,670, $p<0.001$) and second - Government with the faculty (β=-0,602, $p<0.010$) reduce IP revenues; third - Government with VC investments reduce staff start-ups creation activity (β=-0,187, $p<0.010$); fourth – Industry with VC investments reduces IP revenues generation (β=-1,326, $p<0.010$) and staff start-ups creation (β=-1,162, $p<0.050$); sixth – TTOs with faculty (β=-0,412, $p<0.010$) and faculty with VC investments reduce staff start-ups creation (β=-0,541, $p<0.001$). While we find several significant negative interactions between stakeholders, this does not diminish our findings and support for our hypotheses. One can also notice that most of the negative interactions were with the VC. In the interaction analysis, we consider the joint effects of stakeholders on entrepreneurial outcomes of the university, while negative values demonstrate that these two types of stakeholders are complements. Universities as any organization pursue cost minimization strategies given time, managerial and financial constraints, and once the VC support is secured, universities may want to cut down on other forms of collaborations with external stakeholders and prioritise VCs. This led to a negative coefficient in the regression. While each stakeholder has a positive direct effect on entrepreneurial outcomes (H1a-H4a), their joint effect may be conditional on resources and decision-making on each stakeholder for university managers and may lead to a substitution of one stakeholder with another. This interpretation of negative and positive interactions is valid for understanding their contribution to both research and teaching-led universities and will hold for interaction analysis below.

Table 7. Interaction effects for a Baseline Entrepreneurial Universities model and Russel Group Universities

	IP revenues	Uni spin-offs creation	Graduate s-ups creation	Staff s-ups creation	IP revenues	Uni spin-offs creation	Graduate s-ups creation	Staff s-ups creation
University type	**Baseline model of Entrepreneurial University**				**Russel group university**			
Specification	1	2	3	4	5	6	7	8
Science park & Business Incubators # Government	-0.058 (-0.13)	0.175** (-0.07)	-0.044 (-0.11)	0.060 (-0.05)	-0.047 (-0.24)	0.267 (-0.23)	0.230 (-0.3)	0.035 (-0.15)
Science park & Business Incubators # Industry	-0.044 (-0.28)	0.029 (-0.15)	0.202 (-0.23)	-0.028 (-0.11)	-0.467 (-1.13)	-0.412 (-1.09)	2.251 (-1.42)	-0.100 (-0.71)
Science park & Business Incubators # TTOs	0.116 (-0.09)	0.002 (-0.05)	0.037 (-0.07)	-0.043 (-0.03)	-0.063 (-0.2)	0.094 (-0.2)	-0.285 (-0.25)	-0.171 (-0.13)
Science park & Business Incubators # University faculty	0.066 (-0.15)	-0.046 (-0.08)	0.095 (-0.13)	0.086 (-0.06)	-0.310 (-0.32)	-0.051 (-0.31)	0.208 (-0.4)	-0.050 (-0.2)
Science park & Business Incubators # VC investments	-0.201 (-0.13)	-0.048 (-0.07)	-0.138 (-0.11)	-0.059 (-0.05)	-0.670*** (-0.18)	0.071 (-0.17)	0.227 (-0.22)	-0.127 (-0.11)
Science park & Business Incubators # University students	0.129 (-0.18)	-0.101 (-0.1)	0.095 (-0.15)	-0.072 (-0.07)	0.065 (-0.41)	-0.331 (-0.4)	0.037 (-0.52)	0.024 (-0.26)
Science park & Business Incubators # Total number of patents granted per staff	-35.670 (-68.73)	18.710 (-36.64)	2.610 (-57.37)	-22.570 (-28.07)	210.200 (-507.9)	492.100 (-489.62)	-402.300 (-640.01)	-166.000 (-321.29)
Government # industry collaboration	-0.081 (-0.19)	0.017 (-0.1)	0.100 (-0.16)	0.043 (-0.08)	-0.004 (-1.02)	-1.566 (-0.99)	-2.447* (-1.29)	-0.242 (-0.65)
Government # TTOs	-0.081 (-0.08)	0.021 (-0.04)	0.030 (-0.07)	0.002 (-0.03)	-0.210 (-0.3)	0.696** (-0.29)	-0.046 (-0.37)	0.317* (-0.19)
Government # University faculty	0.227 (-0.15)	0.045 (-0.08)	-0.014 (-0.12)	0.010 (-0.06)	-0.602* (-0.32)	-0.482 (-0.31)	-0.153 (-0.4)	0.091 (-0.2)
Government # VC investments	-0.156 (-0.1)	-0.102* (-0.06)	-0.079 (-0.09)	-0.012 (-0.04)	-0.035 (-0.15)	-0.144 (-0.15)	0.006 (-0.19)	-0.187* (-0.1)
Government # University students	-0.191 (-0.17)	0.025 (-0.09)	0.118 (-0.14)	0.037 (-0.07)	0.068 (-0.36)	0.438 (-0.35)	0.643 (-0.46)	-0.060 (-0.23)

Government # Total number of patents granted per staff	-75.900 (-51.37)	29.170 (-27.39)	-47.500 (-42.88)	-19.350 (-20.98)	322.600 (-294.24)	50.530 (-283.65)	-287.700 (-370.78)	383.900** (-186.14)
Industry # TTOs	-0.107 (-0.15)	0.127 (-0.08)	0.201 (-0.13)	0.007 (-0.06)	1.143 (-0.96)	1.779* (-0.93)	-1.031 (-1.22)	-0.300 (-0.61)
Industry # University faculty	0.274 (-0.24)	-0.042 (-0.13)	0.228 (-0.2)	0.032 (-0.1)	-2.322 (-1.47)	0.590 (-1.41)	2.426 (-1.85)	0.072 (-0.93)
Industry # VC investments	-0.407* (-0.24)	0.162 (-0.13)	-0.179 (-0.2)	-0.008 (-0.1)	-1.326* (-0.78)	0.554 (-0.76)	1.238 (-0.99)	-1.162** (-0.5)
Industry # University students	0.079 (-0.26)	0.021 (-0.14)	0.213 (-0.22)	0.076 (-0.11)	0.848 (-1.52)	-0.535 (-1.47)	1.021 (-1.92)	1.157 (-0.96)
Industry # Total number of patents granted per staff	171.900* (-98.77)	56.590 (-52.67)	21.470 (-82.45)	69.770* (-40.34)	-407.000 (-1323.05)	860.800 (-1275.44)	272.900 (-1667.2)	849.200 (-836.95)
TTOs # University faculty	0.014 (-0.11)	0.077 (-0.06)	-0.013 (-0.09)	-0.053 (-0.04)	-0.409 (-0.35)	-0.214 (-0.34)	0.203 (-0.45)	-0.412* (-0.22)
TTOs # VC investments	-0.105 (-0.08)	-0.031 (-0.04)	-0.053 (-0.07)	-0.061* (-0.03)	0.196 (-0.22)	-0.206 (-0.21)	-0.109 (-0.27)	-0.068 (-0.14)
TTOs # University students	-0.039 (-0.12)	0.037 (-0.06)	0.120 (-0.1)	0.008 (-0.05)	-0.014 (-0.33)	0.060 (-0.31)	0.612 (-0.41)	0.062 (-0.21)
TTOs # Total number of patents granted per staff	-43.470 (-43.22)	-34.230 (-23.04)	8.106 (-36.08)	-0.843 (-17.65)	103.200 (-257.22)	-97.720 (-247.96)	16.820 (-324.12)	-95.320 (-162.71)
University faculty # VC investments	-0.307* (-0.16)	0.181** (-0.08)	-0.181 (-0.13)	-0.140** (-0.06)	-0.174 (-0.25)	0.866*** (-0.24)	0.427 (-0.32)	-0.541*** (-0.16)
University faculty # University students	0.030 (-0.24)	-0.037 (-0.13)	0.208 (-0.2)	0.007 (-0.1)	-0.158 (-0.77)	-0.604 (-0.74)	0.976 (-0.97)	1.197** (-0.49)
University faculty # Total number of patents granted per staff	74.800 (-109.78)	-165.80*** (-58.53)	-79.490 (-91.64)	49.330 (-44.84)	234.900 (-569.12)	-116.300 (-548.64)	-2659.7*** (-717.16)	-78.910 (-360.02)
VC investments # University students	0.186 (-0.18)	0.049 (-0.09)	-0.237 (-0.15)	0.055 (-0.07)	0.096 (-0.31)	-0.048 (-0.3)	0.145 (-0.39)	0.427** (-0.19)

VC investments # Total number of patents granted per staff	-103.100 (-65.08)	-21.100 (-34.72)	-37.350 (-54.32)	-23.800 (-26.58)	50.350 (-300.24)	476.100 (-289.44)	898.200** (-378.34)	-659.500*** (-189.93)
University established year	-0.197*** (-0.07)	-0.007 (-0.07)	-0.053*** (-0.07)	-0.000 (-0.07)	-0.084 (-0.07)	-0.109 (-0.07)	0.246*** (-0.09)	0.071 (-0.04)
Constant	395.700*** (-37.47)	14.450 (-19.98)	106.400*** (-31.28)	2.223 (-15.31)	163.500 (-125.72)	199.100 (-121.2)	-446.500*** (-158.43)	-130.200 (-79.53)
Number of observations	997	995	997	997	168	168	168	168
r2	0.92	0.597	0.842	0.552	0.900	0.635	0.843	0.685
F stat	54.210	6.583	23.727	5.476	14.532	2.800	8.665	3.514
* p<.10 **, p<.05, *** p<.01								

Source: Higher Education Business and Community Interaction Survey, Higher Education Statistic Agency

Standard errors are in parenthesis

2.2.2.3. Former Polytechnic Universities

As for the *knowledge enablers* stakeholder group (Table 8, spec. 1-4; Figure B5 and B6), an increase in funding from other government departments by 1 percent increases IP revenues by almost 0.30 percent (β=0,297, p<0.001), as well as graduate start-ups creation by 0.14 percent (β=0,138, p<0.050) whereas reduces spin-offs creation by 0.06 percent (β=-0,062, p<0.010). An increase in other government funding by 1 percent boosts the creation of graduate start-ups by 0.14 percent (β=0,143, p<0.001) while reducing staff start-ups by almost 0.03 percent (β=-0,028, p<0.001). Growth of revenues from bespoke courses does not affect university new ventures creation. Growth in revenues from consultancy and CPD courses by 1 percent increases IP revenues by 0.55 percent (β=0,546, p<0.050) and spin-offs creation by 0.21 percent (β=0,210, p<0.001), while reduces graduate start-up's creation by 0.69 percent (β=-0,689, p<0.001). Our finding partly supports H1b as knowledge enablers increase licencing of technologies, however, the effect on new business creation is mixed, mainly supporting graduate start-ups in teaching-oriented universities.

With respect to *knowledge providers*, an increase in students within the other high degree by 1 percent boosts graduate start-ups creation by 0.54 percent (β=0,541, p<0.050), while reducing staff start-ups creation by 0.31 percent (β=-0,314, p<0.001). An increase in university teaching only capital by 1 percent reduces IP revenues generation by 0.18 percent (β=-0,178, p<0.050). Surprisingly, university research only capital have no effect on outcome variables for this university type. As for the mix of teaching and research capital, an increase in this human capital by 1 percent reduce graduate start-ups creation by 0.13 percent (β=-0,128, p<0.050). As for the undergraduate and postgraduate students, they have different effects on outcome variables (see Table 7, spec. 1-4), however, the standard error is high enough making the influence not significant. Our finding partly supports H2b as knowledge providers have both positive and negative effect on new ventures creation and cause a negative effect on the licencing of technologies in teaching-oriented universities.

When it comes to *knowledge codifiers*, for this type of the university, TTO set up at the university reduces university spin-offs creation by 0.37 percent (β=-0,367, p<0.010) and graduate start-ups creation by 0.96 percent (β=-0,960, p<0.050). When it comes to patenting offices, they have an effect on outcomes variables while it is not significant due to the high standard error. Our finding partly supports H3b as knowledge codifiers indeed do not have an effect on IP revenues generation for this university type (teaching-oriented) while is associated negatively with new companies' creation.

With respect to the *knowledge facilitators* (Table 8, spec. 1-4), the collaboration of the university with external Science Park causes a 0.31 percent rise in the creation of university spin-offs (β=0,311, p<0.001). In the case of Science Park set up within the university, it has a chance creation of spin-offs would increase by 0.43 percent (β=0,434, p<0.001), while the creation of graduate start-ups would decrease by 0.59 percent (β=-0,594, p<0.010). Business Incubators set up at the university, might decrease IP revenues generation by 0.60 percent (β=-0,605, p<0.010), while increase staff and graduate start-ups creation by 0.17 and 1.4 percent respectively (β=0,170, p<0.010; β=1,397, p<0.001). University collaboration with external Business Incubators boosts staff start-ups creation by 0.74 percent (β=0,744, p<0.050). When it comes to the funding, growth of investment into university spin-offs by 1 percent increases the creation of this type of new venture by almost 0.05 percent (β=0,048, p<0.050). Consequently, growth of investment into the staff start-ups by 1 percent, cause a rise in the creation of this type of new ventures by 0.17 percent (β=0,170, p<0.001), while reduce graduate start-up's creation by almost 0.19 percent (β=-0,185, p<0.050). Finally, an increase of the investment into graduate start-ups by 1 percent provide a chance of 0.06 more graduate start-ups would be created (β=-0,064, p<0.010), while 0.04 percent less of university spin-offs (β=-0,036, p<0.010) and 0.05 percent less of staff start-ups (β=-0,046, p<0.001) might be created. Our finding partly supports H4b as knowledge facilitators have mixed effects on new ventures creation and are negatively associated with the licencing of technologies in teaching-oriented universities.

Interaction analysis for the Polytechnics is illustrated in Table 9 (spec. 1-4). We found that a combination of Science parks and Business Incubators with TTOs as well as Government with TTOs increase IP revenues generation (β=0,686, p<0.050 and β=0,385, p<0.010 respectively). The combination of Government with VC investment increases graduate start-ups creation (β=0,491, p<0.010).

We were also able to identify negative interactions between stakeholders in their impact on entrepreneurial outcomes. For example, we found negative interaction coefficients of Science Parks with university students for the graduate start-ups (β=-1,028, p<0.050); and VC investments with students for the creation of the spin-offs (β=-0,904, p<0.001). The number of negative effects is less for teaching type of universities than for research-led universities as they have lower opportunity costs of collaboration and are more likely to collaborate with multiple stakeholders, while research-led universities are more selective in the choice of stakeholders.

Table 8. Results for Pooled OLS regression for the Polytechnic universities and Rest teaching universities

Dependent variables	IP revenues	Uni spin-offs creation	Graduate s-ups creation	Staff s-ups creation	IP revenues	Uni spin-offs creation	Graduate s-ups creation	Staff s-ups creation
Specification	1	2	3	4	5	6	7	8
Independent variables	**Polytechnic universities**				**Rest teaching universities**			
Knowledge enablers (H1)								
Other government funding	0.297***	-0.062*	0.138**	0.019	0.130***	0.020*	0.013	-0.008
	(-0.108)	(-0.032)	(-0.063)	(-0.027)	(-0.035)	(-0.011)	(-0.029)	(-0.009)
Other funding	-0.105	-0.029	0.143***	-0.028*	0.149***	0.009	0.068***	0.015**
	(-0.066)	(-0.019)	(-0.038)	(-0.017)	(-0.030)	(-0.010)	(-0.026)	(-0.008)
Bespoke courses for business	114.401	-350.770*	-715.584*	-387.042**	6.825	1.027	-28.008	-10.089
	(-635.776)	(-188.170)	(-368.687)	(-160.950)	(-31.422)	(-9.981)	(-26.553)	(-7.869)
Consultancy and CPD	0.546**	0.210***	-0.689***	-0.033	0.136**	0.013	-0.010	0.016
	(-0.264)	(-0.078)	(-0.153)	(-0.067)	(-0.055)	(-0.017)	(-0.046)	(-0.014)
Knowledge providers (H2)								
Other high qualifications	0.474	0.060	0.541**	-0.314***	0.134*	0.043*	0.168**	-0.017
	(-0.423)	(-0.125)	(-0.245)	(-0.107)	(-0.080)	(-0.025)	(-0.068)	(-0.020)
Teaching capital	-0.178**	-0.026	-0.057	-0.027	0.073*	-0.016	0.017	0.007
	(-0.083)	(-0.024)	(-0.048)	(-0.021)	(-0.040)	(-0.013)	(-0.034)	(-0.010)
Research capital	0.278	-0.056	0.071	-0.058	0.212***	0.004	-0.009	0.001
	(-0.243)	(-0.072)	(-0.141)	(-0.062)	(-0.075)	(-0.024)	(-0.064)	(-0.019)
Teaching and research capital	0.139	-0.046	-0.128**	0.011	0.007	0.004	-0.260***	0.002
	(-0.102)	(-0.03)	(-0.059)	(-0.026)	(-0.057)	(-0.018)	(-0.048)	(-0.014)
STEM UG	2.962	3.723*	8.954**	3.030*	3.645**	-0.866*	1.712	-0.235
	(-6.667)	(-1.973)	(-3.866)	(-1.688)	(-1.59)	(-0.508)	(-1.344)	(-0.398)
STEM PG	-5.922	-2.040	-9.718	0.188	0.926	0.739	-1.640	0.317
	(-12.973)	(-3.840)	(-7.523)	(-3.284)	(-1.729)	(-0.549)	(-1.461)	(-0.433)
Biology PG	-8.896	2.620	7.531	0.156	5.436***	-0.445	-1.329	-0.590
	(-12.606)	(-3.731)	(-7.310)	(-3.191)	(-1.709)	(-0.542)	(-1.444)	(-0.428)

Biology UG	-13.047** (-6.120)	-1.406 (-1.811)	4.005 (-3.549)	2.302 (-1.549)	-2.746** (-1.172)	-1.015*** (-0.372)	-1.024 (-0.991)	0.019 (-0.294)
Business PG	-5.551 (-7.842)	-4.642** (-2.321)	-2.953 (-4.548)	-0.396 (-1.985)	2.594** (-1.162)	-0.593 (-0.369)	3.786*** (-0.982)	-0.058 (-0.291)
Business UG	5.598 (-4.599)	1.220 (-1.361)	-5.936** (-2.667)	-2.840** (-1.164)	-6.133*** (-1.572)	-0.142 (-0.500)	-0.100 (-1.329)	0.691* (-0.394)
Employment rate	1.828** (-0.865)	-0.322 (-0.256)	0.076 (-0.502)	-0.549** (-0.219)	1.157*** (-0.133)	0.077* (-0.042)	0.073 (-0.112)	0.023 (-0.033)
Knowledge codifiers (H3)								
TTO exist at university	0.721 (-0.728)	-0.367* (-0.216)	-0.960** (-0.422)	0.166 (-0.184)	-0.002 (-0.222)	0.085 (-0.070)	0.696*** (-0.187)	0.021 (-0.056)
TTO and other organisations	0.837 (-0.721)	-0.211 (-0.213)	0.008 (-0.418)	0.289 (-0.182)	0.620*** (-0.206)	-0.099 (-0.065)	0.174 (-0.174)	-0.088* (-0.052)
Patents granted	360.087* (-187.058)	19.433 (-55.366)	-314.140*** (-108.475)	-22.320 (-47.354)	175.246*** (-55.550)	49.656*** (-17.626)	-51.517 (-46.944)	-5.720 (-13.912)
Knowledge facilitators (H4)								
External Science park	0.382 (-0.393)	0.311*** (-0.116)	-0.218 (-0.228)	-0.034 (-0.100)	0.170 (-0.205)	0.043 (-0.065)	-0.182 (-0.173)	-0.008 (-0.051)
University Science park	0.204 (-0.531)	0.434*** (-0.157)	-0.594* (-0.308)	0.214 (-0.134)	-0.043 (-0.242)	0.241*** (-0.077)	-0.448** (-0.204)	0.253*** (-0.061)
University Business incubator	-0.605* (-0.341)	-0.094 (-0.101)	1.397*** (-0.198)	0.170* (-0.086)	-0.030 (-0.174)	0.052 (-0.055)	0.409*** (-0.147)	-0.005 (-0.044)
External Business incubator	-0.259 (-1.355)	-0.199 (-0.401)	-0.042 (-0.786)	0.744** (-0.343)	1.394*** (-0.423)	-0.030 (-0.134)	0.194 (-0.357)	-0.002 (-0.106)
Investment in spin-offs	0.086 (-0.064)	0.048** (-0.019)	-0.005 (-0.037)	0.009 (-0.016)	0.157*** (-0.026)	0.019** (-0.008)	0.009 (-0.022)	0.002 (-0.007)
Investment in staff start-ups	-0.147 (-0.158)	0.059 (-0.047)	-0.185** (-0.091)	0.170*** (-0.040)	0.113** (-0.048)	0.002 (-0.015)	-0.010 (-0.040)	0.095*** (-0.012)
Investment in graduate start-ups	0.009 (-0.065)	-0.036* (-0.019)	0.064* (-0.038)	-0.046*** (-0.016)	0.044 (-0.035)	0.017 (-0.011)	0.216*** (-0.030)	0.018** (-0.009)
Control variables								

Income from infrastructure	-0.136*	0.001	0.075*	-0.010	0.094***	-0.002	0.011	-0.011
	(-0.077)	(-0.023)	(-0.044)	(-0.019)	(-0.029)	(-0.009)	(-0.024)	(-0.007)
Business engagement	-0.784***	-0.010	0.211*	0.069	-0.099	-0.009	0.259***	0.018
	(-0.197)	(-0.058)	(-0.114)	(-0.05)	(-0.086)	(-0.027)	(-0.073)	(-0.022)
Incentives for business engagement	0.554**	0.103	0.022	-0.007	-0.352***	0.021	-0.137	0.007
	(-0.220)	(-0.065)	(-0.128)	(-0.056)	(-0.103)	(-0.033)	(-0.087)	(-0.026)
Regional strategy	-0.985***	0.140	-0.114	0.316***	-0.681***	0.289***	0.224*	0.152***
	(-0.320)	(-0.095)	(-0.185)	(-0.081)	(-0.153)	(-0.049)	(-0.129)	(-0.038)
Widening participation access	0.773**	-0.033	-0.708***	0.097	0.306*	0.014	-0.122	-0.048
	(-0.383)	(-0.113)	(-0.222)	(-0.097)	(-0.168)	(-0.053)	(-0.142)	(-0.042)
Graduates' retention into the region	0.785**	-0.111	1.006***	-0.223**	-0.547***	0.015	0.036	0.002
	(-0.368)	(-0.109)	(-0.214)	(-0.093)	(-0.174)	(-0.055)	(-0.147)	(-0.043)
Support for community	0.09	-0.026	0.935***	-0.327***	-0.196	-0.002	-0.202	0.043
	(-0.467)	(-0.138)	(-0.271)	(-0.118)	(-0.196)	(-0.062)	(-0.166)	(-0.049)
Developing local partnership	1.026***	-0.123	-0.644***	0.086	0.141	-0.041	0.312*	0.037
	(-0.379)	(-0.112)	(-0.220)	(-0.096)	(-0.198)	(-0.063)	(-0.168)	(-0.050)
Meeting regional skills needs	-0.432	0.019	0.622**	0.05	-0.336*	-0.003	0.323**	0.013
	(-0.443)	(-0.131)	(-0.257)	(-0.112)	(-0.179)	(-0.057)	(-0.151)	(-0.045)
Knowledge exchange	0.819*	0.247**	0.603**	0.273**	-0.13	0.256***	0.162	0.106*
	(-0.418)	(-0.124)	(-0.242)	(-0.106)	(-0.224)	(-0.071)	(-0.189)	(-0.056)
Supporting SME	0.038	-0.186	0.103	0.104	0.403**	-0.132**	0.310**	0.010
	(-0.411)	(-0.122)	(-0.238)	(-0.104)	(-0.165)	(-0.052)	(-0.140)	(-0.041)
Research collaboration	-0.047	-0.111	0.037	0.127	0.349*	0.070	-0.019	-0.018
	(-0.338)	(-0.100)	(-0.196)	(-0.086)	(-0.180)	(-0.057)	(-0.152)	(-0.045)
University established year	0.005*	0.001	0.004***	-0.002**	-0.001	-0.001***	0.001**	0.001
	(-0.003)	(-0.001)	(-0.002)	(-0.001)	(-0.001)	(0.001)	(-0.001)	(0.001)
University fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
constant	-23.420***	1.359	-4.666	7.494***	-4.656**	1.075*	-3.692**	-0.168
	(-7.359)	(-2.178)	(-4.268)	(-1.863)	(-1.813)	(-0.576)	(-1.532)	(-0.454)
R^2	0.529	0.445	0.736	0.574	0.686	0.425	0.406	0.301

F	4.215	3.008	10.457	5.051	27.764	9.361	8.685	5.48
Number of observations	210	210	210	210	605	603	605	605
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$								

Source: Higher Education Business and Community Interaction Survey, Higher Education Statistic Agency

Standard errors are in parenthesis

2.2.2.4. Other teaching-led universities

When it comes to *knowledge enablers* (Table 8, spec. 5-8; Figure B7 and B8), increase in funding from other government departments by 1 percent enlarge IP revenues generation by 0.13 percent (β=0,130, p<0.001) as well as spin-offs creation by 0.02 percent (β=0,020, p<0.010). An increase in other funding by 1 percent enlarge IP revenues generation by 0.15 percent (β=0,149, p<0.001), graduate and staff start-ups creation by almost 0.07 and 0.02 percent respectively (β=0,068, p<0.001 and β=0,015, p<0.050). As for the bespoke courses university provide for industry, it has a positive effect on graduate start-ups creation while it is not significant. In addition, an increase in the income from consultancy and CPD courses for business by 1 percent enlarge IP revenues generation by 0.14 percent (β=0,136, p<0.050). Our finding fully supports H1b that knowledge enablers have a positive effect on university start-up activity and the licencing of technologies in teaching-oriented universities.

As for the *knowledge providers* (Table 8, spec. 5-8), a rise in the number of other high qualification students by 1 percent increase IP revenues generation by 0.13 percent (β=0,134, p<0.010), creation of university spin-offs by 0.04 percent (β=0,043, p<0.010) and graduate start-ups by 0.17 percent (β=0,168, p<0.050). Increase in university teaching only capital by 1 percent increase IP revenues by 0.07 percent (β=0,073, p<0.010). An increase in university research only capital by 1 percent boosts IP revenues by 0.21 percent (β=0,212, p<0.001) and spin-offs creation by 0.25 percent (β=0,247, p<0.050). However, growth in the number of faculty who perform a mix of research and teaching activities by 1 percent reduces the creation of graduate start-ups by 0.26 percent (β=-0,260, p<0.001). As for the university undergraduates and postgraduates, they have different effects on outcome variables while only several of them are significant. Thus, an increase in biology, medicine and physics undergraduates by 1 percent decrease university spin-offs creation by 1.01 percent (β=1,015, p<0.001); increase in the number of business studies postgraduates enlarge graduate start-ups creation by 3.79 percent (β=3,786, p<0.001); and increase in business undergraduates by 1 percent cause rise in staff start-ups creation by almost 0.70 percent (β=0,691, p<0.010). Our findings partly support H2b as knowledge providers have both positive and negative effect on university start-up activity and a positive effect on the licencing of technologies in teaching-oriented universities.

When it comes to *knowledge codifiers* (Table 8, spec. 5-8), TTO set up at the university boosts graduate start-ups creation by 0.70 percent (β=0,696, p<0.001). As for the collaboration of the university with external TTO, it has a chance to increase IP revenues generation by 0.62 percent (β=0,620, p<0.001), while reducing staff start-ups creation by almost 0.09 percent (β=-0,088, p<0.010). The patenting offices' support is positive for some outcome variables but not

significant. Our finding partly supports H3b as knowledge codifiers have both positive and negative effects on university start-up activities and are positive for the licencing of technologies in teaching-oriented universities.

As for the *knowledge facilitators* (Table 8, spec. 5-8), Science parks set up around the university cause rise in the creation of spin-offs by 0.24 percent (β=0,241, p<0.001) and staff start-ups creation by 0.25 percent (β=0,253, p<0.001), while it reduces graduate start-ups' creation by 0.45 percent (β=-0,448, p<0.050). When it comes to Business Incubators at the university, they might help universities to increase graduate start-ups' creation by 0.41 percent (β=0,409, p<0.001). For this type of university, Business Incubator support out of the university boundaries might help to increase IP revenues generation by 1.39 percent (β=1,394, p<0.001). An increase in investment into university spin-offs might cause a rise in IP revenues generation by 0.16 percent (β=0,157, p<0.001), in university spin-offs creation by 0.02 percent (β=0,019, p<0.050). An increase of investment into staff start-ups by 1 percent boosts IP revenues generation by 0.11 percent (β=0,113, p<0.050) and staff start-ups creation by almost 0.10 percent (β=0,095, p<0.001). An increase of the investment into graduate start-ups by 1 percent cause a rise of 0.22 and 0.02 percent in the creation of graduate (β=0,216, p<0.001) and staff (β=0,018, p<0.050) start-ups respectively. Our finding partly supports H4b as knowledge facilitators have mostly a positive effect on university start-up activity (except for the negative effect of Science parks on graduate start-ups) and have a positive effect on the licencing of technologies in teaching-oriented universities.

Interaction analysis for the other teaching universities is illustrated in Table 9 (spec. 5-8). The following combinations of stakeholders are positive and significant for the entrepreneurial outcomes for this university type: Government with faculty for IP revenues generation (β=0,320, p<0.010); Government with VC investments for staff s-ups creation (β=0,142, p<0.050).

There were negative associations between Science Parks and Business Incubators with VC investments for spin-offs and graduate start-ups creation (β=-0,330, p<0.050 and β=-0,550, p<0.001); Industry vs VC investment for graduate start-ups creation (β=-0,408, p<0.010); TTOs vs VC investments for IP revenues generation (β=-0,217, p<0.010); Faculty vs VC investments and VC investments vs Students for graduate start-ups creation (β=-0,453, p<0.050 and β=-0,505, p<0.050 respectively).

Table 9. Interaction effects for Polytechnics Universities and Rest teaching universities

	IP revenues	Uni spin-offs creation	Graduate s-ups creation	Staff s-ups creation	IP revenues	Uni spin-offs creation	Graduate s-ups creation	Staff s-ups creation
University type	**Former Polytechnics**				**Other teaching-led universities**			
Specification	1	2	3	4	5	6	7	8
Science park & Business Incubators # Government	-0.442 (-0.56)	0.375 (-0.23)	-0.319 (-0.36)	0.072 (-0.19)	0.005 (-0.20)	0.150 (-0.100)	-0.238 (-0.160)	0.096 (-0.080)
Science park & Business Incubators # Industry	0.687 (-1.85)	1.132 (-0.76)	0.575 (-1.19)	0.499 (-0.62)	0.096 (-0.33)	0.022 (-0.17)	0.026 (-0.26)	0.008 (-0.13)
Science park & Business Incubators # TTOs	0.686** (-0.26)	0.063 (-0.11)	0.007 (-0.17)	0.124 (-0.09)	-0.013 (-0.12)	0.046 (-0.06)	0.046 (-0.1)	-0.044 (-0.05)
Science park & Business Incubators # University faculty	-0.121 (-0.67)	-0.317 (-0.28)	0.077 (-0.43)	-0.079 (-0.23)	0.034 (-0.19)	0.025 (-0.1)	0.158 (-0.15)	0.116 (-0.07)
Science park & Business Incubators # VC investments	0.558 (-0.49)	0.296 (-0.2)	-0.250 (-0.32)	-0.244 (-0.17)	-0.316 (-0.25)	-0.330** (-0.13)	-0.550*** (-0.2)	-0.143 (-0.1)
Science park & Business Incubators # University students	0.556 (-0.78)	0.002 (-0.32)	-1.028** (-0.5)	-0.368 (-0.26)	-0.083 (-0.21)	-0.060 (-0.11)	0.161 (-0.17)	-0.071 (-0.08)
Science park & Business Incubators # Total number of patents granted per staff	-81.570 (-407.46)	314.900* (-166.61)	-422.200 (-262.37)	177.500 (-137.83)	-36.090 (-80.17)	-24.640 (-40.86)	4.267 (-64.44)	-41.840 (-31.58)
Government # industry collaboration	-3.308** (-1.29)	-0.309 -0.53 ()	-0.107 (-0.83)	0.674 (-0.44)	0.026 (-0.22)	0.050 (-0.11)	0.045 (-0.18)	0.027 (-0.09)
Government # TTOs	0.385* (-0.22)	0.136 (-0.09)	0.168 (-0.14)	0.014 (-0.07)	-0.141 (-0.11)	-0.088 (-0.05)	0.130 (-0.09)	-0.021 (-0.04)
Government # University faculty	0.573 (-0.58)	-0.166 (-0.24)	0.292 (-0.37)	-0.146 (-0.2)	0.320* (-0.19)	0.038 (-0.1)	0.127 (-0.15)	0.014 (-0.08)
Government # VC investments	-0.301 (-0.4)	-0.231 (-0.16)	0.491* (-0.26)	-0.073 (-0.14)	-0.170 (-0.17)	0.131 (-0.09)	-0.147 (-0.13)	0.142** (-0.07)
Government # University students	-0.411 (-0.55)	0.083 (-0.22)	0.122 (-0.35)	0.060 (-0.19)	-0.178 (-0.22)	-0.111 (-0.11)	-0.054 (-0.17)	0.042 (-0.09)

Government # Total number of patents granted per staff	125.600 (-292.21)	-124.600 (-119.49)	57.690 (-188.16)	-151.800 (-98.85)	-86.710 (-57.89)	-10.730 (-29.51)	-3.463 (-46.54)	-25.490 (-22.81)
Industry # TTOs	0.641 (-0.72)	0.261 (-0.3)	0.636 (-0.47)	0.165 (-0.25)	-0.156 (-0.2)	0.134 (-0.1)	0.184 (-0.16)	0.075 (-0.08)
Industry # University faculty	4.364** (-2.12)	0.386 (-0.87)	0.398 (-1.36)	-0.197 (-0.72)	0.381 (-0.28)	-0.033 (-0.14)	0.140 (-0.22)	-0.002 (-0.11)
Industry # VC investments	0.758 (-2.5)	-0.737 (-1.02)	1.421 (-1.61)	-0.559 (-0.85)	-0.427 (-0.29)	0.080 (-0.15)	-0.408* (-0.23)	0.016 (-0.11)
Industry # University students	-1.593 (-2.43)	0.075 (-0.99)	-2.897* (-1.57)	-0.037 (-0.82)	0.033 (-0.3)	0.169 (-0.15)	0.333 (-0.24)	0.068 (-0.12)
Industry # Total number of patents granted per staff	354.400 (-1134)	-301.700 (-463.7)	373.200 (-730.2)	736.900* (-383.6)	209.300* (-110.03)	61.840 (-56.11)	76.770 (-88.45)	41.330 (-43.35)
TTOs # University faculty	0.112 (-0.31)	-0.039 (-0.13)	-0.084 (-0.2)	-0.095 (-0.1)	0.097 (-0.15)	0.022 (-0.07)	0.002 (-0.12)	-0.011 (-0.06)
TTOs # VC investments	-0.059 (-0.24)	-0.069 (-0.1)	-0.202 (-0.15)	-0.063 (-0.08)	-0.217* (-0.11)	0.013 (-0.06)	-0.085 (-0.09)	-0.026 (-0.04)
TTOs # University students	-0.044 (-0.32)	0.017 (-0.13)	0.406* (-0.21)	-0.019 (-0.11)	-0.089 (-0.18)	-0.062 (-0.09)	-0.162 (-0.14)	0.022 (-0.07)
TTOs # Total number of patents granted per staff	-230.200 (-171.71)	-81.050 (-70.21)	169.001 (-110.56)	-111.300* (-58.08)	-37.140 (-52.05)	-44.410* (-26.53)	18.910 (-41.84)	12.590 (-20.5)
University faculty # VC investments	-0.357 (-0.69)	-0.198 (-0.28)	0.038 (-0.44)	-0.111 (-0.23)	-0.350 (-0.24)	-0.061 (-0.12)	-0.453** (-0.19)	-0.116 (-0.09)
University faculty # University students	-1.316 (-0.89)	-0.252 (-0.36)	-0.221 (-0.57)	0.197 (-0.3)	0.414 (-0.29)	-0.089 (-0.15)	0.329 (-0.23)	-0.022 (-0.12)
University faculty # Total number of patents granted per staff	-113.200 (-387.31)	-103.900 (-158.37)	34.530 (-249.39)	105.001 (-131.02)	116.800 (-128.34)	-138.20** (-65.42)	-18.200 (-103.16)	47.890 (-50.56)
VC investments # University students	-0.114 (-0.8)	-0.904*** (-0.33)	0.327 (-0.51)	0.068 (-0.27)	0.336 (-0.25)	0.063 (-0.13)	-0.505** (-0.2)	-0.063 (-0.1)
VC investments # Total number of patents granted per staff	-104.400 (-373.68)	-205.200 (-152.8)	566.700** (-240.62)	56.190 (-126.4)	-122.300* (-71.19)	-26.160 (-36.3)	-59.210 (-57.22)	-6.706 (-28.04)
University established year	0.028 (-0.02)	0.015** (-0.01)	0.031*** (-0.01)	0.032*** (-0.01)	-0.220*** (-0.02)	-0.003 (-0.01)	-0.044** (-0.02)	0.003 (-0.01)

Constant	-51.860 (-32.27)	-29.620** (-13.19)	-54.830*** (-20.78)	-61.08*** (-10.92)	442.500*** (-44.08)	6.744 (-22.47)	88.860** (-35.43)	-7.076 (-17.36)
Number of observations	210	210	210	210	598	596	598	598
r2	0.846	0.654	0.893	0.751	0.916	0.601	0.855	0.546
F stat	10.936	3.759	16.708	6.011	40.829	5.624	22.176	4.502
* p<.10, ** p<.05, *** p<.01								

Source: Higher Education Business and Community Interaction Survey, Higher Education Statistic Agency

Standard errors are in parenthesis

2.2.2.5. Other control variables

When it comes to the *control variables*, there are some patterns between the university groups on the impact of variables included in the final calculations. Thus, the impact of the control variables is somehow similar between the general model of the entrepreneurial university and Polytechnic universities. Below, we have provided general information, while details can be found in Tables 6 - 9.

Interestingly, renting university facilities is not exactly beneficial for universities in general and only teaching universities might benefit significantly out of that when it comes to IP revenues generation. Having a plan for engagement with business has a negative effect on IP revenues generation for the general university model as well as Polytechnics, while is positive for the graduate start-up's creation for these university types as well as rest teaching universities. This factor together with the partnership development indicator as well as the one on contributing to knowledge development is not significant for the strategy of Russel group universities. As for the incentives for engagement with business, this priority in the university strategy has a positive effect on IP revenues generation for Polytechnics while is negative for other teaching universities. The contribution of the university to regional strategy is negative for the IP revenues generation for teaching universities as well as the general model of universities, while is positive for the start-ups and spin-offs creation. This factor is not significant for the Russel group universities.

The contribution of the university to economic development through widening participation/access, have a positive effect on IP revenues generation for teaching universities. The contribution of universities to graduates retention to the region has different effects on IP revenues generation with being positive for Polytechnics and Russel group universities, while is negative for the general model of the entrepreneurial university and teaching universities. However, this factor has a positive effect on graduate start-ups creation. The contribution of the university to the community has a positive effect on graduate start-ups creation for the Polytechnics. The contribution of the university to the economic development of the region through partnerships development has a positive effect on IP revenues generation in general but vary when it comes to the new ventures' creation.

University's contribution to the regional skills development has a positive effect on graduate start-ups creation for Polytechnic and other teaching universities. The contribution of universities to knowledge sharing has a positive effect on IP revenues generation as well as the creation of new ventures. This factor is not statistically significant for the Russel group universities.

The contribution of the university to SMEs development has a positive effect on IP revenues generation and graduate start-ups creation. The contribution of universities through research collaboration with industry has a positive effect on IP revenues generation for the general model of entrepreneurial as well as teaching universities.

2.3 Discussion

By analysing the impact of university collaboration with different actors, this Chapter classifies stakeholders and conceptualises the process of knowledge creation and spillover from universities of different types. Our results demonstrate that while all the four stakeholder dimensions presented make a substantial contribution to the final outcome – licencing of technology and university spin-offs and start-ups, their impact varies with the type of entrepreneurial university.

Summary of the impact of stakeholders and other factors on the university entrepreneurial outcomes based on university type and type of the outcome is provided in Table 10 and the detailed discussion is provided below.

Table 10. Main outcomes of the university collaboration with stakeholders by university type.

Stakeholder / Factor	*IP Revenues*	*Spin-offs*	*Graduate start-ups*	*Staff start-ups*
Russel Group University				
Government	+	+		
Industry				
University Faculty	+ (Teaching capital; Research capital; Teaching & Research capital)	+ (Research capital; Teaching & Research capital)	+ (Research capital)	
University Students				
TTO	+			+
Science Park	+			+
Business Incubator	+		+	
VC	- (Inv. in grad start-ups)		+ (Inv. in grad start-ups)	+ (Inv. in staff start-ups)
Income from infrastructure	-	-		-
Regional strategy			-	
Graduates' retention into the region	+	-		+
Support for community	-			
Meeting regional skills needs		+		-
Supporting SME			+	

Research collaboration				+
Stakeholder / Factor	*IP Revenues*	*Spin-offs*	*Graduate start-ups*	*Staff start-ups*
Polytechnic University				
Government	+	-	+	-
Industry	+ (CPD and Consultancy)	+ (CPD and Consultancy)	- (CPD and Consultancy)	
University Faculty	- (Teaching capital)		- (Teaching & research capital)	
University Students			+ (Other high qualifications)	+ (Other high qualifications)
TTO		-	-	
Science Park		+	-	
Business Incubator	-		+	+
VC		+ (Inv. in spin-offs) - (Inv. in grad start-ups)	- (Inv. in staff start-ups) + (Inv. in grad start-ups)	+ (Inv. in staff start-ups) - (Inv. in grad start-ups)
Income from infrastructure	-		+	
Business engagement	-		+	
Incentives for business engagement	+			
Regional strategy	-			+
Widening participation access	+		-	
Graduates' retention into the region	+		+	-
Support for community			+	+
Developing local partnership	+		-	
Meeting regional skills needs			+	
Knowledge exchange	+	+	+	+
University established year	+		+	+
University established year		-	+	
Stakeholder / Factor	*IP Revenues*	*Spin-offs*	*Graduate start-ups*	*Staff start-ups*
Rest Teaching Universities				
Government	+	+	+	+
Industry	+			
University Faculty	+ (Teaching capital; research capital)		- (Teaching & research capital)	
University Students	+ (Other high qualifications)	+ (Other high qualifications) - (STEM undergraduates)	+ (Other high qualifications) + (Business PG)	+ (Business UG)

TTO	+		+	
Science Park		+	-	+
Business Incubator	+			
VC	+ (Inv. in spin-offs) - (Inv. in staff start-ups)	+ (Inv. in spin-offs)	+ (Inv. in grad start-ups)	+ (Inv. in staff start-ups) + (Inv. in grad start-ups)
Income from infrastructure	+			
Business engagement			+	
Incentives for business engagement	-			
Regional strategy	-	+	+	+
Widening participation access	+			
Graduates' retention into the region	-			
Developing local partnership			+	
Meeting regional skills needs	-		+	
Knowledge exchange		+		+
Supporting SME	+	-	+	
Research collaboration	+			
Note: "+" means positive influence; "-" means negative influence. In brackets details regarding some of the stakeholders are provided.				

A brief comparative summary of university collaboration with stakeholders by type of outcome and by university type are provided in the next two paragraphs while more details are provided further.

As for the *IP revenues* generation, the effect of the government in the form of providing research funding is positive for all university types. Collaboration with industry in the form of the consultancy and trainings provided is positive and significant for all university types with no significant effect of research funding on this outcome variable. The effect of university faculty is different across university types and types of human capital (see Table 10 for more details). Both Russel group, as well as rest teaching universities, are benefiting from having or collaborating with TTOs while there is no effect of this stakeholder on IP revenues generation at Polytechnics. Only Russel group universities do benefit from collaboration with Science Parks while the effect of Business Incubators and VCs varies across university types (details are below).

When it comes to the government, this stakeholder is important for *new ventures creation* across different university types via providing funding for research. By contrast, a collaboration of universities with industry in the form of research funding seems not to have a significant effect on new ventures creation for all universities within the UK higher education sector. Only consultancy and training for the industry could positively affect new ventures creation at Polytechnics. University faculty and students have different effects on new companies' creation and details are provided below. When it comes to TTOs, only Russel group universities do benefit significantly from this stakeholder when it comes to new ventures creation while the effect is opposite at teaching-oriented universities. Science Parks and VCs have different effects across university types while the effect of Business Incubator is always positive when it comes to new venture creation.

We drew on the ideas of Klepper (2007), Fini et al. (2011), Siegel (2018) to formulate our conceptualisation of the stakeholders relevant to licencing of intellectual property. We also built on the empirical developments of Kortum and Lerner, (2001), Audretsch and Belitski (2019), Siegel and Waldman (2019) and Dahlborg et al. (2017) when examining the support of university intermediaries. This study demonstrated that all stakeholders have a substantial positive impact on IP revenues illustrated in our main conceptual model (Figure 1B, Appendix B).

In particular, *knowledge enablers* (both government and industry) contribute to IP revenues generation with the government's provision of financial resources is one of the key elements of entrepreneurship activity (Fini et al., 2011; Klepper, 2007) as it increases facilitation and exchange of ideas between industry and university (Deeds et al., 1997; Miller et al., 2014; Belitski et al. 2019). An important role of industry spills over by patenting activity and IP revenues generation and by providing access to relevant resources and competencies (Kortum and Lerner, 2001).

The role of *knowledge providers*, such as faculty, holding different roles (engaging purely in teaching or research, or a combination of both) is to contribute to IP income generation, while we do not find the same effect in the former Polytechnic universities due to the specialization of such universities and their short history of research. Our findings advance the traditional human capital view, where scholars found that research capital positively influences university entrepreneurship (Sideri and Panagopoulos, 2018; Pavone, 2019), by clarifying what university types are there to fully appropriate such benefits.

However, as for the Polytechnics, the teaching only oriented faculty have a negative effect on IP income generation. Thus, according to Somers et al. (2018), one of the challenges facing the

entrepreneurial path of teaching-led universities is related to a lack of research resources when the majority of faculty focus on teaching. However, much more is expected from the faculty being more diverse and multidirectional, as they will be able to perform different activities simultaneously (teaching, research, entrepreneurship, engaging with society, etc.) (Mccowan, 2017).

Interestingly, internal stakeholders such as postgraduate students are associated with an increase in IP income and in particular for the teaching-led universities (Meoli & Vismara, 2016) while this indicator is negative for the Russel group universities, demonstrating that different internal stakeholders (staff) are more involved in research projects. This finding also follows the traditional human capital view (Sideri and Panagopoulos, 2018; Pavone, 2019). As for graduate students, they often engage in entrepreneurship via spin-offs relevant to academic research. As an example, Hayter et al. (2018) showed the creation of academic spin-offs quite often linked with research students and revealed that they play a crucial role in the earlier stages of spin-off development. However, university students might choose to avoid working with the university and license technologies, thus avoiding sharing intellectual rights and potential future income with the university (e.g., Facebook, Apple).

As for the *knowledge codifiers*, the presence of the TTO increases licencing income. This supports prior research findings (Siegel & Waldman, 2019; Siegel, 2018) on the role that TTO play in knowledge commercialization and contrast to studies of Aldridge and Audretsch (2010) and Belitski et al. (2019) where due to industry specificity and institutional context researchers would aim to bypass TTOs. Intellectual property rights facilitate the commercialisation of research (third stream income) (Siegel & Waldman, 2019) through the support of university intermediaries (i.e., TTOs who help to evaluate inventions and search for partners to license the patents) (Dahlborg et al., 2017). The exception here is related to the Polytechnic universities, where there is no impact of TTOs on IP income generation. Thus, in universities where the emphasis has been historically placed on acquiring and strengthening research endowments, the entrepreneurial behaviour will favour the generation of research related entrepreneurship outcomes. Conversely, HEIs traditionally focused on teaching-related activities are better positioned to enable the greater success of student start-ups creation (Shah and Pahnke 2014**)** rather than IP revenues.

We demonstrated that *knowledge facilitators* such as science parks positively contribute to IP income at research and teaching-oriented universities. This advances the recent study of Marzocchi et al. (2019) on the role of science parks in achieving the entrepreneurial mission of the university, including the use of knowledge through the creation of new companies. Our

finding also advances the knowledge of science park location (Audretsch and Belitski, 2019) and knowledge spillovers (Audretsch and Feldman, 1996a, 1996b) as both on- and off-campus science parks boost licencing incomes. However, we show that this is only Russel group universities who benefit from Science parks services most while other universities have mixed effects of a science park on licencing of IP. According to the literature, Science parks are a technology catalyst and might facilitate the creation of spin-offs that stems from university IP while when it comes to the UK case, their impact might be negligible (Siegel et al., 2003) or slightly negative. Further research is needed to explain why this happens.

Business incubators were found to positively contribute to the IP income generation to all the university subgroups except the Polytechnic universities where business incubators are seen as substitutes for direct commercialization of knowledge with the industry.

We contend that the availability of venture capital has been seen as the most powerful stakeholder to increase the licencing income and finance spinouts on both teaching and research-oriented universities. We believe that research-oriented universities are focused more on IP revenues generations while VCs are more vital for the different extents for the new ventures' creation.

Our finding on the role of stakeholders in new firm creation at universities is directly consistent with Shah and Pahnke (2014), Rasmussen et al. (2011), Marzocchi et al. (2019), Fini et al. (2020) and Markman et al. (2008), who emphasises these as being at the core of the entrepreneurial university.

Our findings emphasize the impact of *knowledge providers* on start-ups and spin-outs across all university types *(*Markman et al. 2008). In this way, they reflect an entrepreneurial outcome linked to the research capacity of university staff being able to transfer the benefits steaming from research to the wider society (Rasmussen et al. 2011). Thus, following the UK higher education system, faculty mostly represented by research as well as the mix of research and teaching capital allows for a significant contribution to the new ventures creation. This trend is applied to the Russel group as well as Polytechnic universities. As for the other teaching-oriented universities, the faculty may have an adverse effect on new venture creation. These results are not supportive of those in the existing literature claiming that entrepreneurial outputs in the form of new ventures are informed by both teaching and research activities (Shah and Pahnke, 2014; Marzocchi et al., 2019) and thus should be further tested and explained according to the examples of other cases. University students have both positive and negative impact on the new ventures' creation within the baseline entrepreneurial model as well as other teaching and Polytechnic universities. Previous research showed that there is no advantages for students

within research universities from engaging in research and entrepreneurial activities with faculty (Hu et al., 2007) and they do not participate in such activities as often as their fellows at liberal art colleges.

The academic entrepreneurship literature (Honig, 2004; Béchard and Grégoire, 2005; Fayolle, 2013) stressed a high level of the role of higher education in the new ventures' creation by graduates. There is evidence that entrepreneurship education, as well as the stimulation of universities for the graduate enterprise (European Commission, 2012, 2015; GEM, 2012), play a huge role in the new ventures' creation by students. As for the different categories of students, doctoral students, STEM and biology, physics and medicine undergraduates have a strong impact on new ventures creation (Pavone, 2019). In addition, the number of students studying a higher degree positively affects the creation of new ventures at the university (Meoli & Vismara, 2016).

When it comes to *knowledge codifiers*, studies have found that within the organisational factors the role of TTOs is considered as a key for the success of university spin-offs (e.g. Goldstein 2010; Siegel et al., 2003). This is mostly based on the expertise of TTOs, networking capacity as well as their ability to recognise opportunities and help with organising equity ownership for the new ventures' creation (Lockett and Wright, 2005; O'Shea et al. 2008). Thus, in the UK higher education system, TTOs can be viewed as conduits for start-up activity and spinouts with the effect being highest in the Russel group universities. While prior research demonstrated that scientists might choose to bay pass TTOs to commercialise their inventions (Aldridge and Audretsch, 2011) and perceive TTOs as barriers (Siegel et al., 2003; Huyghe et al., 2016; Link et al., 2007), our study provides robust evidence of the importance of TTOs in the UK universities and in particular in the Russel group universities. Universities in other countries need to be aware that high level of bureaucracy, lack of freedom in decision making for acquiring patents and applying them within new venture context as well as have an aggressive policy on intellectual rights may impede scientists to commercialise their knowledge via TTOs (Kerr and Nanda, 2009; Yegorov, 2009; Huyghe et al. 2016).

When it comes to *knowledge facilitators*, there are still limited studies to assess e.g., the effectiveness of science parks (SPs) with providing both positive and negative impact on new ventures creation at the university. The relevant contribution in the literature to the UK SPs have been done by Siegel et al, (2003) and Phan et al (2005) who showed that SPs stimulate technological spillover. Our studies follow Ferguson and Olofsson (2004) who found that companies located on SP have much higher survival rates comparing those off-park including

due to such factors as getting access to the broad network, facilities, link to the university to improve product innovations, while in our case also increase knowledge transfer.

Our results also expand Monck (1988) and Wallsten (2004) research on the role of science parks and their policy mission to contribute to the new ventures creation. While we found that on-park firms have fewer opportunities to invest in greater R&D outputs (e.g., patents) compared to those located off-park (Lofsten and Lindelof, 2005), we support Audretsch and Belitski (2019) in the role that on-site science parks and incubators play in knowledge transfer and spin-off activity in the UK. These could be used to increase a new business ownership rate in the UK higher education system and in particular in the Russel group universities.

Our findings on business Incubators expand Huynh et al (2017) research on a significant transformation change between research and/or business idea and incorporation it into the new venture. Such a change happens very often due to the business incubator support that helps to introduce new members with relevant skills, facilitate access to the wider range of financial resources which works for teaching and research-based universities Business incubators in UK universities have become useful in writing business plans, mentoring, being a platform for fund-raising (Fini et al., 2020; Siegel et al., 2007, 2003). In addition, the venture capitalist funding available at science parks and business incubators are one of the most vital instruments needed to promote the creation of all types of new ventures (Florida et al., 2020; Marzocchi et al., 2019; M'Chirgui et al., 2018). However, several studies have revealed that VC's participation in companies might bring some obstacles to the new ventures' creation including the managerial experience of the investor as well as their willingness to take their companies public much earlier than they are actually ready to generate additional business (Brav and Gompers, 1997). While we do not confirm this thesis with our findings, we demonstrate by the interaction analysis that most of the universities will make a choice between VCs collaboration and other stakeholders due to time and resource constraints as well due to the fact that VCs will aim to prevent other stakeholders in appropriating results of research. Thus, in the case of the UK higher education system, VC spurs new venture creation, with the mixed effects between different university types. Interaction analysis enabled us to show the interconnections between stakeholders and how various combinations become a conduit of licencing income and university spinouts for three types of entrepreneurial universities.

While most of the interconnections occur for the Russel group universities and they are positive, we also find negative interaction effects, in particular with the VCs. We argue that the negative joint effects point out substitutability between different stakeholders' collaboration, as university managers need to be selective in the type of internal and external stakeholder, they

collaborate on knowledge creation and commercialization. We clearly demonstrated that research-oriented universities would benefit more from a much broader entrepreneurial ecosystem and interaction between stakeholders extending Guerrero et. al. (2016) and Guerrero and Urbano (2019). Interestingly that the government with TTOs effects have always had positive complementarities with stakeholders while VCs are more likely to be a substitute for other networks and collaborations in particular in teaching-led universities with limited resources.

Following the traditional path of commercialisation, the majority of complementarities for IP revenues generation include TTOs. Thus, we see significant positive complementarities between knowledge codifiers (TTOs) and knowledge facilitators (science parks and business incubators, venture capitalists). This might show a strong connection between the research and entrepreneurship missions of universities in the UK. In this context, IP revenues and spin-offs are a crucial part of the university's entrepreneurial mission. They include the development of business activity based on the technology which emerged from the academic engagement (Markman et al., 2008). In this way, they represent an entrepreneurial output directly connected to the university's capacity to transfer the research benefits to society (Rasmussen et al., 2011).

Interestingly, that collaboration with Industry and VC is negative. These results seem to be surprising while we see in the literature that VCs are mostly positive for the developmental stages of the new ventures, including sales, turnover and employment (Colombo et al. 2016; Meglio et al. 2016). We consider the negative impact of the interconnections between two stakeholders occur from the choice of commercialization route via VCs or industry (Bradley et al. 2013) and will vary with the university type.

Thus, this research has shown that from the organisational point of view different stakeholders, as well as factors, contribute to different entrepreneurial outcomes of the university. However, one feature has stand-out that no matter of university type they would always benefit from having or collaborating with Business Incubators while much attention within the academic research as well as government policy has been given to TTOs. Beyond university settings there are external factors contributing to achieving entrepreneurial outcomes of academia. Our results have shown that mostly teaching-oriented universities benefit from utilising university facilities. In addition, having a plan for engaging with business might cause a negative effect on IP revenues generation while is positive for new ventures creation. Therefore, while developing a university strategy about collaborating with business university managers should take into account this fact.

When it comes to the *control variables*, there are some patterns between the university groups on the impact of variables included in the final calculations. Below, we have provided general information, while details can be found in Tables 3.2.5.

Interestingly, renting university facilities is not exactly beneficial for universities in general and only teaching universities might benefit significantly out of that when it comes to IP revenues generation. Having a plan for engagement with business has a negative effect on IP revenues generation for Polytechnics, while is positive for the graduate start-up's creation for these university type as well as rest teaching universities. This factor together with the partnership development indicator as well as the one on contributing to knowledge development is not significant for the strategy of Russel group universities. As for the incentives for engagement with business, this priority in the university strategy has a positive effect on IP revenues generation for Polytechnics while is negative for other teaching universities. The contribution of the university to regional strategy is negative for the IP revenues generation for teaching universities, while is positive for the start-ups and spin-offs creation. This factor is not significant for the Russel group universities.

The contribution of the university to economic development through widening participation/access, have a positive effect on IP revenues generation for teaching universities. The contribution of universities to graduates retention to the region has different effects on IP revenues generation with being positive for Polytechnics and Russel group universities, while is negative for teaching universities. In addition, this factor has a positive effect on graduate start-ups creation. The contribution of the university to the community has a positive effect on graduate start-ups creation for the Polytechnics. The contribution of the university to the economic development of the region through partnerships development has a positive effect on IP revenues generation in general but vary when it comes to the new ventures' creation.

University's contribution to the regional skills development has a positive effect on graduate start-ups creation for Polytechnic and other teaching universities. The contribution of universities to knowledge sharing has a positive effect on IP revenues generation as well as the creation of new ventures. This factor is not statistically significant for the Russel group universities.

The contribution of the university to SMEs development has a positive effect on IP revenues generation and graduate start-ups creation. Contribution of universities through research collaboration with industry has a positive effect on IP revenues generation for teaching universities.

The next Chapter of this thesis test the concept of academics' engagement with others at the individual level of analysis to identify factors facilitating or inhibiting such engagement.

CHAPTER 3. THE ROLE OF STAKEHOLDERS FOR ACADEMIC ENTREPRENEURSHIP WITHIN THE ENTREPRENEURIAL UNIVERSITY (INDIVIDUAL LEVEL OF ANALYSIS)

The idea of an entrepreneurial university means transferring academic knowledge and technologies outside of university boundaries to foster socio-economic development. This transfer happens not directly perse but with the mean of supportive and facilitating structures within the university domain. MIT and Stanford universities are considered as pioneers of entrepreneurial universities in the world. Their main purpose was to develop and implement university-wide patent and technology policy via technology transfer department that helps to set-up university-business partnerships and spin-out companies (Dalmarco et al., 2015). The engagement of academics with diverse stakeholders for knowledge transfer is individually driven and is discretionary in nature (Perkmann et al., 2021). Universities are considered as "professional bureaucracies" (Mintzberg, 1979) with highly skilled professionals who are autonomous in their initiatives to reach organisational goals. However, there are different factors that influence the decision of academics to engage with others for the following transfer of newly originated knowledge. Within the development of the phenomenon of the entrepreneurial university, a broader set of organisations (or departments) has been originated beyond technology transfer offices to facilitate knowledge and technology transfer out of university boundaries.

The concept of university collaboration with diverse stakeholders for commercialisation and knowledge dissemination pushed us further to explore the reasons and impediments of academics to engage with other actors. University-industry collaboration has different forms and include contract and collaborative research, consulting, start-ups creation which is practised by a larger proportion of academics than patenting, IP licensing or spin-offs creation. Engagement of academics for knowledge and technologies transfer and dissemination is a multilevel phenomenon and is a process like activity involving interaction with different stakeholders at different levels of new knowledge development (e.g., idea – research – prototype – product – company). Evidence suggests that there is a significant correlation between different types of engagement and subsequent commercialisation (Schaeffer et al., 2020).

The research question guiding our research is: What universities can do to facilitate the engagement of academics with diverse supportive infrastructure within the university to

promote knowledge and technologies commercialisation? As naturally academics might possess different types of motivation or financial, learning and pro-social (more details are in the next section). Our findings should inform university management about facilitators and antecedents of engagement for commercialisation (Rothaermel et al., 2007). This analysis should allow us to address whether all the universities in the country should follow the same political and managerial incentives (e.g., supporting TTOs establishment and development in the UK) or the phenomenon of the entrepreneurial university is not homogeneous in terms of the role of stakeholders and thus should be treated differently by researchers and policy-makers.

Academic engagement means collaboration and factors of what impact individuals within entrepreneurial university context initiate and maintain collaboration with others are not explored by the literature (Bouty, 2000). In addition, little is known about the role of departmental or university level support in facilitating academic engagement (Perkman et. al., 2021). The role of technology transfer offices (explored widely in the literature as an important intermediary for the knowledge and technologies transfer) appears to be less relevant (Perkman et. al., 2021) and thus we have yet to learn about whether and how alternatives structures put in place by the university (industry liaison office or Business incubator) encourage the academic engagement.

In order to close the identified research gap, the objective of this chapter is the following. First, we aim to explore how academics perceive their interest in engagement with stakeholders around the university for the possible commercialisation later. Based on the fact of actual engagement (previous experience) we explore individual academics' interest to engage with other actors for commercialisation. We have two groups of people those who are interested to engage and those who are not interested based on their perception but both groups have actually engaged with other actors (even though have not been interested in it). This would help us to paint a comprehensive picture of antecedents of the engagement of academics for the subsequent commercialisation. Second, it allows us to get a perspective on what do academics in the UK experienced when it comes to collaboration with different stakeholders and what managers can do to make the experience much more efficient. We also revealed aspects that require wider exploration, providing direction for future research.

Our goal is to move beyond existing works on academics' engagement and provide contributions to the field of academic entrepreneurship, knowledge and technologies transfer and entrepreneurial university by answering research questions considering academics from different scientific disciplines (Business and economics, engineering, chemistry, biological science, physics and mathematics, medicine, computer science, pharmacology, agriculture and

plant science, other) and analysing engagement of academics with actors around university beyond government, industry and TTO.

We rely on an in-depth survey of experience of 412 academics engaged with stakeholders around the universities in the UK as well as subsequent 22 interviews with university academics and managers.

3.1 Engagement of academics with stakeholders within the entrepreneurial university

Hypothesis development

The third or entrepreneurial mission of universities have been popularised for the last couple of decades but is strongly promoted by governments as a mean of regional development and growth (Etzkowitz et al., 2000).

Before we have described three types of motivation explored in the literature leading to the various forms of academic's engagement with different stakeholders (Chapter 1.3, P. 46-49).

Academic engagement represents a focus of attention for university managers and policy makers as it considered to be a transition mechanism to ensure academic research has an impact on the economy and society at large (Martin, 2011; Bornmann, 2013).

When it comes to the third mission of universities, creating and selling intellectual property or setting up a spin-off is considered as one of the most used indicators to measure outcomes of the third mission (Hughes et al., 2016). For academic entrepreneurship, patenting is used as a proxy of entrepreneurial behaviour and increase the commercial success of the invention (Agrawal, 2006).

However, faculty entrepreneurship within the university is practised widely across different disciplines (e.g., not only natural and life sciences or STEM) and involve engagement with a diverse set of stakeholders except TTOs (not only direct research outcomes commercialisation) including, e.g., collaboration with business incubators or science parks. Such engagement can facilitate spin-offs creation and bring different outcomes, e.g., staff and graduate start-ups. In addition, this is a great contribution of universities to the region and economy (Marzocchi et al., 2019). The non-commercial-based activities (Lassnigg et al., 2013) include capacity building and steering activities (developing management skills), expanding networks and meeting partners needed (Boucher et al., 2003; Goddard and Vallance, 2011) which can lead to broader entrepreneurial outcomes later. Engagement of academics with other actors involves person-to-person interaction that links different actors with each other (Cohen et al., 2002).

Engagement of academics with other actors for knowledge and technologies transfer is regarded as a necessary vehicle to promote knowledge and research in a more impactful way bringing universities and business to a developed rapport (Upton et al., 2014). UK Research and Innovation state: "Encouraging even greater collaboration between business and the research base is the key to achieving this ambition [of greater impact]" (UK Research and innovation, 2020). This collaboration happens in most cases not straight and directly between academics and business representatives but with the help of other stakeholders (e.g., business incubator) or might occur based on the previous engagement (collaborative or contract research). Thus, identifying drawbacks and assessing the consequences of engagement with different stakeholders and the impact of engagement at one level for engagement on the other stages of new knowledge or technology development is a central interest to those informing and developing the public policy or university strategy (Perkmann et al., 2021).

It is argued by literature that seniority is strongly correlated with the decision of academics to collaborate with the external environment (Link et al., 2007; Ponomariov, 2008; Boardman, 2009; D'Este and Perkmann, 2011) as well as is a predictor that stakeholders would be more inclined to develop collaboration (D'Este and Perkmann, 2011). This is also because engagement is seeded more by personal contacts (Iorio et al., 2017) and thus more experienced researchers are likely to have a larger network and as such more social capital that enable them to find relevant partners (Landry et al., 2006; Giuliani et al., 2010). Such network strengthened by constant connections with partners from the industry and the engagement with relevant supportive stakeholders at the university.

On the other hand, scientists who are more scientifically productive (usually those on the career progression stage) compared to their colleagues have higher chances to engage with stakeholders to transfer their knowledge in different forms (Perkmann et al., 2013). Thus, when it comes to obtaining government grants, seniority is a predictor of success in this direction.

Funding from the government is based on the peer review process and serve as an indicator for the success of the scientist in the field (Perkmann et al., 2013). Linking collaboration of scientists with government and industry, productivity and success of the scientists in fundraising from the government is a signal for companies while identifying potential actors to collaborate with. Later this leads to more opportunities and wider engagement activities. In addition, the ability of a scientist to acquire public resources increase the likelihood of moving into collaborative projects with industry (Perkmann et al., 2013). Thus, engagement for commercialisation is likely to be pursued by more productive academics than their colleagues

and engagement is clearly associated with the seniority and success in obtaining government grants (Perkmann et al., 2013).

Senior faculty have more expert knowledge and talent and are more likely to produce technologies with high commercial potential. Thus, the reputation of the senior scholar compared to the junior scholar might be among one of the factors that could impact the attempt of the technologies transfer office to assess the commercial potential of the invention (Zucker and Darby, 2001).

This led us to hypothesise that:

H1: *Willingness of senior faculty to commercialise knowledge and technologies is defined by the support of knowledge enablers (Industry and Government) and knowledge codifiers (TTO and IPO).*

However, being a senior academic is not necessarily the strongest factor for academics to be interested in engagement for commercialisation. Senior academics do engage with stakeholders through more formal modes of interaction, younger scholars on the other hand are trying to engage in less formal collaboration activities (e.g., engage with Business Incubator to establish a start-up company) having less social capital, credibility, and skills (e.g., to engage with government and industry) at the initial stages of their career. In addition, studies suggest that commercialisation behaviour can be associated with being younger as lower age academics socialised in the context when commercialisation become more legitimate (Bercovitz and Feldman, 2008).

As senior university faculty are usually motivated by academic rationales which are conflict with a commercial mindset, most academic entrepreneurs see themselves as scientists first and then as entrepreneurs (Jain et al., 2009). Thus, junior scholars at the university have a higher possibility e.g., to establish a company compared to the senior researchers (Karlsson and Wigren, 2012). In addition, the training effect might be applied where individuals who have been trained earlier when engagement with industry was less relevant or even discouraged, can be attached to norms less compatible with interaction with business (Bercovitz and Feldman, 2008). Training effect also can be explained by entrepreneurship education which became more popular for the last couple of decades and what junior researchers might have experienced. Entrepreneurship education is one of the key instruments to increase entrepreneurial attitudes of people which is strongly related to entrepreneurial intention (Noel, 1998) and is an indication of the development of certain skills and attributes leveraged entrepreneurial behaviour (OECD, 2009).

More junior researchers also in a need to develop networks with others outside of academia and is require a platform to be introduced to another stakeholder. In this sense, Science Parks and Business Incubators act as a boundary spanner and network platform between junior scholars and others outside of academia (Audretsch et al., 2016). These stakeholders bring both sides together and are helping academics to develop skills and networks for the commercial exploitation of knowledge.

In addition, academics interested in academic progression and promotion would engage more with other actors (Perkmann et. al., 2021).

This led us to hypothesise that:

H2: *Willingness of junior faculty to engage for commercialisation of knowledge and technologies is defined by the support of knowledge facilitators (Business Incubators, Science Parks and Venture Capitalists).*

It is widely believed that the decision of an individual to become an entrepreneurial academic and engage with other stakeholders to commercially exploit their knowledge starts when the invention disclosure is filled with university TTO (Bercovitz and Feldman, 2008). University success in terms of entrepreneurial activities is measured by the set of indicators including the number of patents (applied and received), number of licences and amount of licensing revenue, number of new ventures created based on the disclose of their ideas to university TTO. It is assumed that filing an invention disclosure is the initiating stage of the technology transfer process and the following measures towards new initiatives depends on the faculty disclosure of their research results.

However, university disclosure is only a subset of university research with commercial potential (Thursby et al., 2001). Authors have also discussed reasons why faculty might choose not to disclose their research results (Thursby and Thursby, 2002). The first reason might be that they are unwilling to spend time on the applied R&D required to get interested from businesses in the licensed invention. This scenario is mostly relevant to patenting the results from basic research that have immediate commercial potential utilising university facilities mostly in natural science (e.g., biology, chemistry, physics) and applied science (e.g., engineering and medicine).

The second reason is that faculty might not disclose due to the publication delay caused by the patenting process. In addition, faculty might not disclose if they believe that commercial activity is not appropriate for them. These reasons mostly represent older norms of open science (Perkmann et al., 2021). However, research shows that to the extent when faculty disclosure

inventions, academic norms are changing (Krimsky, 2003) persuading academics to engage with other actors to commercially exploit disclosed results.

There are also concerns that faculty might behave opportunistically and bypass TTO procedures and commercially exploit invention without university involvement. Perkmann et al. (2021) showed that it is not necessarily a concern as at later stages commercial interest from potential investors would require evidence of ownership prior to committing funds. All the potential investors would require due diligence to clarify the origins of the idea and that the inventor (not the university or anyone else) holds invention rights. In addition, e.g., biomedical inventions, electronic devices or software would require infrastructure which is difficult to assemble by company or individual (Perkmann et al., 2021). Thus, disclosure of the invention is inevitable which is an initial stage for the following engagement of new knowledge promotion to the market. In addition, Owen-Smith and Powel (2001) showed that incentives for disclosure in life and biomedical sciences are demonstrated by the way for faculty to get additional financial returns and gain academic freedom on follow-on research.

In addition, the engagement of faculty with other relevant stakeholders or departments is influenced by the perception of academics about the competencies and capabilities of that department staff (e.g., TTO) and the comprehensiveness of the response received (Colyvas et al., 2002). Such perceptions are shaped by the institutional history and the environment (Perkmann et al., 2021). Academics usually need to know the future prospective about the support available at the next steps of the commercial exploitation of knowledge (e.g., access to the potential market and customers, available opportunities to get funding for idea promotion).

The process of organisational change towards entrepreneurship is usually challenging including the transformation of the university. Thus, at the initial stages of entrepreneurial university development as an organisation, much more attention has been given to the standard technology transfer acts (Feldman et al. 2002). However, the following stages of commercial exploitation of knowledge and technologies would require broader support beyond technologies codification but facilitation and exploitation on the market.

Thus, we hypothesise that:

H3*: Support of knowledge facilitators (science parks, business incubators and venture capitalists) might be among one of the strongest factors that impact the willingness of both young and senior academics to engage with others for knowledge and technologies transfer*.

3.2. Analysis of academics' engagement with stakeholders within the UK higher education sector

3.2.1 Sampling and data collection.

Hayter et al. (2018) has stressed the importance of accounting for the individuals' experience while exploring the stakeholders' engagement in knowledge and technology sharing. Individuals are at the heart of the university entrepreneurial ecosystem (Belitski and Heron, 2017) and their experience of working with others as well as sharing knowledge from other colleagues' impact significantly their decision to collaborate with others. To examine the individual experience a survey was conducted among UK academics followed by interviews to explore the phenomenon deeper.

The analysis is based on a unique cross-sectional database constructed by the online survey among 47 UK universities between September 2020 and January 2021 as a survey on academics' (both university faculty and PhD and postdoctoral researchers) interaction with university stakeholders including: government, industry, TTO, intellectual property office, science park, business incubator, venture capitalists. Participation in the survey was absolutely voluntary and is considered as a first-ever attempt to generate a database on academics' engagement with a number of actors within the university ecosystem. No similar attempts/surveys have been collected by official statistics or any other relevant departments (e.g. TTO). The survey generated a comparatively small dataset that might be challenged by a non-response bias. However, we have provided the justification for the sample representation for the entire population below.

The disciplines of the respondents include social sciences, engineering, biological science, chemistry, physics and math, medicine, computer science, pharmacology, agriculture and plant science. The general outlook of the population studied, and the sample is provided in Table 9.

We started by collecting emails of individual academics via universities' webpages both manually (where AI cannot be applied) and applying two types of AI which are Python and Google email extractor. All the records generally can be found on universities websites while exploring individual academic's profiles. Universities, which do not disclose emails of their academics on the website have not been covered by this study.

All the universities are from three university groups which are Russel Group Universities, former Polytechnics and the rest teaching universities (following Guerrero et al., 2016). All the universities have different backgrounds and different orientations (research universities, polytechnics, teaching universities). The survey is anonymous, and we cannot identify

respondents' names and/or the university, while our main goal was to identify respondents' feedback of collaboration with actors across the university regardless of affiliation. We were able to define groups of our respondents by the subject of study.

Following the literature, a survey was developed applying Dillman's (2007) tailored design method. The method describes procedures needed for conducting successful, self-administrated surveys devoted to both delivering high quality information and getting high response rates. Qualtrics affiliated with the University of Reading was used to produce a survey. According to Couper (2008), web surveys are a well-designed and effective instrument in a cost-effective manner.

Before spreading the survey to the entire population, as a validation step, the questionnaire has been sent to a group of potential respondents who are experts in the area of academic entrepreneurship. The feedback was collected from six individuals and all the comments were considered and incorporated into the design of the final version of the survey. Then, the final version has been administered to university academics.

Academics received an individual invitation letter to participate with the link provided to access the survey. The participation was voluntary and on request, we offered a summary of the research findings. In addition, by the means of the survey, we found potential interviewers who are willing to participate in the interview and share their experience and view on research commercialisation and engagement with stakeholders. Thus, only those academics who were willing to get the summary of our findings and/or agreed to be interviewed disclosed their emails. However, we do not associate their responses with their university and only treat their responses as anonymous. In general, actions for the purpose of this chapter have been undertaken according to Figure 4. We have applied sequential design for the purpose of this research.

In total, around 35 000 emails were sent out with 412 responses returning. Following Abreu and Grinevich (2013), we were trying to cover all the institutions, scientific fields, and professional categories available within the country.

The responses received are a representative sample of the total population. There are three key points that can show us if the sample is representative of the entire population which are population size, margin errors and sampling confidence level (Wooldridge, 2010).

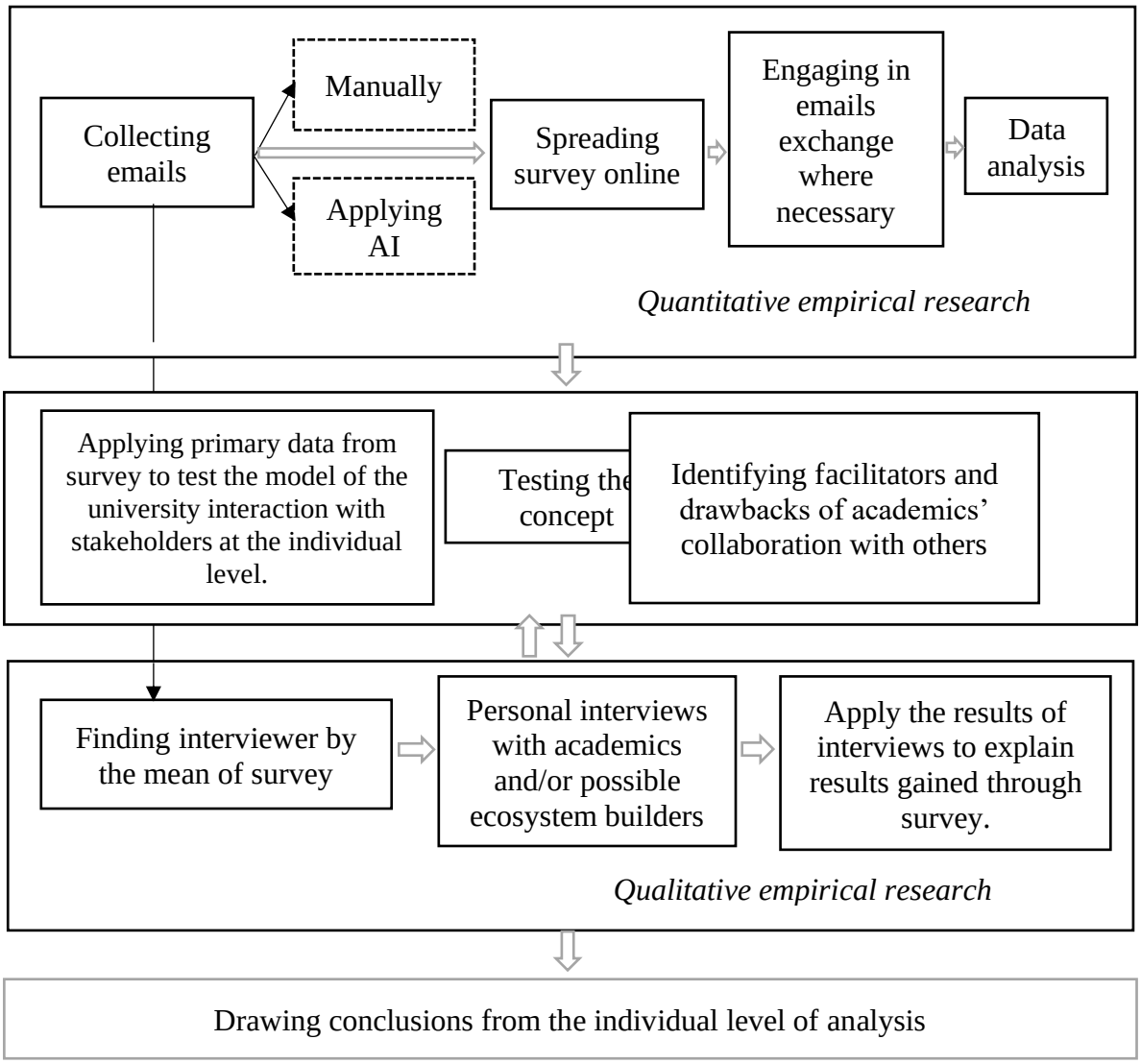

Figure 4: Research actions for the purpose of this research

We applied a simple random sampling technique for the purposes of this study. Under random sampling, there is an equal chance of being selected for each member of the population size. Our population size was 35 000 email addresses. To calculate the sample size, we need to know the margin errors and sampling confidence level. The margin of error is a percentage that shows how much we can expect survey results reflect the view of the entire population. The smaller the error margins, the closer we are to having the exact answer within the given confidence level.

The confidence level is a percentage that shows how confident we are that the population would select an answer within a certain range. Thus, a 95% confidence level would mean that we are 95% sure that results will be between A and B. Sample size for the simple random sampling is calculated using the equation (3) below (McConnell & Vera-Hernandez, 2015).

$$n = \left(\frac{z^2 * p(1-p)}{e^2}\right) / \left(1 + \frac{z^2 * p(1-p)}{e^2 N}\right) \quad (3),$$

where z score is a standard deviation of given proportion from the mean; e is the margin of error; N is population size and p is the population proportion.

Following the equation above, for the population size of 35 000 with 95% confidence level and error margins 5, the sample size should be at least 380 responses. Thus, we can confirm that the sample size of 412 respondents is representative of the entire population studied.

As we didn't define any selection options for the population and included all for whom we were able to get email addresses, there is no concern that our analysis is biased towards university or subject area (Iorio et al., 2017).

In total, 412 people responded to the questionnaire with 12 responses being excluded from the analysis because of the high level of missing data (11 responses have more than 60% of missing values and 1 response has more than 20% of missing values). Missing data is interpreted as missing completely (as it is applied for more than 50% of variables from one respondent) at random and therefore cannot be used in the study even with applying different imputation techniques (Hair et al., 2010). As opposed to other studies (e.g. Kalar & Antonic, 2015) we left emeritus professors' responses as those participated as all the responses related to the previous experience of academic without any concrete time-frames. Thus, the final number of responses for this research is 400 and is a representative sample for the overall population of academics studied with a 95% confidence level and error margins of 5. We made a general comparison of the sample to reveal the distribution of responses by the subject of study (Table 9). The total number of participants is bringing the sum of 455 which is higher than 412 showing that some participants have represented several different areas and career paths together. More details about the sample are presented in Table 9.

For the purpose of this research, we have applied a mixed method approach as there is a compelling reason to suspect that analysing the data on the commercialisation of university research relying only on data collected by the means of the survey might lead to the systemic underestimation of knowledge transfer (Aldridge and Audretsch, 2011; Caldera and Debande, 2010). Thus, we have applied a sequential explanatory strategy starting with quantitative analysis of the survey and then utilising qualitative study with 22 semi-structured interviews to gain an explanation and better understanding of the emergence and meaning of solutions (Venkatesh et. al., 2013). Semi-structured interviews with university academics and managers are a powerful way to understand the dynamics of the solution and why some factors are

important under certain conditions while others are not. Questions for the interviews have not been driven by the survey results.

3.2.2 Measurement instrument for the questionnaire

All the variables used in this research have been measured via adequately modified scales that were tested and used by other researchers. In the pre-testing or validation phase, we have checked whether all the questions are appropriate and relate to the experience as well as clear to answer and can be used in the individual academic context. We have not got any questions raised by academics within the pilot study stage that question or part of the question are not related to a particular stakeholder and thus not applicable. We rather got recommendations that some of the questions were too specific to the row outcomes of research commercialisation including patent and IP issues as well as spin-offs creation while there is a number of interactions that occur before receiving commercialisation outcomes. Based on these comments some questions were amended while others have been deleted. Following D'Este and Patel (2007) it is important to account for environmental factors including university policies and structure on academic's behaviour. Assessing the level of engagement with others and university, survey respondents were asked to show the level of their agreement with 46 statements on a five-point Likert scale ranging from "Strongly agree" to "Strongly disagree". Out of 46 statements, 28 were relevant to 5 stakeholders and/or activities related to those stakeholders while the other 18 statements have been relevant to the nature of the research and university culture related to entrepreneurship. All the questions have an open-ended option so that respondents can add some information based on their experience which is not included in the statement provided. In addition, there is an open-ended question relevant to each stakeholder allowing academics to express their opinion on what kind of support they want to get to accelerate the knowledge and or technology transfer. Demographical questions have also been provided allowing us to draw general conclusions about the sample.

All activities were measured regardless of time and only related if in general, the respondent has experienced engagement with other actor or not and what respondent can share about that experience. All the statements in questions were adopted from the previous research. Thus, all the points regarding academics' interaction with industry were mostly adopted from Ponomariov and Boardman (2008) and D'Este and Patel (2007); with TTOs – adopted from Perkman et al. (2013), Siegel (2018) and Aldridge and Audretsch (2010); with government –

from Siegel et al. (2003) and Shane (2001); with Business Incubators and Science Parks – from Murphy and Dyrenfurth (2019), Hatten (2006) and Hobbs et al. (2017).

3.2.3 Data analysis

Dependent variable

The survey which is used for the purpose of this research is considered to be the main source of information for academic engagement (Perkmann et al., 2013).

Previous studies on academic entrepreneurship view academic engagement as pro-active behaviour within the context of knowledge-intense organisation (Crant, 2000; Iorio, 2017). Academia is considered as an ideal context to study such type of individual behaviour that is beneficial to overall organisational performance (Perkmann et al., 2013). This is because academics are pleased by the large degree of professional autonomy and their performance as well as contribution to the organisation is driven mostly by self-motivation rather than control and commands (Iorio et al., 2017).

Academic engagement with different stakeholders is expressed in market acceptance of research outputs and can take different forms including patenting, IP, collaborative and/or contract research, consultancy etc. (D'Este and Patel, 2007; Nilsson et al., 2010; Perkmann et al., 2013). Beyond commercialising research outputs (e.g., through licensing) academics expose to market forces their knowledge that is not bounded by any means of legal documents such as setting up a start-up company. To support all these types of knowledge and/or technology spillover universities establish specialised structures such as TTOs, Business Incubators or Science Parks.

Our dependent variable is represented by the actual motivation of academics to engage with relevant stakeholders expressed in their interest to do one or another type of knowledge spillover (contract or collaborative research with government and industry) or technology commercialisation (selling IP or setting up a spin-off company). The variable is ordinal (5-point Likert scale) and is expressed in the interest of academics to engage for knowledge spillover or technology commercialisation.

Independent variables

Researchers measure engagement as an outcome of collaboration e.g. patents, licenses, contract or collaborative research, a number of spin-offs created (Lissoni et al., 2008). These activities however are likely under-represent collaboration which is more process like in nature and might not result in a contract or consulting assignment from the first instance (Perkmann, et. al., 2013).

Researchers use an analytical framework of entrepreneurship to explore commercialisation and other types of engagement emphasising aspects of opportunity recognition (Wright et al., 2007) and the importance of getting appropriate support (Perkmann et al., 2021).

Thus, while previous research measures the outcome of academic entrepreneurship within the engagement process, the fact of actual engagement and the impact of the positive or negative experience of such engagement have not been explored. Engagement is preceding commercialisation (Perkman et al., 2013) and other types of third-stream activities (e.g., setting up a start-up company) and is a predictor for the further steps of academics towards entrepreneurship.

Thus, our independent variables are presented by factors that are constructed from the question of actual (or fact of) engagement of academics with relevant stakeholders for one or another type of activity at different levels of their career (see Table 11 for more information about the entire sample).

Factors have been extracted based on the career path of academics and their engagement with others for different purposes.

In addition, set of independent variables presented by ordinal variables (5-point Likert scale) of the faculty feedback (positive or negative) on the impact of actual engagement with one or other stakeholders on their motivation to commercialise or spillover knowledge (e.g., TTO supports me to seek-out licensing opportunities for all forms of IP (patents, copyrights, designs and trademarks)).

Control variables

With respect to academic engagement for entrepreneurial activities, we included control variables as predictors of readiness of academics to engage with other stakeholders. Variables have been built from questions related to academics' age and experience, the effect of time availability, university strategy towards commercialisation as well as administrative support received for commercialisation.

Age of academic. Previous research shows that age has an ambiguous effect on the engagement of academics. Some authors have found positive relationships between age and engagement (Boardman and Ponomariov, 2009), while others revealed negative connections (D'Este and Perkmann, 2011), or no relationships between both (Boardman and Ponomariov, 2009).

Experience. Academic engagement is associated with scientists who are well established and strongly connected within the academic community (Perkmann et al., 2013). More senior academics tend to have a higher number of publications, more grants (both from government and industry), much productive work with industry and thus more social capital. Research

revealed that engagement of academics and experience are correlated as well as seniority and collaboration are positively related (D'Este and Perkman, 2011; Ponomariov, 2008).

Time. Having enough time for engagement and following commercialisation and entrepreneurship might be considered as one of the critical factors for the decision academics to engage. To the best of our knowledge, time as a variable has not been included in the models of academic engagement so far.

Strategy. Engagement is a phenomenon embedded within the certain institutional context in which academics operate including the effect of certain rules and regulations. Thus, university strategic orientation towards commercialisation and the university-industry collaboration informs academic engagement as it shapes norms and rules relevant to university employees (Crane, 1972).

Administrative support. Finally, the perception of academics about the opportunity to get adequate administrative support from relevant university departments at the appropriate time is a crucial factor to control.

Descriptive statistics of all the variables are presented in Table C1 (Appendix C).

3.2.4 Method

We test our hypothesis applying multinomial logistic regression as the best appropriate method to evaluate nominal outcome variables in which the log odds of the outcomes are modelled as a linear combination of the predictor variables (Wooldridge, 2010).

The following model was estimated (4 - 5):

$$\Pr(Yi = 2) = \frac{e^{\beta 2 * Xi}}{1 + \sum_{k=1}^{K-1} (e^{\beta k * Xi})} \quad (4)$$

$$\cdots\cdots$$

$$\Pr(Yi = K - 1) = \frac{e^{\beta k-1 * Xi}}{1 + \sum_{k=1}^{K-1} (e^{\beta k * Xi})} \quad (5)$$

where we considered Pr(Y_i=*1*) is a pivoting choice and is measuring strongly negative interest of academic to engage with other stakeholders for commercialisation. The next choices represented by K – 1 and are examining how much better or worse the other K – 1 choice is relatively to the choice we are pivoting; K-1 are separately identifiable vectors of coefficients; βk is the set of regression coefficients associated with outcome K and Xi is a set of explanatory variables associated with observation i.

3.2.5 Results

3.2.5.1 Quantitative data.

In our analysis, we first examine the structure of the sample and the overall situation of academics' engagement with relevant stakeholders. Then, we conduct a factor analysis and build a sum of measures to represent engagement patterns. Finally, we study patterns of engagement to further analyse practises that would work best among the entire population of academics.

Results of Table 11 show that a wide range of individuals from different areas/subjects participated in the survey.

Table 11. Details about the sample by subject and position

No	Question	PhD researcher	Postdoc researcher	Teaching assistance	Lecturer	Assistant Professor	Associate Professor	Full Professor	Emeritus Professor	Total
1	Business and Economics	11 (9.40%)	10 (8.55%)	1 (0.85%)	34 (29.06%)	14 (11.97%)	19 (16.24%)	24 (20.51%)	4 (3.42%)	117
2	Engineering	14 (20.59%)	10 (14.71%)	0 (0.00%)	12 (17.65%)	4 (5.88%)	13 (19.12%)	13 (19.12%)	2 (2.94%)	68
3	Chemistry	5 (17.86%)	3 (10.71%)	0 (0.00%)	5 (17.86%)	2 (7.14%)	3 (10.71%)	5 (17.86%)	5 (17.86%)	28
4	Biological science	7 (10.45%)	16 (23.88%)	1 (1.49%)	8 (11.94%)	6 (8.96%)	11 (16.42%)	14 (20.90%)	4 (5.97%)	67
5	Physics and math	4 (15.38%)	4 (15.38%)	0 (0.00%)	3 (11.54%)	4 (15.38%)	4 (15.38%)	6 (23.08%)	1 (3.85%)	26
6	Medicine	9 (22.50%)	4 (10.00%)	1 (2.50%)	6 (15.00%)	2 (5.00%)	5 (12.50%)	11 (27.50%)	2 (5.00%)	40
7	Computer science	7 (24.14%)	6 (20.69%)	0 (0.00%)	5 (17.24%)	1 (3.45%)	4 (13.79%)	6 (20.69%)	0 (0.00%)	29
8	Pharmacology	2 (25.00%)	2 (25.00%)	0 (0.00%)	1 (12.50%)	2 (25.00%)	1 (12.50%)	0 (0.00%)	0 (0.00%)	8
9	Agriculture and plant science	2 (33.33%)	2 (33.33%)	0 (0.00%)	0 (0.00%)	1 (16.67%)	0 (0.00%)	1 (16.67%)	0 (0.00%)	6
10	Other	8 (12.12%)	8 (12.12%)	1 (1.52%)	25 (37.88%)	3 (4.55%)	6 (69.09%)	13 (19.70%)	2 (3.03%)	66

In total, the majority of respondents are from the Business and Economics area (28%). This pattern was followed by literature findings that Business and economics scholars are more active when it comes to engagement (Perkmann et al., 2021). We might assume here that people, working within the business domain might be more knowledgeable about what it means to work within the business domain and so they are trying to investigate opportunities available. Following the Business and Economics domain, people in Engineering (16%), Biological

science (16%), and Medicine (9.7%) were among the next most representative respondents. Many respondents comprise the group of Other subject areas (16%).

Respondents within all the subject areas presented at each level of career progression including junior (PhD researcher, Postdoctoral researcher), middle (Teaching assistant and Lecturer) and senior level positions (Professorship). Another interesting feature of the sample is that both junior researchers and senior scholars equally represent a majority of the sample.

We also asked respondents to identify which type of stakeholder they have engaged with during various positions of their career path. We have not been able to differentiate types of engagement with technology transfer offices (e.g., either helping to fill in an IP or seeking some advice), intellectual property offices (e.g., either helping to fill patent application or seeking some advice). The same is applied to business incubators, science parks, venture capitalists and non-government organisations. While we have been able to differentiate some types of faculty engagement with government and industry (Table 12).

Table 12. Engagement with stakeholders at different career paths (total number of engagements (not people))

#	Question	PhD researcher	Postdoctoral researcher	Teaching assistance	Lecturer	Assistant Professor	Associate Professor	Full Professor	Emeritus Professor	Total number of engagements
1	Industry to get funding for research	17.30% (82)	17.72% (84)	1.69% (8)	20.89% (99)	11.60% (55)	12.87% (61)	15.40% (73)	2.53% (12)	474
2	Industry to provide consulting service	11.18% (37)	13.90% (46)	1.51% (5)	23.26% (77)	12.69% (42)	16.31% (54)	19.03% (63)	2.11% (7)	331
3	Industry to sell IP rights	8.80% (11)	16.00% (20)	1.60% (2)	20.00% (25)	12.00% (15)	16.80% (21)	23.20% (29)	1.60% (2)	125
4	Government to get funding for research	11.13% (55)	19.23% (95)	1.42% (7)	22.67% (112)	12.55% (62)	15.79% (78)	15.79% (78)	1.42% (7)	494
5	Government to get funding for commercialisation activities	7.39% (13)	15.34% (27)	2.84% (5)	18.75% (33)	13.64% (24)	17.61% (31)	21.59% (38)	2.84% (5)	176
6	Technology Transfer Office	6.80% (17)	16.40% (41)	1.60% (4)	22.40% (56)	14.80% (37)	16.00% (40)	21.60% (54)	0.40% (1)	250
7	Intellectual Property Office	4.17% (8)	17.19% (33)	2.08% (4)	23.44% (45)	15.63% (30)	15.10% (29)	21.88% (42)	0.52% (1)	192
8	Science/Technology Park	7.25% (5)	11.59% (8)	4.35% (3)	14.49% (10)	10.14% (7)	20.29% (14)	27.54% (19)	4.35% (3)	69
9	Business Incubator	10.71% (9)	10.71% (9)	5.95% (5)	16.67% (14)	8.33% (7)	17.86% (15)	27.38% (23)	2.38% (2)	84

10	Venture Capitalist and/or Angel Investor	7.37% (7)	9.47% (9)	3.16% (3)	20.00% (19)	11.58% (11)	16.84% (16)	29.47% (28)	2.11% (2)	95
11	Non-government organisation	12.88% (34)	17.05% (45)	3.41% (9)	23.11% (61)	10.98% (29)	14.77% (39)	16.67% (44)	1.14% (3)	264
12	Other stakeholders	27.78% (5)	5.56% (1)	5.56% (1)	22.22% (4)	11.11% (2)	5.56% (1)	22.22% (4)	0.00% (0)	18

Not surprisingly, and this trend is followed by what has been found in the literature that the majority of respondents engaged more frequently with industry (474 engagements) and government (494 engagements) to get funding for the research (e.g., in the form of contract and collaborative research). In total, a number of engagements might represent returning engagement with stakeholders in one career level (e.g., senior level) or progression of interaction with the same stakeholder during various career stages (e.g., engaging with the government being junior, middle, and senior level academic). Following the most popular path of engagements presented by the collaboration with industry to provide consultancy (331 engagements) and technology transfer office (250 engagements). Interaction with the government to get funding for commercialisation and interaction with intellectual property office is followed the frequencies of collaboration patterns or 176 and 192 engagements, respectively. What is interesting, within the patterns of engagements, faculty in the middle position (or being a lecturer) engage more frequently with all the stakeholders covered except science parks, business incubators and venture capitalists. Collaboration with this type of stakeholders is more common for faculty on the senior position or professorship (on average 28% of engagement accounted for this group of academics).

Extraction of factors.

Next, we conduct a factor analysis to identify factors to be included in the final calculations. Indicators of actual engagement that academics have experienced constituted variables to be included in the factor analysis (following Table 13). For further analysis among the overall set of factors, we included those with minimum eigen value 2 and having at least three loadings.

Exploratory factor analysis with varimax rotation produced 9 factors which together explain a reasonable 63 per cent of the overall variation. Extraction of factors has been split following career level progression and stages.

The first factor had three variables and has been labelled "*Engagement with stakeholders at Professorship position*". The strongest loading was engagement with Venture Capitalist or Business Angel (0.67) and the second strongest was engagement with Business Incubator

(0.64). This factor also included engagement with Government to get funding for commercialisation (0.56).

The second factor extracted included engagement with stakeholders at all levels of career progression from junior till senior and was labelled "*Engagement with stakeholders at junior, middle and senior positions*". For this factor, the strongest loadings were engagement with Business Incubator (0.88) and Venture Capitalist or Business Angel (0.88), the second strongest was engagement with Industry to sell IP (0.65). This factor also included engagement with Science Park (0.64) as well the Government to get funding for commercialisation (0.52).

The third factor was engagement with stakeholders at the middle position (Teaching and Lectureship) has been labelled "*Engagement with stakeholders at middle position*". The strongest loading for this factor was engagement with Business Incubator (0.71) and the second strongest loading was engagement with Science Park (0.67). This factor also included engagement with Venture Capitalist or Business Angel (0.61), engagement with Government to get funding for commercialisation (0.56), engagement with Industry to sell IP (0.54), engagement with Technology Transfer Office (0.52).

The fourth factor extracted was engagement with stakeholders at the senior position (Assistant and Associate professor) and was labelled "*Engagement with stakeholders at tenure-track position*". This factor included three loadings or engagement of faculty with three stakeholders which are Business Incubator (0.77), Venture capitalist or Business Angel (0.76) and Science Park (0.53).

The fifth factor was engagement with stakeholders at PhD research and/or Postdoctoral research levels and was labelled "*Engagement with stakeholders at junior level*". This factor included engagement with Business Incubator (0.66), Venture capitalist or Business angel (0.67), as well as with TTO (0.59) and Intellectual Property Office (0.58).

Factor number six was engagement with stakeholders at the middle (Teaching assistant and Lectureship) and senior (Professorship) positions. Factor has been labelled "*Engagement with stakeholders at middle and senior positions*". This factor included two loadings or engagement with a Venture capitalist or Business angel (0.76) and engagement with Business Incubator (0.58).

Factor number seven was engagement with stakeholders at the junior (PhD researcher and/or Postdoctoral researcher) and middle (Teaching assistant and Lectureship) positions and included only one loading or engagement with Venture Capitalist or Business Angel (0.75). Factor has been titled "*Engagement with investors at junior and middle positions*".

Factor number eight was another extraction of junior (PhD researcher and/or Postdoctoral researcher) and middle (Teaching assistant and Lectureship) faculty interaction with other stakeholders. This factor had three loadings which are engagement with Technology Transfer Office (0.69) and Intellectual Property Office (0.67), and engagement with Government to get funding for research (0.62). Factor has been titled "*Engagement with stakeholders at junior and middle positions*".

Finally, the last factor or factor number nine was the extraction of interactions of university faculty at the middle (Teaching assistant and Lectureship) and senior (Professorship) positions and included one loading or interaction with Business Incubator (0.53). Factor has been titled "*Engagement with business incubator at middle and senior positions*".

Table 13. Loadings of factors

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Engagement with industry to sell IP at Teaching and lectureship positions			0.538		
Engagement with industry to sell IP at junior, middle and high positions		0.654			
Engagement with government to get funding for research at junior and middle positions					
Engagement with government to get funding for commercialisation at Teaching and lectureship positions			0.557		
Engagement with government to get funding for commercialisation at Professorship position	0.575				
Engagement with government to get funding for commercialisation at junior, middle and senior positions		0.519			
Engagement with technology transfer office at junior level					0.591
Engagement with technology transfer office at middle position			0.522		
Engagement with technology transfer office at junior and middle positions					
Engagement with intellectual property office at junior level					0.578
Engagement with intellectual property office at junior and middle positions					
Engagement with science park at middle position			0.674		
Engagement with science park at Assistant and Associate professor position				0.5346	
Engagement with science park at junior, middle and senior positions		0.635			
Engagement with business incubator at junior level					0.664
Engagement with business incubator at Teaching and lectureship positions			0.714		
Engagement with business incubator at Assistant and Associate professor position				0.770	
Engagement with business incubator at Professorship position	0.638				
Engagement with business Incubator at middle and senior positions					
Engagement with business incubator at junior, middle and senior positions		0.882			
Engagement with Venture capitalist / Business Angel at junior level					0.668
Engagement with Venture capitalist / Business Angel at Teaching and lectureship positions			0.610		
Engagement with Venture capitalist / Business Angel at Assistant and Associate professor position				0.759	
Engagement with Venture capitalist / Business Angel at Professorship position	0.665				
Engagement with Venture capitalist / Business Angel at middle and senior positions					
Engagement with Venture capitalist / Business Angel at junior, middle and senior positions		0.882			
Engagement with investors at junior and middle positions					

All the new factors extracted have been validated for internal consistency applying the Cronbach alpha approach. Cronbach alpha is a measure of scale reliability and might be written as a function of a number of tested items, the average inter-correlation among them and the cut-off points (Wooldridge, 2012). All new factors have Cronbach alpha greater than 0.68, which is the reliability threshold for this analysis (Cronbach, 1951). The variables used to create Cronbach alphas are described in Table 13. Created Cronbach alphas were used in the

interaction analysis when testing for interdependence and collaboration among university faculty and stakeholders in their effect on academics' interest to engage with other actors for knowledge and technology transfer.

Hypothesis estimations.

When it comes to hypothesis validation, we start by reporting the results of Table 14, which illustrate the effect of collaboration with diverse stakeholders on academics' interest to engage with other actors for knowledge and technologies transfer. We report the main findings in this section and discuss them in the next section.

Table 14. Multinomial logit regression results

No	1	2	3
	Factors	Neutral interest in commercialisation	Strongly positive interest in commercialisation
	Dependent variable – Interest in engagement for commercialisation Base outcome – Strongly negative interest in engagement for commercialisation		
1	Engagement with stakeholders at Professorship position (F1)	1.081 (0.595)	1.529*** (0.574)
2	Engagement with stakeholders at junior, middle and senior positions (F2)	4.062*** (1.244)	4.146*** (1.228)
3	Engagement with stakeholders at junior level (F5)	4.108** (1.977)	4.077*** (1.985)
4	IP protection management support from TTO	-2.104** (0.966)	-1.480 (0.931)
5	TTO awareness about commercialisation	2.524** (1.264)	2.359 (1.270)
6	TTO's assistance in spin-offs creation	-4.802*** (1.654)	-4.308*** (1.637)
7	Business incubator enhanced business skills	4.507** (2.082)	5.450*** (2.116)
8	Business incubator encourages me to start a new venture	-4.289*** (1.488)	-4.225*** (1.504)
9	Government programmes are supportive for research commercialisation	2.793** (1.185)	1.697 (1.143)
10	Industry is open for implementing new technologies from research	2.242*** (0.813)	2.002** (0.840)
11	Time for commercialisation numerical	0.762 (0.865)	0.876** (0.874)
12	Administrative support for commercialisation	-1.613** (0.697)	-1.460** (0.710)
13	I have enough knowledge and skills for commercialisation	1.310 (0.772)	2.336** (0.785)
14	Opportunities awareness about collaboration with industry	0.688** (0.697)	0.833 (0.828)

Let us focus on coefficients of faculty interest to engage with relevant stakeholders and describe what impacted their decision at different stages of engagement.

The relative probability of faculty engagement with stakeholders for knowledge and technologies transfer when they have a *neutral interest in commercialisation* would be led by factors 2 and 5.

In particular, factor 2 is represented by faculty within all the levels of career development or those who are at PhD and postdoctoral levels, teaching and lectureship levels, as well as professorship positions. The relative probability of faculty engagement with stakeholders within three levels of career progression (F2) (junior – middle – senior) who have "Neutral" interest in commercialisation is 58% higher (exp 58.104) compared to those who have strongly negative interest in commercialisation within the same group. Interactions would be with Business Incubator and Venture Capitalist or Business Angel, with Science Park, with Industry to sell IP, as well as with the Government to get funding for commercialisation.

Faculty in junior positions (F5) (PhD researcher and Postdoctoral student) have a 61% higher probability (exp 60.873) to engage with other stakeholders compared to those who have strongly negative interest in commercialisation within the same group. Engagement would likely be with TTO and intellectual property office as well as a business incubator and venture capitalist/business angel.

When it comes to Business Incubators, two factors statistically significant have different effects on the interest of academics to engage with others. Thus, BI trainings to enhance business skills were positive while encouragement for new venture creation from BI is likely to be negative.

On the one hand within the group of academics with neutral interest, IP protection management from TTO has a negative effect on the decision of academics to engage with other actors while awareness of TTO's employees about commercialisation can push them to collaborate. In addition, TTO's facilitation of spin-off creation would likely provide a negative effect on the decision of academics to collaborate.

When it comes to Government, academics perception that government programmes are supportive for research commercialisation would increase the probability of engagement. In addition, industry openness to implementing new technologies from research would lead to the same outcome. Faculty perception about the adequacy of administrative support for commercialisation they can receive within the organisation is likely to have a negative effect on engagement for commercialisation among academics having a neutral interest in commercialisation.

Finally, opportunity awareness about collaboration with industry from any university department would likely increase the probability of faculty to engage with relevant stakeholders.

The relative probability of faculty engagement with stakeholders for knowledge and technologies transfer when they have a *strongly positive interest in commercialisation* would

be higher among academics from the previous subgroup (F2, F5) additionally to faculty on senior (professorship) position (F1).

The relative probability of faculty engagement with stakeholders within three levels of career progression (F2) (junior – middle – senior) who have "Strongly positive" interest in commercialisation is 63% higher (exp 63.185) compared to those who have strongly negative interest in commercialisation within the same group of academics. Interactions would be with business incubator and Venture capitalist/Business Angel, with science park, with industry to sell IP, as well as the government to get funding for commercialisation.

Faculty in junior position (F5) (PhD researcher and Postdoctoral student) have almost 59% higher probability (exp 58.990) to engage with other stakeholders compared to those who have a strongly negative interest in commercialisation within the same group of academics. Engagement would likely be with TTO and intellectual property office as well as a business incubator and venture capitalist/business angel.

Faculty in senior positions (F1) (Professors) have an almost 4% higher probability (exp 4.901) to engage with other stakeholders compared to those who have a strongly negative interest in commercialisation within the same group of academics. Engagement would likely be with Government to get funding for commercialisation as well as a business incubator and venture capitalist/business angel.

The control factors that guide academics' interest within the group of faculties who are highly interested in commercialisation would be the following. It is a positive contribution of Business Incubators from the side of business skills development while both Technology transfer office and Business Incubators support for new ventures creation would likely have a negative effect on the interest of academics to engage for commercialisation. As in the previous group, while perception about adequate administrative support likely has a negative effect on the decision of academics to commercialise, the openness of industry to implement new technologies from research would have a positive effect.

Interestingly, control factors which turn out to be statistically significant within the group of academics having "Strongly positive" interest are some of the variables from the previous sub ranking (from those who have neutral interest) and have the same effect. Thus, TTO and BI support for new ventures creation turned out to be negative, while BI support for business skills development has a positive contribution to this sub-group. Readiness of industry to collaborate with academics and implement research results would likely be positive while perception about administrative support would likely have a negative effect. However, factors that would likely

increase the interest of academics to engage in commercialisation are having enough time for engagement and commercialisation as well as evaluation of personal skills.

3.2.5.2 Qualitative data.

Within the semi-structured interviews, we have extracted data that would be able to help us to explain the results of the quantitative study both on collaboration with stakeholders and control factors (all the original names of participants have been replaced).

Interestingly, within one of the interviews with the university manager on stakeholders' engagement and the role of faculty and the work of Business Incubator, James stated:

> *"What we have learned is that those people who are brilliant scientists are not necessarily great businesspeople. So, one of the difficult conversations we have, or I used to have in University X … is professor Smith who has a wonderful new idea is explaining to him that first, the idea is great, but you need to build it into the business and that is a very complicated thing – not a very easy thing as Professor Smith thinks it is. And second, the best person to run that business idea is probably not Professor Smith but it would be somebody else. In fact, in University X, we found that Professor Smith is often or very often not a very good person to run the business. But sometimes it may be one of his postdocs or his PhD students who were worked with him on the project and understand it as well if not better than he does".*

A manager from another university, Jack, mentioned the role of investment for new ventures creation within the university domain:

> *"The incubators are definitely in touch with VCs and Angel investors, … especially through the kind of commercialization managers who are setting up spin out companies and are looking for that kind of investment. So, it's definitely a lot of activity there. We had a recent success where we spat out company and we've had £… of investment in a new company, so I should mention that … it is a very important factor".*

One of the interviewees Peter, stated the following about the funding for commercialisation and entrepreneurship that comes from Government:

> *"Obviously, the other major source of funding which comes from government ultimately is high funding. Which pays my salary and pays for the salary of a lot of people doing entrepreneurial and kind of innovation work".*

One of the interview participants, Lucas, stated the following about support from the Government:

> *" …. Government, … Yes, … without its support and financial opportunities both for the research and commercialisation, we have not been able to do anything …".*

When it comes to working with TTOs, one of the academics said:

> *" … with the legal agreements and things that are essential, … absolutely, you know, you cannot have a business relationship without IP agreements and contracts and non-disclosure agreements, and my experience is that the universities often can barely do that. It is very it is much harder than you would think because there is a lot of different ways it can be done, and it can be very expensive and also very ineffective. But that is something that the University has to do, and often universities can't do it very well ... I don't think it's anyone's fault … it is just a hard thing to do".*

On the other note, the university manager mentioned the following interesting note about the role of TTO:

> *"I believe that TTO works much effectively when it incorporates into the larger system which helps new business spin-out, which has sources of funding and which is fully integrated business support and development activity. Before we set up … (from the author: title of the organisation responsible for commercialisation) there used to be a small tech transfer centre at University. In fact, when I set up an …, the tech transfer office had only two people in it. And it is not do anything to support or encourage entrepreneurship and it did anything rather than it helps to patent at scientists' request".*

One of the interview participants, Alex, mentioned about the role of Business Incubator in nurturing business skills in people:

> *"… that someone … can get loads of different experience of kind of business development and sales product development and financial management".*

Another academic has mentioned the following about the administrative support from the university:

> *"… what I am finding now over the years is that the University management team has become more myopic, more operational, intrusive in the lives of academics and researchers. And I don't find it helpful".*

Andrew, a professor from University Y, who participated in the interview has mentioned the following about the time available for commercialisation:

"… they, university, e.g. TTO's or Business development department are trying to help academics and connect us with industry within the network they have but it is not always successful. It is not always the case that with the industry partner university connect you with, you would be able to develop successful collaboration and understand each other. … What I need is time to go out, develop my network and build the further collaboration upon on it".

Combining results from both qualitative and quantitative studies, our findings partly support our H1 that the willingness of senior faculty to commercialise knowledge and technologies is defined by the support of knowledge enablers only without knowledge codifiers (TTO and IPO). In particular, we showed that faculty on the senior level (or having senior faculty as one of the loadings for the Factor) would engage with Government both if they are highly interested in commercialisation as well as if they have a neutral interest. We did not get knowledge codifiers as a loading for the Factors for senior faculty engagement into the commercialisation. By contrast, our results show that junior researchers (PhD and postdoc positions) would more likely engage with knowledge codifiers (TTO and IPO) if they have a high interest in commercialisation. For those academics who have a neutral interest in commercialisation, information about opportunities available from the relevant departments at the university tend to be significant.

Our H2 stating that the willingness of earlier career researchers to commercialise knowledge and technologies is defined by the support of knowledge facilitators (Business Incubators and Venture Capitalists) is supported. In particular, we showed that junior researchers would more likely engage with Business Incubators and Venture Capitalists if they have both neutral as well as high interest in commercialisation. To facilitate the interest of faculty to engage with other actors for commercialisation business skills development is significant while opportunities can be found by faculty themselves with the availability of time.

Our H3 have been supported. In particular, we see that among the factors extracted and those which tend to be significant, knowledge facilitators from our classification (business incubators and availability of venture funds) are present in all the factors that become significant for the final outcome.

3.3 Discussion.

Within the framework of this research, we have tried to systemically evaluate the results of academic engagement with relevant stakeholders at and/or around the university on the decision of academics to interact with other actors for knowledge and technologies commercialisation. We have also tried to reveal factors from the side of stakeholders that can boost the interest of academics to interact with other actors for the purpose of commercialisation. Unlike academic engagement with all the relevant actors within university boundaries, studies on the engagement of university faculty with industry and for research commercialisation has previously been systematically and empirically evaluated by published reviews (Perkmann et al., 2013; Perkmann et al., 2021). Compared to research commercialisation per se and interaction with industry, engagement of university faculty for consultancy or start-ups (not spin-offs which require patent or licence) creation is practised more widely across disciplines and is a predictor of the decision of academic to pursue academic entrepreneurship (Hughes and Kitson, 2012; Hughes et al., 2015). Our results demonstrate that while engagement of academics with stakeholders varies based on the level of interest of academics, engagement with knowledge facilitators (business incubators and venture capitalists) is among the most frequently happened and significant interactions that might impact academics' interest to engage for commercialisation both if they have neutral as well as high interest in commercialisation. Enhancement of business and commercialisation skills would facilitate the interaction of academics with other actors. In addition, we reveal that young career researchers tend to interact with a wider set of stakeholders compared to senior academics.

We drew our research based on ideas of Perkmann et al. (2013) on academic engagement and commercialisation, Iorio's et al. (2017) concept on the breadth and depth of knowledge transfer activities to evaluate factors impacting the interest of academics to engage with other actors around the university for commercialisation. We also built our empirical development based on D'Este and Patel (2007), Audretsch and Belitski (2019), Siegel and Waldman (2019) when examining factors underlying the variety of interactions of academics with other actors while transferring new knowledge and technologies.

In particular, senior academics engage with more formal modes of collaboration including knowledge enablers (government and industry) while within our sample junior academics engage with knowledge codifiers (TTO and IPO) additionally as knowledge enablers. Furthermore, for both senior and junior academics, engaging with other actors' support of

knowledge facilitators (Business Incubators and Venture capitalists) tend to be one of the significant factors.

Studies show that tenure (academic experience since PhD) has an unclear effect on academic engagement, being positive for US academics (Schuelke-Leech, 2013) or having no effect in Germany and Sweden (Aschhoff and Grimpe, 2014; Huyghe and Knockaert, 2015). UK and Italy experiences show that seniority is more robustly associated with academic engagement (Abreu and Grinevich, 2013; Lawson et al., 2019). However, when it comes to collaboration with industry, senior academics (generally principal investigators) play a leading role in establishing and managing collaboration (Boehm and Hogan, 2014). Collaboration of academics with industry and government are strictly connected and both are correlated with seniority (Lawson et al., 2019).

However, in general, commercialisation behaviour can be associated with being younger as lower age academics socialised in the context when commercialisation become more legitimate (Bercovitz and Feldman, 2008). Most advanced academic entrepreneurs and senior scholars see themselves as scientists first and then as entrepreneurs (Jain et al., 2009). When it comes to junior researcher interest in engagement for commercialisation, training effect might be applied where individuals who have been trained earlier when engagement with industry was less relevant or even discouraged, can be attached to norms less compatible with interaction with business (Bercovitz and Feldman, 2008). Many academics lack skills needed to start a business or commercialise knowledge or technologies as such skills are different from those used in academic careers (Locket et al., 2003). Trainings for gaining business skills and contacting the relevant entities which provide the necessary support for entrepreneurship tend to favour the interest and readiness to start a business (Siegel and Phan, 2005). Entrepreneurial training provides access to necessary resources to facilitate the work of entrepreneurs as well as access to experienced entrepreneurs that might change the values and attitudes of academics towards entrepreneurship (Rauch and Hulsink, 2015).

Entrepreneurial university and academic entrepreneurship are a relatively new phenomenon with much more attention have been given to the faculty (Pirnay et al., 2003), while modest literature also pays wider attention to the role of young researchers (PhD students) and postdoctoral scholars (Rasmussen and Wright, 2015; Boh et al., 2016). The interest in the focus of students as entrepreneurs might emerge within the development of entrepreneurship education within universities (Souitaris et al., 2007). More recent research has also examined the role of young researchers (PhDs and postdocs) as entrepreneurs within setting up spinoffs (Hayter et al., 2018).

On the other hand, necessity, or push factors (Reynolds et al., 2002) can drive young individuals to pursue academic entrepreneurship, among which unemployment is the most significant factor (Storey, 1991; Ritsila and Tervo, 2002; Rizzo, 2015) and is much higher among young researchers who are just starting their career. Studies have found a correlation between unemployment and the propensity of being self-employed starting from the beginning of 90s (Storey, 1991). Under the necessity young academics might be willing to create a firm to escape dissatisfaction with the uncertain situation and lack prospect in the current job (Uhlaner and Thurik, 2007).

In addition, from the nonmonetary perspective, younger academics might be driven to academic entrepreneurship for the demand of recognition and career progression (Stuart and Ding, 2006), including university strategy orientation towards entrepreneurship, additional career and skills advantages to getting research funding (Hayter, 2011), the individual willingness of younger academics to bring research into the market (Fini et al., 2009). For those spinoffs or start-ups that succeed young researchers may choose to pursue entrepreneurship as a career either to get more knowledge about how the market works or proceed to a higher responsible role as CEO (de Haan et al., 2020).

University graduates and young researchers play a crucial role in many pathways for the transfer of knowledge and technologies. In fact, research shows that around 77% of new ventures involve graduate students (Boh et al., 2016). Students are usually more knowledgeable about business creation and are highly motivated at the beginning of their career (Boh et al., 2016; Sansone et al., 2021). They have broader access to the expertise both inside and outside the university and they are more active to engage with the broader set of stakeholders to get access to opportunities and skills needed. In addition, their opportunities as students or earlier career researchers both to reach the wider sets of actors and to get to know about the available opportunities cost low (de Haan et al., 2020). While they might lack experience, research suggests that usually PhD and postdocs are savvy enough to transit easily between academic and business context (de Haan et al., 2020) and understand well the language of all the stakeholders involved in the process. Also, as the rate of failure is higher among young or less experienced professionals, they try to use all the opportunities available, especially around the university, to benefit from them at each stage of knowledge and/or technology development and application and engage more often with others. Thus, young researchers are more willing to interact with whoever has a credible commitment to the dissemination of knowledge and technologies (Bruneel et al., 2010). Such trust relationships usually take time to develop and

the more stakeholders within the ecosystem researcher are aware of the easier it is for him to act accordingly and seek support where needed.

When it comes to the efficacy of university efforts to support entrepreneurship, diversity and quality of organisational networks do matter. As an example, organisational intermediaries do play a significant role in connecting academic entrepreneurs with necessary resources (Rasmussen and Borsch, 2010; Rasmussen et al., 2011). Research has paid a lot of attention to the networks of TTOs which are critical to exposure to commercial resources (Comacchio et al., 2012; Clarysse et al., 2011) however they are generally limited (Clarysse et al., 2014; Perez and Sanchez, 2003). It is argued that networks associated with business incubators (Cooper et al., 2012) and science parks (Zou and Zhao, 2014) play an important role is reaching out to broader audience, developing new skills and getting access to the broader market to explore the commercial value of the research (Hayter et al., 2018).

In addition, early-stage venture funding is vital for the success of academic entrepreneurship and new companies' creation (Algieri et al., 2013; Huyghe et al., 2014), and might play a significant role in the decision of academics to pursue academic entrepreneurship (Hayter et al., 2018). As an example, funding is considered a constrain for Italian academics to pursue entrepreneurship (Rizzo, 2015). Research has primarily focused on the importance of the availability of venture capital and its role in the development of university entrepreneurship (Fini et al., 2009; O'Shea et al., 2008) and achieving IPO (Shane and Stuart, 2002). Venture capitalists bring not only financial resources but also provide academic entrepreneurship with technical and managerial advice (Hayter, 2016), credibility (Fernandez-Alles et al., 2015), broader access and connection to industry (Vohora et al., 2004).

Thus, within the individual level of analysis, or university faculty, results of this study have shown that academics would be more inclined to collaborate with others for the purpose of knowledge and technologies transfer when they are more confident in their skills and knowledge about business and commercialisation. As for the former, university faculty expect to get support from Business Incubators to enhance their business skills. In addition, industry openness to implementing innovations impacts faculty's readiness to collaborate with others.

The next part of this thesis provides concluding remarks as well as recommendations for practice and directions for future research.

CONCLUSION AND RESEARCH RECOMMENDATIONS

This part of the thesis provides an overview of the research with an overview of the most critical insights and summary developed in each Chapter.

The first Chapter of the dissertation is conceptual and brings a contribution to the literature. Prior research on entrepreneurial university suggests that there is a lack of studies that conceptualizes shareholder perspective from holistic view and the multi-dimensional structure of entrepreneurial university (Cunningham et al., 2021). This also includes providing a common definition integrating the stakeholder approach. Within this research, we have explored the entrepreneurial university as any university that has the ability to innovate, recognise and create opportunities (Kirby, 2002) and can produce and disseminate knowledge (Etzkowitz, 2003). It can also develop a comprehensive internal system for knowledge commercialisation (custom-made further-education courses, consultancy services, contract research) (Jacob et al., 2003) and commoditisation (patenting, licensing; both staff and student spin-offs and start-ups) (Chrisman et al., 1995; Jacob et al., 2003) by providing a support structure, as a "natural incubator" (Etzkowitz, 2003), through different stakeholders.

The majority of studies on entrepreneurial university collaboration with stakeholders have been fragmented exploring the effect of a single or couple of stakeholders within the university ecosystem and their effect on university development and positioning. Thus, within the first chapter, it has been provided the first generalisation of the multi-level model of the entrepreneurial university and identified various types of stakeholders involved and their roles in knowledge transfer within and outside the university. Four distinctive types of stakeholders have been identified based on the role they perform within the entrepreneurial university or knowledge enabling, knowledge codification, knowledge production and knowledge facilitation.

The first chapter contributes to the literature from the perspective of entrepreneurial university model development applying the stakeholder approach . Application of stakeholder constructs helped build an architecture of the entrepreneurial university and showed different paths for knowledge transfer out of the university boundaries including IP revenues generation and new companies' creation. Later this concept could help university managers identify the impact that multiple stakeholders have on the development of entrepreneurial universities from knowledge generation to its transfer into the ecosystem. Within this research, it has been shown which type of stakeholders are engaged within all university missions or teaching, research and entrepreneurship across different university types. In addition, this research is expanding

literature in terms of conceptualizing shareholder perspective and the multi-dimensional structure of the entrepreneurial university.

Chapter 2, which evaluated the entrepreneurial university from the organisational point of view allowed us to identify in which way universities in the UK collaborate with other actors. In particular, our results show that within UK higher education system research-oriented universities (or Russel group universities) are more aligned with the entrepreneurial university model and for this type of universities all the stakeholders are vital for achieving entrepreneurial outcomes except university students. Following one of the interviews with university managers at one of the universities from Russel Group, the role of students within such universities is to develop an entrepreneurial culture and spirit throughout the university rather than directly contribute to entrepreneurial outcomes.

From an organisational point of view, when it comes to **Russel Group Universities**, almost all stakeholders are contributing positively to IP revenues generation except university students (which have no effect) and VCs (investment into graduate start-ups turned out to be negative). When it comes to new companies' creation for this universities type, industry and students as stakeholders are not significant. However, Government, university faculty (university research capital; teaching & research capital for spin-offs; university research capital for graduate start-ups), TTOs, Science Parks and Business Incubators, as well as VCs support, have a positive effect on new ventures creation.

As for other factors, utilising university infrastructure could cause a negative effect on IP revenues generation as well as spin-offs and staff start-ups. Orientation of university onto regional strategy might cause a negative effect on graduate start-ups creation. Orientation of universities to graduates retention into the region is positive for IP revenues as well as graduate start-ups while is negative for spin-offs creation. Support for the community might have a negative effect on IP revenues. Meeting the regional skills needs is positive for spin-offs while is negative for staff start-ups. Support provided by universities to SMEs is positive for graduate start-ups. University intentions to develop research collaborations with actors around is positive for staff start-ups creation.

For **Polytechnics**, both Government and Industry positively contribute to IP income generation, while the effect of Business Incubators turns out to be negative. Teaching only as well as research only faculty might have a negative effect on IP revenues generation. When it comes to new companies' creation, Government support is positive for the graduate start-ups creation while it has a negative effect on both spin-offs and staff start-ups. As for the Industry, consultancy and trainings for the industry have a positive effect on spin-offs creation while is

negative for graduate start-ups. From the university faculty perspective, faculty holding both teaching & research positions might have a negative effect on graduate start-ups creation. Students studying on other high degrees have a positive effect on both graduate and staff start-ups. The TTO might have a negative effect on spin-offs as well as graduate start-ups. The effect of Science Parks is positive for spin-offs while is negative for graduate start-ups. Collaboration of universities with Business Incubators is positive for start-ups both staff and graduate. When it comes to VCs, the effect is different by type of investment and type of the company. Thus, investment into spin-offs is positive for spin-offs creation while is negative for graduate start-ups. Investment into graduate start-ups facilitates the creation of this type of companies while is negative for staff start-ups creation. Finally, investment into staff start-ups is positive for staff start-ups creation while is negative for graduate start-ups.

As for the effect of other factors, utilising university infrastructure as well as engaging with business have a negative effect on IP revenues generation, while it is positive for graduate start-ups creation. Incentives for business engagement have a positive effect on IP revenues generation. University support for regional strategy has a negative effect on IP revenues while is positive for staff start-ups. Widening participation access to university knowledge as well the development of local partnerships has a positive effect on IP revenues generation while is negative for graduate start-ups creation. Orientation of university towards graduates' retention into the region has a positive effect on both IP revenues and graduate start-ups while is negative for staff start-ups creation. University support for the community positively correlated with graduate and staff start-ups. Meeting the regional skills have a positive effect on graduate start-ups. Participation of universities in knowledge exchange has a positive effect on all the outcome variables.

As for the **Rest teaching universities**, all the stakeholders contribute positively to IP revenues generation, including Government, Industry (trainings and consultancy), faculty (teaching only and research only capital), students (other high degree), TTOs, Business Incubators, VCs. As for the new venture creature, Government, Business Incubators and VCs are positive. University faculty (teaching and research capital), have a negative effect on graduate start-ups creation. When it comes to university students, other high qualification students have a positive effect on both spin-offs and graduate start-ups. While business postgraduates are positive for graduate start-ups, business undergraduates have a positive effect on staff start-ups. STEM undergraduates have a negative effect on spin-offs creation for this universities type. TTOs are negative for new ventures creation. As for Science parks, while they have a positive effect on spin-offs and staff start-ups, they have a negative effect on graduate start-ups.

When it comes to rest-teaching universities, income from infrastructure as well as widening participation access and research collaboration has a positive effect on IP revenues generation. Engagement of the university with business as well as developing local partnerships have a positive effect on graduate start-ups creation. Incentives for business engagement as well as graduates' retention into the region have a negative effect on IP revenues generation. University support for regional strategy is negative for IP revenues generation while is positive for the creation of any types of new companies. Meeting regional skills needs is negative for IP revenues generation while is positive for graduate start-ups. Participation of university in knowledge exchange has a positive effect on spin-offs as well as staff start-ups. Support of universities to SMEs has a positive effect on both IP revenues as well as graduate start-ups while is negative for spin-offs creation.

This research has demonstrated that research-oriented universities would benefit more from a much broader entrepreneurial ecosystem and interaction between stakeholders extending Guerrero et. al. (2016) and Guerrero and Urbano (2019). Interestingly the Government with TTOs effects has always had positive complementarities with stakeholders while VCs are more likely to be a substitute for other networks and collaborations in particular in teaching-led universities with limited resources. Following the traditional path of commercialisation, the majority of complementarities for IP revenues generation include TTOs. Thus, we see significant positive complementarities between knowledge codifiers (TTOs) and knowledge facilitators (science parks and business incubators, venture capitalists). This might show a strong connection between the research and entrepreneurship missions of universities in the UK.

Looking at the effect of stakeholders on entrepreneurial outcomes generation, all the university types would benefit from having knowledge facilitators such us Business Incubators (teaching path for commercialisation) while collaborating with TTOs are not always positively contribute to the university entrepreneurial outcomes (research mission of universities).

From the individual point of view, academic engagement impacts the decision of academics to interact with stakeholders for knowledge and technologies commercialisation what has been shown in Chapter 3. Compared to research commercialisation per se and interaction with industry, engagement of university faculty for consultancy or start-ups (not spin-offs which is usually an outcome of the research) creation is practised more widely across disciplines and is a predictor of the decision of academics to pursue academic entrepreneurship (Guindalini et al., 2021). Our results demonstrate that while engagement of academics with stakeholders varies based on the level of interest of academics, engagement with business incubators and venture

capitalists is among the most significant interactions that might impact academics' interest to engage with others for the purpose of commercialisation. When it comes to the efficacy of university efforts to support entrepreneurship, diversity and quality of organisational networks do matter. It is argued that networks associated with business incubators (Cooper et al., 2012) and science parks (Zou and Zhao, 2014) play an important role in reaching out to a broader audience, developing new skills and getting access to a broader market to explore the commercial value of the research (Hayter et al., 2018). Enhancement of business and commercialisation skills of faculty would facilitate the interaction of academics with other actors.

In general, this research has justified that those academics who are more confident in their business skills and knowledge about commercialisation would be more inclined to collaborate with others for the purpose of knowledge and technologies transfer. Academics would expect Business Incubators to contribute to enhancing their business skills.

In addition, young career researchers tend to interact with a wider set of stakeholders compared to senior academics. Studies suggest that commercialisation behaviour can be associated with being younger as lower age academics socialised in the context when commercialisation become more legitimate (Bercovitz and Feldman, 2008). Training effect might be applied where individuals who have been trained earlier when engagement with industry was less relevant or even discouraged, can be attached to norms less compatible with interaction with business (Bercovitz and Feldman, 2008). In addition, younger academics might be driven to academic entrepreneurship for the demand of recognition and career progression (Stuart and Ding, 2006).

This research shows that universities can still be entrepreneurial utilising only one of the missions e.g., teaching or research (but not simultaneously three missions or teaching, research, and entrepreneurship). This has been proved based on the example of the UK higher education sector, where teaching universities can still have entrepreneurial outcomes via utilising teaching mission only (e.g., start-ups) while they might not possess entrepreneurial outcomes stemming from utilising research mission (e.g., IP revenues). They do so via building entrepreneurial architecture and collaborating with relevant actors (e.g., Business Incubators are vital for supporting start-up businesses).

These thoughts might be confronted with the general literature on the entrepreneurial university business model which argues that universities can be entrepreneurial only when they utilise three missions simultaneously (teaching, research, and entrepreneurship).

In addition, from the individual point of view, the decision to engage with other actors for the purpose of commercialisation and entrepreneurship firstly depends on the academic himself

and is guided by knowledge and skills he/she poses (not the availability of organisational infrastructure/architecture which is the next level). As academics have different types of motivation to pursue entrepreneurship what has been proven in the literature. Academics both in real life as well as what is seen in the literature are very often mentioned TTOs and expected their support as one of the departments who is an intermediate between academia and business. While this research has shown that academics who are more confident in their skills and knowledge about business creation and commercialisation would engage more broadly for the purpose of commercialisation and entrepreneurship. They will find their own opportunities (as any university department/external organisation university collaborate with is not able to respond to the needs of every individual academic) with the availability of time.

Based on the research outcomes within this PhD study, a number of *implications and recommendations* have been developed both for university managers and policymakers. Firstly, university management teams might gain deeper insights into how the knowledge transfer process occurs at the university along different paths (research and commercialisation) and across different types of universities. This study has deciphered at which stages different types of stakeholders engage in order to facilitate university entrepreneurial outcomes through knowledge creation and spillover. The challenge for university management teams involves working out how to best manage and balance each stakeholder's interests to maximise the entrepreneurial outputs of the university across three specific university types.

University managers should carefully consider the knowledge transfer mechanism and associated contextual dynamics, including the interrelationship between various groups of stakeholders to make the process more effective and thus facilitate entrepreneurial outcomes. In terms of enabling the process, decisions regarding resource allocation should be undertaken appropriately to continue using different knowledge transfer channels in the most effective manner. Individual universities generate different types of entrepreneurial outcomes as a result of their particular resources, capabilities and strengths. At the university level, tensions might occur in strategic decisions regarding the level and type of support required to achieve particular entrepreneurial outcomes. As different values for different entrepreneurial outcomes co-exist within the university, they shape the university's different missions.

In addition, the different types of university mean questions remain at the policy level with regard to institutional management: do universities have to choose between IP revenue generation or the creation of new ventures (both graduate and staff or emphasising one of these types). This in turn leads to the policy question of whether universities in the UK should develop a more-or-less similar mechanism to increase their entrepreneurial outputs or otherwise (e.g.,

teaching-oriented institutions might require more support from the government to develop and support Business Incubators and incubation programs).

This study contributes to a better understanding of the academic entrepreneurship phenomenon. Our findings show that young career researchers tend to interact with wider set of stakeholders comparing to senior academics. University policy on facilitating the faculty engagement with stakeholders for commercialisation should be devoted to nurturing business skills in people while opportunities can be found by faculty themselves with the availability of time.

Through analysing the UK higher education system and applying stakeholder approach we have developed conceptual framework on the role different stakeholders play for the promotion of entrepreneurial outcomes of the university. While chapters presented in this research are standalone in their research focus, they are connected around the topic of entrepreneurial university and the role stakeholders play. We investigated phenomenon from organisational and individual point of views.

This research is motivated by the fact that little is known about the holistic approach to entrepreneurial university from the prospective of stakeholders and multidimensional structure of entrepreneurial university. Three chapters have examined the topic to answer research questions in the following order:

1) Who are stakeholders of entrepreneurial university? What role do they play for knowledge and technologies transfer? (Chapter 1)

2) How do stakeholders contribute to achieving university entrepreneurial outcomes? Which factors affect the contribution of stakeholders to achieving university entrepreneurial outcomes? What type of stakeholders are important for which university type within the UK higher education system? (Chapter 2)

3) What university managers can do to facilitate the engagement of academics with diverse supportive infrastructure within the university to increase university entrepreneurial outcomes? What type of stakeholders do academics engage more? (Chapter 3)

These questions have been researched through the UK higher education system at organisational and individual levels. Studies have been based on primary and secondary data including secondary source or Higher Education Business and Community Interaction Survey (HE-BCIS) collected by the Higher Education Statistics Agency (HESA) (Chapter 2) and primary data collected via survey and interviews with academics (Chapter 3).

As concluded in the conceptual part (Chapter 1), the model of entrepreneurial university has been fragmented with describing the role of separate stakeholders within different case studies, this research undertakes first comprehensive review of the available case studies to bring

together all the stakeholders into one concept. This research provides first generalisation of the multi-level model of entrepreneurial university and shows their role within the static process of knowledge creation and generalisation.

Findings from the phenomenon analysed have brough the following developments that can be accepted as recommendations to practice and policy:

- Stakeholders around entrepreneurial university constitute four main groups according to their role within the knowledge and technologies transfer, including those enabling knowledge facilitation, producing knowledge, codifying knowledge, facilitating knowledge spillover out of university boundaries.
- University managers should carefully consider the knowledge transfer mechanism and associated contextual dynamics, including the interrelationship between various groups of stakeholders to make the process more effective and thus facilitate entrepreneurial outcomes.
- In terms of enabling the process, decisions regarding resources allocation should be undertaken appropriately to continue using different knowledge transfer channels in the most effective manner.
- Individual universities generate different types of entrepreneurial outcomes as a result of their particular resources, capabilities and strengths. At the university level, tensions might occur in strategic decisions regarding the level and type of support required to achieve particular entrepreneurial outcomes (e.g., via utilising research or teaching missions).
- The different types of university mean questions still remain at the policy level with regard to institutional management: do universities have to choose between IP revenue generation or the creation of new ventures (both graduate and staff or emphasising one of these types). This in turn leads to the policy question of whether universities in the UK should develop a more-or-less similar mechanism to increase their entrepreneurial outputs or otherwise.
- Relying on our results government could build diversified policies taking into account the effect of stakeholders based on university types.
- Our findings also suggest that young career researchers tend to interact with a wider set of stakeholders compared to senior academics.
- University policy on increasing the faculty engagement with stakeholders for commercialisation should be devoted to nurturing commercialisation and business skills in people while opportunities can be found by faculty themselves with the availability of time.

When it comes to the *contribution*, firstly, this research has theoretically expanded the concept of the entrepreneurial university. It has achieved this by providing in-depth insights into the organisational structure of the entrepreneurial university and its connections with different stakeholders (Foss and Gibson, 2015; Miller et al., 2014). Although the literature on these universities has identified a number of their various features, there has been little theorization and empirical investigation into the actual model of university collaboration with relevant stakeholders in the context of the UK entrepreneurial university ecosystem.

Secondly, we made a significant contribution to utilising the stakeholder perspective to represent the entrepreneurial university, as applied to the technology transfer domain and education by matching four groups of entrepreneurial university stakeholders with three specific types of entrepreneurial university. This represents a first step in the relevant literature towards analysing the organisational structure of the entrepreneurial university and its contribution to the entrepreneurial outcomes of the university. Such an approach contributes to the existing literature on entrepreneurial university architecture, which has largely been atomistic in focussing on specific stakeholders (Audretsch, 2014).

Thirdly, this research unfolds the complexity of the entrepreneurial university and entrepreneurial university ecosystems of different types. This is beneficial in terms of improving our understanding of the interdependent processes and mechanisms of knowledge transfer among different university missions and stakeholders and their roles in facilitating university entrepreneurial outcomes and knowledge transfers (Foss and Gibson, 2015) between different university types.

A number of existing studies (see Table A1 Appendix A) are devoted to one specific dimension of knowledge commercialisation, be it patenting, licensing, contract research and consultancy, or new ventures creation such as spin-offs or start-ups. Unlike prior research, our study assesses all stakeholders within one model considering both organisational and individual points of view. We, therefore, moved towards a more comprehensive understanding of how different stakeholders utilise different channels to transfer knowledge and technology. Moreover, maintaining this scope is important as the effect of a specific stakeholder or type of commercialisation activity on university performance likely depends on the performance metrics used in the analysis (Backes-Gellner et al., 2011).

In addition, this study contributes to a better understanding of the academic entrepreneurship phenomenon within the entrepreneurial university from the perspective of support universities provide for individuals. For further steps, research should consider exploring richer career

histories of academics to uncover how career experience within different levels shapes the nature of academics' efforts to engage with others. When it comes to policy implications, it might be considered that while the literature presents engagement as a positive phenomenon for both academics and external stakeholders, it is not very clear that all the members of the academic community can be equally placed to be effective in this role of engagement.

Besides contributions that have been developed, this research has a number of *limitations and form directions for future research*.

In terms of the data, the HE-BCI is a survey that collects institutional-level data and does not allow for control of the disciplinary profile of the university. A better analysis is thus needed to understand and compare such differences between universities as academic entrepreneurship varies between disciplines. In addition, reports show that some of the universities that participated in the survey did not provide data (Rae, 2010), which might cause the results to be inaccurate. However, HE-BCIS is the most comprehensive dataset at the university level available to researchers.

As for the conceptualisation, we were not able to engage all types of knowledge transfer channels into the modelling to measure the actual contributions of stakeholders to the final outcomes. The nature of the institutional data does not provide detailed information with respect to training (mentorship, coaching, etc.), networking activities (conferences, workshops, etc.), as well as the impact of government from a legislative perspective. It also does not allow the measurement of the full contribution of TTOs with respect to technology evaluation and partner searching. In addition, not all the stakeholder contributions (e.g., university managers, banks, acceleration, alumni) were evaluated due to the absence of associated data. Additional research with broader access to data is thus needed to evaluate the heterogeneous nature of the stakeholders in the process.

However, the conceptualisation and results presented in Chapter 2 are not only reliable for universities in the UK, but the methodology applied could further be duplicated in other countries as well (e.g., the USA, Germany, Switzerland, China and Spain, among others). It would be worthwhile collecting similar data from universities in these countries and applying it within a more complex analytical framework (specific to each country) at some point in the future.

We recognise that there might be different ways to conceptualise the process of knowledge commercialization at university, presenting generating questions for future research. In such a sense, future research might focus on solving data availability issues (i.e., access to data to

evaluate all stakeholder contributions, integrating contextual variables per university, etc.) and building additional proxies (other measures of entrepreneurship) which could be used to measure stakeholder contributions more precisely. Another extension might be the analysis of resources and capabilities, as well as the managerial activities each stakeholder provides by adopting a resource-based view.

In addition, the discussion on entrepreneurial universities should be done more broadly incorporating ideas of Quadruple helix and the society as one of the main stakeholders for the university to focus on. This also could be touched upon ideas of corporate social responsibilities.

When it comes to the individual level of analysis, the majority of studies that have traced the engagement of academics with stakeholders for knowledge and technologies exchange usually asks academics for self-reported information via questionnaires. In the case of our questionnaire questions have been structured around the support academics got from relevant departments within different stages of knowledge and technologies transfer. It is obvious that self-reported information from questionnaires have specific challenges of personal evaluation that future research should address in order to improve the quality, reliability and validity of research results (Perkmann et al., 2021).

Much research on academic engagement applies panel data on patents and publications taking time dimension into account (Stuart and Ding, 2006), yet have to be accomplished by research applying survey data. There are studies that acknowledge longitudinal dimension, but they have a qualitative contribution (Etzkowitz, 1998; Jain et al., 2009; Kenney and Goe, 2004; Shinn and Lamy, 2006). When it comes to academics' collaboration with relevant stakeholders to pursue academic engagement, this research is the first in its origin on gathering information around it. Future research should conduct surveys repeatedly or administer surveys containing identical questions across a comparable population of academics in different countries.

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Appendix A

Table A1. Cases studied: Entrepreneurial university and collaboration with stakeholders.

Author(-s), Publication year	Unit of Analysis	Theoretical framework	Data	Methodology	Findings	Stakeholders covered	Research focus
Keast, 1995	University of Alberta, Canada	Entrepreneurship	Interviews with the vice president and director of research	Description of differences between university and business	Entrepreneurship and associated activities or initiatives is becoming increasingly important to administrators	Academic entrepreneurs, government, industry, Patenting office, TTO	Entrepreneurship and administrators
Kirby, 2006	University of Surrey	The theories of entrepreneurship and intrapreneurship development		Case study	Theory proposes the formulation of a high-level strategy that demonstrates the university's intent, makes it clear that the university encourages this form of behaviour, provides the university's staff with the knowledge and support to start their own businesses and creates an environment that reduces the risk involved	Incubation, technopark, education programmes, HEIF, research centre (pre-incubator), venture capital fund	University strategy, supportive environment
Kalar B., Antoncic B., 2015	University of Amsterdam, University of Antwerp, University of Ljubljana and the University of Oxford		1300 survey from academics in different disciplines	Descriptive analysis, cross-tabulation	Academics perceiving their university department as being highly entrepreneurially oriented are less likely to believe that engagement in technology and knowledge transfer can be harmful to academic science.	Department entrepreneurial orientation and individual engagement	Academics and departmental orientation
Banal-Estanol, A., Jofre-Bonet, M., Lawson, C., 2015	40 UK universities 24 – Russell group 16 - other (engineering departments)	Individual characteristics, publications, patents, research funds	Publications in SSCI	Generalised least squares method with fixed effects estimators	The formation of links with the private sector may boost research output (provide new ideas and additional funding), but high degrees of collaboration can also damage research output (low value of research ideas, time consuming).	Patenting office, government, Academic entrepreneurs	University-industry research collaboration
Miller, K., McAdam, M., McAdam, R., 2014	1 UK university	Stakeholder theory	Multi-level semi-structured Interviews with stakeholders' representatives	Case study, observation analysis, coding of interviews (Nvivo 10)	Conflicting objectives between each of the stakeholder groups have led to the university business model evolving not as a process of co-creation but rather in a series of transitions whereby multiple stakeholders are continually shaping the university business model through strategies that are dependent upon their salience.	Academic entrepreneurs, TTO, Patenting office, government	The changing university business model–stakeholder relationship
Bramwell, A., Wolfe, D.A., 2008	University of Waterloo		96 in-depth interviews with firms, associations, and knowledge institutions	Case study	Beyond generating commercialisable knowledge and qualified research scientists, universities produce other mechanisms of knowledge transfer, such as generating and attracting talent to the local economy and collaborating with local industry by providing formal and informal technical support.	Government, Patenting office, Academic entrepreneurs, TTO, Industry	Mechanisms of knowledge transfer
Guerrero, M., Cunningham J.A., Urbano, D., 2015	147 public Universities in the UK in 74 NUTS-3 regions (2005-2007)	The endogenous growth theory	Secondary data, HEBCIS (university-business - community interaction survey)	Structural equation modelling, exploratory (EFA) and confirmatory factor analysis (CFA).	The economic impact of control group (UK universities that are not part of the Russell Group) is evident on research, teaching, and entrepreneurial activities, with the highest impact associated with research and knowledge transfer.	Government, Patenting office, Academic entrepreneurs, TTO, Industry	The impact of universities on economic development
Guerrero and Urbano, 2014	Public entrepreneurial universities in Spain	The knowledge spillover theory of entrepreneurship	207 Online questionnaires with academics enrolled	Structural equation modelling. The confirmatory factor analysis.	Partially find support for their hypotheses that academics motivational factors, subjective norms and entrepreneurial	Entrepreneurial intentions and economic growth	Knowledge spillover process by level of analysis

	(academic period 2008-2009)	The planned behaviour theory	in business economics and engineering areas		university policies have a knowledge filter effect on academics' start-up intentions		
Hu, 2009	Feng Chia University, Taiwan		149 answers from 435 questionnaires	SEM (Structural Equation Modelling)	Industry-university links are strengthened by private and public research funding, while there was no evidence that establishing technology licensing and business incubation may reinforce those links.	Academic entrepreneurs, TTO, Patenting office, incubators, industry and government	Stakeholders and university-industry collaboration
Goddard et al., 2012	North-East of England: Newcastle University (1998-2008)		In-depth interviews with key decision makers (government) and academics	Description of interviews	The relationships between regional firms and technology and innovation centres in the North-East of England to be limited due to poor matching between a strong academic research base and limited absorptive capacity.	Academic entrepreneurs, government and industry	The relationships between regional firms and technology centres
Meyer M., 2006	A small set of European countries (United Kingdom, Germany, Belgium)		Publications (SCI) and patents (US patents)	Description, categorisation	The minority of inventor-authors, that is researchers with high numbers of patents, also tends to publish and be cited over-proportionally	Patenting office and academic entrepreneurs	The relationship between scientific publication and patenting activity.
Sterzi, 2013	UK universities		1376 patent applications at the European Patent Office (EPO) and invented by academic scientists in the UK	A cross-sectional analysis	We find a quality premium for academic patents owned by business companies (corporate patents) in the short and medium term (till 6 years after the patent priority year) with respect to academic patents owned by universities (university patents).	Industry, human capital, IPO	The quality of patents (academia and business)
Culkin, N. and Mallick, S., 2011	University of Hertfordshire		Analysis of university strategy and policy	Case study	Delivering employment-ready graduates ignores the demands of a radically altered world of work in the face of the government's response to the latest economic crisis.	Students and industry	University graduates and changed demands
Guerrero M., Urbano D., 2010	13 Spanish universities	Institutional theory	Spanish Entrepreneurial University Scoreboard (SEUS) (secondary information from 50 universities); e-mail questionnaires with academics	SEM (Structural Equation Modelling)	Each university community is unique and its attitudes towards entrepreneurship are defined by a combination of factors, such as entrepreneurship education, teaching methodologies, role models and reward systems.	Incubators, Science Parks; human capital, government, TTO, Patenting office	Entrepreneurship education, teaching methodologies, role models and reward systems as factors that explain the attitude towards entrepreneurship at university
Bischoff K., Christine K. Volkmann Ch. K., Audretsch D. B., 2017	20 different HEIs from 19 European countries	Stakeholder theory	Interviews and validation through peer groups	An exploratory cross-case analysis of all 20 case studies was conducted on the basis of a context analysis	The findings of this study indicate that none of the examined 20 HEIs possesses an explicit, verbalized strategy for the management of its external stakeholder relations in the context of entrepreneurship education.	Different levels at different universities	University strategy for collaboration with stakeholders
Hewitt-Dundas, 2012	158 universities across the UK	Stakeholder theory	Secondary data, HEBCIS (university-business - community interaction survey)	K-means cluster analysis	Universities' approach to knowledge transfer is shaped by institutional and organisational resources, in particular their ethos and research quality, rather than the capability to undertake knowledge transfer through a Technology Transfer Office.	All stakeholders included into our study	Institutional and organisational resources to support knowledge transfer
Etzkowitz H., Germain-Alamartine E., Keel J., Kumar C., Smith K.N., Albats E., 2019	Stanford University	Triple-Helix concept	Participant observation in the Office of Technology Licensing, archival research and interviews of university-industry relations	Case study	As innovation is institutionalized in novel organizational structures, as well as linked to teaching and research, the entrepreneurial university becomes a key element in the Triple Helix of university-industry-government interaction. Stanford developed university- industry and then university-government relationships as part of an increasingly explicit university-region	TTO, acceleration, incubation, coaching organisation, investors, industry, public and private funds, government and industry	University-government-industry relations and supportive stakeholders

					co-development strategy. These double helices converged into a university-industry-government coalition, Joint Venture Silicon Valley, a public brainstoming initiative "...following a venture capital winnowing approach" that generated networking start-ups in response to the 1990's recession.		
Luciana Lazzeretti & Ernesto Tavoletti, 2005	University of Twente	Entrepreneurial university (Clark)	15 Interviews	Case study	Local economic relevance and international excellence are not incompatible objectives: they were not at the University of Twente; they can be reached even in a new-born and poor endowed university, located in a peripheral, depressed and not industrialized countryside.	Incubator, Research centres (people), accelerators, Business and Science park, Government and industry	Local economic relevance and international excellence
Wong PK., Ho Y-P., Singh A., 2007	University of Singapore	Entrepreneurial university	Documents analysis	Case study	University of Singapore was shifting from being primarily a manpower provider and knowledge creator to take on a more visible role in knowledge commercialization through increased patenting, licensing to private industry and spinning-off new ventures.	Venture Support unit, Incubator, patenting office, TTO, government	University changing role in knowledge creation process.
Fuster E. et. al., 2019	10 public universities in Spain	The knowledge spillover theory of entrepreneurship, Social network approach	Interviews	Social network analysis, in-depth analysis	The entrepreneurial universities influence the development of regional entrepreneurial university ecosystems through the promotion of USOs, as one of the knowledge transfer mechanisms. However, entrepreneurial universities should develop a more proactive role, through intermediaries like TTOs and UVCs, collaborating with USOs.	Science parks, BI, VC, Industry and government, Patenting office, TTO	University spin-offs as knowledge transfer mechanism in the ecosystem.
Bae et al., 2018	Korea Advanced Institute of Technologies	Human capital theory and entrepreneurial self-efficacy	Publications	A comprehensive review of the literature, Meta-Analysis	There is a significant correlation between entrepreneurship education and entrepreneurial intentions. This correlation is also greater than that of business education and entrepreneurial intentions. However, after controlling for pre-education entrepreneurial intentions, the relationship between entrepreneurship education and post-education entrepreneurial intentions was not significant.	Scientists, students, TTO, Incubator, research centres/Institute for start-ups	Entrepreneurship Education and Entrepreneurial Intentions
Miller and Acs, 2017	University of Chicago	Turner's theory	Interviews, observation, document analysis, internet search/analysis	Case study	The open, innovative American frontier that closed at the end of the twentieth century has reemerged in the entrepreneurial economy on the U.S. campus	Alumnies, venture capitalists, faculty, students, angel investors, government, business incubator	Entrepreneurial university as an ecosystem.
Chrisman, et al., 1995	Alberta, Canada	Entrepreneurship	Personnel interviews	Case study, in-depth analysis	Identification of administrative role, the impact of funds reduction and different types of entrepreneurial activities.	TTO, HC, government, industry, Patenting office	Administrators and their role in entrepreneurship
Bernasconi, 2005	Universidad Catholic de Chile 44481610	Entrepreneurial Universities (the concept of Clark, 1998)	Secondary sources	Case study	The results suggest the orientation to market as a means of survival and growth under the pressure of privatization, than a result of a Triple Helix strategy of university.	Government, HC, industry	Entrepreneurship strategy of the university
De Zilwa, 2005	Australian Universities	University categories and contrast levels of independence	Secondary data from annual financial reports by Australian Higher Education	Descriptive analysis of the secondary data	Universities have used isomorphism tactics transforming themselves from being rigid bureaucracies to become more flexible network enterprises.	Industry, Patenting office, government, HC, investment, TTO	University strategy on entrepreneurship

Jacob, *et al*., 2003	Technologic of Chalmers in Sweden	Entrepreneurial Universities (Clark, 1998).	Interviews with the principal actors in the internal transformation process	Case study	One important element required for innovation is macro (vision and implementation) and micro (university organization) level flexibility and diversity.	IPO, VC, Academic entrepreneurs, Incubators, seed finance	The factors for universities to become entrepreneurial
Zhao, 2004	Australian Universities	Academic Entrepreneurship	Extensive interviews with academic entrepreneurs and commercialization managers, survey	A comprehensive review of the literature on research commercialization; in-depth analysis	Identified and discussed the key issues in the study and proposed a series of recommendations to enhance the overall performance of university research commercialization.	Academic entrepreneurs and commercialization managers	Issues related to research commercialisation
Schmoch, 1999	Germany and USA	Knowledge transfers	Description about the interaction	Comprehensive literature review	Identification of similes and differences related with the formalization	Patenting office, industry, government	University-industry relations formalisation
Klofsten M. and Jones-Evans D., 2000	Ireland and Sweden Universities	Academic Entrepreneurship	10 case studies 1857 structured questionnaire to all academics	Case study	Impact of previous entrepreneurial experiences among academics in both countries and their practical application in activities as consultancy and contract research	Industry, government, Patenting office, TTO, Academic entrepreneurs	Practical experience of academics
Ryu, 1998	Yonsei University of Korea	Entrepreneurial Scholarship	Semi-structured interviews with male full professors	Case study, in-depth analysis	Identification of strategic planning and the development of the academic services.	Government, Academic entrepreneurs, industry, science/technology park	Role of strategy in entrepreneurship

Table A2. The general information of the sample (entrepreneurial outcomes and entrepreneurial infrastructure)

Institution	Polytechnic University	Russel Group University	Rest Teaching-oriented university	Consultancy and CPD	Contract research	IP revenues	Staff start-ups	Graduate start-ups	University spin-offs	University Business incubator	External Business incubator	Venture capitalists support	University Science park	External Science park	TTO exist at university	TTO and other organisations	University Business incubator	External Business incubator
Anglia Ruskin University	1	0	0	+	+	-	-	-	-	-	-	-	-	-	+	-	-	-
Bournemouth University	1	0	0	+	+	+	-	+	-	+	+	+	-	-	+	-	+	-
The University of Brighton	1	0	0	+	+	+	+	+	-	-	+	+	-	-	+	-	-	-
Birmingham City University	1	0	0	+	+	+	-	+	+	-	-	-	-	-	-	+	-	-
The University of Central Lancashire	1	0	0	+	+	+	-	+	-	+	+	+	-	-	-	+	+	-
Coventry University	1	0	0	+	+	+	+	+	+	+	+	+	+	-	+	-	+	-
The University of East London	1	0	0	+	+	-	-	+	-	+	+	+	-	-	-	-	+	-
The University of Greenwich	1	0	0	+	+	+	-	-	-	+	+	+	-	-	+	-	+	-
The University of Lincoln	1	0	0	+	+	+	-	+	-	+	+	+	-	+	+	-	+	-
Kingston University	1	0	0	+	+	+	-	+	-	+	+	-	-	-	-	+	+	-
Leeds Beckett University	1	0	0	+	+	+	-	+	+	+	-	+	-	-	-	+	+	-
Liverpool John Moores University	1	0	0	+	+	+	-	+	-	-	+	+	+	-	-	+	-	-
The Manchester Metropolitan University	1	0	0	+	+	+	-	+	+	+	+	+	-	+	-	-	+	-
Middlesex University	1	0	0	+	+	+	-	-	+	-	-	+	-	-	-	+	-	-
De Montfort University	1	0	0	+	+	+	-	+	+	+	+	+	-	-	-	+	+	-
University of Northumbria at Newcastle	1	0	0	+	+	+	-	+	-	-	+	+	-	-	-	-	-	-
The Nottingham Trent University	1	0	0	+	+	+	-	+	+	+	+	+	-	+	+	-	+	-
Oxford Brookes University	1	0	0	+	+	+	-	-	+	-	+	+	-	+	+	-	-	-
University of Plymouth	1	0	0	+	+	+	+	+	+	+	+	+	+	-	-	+	+	-
The University of Portsmouth	1	0	0	+	+	+	+	+	+	+	+	+	-	+	+	-	+	-
Sheffield Hallam University	1	0	0	+	+	+	-	+	-	-	+	-	-	-	+	-	-	-
London South Bank University	1	0	0	+	+	+	+	+	-	+	+	+	-	+	+	-	+	-
Staffordshire University	1	0	0	+	+	+	+	+	-	+	+	-	-	-	-	+	+	-
The University of Sunderland	1	0	0	+	+	+	-	+	-	+	+	+	+	-	-	+	+	-
Teesside University	1	0	0	+	+	+	+	+	+	+	+	+	-	-	-	+	+	-
The University of West London	1	0	0	+	+	-	-	-	-	-	+	-	-	-	+	+	-	-
University of the West of England, Bristol	1	0	0	+	+	+	+	+	+	+	+	-	-	+	+	-	+	-
The University of Westminster	1	0	0	+	+	+	-	-	-	-	-	-	-	-	+	-	-	-
The University of Wolverhampton	1	0	0	+	+	+	+	+	+	+	+	+	+	-	-	+	+	-
London Metropolitan University	1	0	0	+	+	+	-	+	-	+	+	-	-	-	-	-	+	-
The University of Birmingham	0	1	0	+	+	+	-	+	+	+	-	+	+	-	+	-	-	-
The University of Bristol	0	1	0	+	+	+	+	+	-	+	+	+	-	+	+	-	+	-
The University of Cambridge	0	1	0	+	+	+	+	+	+	+	+	+	-	+	+	-	+	-
University of Durham	0	1	0	+	+	+	+	+	+	-	+	-	-	+	+	-	-	-
The University of Exeter	0	1	0	+	+	+	-	+	+	+	-	+	-	-	-	+	+	-
The University of Leeds	0	1	0	+	+	+	-	+	+	+	-	+	-	-	+	-	-	+
The University of Liverpool	0	1	0	+	+	+	-	+	+	+	+	+	-	+	-	+	+	-
Imperial College of Science, Technology and Medicine	0	1	0	+	+	+	-	+	+	+	+	+	+	-	-	-	+	-
King's College London	0	1	0	+	+	+	-	+	+	+	-	+	-	-	+	-	+	-
London School of Economics and Political Science	0	1	0	+	+	+	-	-	-	-	-	-	-	-	+	-	-	-
Queen Mary University of London	0	1	0	+	+	+	-	-	+	+	+	+	-	-	+	-	+	-
University College London	0	1	0	+	+	+	-	-	+	+	+	+	-	-	+	-	+	-
Newcastle University	0	1	0	+	+	+	-	+	+	+	+	+	-	+	+	-	+	-
University of Nottingham	0	1	0	+	+	+	-	+	+	+	+	+	-	-	+	-	+	-
The University of Oxford	0	1	0	+	+	+	-	+	+	+	+	+	+	-	+	-	+	-
The University of Sheffield	0	1	0	+	+	+	-	+	+	+	+	+	+	-	-	+	+	-
The University of Southampton	0	1	0	+	+	+	+	+	-	+	+	+	+	-	+	-	+	-
The University of Warwick	0	1	0	+	+	+	-	-	+	+	+	+	+	-	+	-	+	-
The University of York	0	1	0	+	+	+	-	-	+	+	-	+	+	-	-	+	+	-

The University of Edinburgh	0	1	0	+	+	+	+	+	+	+	-	+	+	-	+	-	+	-
The University of Glasgow	0	1	0	+	+	+	-	+	+	+	+	+	-	+	+	-	+	-
Cardiff University	0	1	0	+	+	+	-	+	+	+	+	+	-	-	+	-	-	+
The Queen's University of Belfast	0	1	0	+	+	+	-	-	+	+	+	+	+	-	+	-	+	-
The University of Manchester	0	1	0	+	+	+	+	+	+	+	+	+	-	+	+	-	+	-
The Open University	0	0	1	+	+	+	-	+	-	+	+	-	-	-	-	+	+	+
Cranfield University	0	0	1	+	+	+	-	-	+	+	+	+	+	+	-	+	+	-
Royal College of Art	0	0	1	+	+	+	-	+	+	+	+	-	-	-	+	-	+	-
Buckinghamshire New University	0	0	1	+	+	-	+	+	-	+	-	+	-	-	-	-	+	-
University of Chester	0	0	1	+	+	+	-	+	-	+	+	-	+	-	-	-	-	-
York St John University	0	0	1	+	+	-	-	+	-	+	+	+	-	+	-	-	+	-
University of St Mark and St John	0	0	1	+	+	-	-	+	-	-	+	-	-	+	-	-	-	-
Falmouth University	0	0	1	+	+	-	+	+	-	+	+	-	-	-	+	-	+	-
The University of Winchester	0	0	1	+	+	-	+	+	-	+	+	-	-	-	+	-	+	-
Liverpool Hope University	0	0	1	+	+	-	+	+	-	+	-	-	-	-	-	+	-	-
University of the Arts, London	0	0	1	+	+	+	+	+	-	+	+	+	-	-	+	-	+	-
University of Bedfordshire	0	0	1	+	+	-	-	+	-	+	+	+	-	+	+	-	+	-
The University of Northampton	0	0	1	+	+	+	+	+	-	+	+	+	-	-	-	+	+	-
Ravensbourne	0	0	1	+	-	-	-	+	-	+	+	-	-	-	-	-	+	-
Rose Bruford College	0	0	1	+	-	-	-	+	-	+	-	-	-	-	-	-	+	-
Royal Academy of Music	0	0	1	+	-	+	-	-	-	-	-	-	-	-	-	+	-	-
Royal College of Music	0	0	1	+	-	-	-	+	-	-	-	-	-	-	+	-	-	-
Southampton Solent University	0	0	1	+	+	+	-	+	-	-	-	+	-	-	-	+	-	-
University of Cumbria	0	0	1	+	+	+	-	+	-	+	-	-	-	-	-	-	-	-
Trinity Laban Conservatoire of Music and Dance	0	0	1	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
University of Worcester	0	0	1	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-
Bath Spa University	0	0	1	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-
The University of Bolton	0	0	1	+	+	+	-	-	-	-	+	-	-	-	-	+	-	-
University of Gloucestershire	0	0	1	+	+	-	+	+	-	+	+	+	-	-	-	-	+	-
University of Derby	0	0	1	+	+	+	-	+	-	+	+	+	-	-	-	+	+	-
University of Hertfordshire	0	0	1	+	+	+	+	+	+	+	+	+	+	-	+	-	+	-
The University of Huddersfield	0	0	1	+	+	+	-	+	-	+	-	+	-	-	-	+	+	-
The University of Chichester	0	0	1	+	+	-	-	-	-	+	+	+	-	-	-	-	+	-
The University of Wales, Newport	0	0	1	+	+	+	-	+	-	-	+	+	-	-	-	+	-	-
Glyndŵr University	0	0	1	+	+	-	-	+	-	+	+	-	-	-	-	-	+	-
Cardiff Metropolitan University	0	0	1	+	+	-	+	+	+	+	+	-	-	-	-	-	+	-
University of South Wales	0	0	1	+	+	+	-	+	+	-	+	+	-	-	+	-	-	-
Swansea Metropolitan University	0	0	1	+	-	-	-	+	-	+	+	+	-	+	-	-	+	-
Trinity University College	0	0	1	+	-	-	-	-	-	+	+	-	-	+	-	-	+	-
University of Abertay Dundee	0	0	1	+	+	+	-	-	-	+	+	-	-	-	+	-	+	-
Glasgow School of Art	0	0	1	+	+	-	-	-	-	-	-	-	-	-	-	+	-	-
Queen Margaret University, Edinburgh	0	0	1	+	+	+	-	-	-	+	-	+	-	-	-	+	+	-
The Robert Gordon University	0	0	1	+	+	+	-	-	+	-	-	+	-	-	+	-	-	-
The University of the West of Scotland	0	0	1	+	+	-	-	-	+	+	+	-	-	+	+	-	+	-
Glasgow Caledonian University	0	0	1	+	+	-	-	+	+	+	+	+	-	+	+	-	+	-
Edinburgh Napier University	0	0	1	+	+	+	-	+	+	+	+	-	-	-	+	-	+	-
Aston University	0	0	1	+	+	+	-	+	+	+	+	+	-	+	-	+	+	-
The University of Bath	0	0	1	+	+	+	-	+	-	-	+	+	-	+	+	-	-	-
The University of Bradford	0	0	1	+	+	+	-	+	+	+	-	+	-	+	-	+	+	-
Brunel University London	0	0	1	+	+	+	-	-	+	-	+	+	+	-	-	+	-	-
The City University	0	0	1	+	+	+	-	+	+	+	+	+	-	-	-	-	+	-
The University of East Anglia	0	0	1	+	+	+	+	+	-	+	+	+	-	+	+	-	+	-
The University of Essex	0	0	1	+	+	+	-	-	+	+	-	+	-	-	+	-	+	-
The University of Hull	0	0	1	+	+	+	-	+	-	+	+	+	+	-	+	-	+	-
The University of Keele	0	0	1	+	+	+	+	+	-	+	+	+	+	-	-	+	+	-
The University of Kent	0	0	1	+	+	+	+	+	-	+	-	+	+	-	+	-	+	-
The University of Lancaster	0	0	1	+	+	+	-	+	+	+	+	+	-	+	+	-	+	-
The University of Leicester	0	0	1	+	+	+	-	+	+	+	+	+	-	+	-	+	+	-
Birkbeck College	0	0	1	+	+	+	-	-	+	+	-	-	-	-	-	-	-	-
Goldsmiths College	0	0	1	+	+	-	-	-	+	+	-	+	-	-	-	+	-	-

Institute of Education	0	0	1	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
London Business School	0	0	1	+	+	+	-	+	-	+	-	+	-	-	-	-	+	-
London School of Hygiene and Tropical Medicine	0	0	1	+	+	+	-	-	-	-	-	-	-	-	+	-	-	-
Royal Holloway and Bedford New College	0	0	1	+	+	+	-	+	-	+	+	+	-	-	+	-	+	-
The Royal Veterinary College	0	0	1	+	+	+	-	-	+	+	+	-	-	-	+	-	+	-
St George's Hospital Medical School	0	0	1	+	+	+	-	-	+	-	-	-	-	-	+	-	-	-
The School of Pharmacy	0	0	1	+	+	+	-	-	+	+	+	+	-	-	+	-	+	-
University of London	0	0	1	+	-	+	-	-	-	-	+	-	-	-	-	-	-	-
Loughborough University	0	0	1	+	+	+	-	+	-	+	+	+	-	-	+	-	+	-
The University of Reading	0	0	1	+	+	+	-	-	+	+	+	+	+	-	+	-	+	-
The University of Salford	0	0	1	+	+	+	-	+	+	+	+	-	-	+	+	-	+	-
The University of Surrey	0	0	1	+	+	+	-	+	+	+	+	+	+	-	+	-	+	-
The University of Sussex	0	0	1	+	+	+	-	+	+	+	-	+	+	-	+	-	+	-
The University of Strathclyde	0	0	1	+	+	+	+	+	+	+	+	+	-	+	+	-	+	-
The University of Aberdeen	0	0	1	+	+	+	-	+	+	+	-	+	-	+	+	-	+	-
Heriot-Watt University	0	0	1	+	+	+	+	+	+	-	+	+	+	-	+	-	-	-
The University of Dundee	0	0	1	+	+	+	-	+	-	+	+	+	-	-	-	+	+	-
The University of St Andrews	0	0	1	+	+	+	-	-	+	+	+	-	-	-	+	-	-	+
The University of Stirling	0	0	1	+	+	-	-	+	-	+	+	-	-	+	+	-	+	-
University of Wales Trinity Saint David	0	0	1	+	+	-	-	+	-	+	+	+	-	-	-	-	+	-
Aberystwyth University	0	0	1	+	+	+	-	+	-	+	+	+	-	-	+	-	-	+
Bangor University	0	0	1	+	+	+	-	+	+	+	+	+	-	-	+	-	+	-
Swansea University	0	0	1	+	+	+	+	+	+	+	+	+	+	-	+	-	+	-
University of Ulster	0	0	1	+	+	+	-	-	-	-	+	+	-	+	-	+	-	-
The Institute of Cancer Research	0	0	1	+	+	+	-	-	-	-	+	+	-	-	+	-	-	-
Norwich University of the Arts	0	0	1	+	+	-	-	+	-	-	+	-	-	-	-	+	-	-
Royal Agricultural University	0	0	1	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-
University of the Highlands and Islands	0	0	1	+	+	-	-	-	-	+	+	+	-	+	-	+	+	-
The University of Buckingham	0	0	1	+	+	-	-	-	-	+	-	-	-	-	-	-	+	-
University for the Creative Arts	0	0	1	+	-	-	-	+	-	-	+	+	-	-	-	+	-	-

Source: Higher Education Business and Community Interaction Survey

Table A3. Sources and definition of all variables used in this study

Name	Description	Source
	Dependent variable	
IP revenues	The gross income to the HEP, including the sale of shares in spin-offs, before disbursements to investors and other interested parties. As such this total differs from that recorded in the HESA Finance Statistics Return	HE-BCIS
University spin-offs	The number of new spin -off companies for the reporting period	HE-BCIS
Staff start-ups	The number of new staff start-up companies for the reporting period	HE-BCIS
Graduate start-ups	The number of new graduate start-up companies for the reporting period	HE-BCIS
	Independent variables	
	Knowledge enablers	
CPD courses	This includes revenue generated by Continuing Professional Development (CPD) courses, defined as a range of short and long training programmes for learners already in work who are undertaking the course for purposes of professional development, upskilling or workforce development	HE-BCIS
Bespoke courses	Does university provide bespoke courses at business premises or not	HE-BCIS
Contract research	This includes contract numbers and income identifiable by the HE provider as meeting the specific research needs of external partners, excluding any already returned in collaborative research involving public funding and excluding basic research council grants.	HE-BCIS
Consultancy	This includes contract numbers and income associated with consultancy, that is advice and work crucially dependent on a high degree of intellectual input from the HE provider to the client (commercial or non-commercial) without the creation of new knowledge. May be carried out either by academic staff or by members of staff who are not on academic contracts.	HE-BCIS
UK funding	includes income from other UK government departments and includes income from Knowledge Transfer Partnerships	HE-BCIS
Other funding	includes charities, public and not-for-profit organisations as well as commercial businesses.	HE-BCIS
	Knowledge providers	
Employment rate	An employment rate at the university per 1000 students	HESA
Doctoral students	Number of doctoral students	HESA
Other higher degree	Number of students with other higher degree	HESA
Teaching capital	Number of faculty representing teaching capital	HESA
Research capital	Number of faculty representing research capital	HESA
Teaching and research capital	Number of faculty representing teaching and research capital	HESA
STEM UG	Share of stem undergraduates	HESA
STEM PG	Share of stem postgraduates	HESA
Biology PG	Share of biology physics and medicine postgraduates	HESA
Biology UG	Share of biology physics and medicine undergraduates	HESA
Business PG	Share of business & administrative studies postgraduates	HESA
Business UG	Share of business & administrative studies undergraduates	HESA
Other degree	Number of students studying on other higher degree	HESA
	Knowledge codifiers	
Patents granted	Includes all individual patents and any individual national patents	HE-BCIS
TTO exists at university	There is a technology transfer office at the university to support knowledge transfer	HE-BCIS
TTO and other organisations	university works with technology transfer office and other organisations to support knowledge transfer	HE-BCIS
	Knowledge facilitators	
External Science park	Science park support do not exist at the university, but university work with it as partnership	HE-BCIS
University Science park	Science park support exists at the university	HE-BCIS
University Business incubator	University provide business incubation support at the university	HE-BCIS
External Business incubator	University provide business incubation support at the university and involving external agencies	HE-BCIS
Investment in spin-offs	Total investment received to support university spin-offs (venture capital or VC)	HE-BCIS
Investment in staff start-ups	Total investment received to support staff start-ups (venture capital or VC)	HE-BCIS
Investment in graduate start-ups	Total investment received to support graduate start-ups (venture capital or VC)	HE-BCIS
External investment**	Estimated external investment received (£000s) to support new ventures	HE-BCIS
	Control variables	
Income from infrastructure	This includes the use and income associated with the use of the HE provider's physical academic resources by external parties and captures provision which can be uniquely provided by a HE provider. It does not include simple trading activities such as commercial hire of conference facilities or academic conferences.	HE-BCIS
Business engagement	University has a strategic plan for business engagement	HE-BCIS
Incentives for business engagement	University has incentives for faculty to engage with business and community	HE-BCIS
Regional strategy	University has a strategy to engage with business	HE-BCIS
Widening participation access	University provides contribution to economic development of the region through widening participation access	HE-BCIS
Graduates' retention into the region	University provides contribution to economic development of the region through the programme for graduates' retention into the region	HE-BCIS
Support for community	University provides contribution to economic development of the region through support provided to community	HE-BCIS
Developing local partnership	University provides contribution to economic development of the region through developing partnerships with local business and community	HE-BCIS
Meeting regional skills needs	University provides contribution to economic development of the region through meeting regional need	HE-BCIS
Knowledge exchange	University provides contribution to economic development of the region through knowledge exchange	HE-BCIS
Supporting SME	University provides contribution to economic development of the region through supporting SMEs	HE-BCIS
Research collaboration	University provides contribution to economic development of the region through research collaboration	HE-BCIS
University established year	Year, when the university was established	website

Source: Higher Education Business and Community Interaction Survey, Higher Education Statistic Agency

** estimates for estimated external investment received (£000s) (from external partners but excluding investment from HEFCE (now OfS)/ BEIS) third stream funds) are provided by HE providers where possible.

Table A4. Descriptive statistics

Variable	Entrepreneurial University			Russel Group Universities			Polytechnic Universities			Rest Teaching Universities		
	Obs	Mean	S.D.	Obs	Mean	S.D.	Obs	Mean	S.D.	Obs	Mean	S.D.
Specification	1	2	3	4	5	6	7	8	9	10	11	12
IP revenues	953	3.56	2.85	168	6.99	1.47	210	2.78	2.09	567	2.88	2.66
University spin-offs	951	0.49	0.68	168	0.97	0.74	210	0.36	0.57	565	0.40	0.64
Graduate start-ups	953	2.03	1.66	168	1.95	1.48	210	2.79	1.62	567	1.76	1.65
Staff start-ups	953	0.23	0.50	168	0.27	0.53	210	0.25	0.56	567	0.21	0.46
Income from infrastructure	953	4.85	2.84	168	6.94	2.42	210	5.18	2.06	567	4.09	2.88
Business engagement	953	4.22	0.80	168	4.29	0.76	210	4.28	0.78	567	4.17	0.82
Incentives business engagement	953	3.74	0.83	168	4.04	0.77	210	3.54	0.89	567	3.71	0.79
Regional strategy	953	0.33	0.47	168	0.20	0.40	210	0.37	0.48	567	0.34	0.47
Widening participation access	953	0.68	0.47	168	0.62	0.49	210	0.80	0.40	567	0.67	0.47
Graduates' retention into the region	953	0.42	0.49	168	0.33	0.47	210	0.54	0.50	567	0.40	0.49
Support for community	953	0.34	0.47	168	0.32	0.47	210	0.31	0.46	567	0.35	0.48
Developing local partnership	953	0.48	0.50	168	0.44	0.50	210	0.51	0.50	567	0.47	0.50
Meeting regional skills needs	953	0.48	0.50	168	0.33	0.47	210	0.64	0.48	567	0.47	0.50
Knowledge exchange	953	0.57	0.50	168	0.81	0.39	210	0.54	0.50	567	0.51	0.50
Supporting SME	953	0.59	0.49	168	0.45	0.50	210	0.67	0.47	567	0.61	0.49
Research collaboration	953	0.63	0.48	168	0.93	0.25	210	0.51	0.50	567	0.60	0.49
External Science park	953	0.23	0.42	168	0.30	0.46	210	0.24	0.43	567	0.20	0.40
University Science park	953	0.21	0.41	168	0.39	0.49	210	0.18	0.39	567	0.17	0.38
University Business incubator	953	0.66	0.47	168	0.81	0.39	210	0.64	0.48	567	0.63	0.48
External Business incubator	953	0.04	0.19	168	0.08	0.28	210	0.01	0.12	567	0.03	0.17
Patents granted	953	0.00	0.00	168	0.00	0.00	210	0.00	0.00	567	0.00	0.00
UK funding	952	5.38	2.95	168	7.71	2.19	210	5.66	1.98	566	4.67	3.04
Consultancy and CPD	950	8.14	1.65	168	9.46	0.69	210	8.75	0.68	565	7.55	1.79
Contract research	953	7.10	2.66	168	10.17	0.78	210	7.08	0.88	567	6.29	2.69
TTO exist at university	953	0.54	0.50	168	0.79	0.41	210	0.50	0.50	567	0.48	0.50

TTO and other organisations	953	0.31	0.46	168	0.21	0.41	210	0.44	0.50	567	0.29	0.45
Employment rate	953	4.35	0.66	168	4.81	0.36	210	3.97	0.25	567	4.34	0.72
Doctoral students	953	4.03	1.66	168	6.19	0.46	210	3.92	0.66	567	3.48	1.60
Teaching capital	953	4.79	2.11	168	5.90	0.91	210	4.95	2.07	567	4.42	2.24
Research capital	953	5.62	1.62	168	6.73	0.67	210	6.08	1.43	567	5.15	1.65
Teaching and research capital	953	2.89	1.86	168	4.65	1.66	210	2.91	1.58	567	2.40	1.69
Investment in spin-offs	953	3.13	3.97	168	7.84	3.63	210	1.29	2.52	567	2.47	3.45
Investment in staff start-ups	953	0.59	1.80	168	1.17	2.75	210	0.33	1.26	567	0.51	1.58
Investment in graduate start-ups	953	1.64	2.61	168	2.67	3.58	210	1.71	2.42	567	1.28	2.23
STEM UG	953	0.07	0.06	168	0.10	0.04	210	0.08	0.03	567	0.06	0.06
STEM PG	953	0.03	0.04	168	0.05	0.04	210	0.02	0.03	567	0.02	0.05
Biology PG	953	0.03	0.07	168	0.07	0.05	210	0.02	0.03	567	0.03	0.08
Biology UG	953	0.10	0.07	168	0.17	0.05	210	0.08	0.03	567	0.08	0.07
Business PG	953	0.04	0.06	168	0.04	0.02	210	0.04	0.04	567	0.04	0.07
Business UG	953	0.07	0.05	168	0.04	0.02	210	0.11	0.04	567	0.07	0.06
Other degree	953	6.56	1.25	168	7.81	0.40	210	6.94	0.49	567	6.07	1.29
University established year	953	1857.01	132.19	168	1741.54	216.62	210	1867.96	65.96	567	1887.67	93.54

Source: Higher Education Business and Community Interaction Survey, Higher Education Statistic Agency

Table A5. Pearson correlation matrix for the main variables

IP revenues	1.000																								
University spin-offs	0.463*	1.000																							
Graduate start-ups	0.134*	0.170*	1.000																						
Staff start-ups	0.162*	0.284*	0.223*	1.000																					
External Science park	0.152*	0.133*	0.104*	0.056	1.000																				
University Science park	0.319*	0.295*	0.113*	0.237*	-0.231*	1.000																			
University Business incubator	0.249*	0.268*	0.347*	0.21*	0.235*	0.273*	1.000																		
External Business incubator	0.156*	0.031	0.052	-0.018	-0.024	-0.057	-0.209*	1.000																	
UK funding	0.440*	0.345*	0.258*	0.135*	0.176*	0.263*	0.303*	0.058	1.000																
Consultancy and CPD	0.488*	0.309*	0.278*	0.189*	0.157*	0.242*	0.342*	0.066*	0.377*	1.000															
Bespoke courses for business	-0.263*	-0.183*	-0.157*	-0.103*	-0.072*	-0.129*	-0.168*	-0.047	-0.225*	-0.238*	1.000														
TTO exist at university	0.435*	0.304*	0.186*	0.152*	0.158*	0.174*	0.283*	0.069*	0.284*	0.338*	-0.260*	1.000													
TTO and other organisations	-0.014	-0.041	0.090*	-0.016	-0.022	0.034	-0.014	0.001	0.014	0.066*	-0.036	-0.584*	1.000												
Employment rate	0.340*	0.146*	-0.138*	-0.029	-0.048	0.058*	-0.094*	-0.014	0.043	-0.076*	-0.094*	0.154*	-0.154*	1.000											
Other high degree	0.456*	0.401*	0.342*	0.180*	0.160*	0.295*	0.356*	0.067*	0.393*	0.673*	-0.316*	0.418*	0.064*	-0.028	1.000										
Teaching capital	0.297*	0.144*	0.159*	0.099*	0.046	0.202*	0.150*	0.074*	0.229*	0.285*	-0.266*	0.225*	0.002	0.113*	0.406*	1.000									
Research capital	0.442*	0.321*	0.255*	0.167*	0.128*	0.222*	0.264*	0.082*	0.331*	0.514*	-0.361*	0.363*	-0.006	-0.069*	0.660*	0.111*	1.000								
Teaching and research capital	0.533*	0.372*	0.089*	0.159*	0.129*	0.246*	0.254*	0.121*	0.356*	0.486*	-0.283*	0.391*	-0.032	0.123*	0.575*	0.314*	0.575*	1.000							
STEM UG	0.435*	0.337*	0.271*	0.206*	0.232*	0.346*	0.336*	0.041	0.346*	0.380*	-0.250*	0.340*	0.056	-0.062*	0.482*	0.336*	0.359*	0.366*	1.000						
STEM PG	0.347*	0.283*	0.034	0.104*	0.147*	0.251*	0.216*	0.002	0.141*	0.265*	-0.117*	0.172*	0.010	0.083*	0.343*	0.095*	0.265*	0.323*	0.422*	1.000					
Biology PG	0.278*	0.158*	-0.048	0.022	0.023	0.100*	0.087*	0.035	0.196*	0.128*	-0.124*	0.187*	-0.045	0.363*	0.143*	-0.013	0.170*	0.238*	0.107*	0.315*	1.000				
Biology UG	0.392*	0.275*	0.119*	0.142*	0.169*	0.247*	0.292*	0.126*	0.365*	0.352*	-0.222*	0.297*	-0.058	0.031	0.371*	0.334*	0.346*	0.398*	0.432*	0.181*	0.244*	1.000			
Business PG	0.091*	0.015	0.136*	-0.008	0.034	0.061*	0.118*	-0.004	-0.017	0.221*	0.064*	0.047	-0.039	-0.066*	0.262*	0.007	0.143*	0.052	0.100*	0.267*	0.104*	0.011	1.000		
Business UG	-0.066*	-0.019	0.207*	0.029	0.135*	0.044	0.219*	-0.041	0.064*	0.200*	-0.076*	0.063*	0.100*	-0.334*	0.307*	0.209*	0.212*	0.084*	0.300*	-0.017	-0.132*	0.113*	0.209*	1.000	
Investment into spin-offs	0.461*	0.515*	0.133*	0.192*	0.164*	0.290*	0.272*	0.132*	0.383*	0.387*	-0.234*	0.430*	-0.109*	0.233*	0.475*	0.275*	0.366*	0.454*	0.424*	0.303*	0.203*	0.451*	0.027	-0.079*	1.000
Investment into staff start-ups	0.256*	0.210*	0.083*	0.397*	0.119*	0.122*	0.180*	0.005	0.202*	0.184*	-0.104*	0.219*	-0.101*	0.087*	0.194*	0.126*	0.155*	0.159*	0.172*	0.109*	0.066*	0.138*	-0.001	-0.022	0.350*
Investment into graduate start-ups	0.242*	0.230*	0.381*	0.169*	0.072*	0.099*	0.249*	0.021	0.231*	0.211*	-0.104*	0.202*	-0.023	0.083*	0.259*	0.179*	0.155*	0.161*	0.215*	0.082*	0.026	0.100*	-0.005	0.074*	0.275*

IP revenues																									
University spin-offs																									
Graduate start-ups																									
Staff start-ups																									
External Science park																									
University Science park																									
University Business incubator																									
External Business incubator																									
UK funding																									
Consultancy and CPD																									
Bespoke courses for business																									
TTO exist at university																									
TTO and other organisations																									
Employment rate																									
Other high degree																									
Teaching capital																									
Research capital																									
Teaching and research capital																									
STEM UG																									
STEM PG																									
Biology PG																									
Biology UG																									
Business PG																									
Business UG																									
Investment into spin-offs																									
Investment into staff start-ups																									
Investment into graduate start-ups	1.000																								

Source: Higher Education Business and Community Interaction Survey, Higher Education Statistic Agency

Appendix B

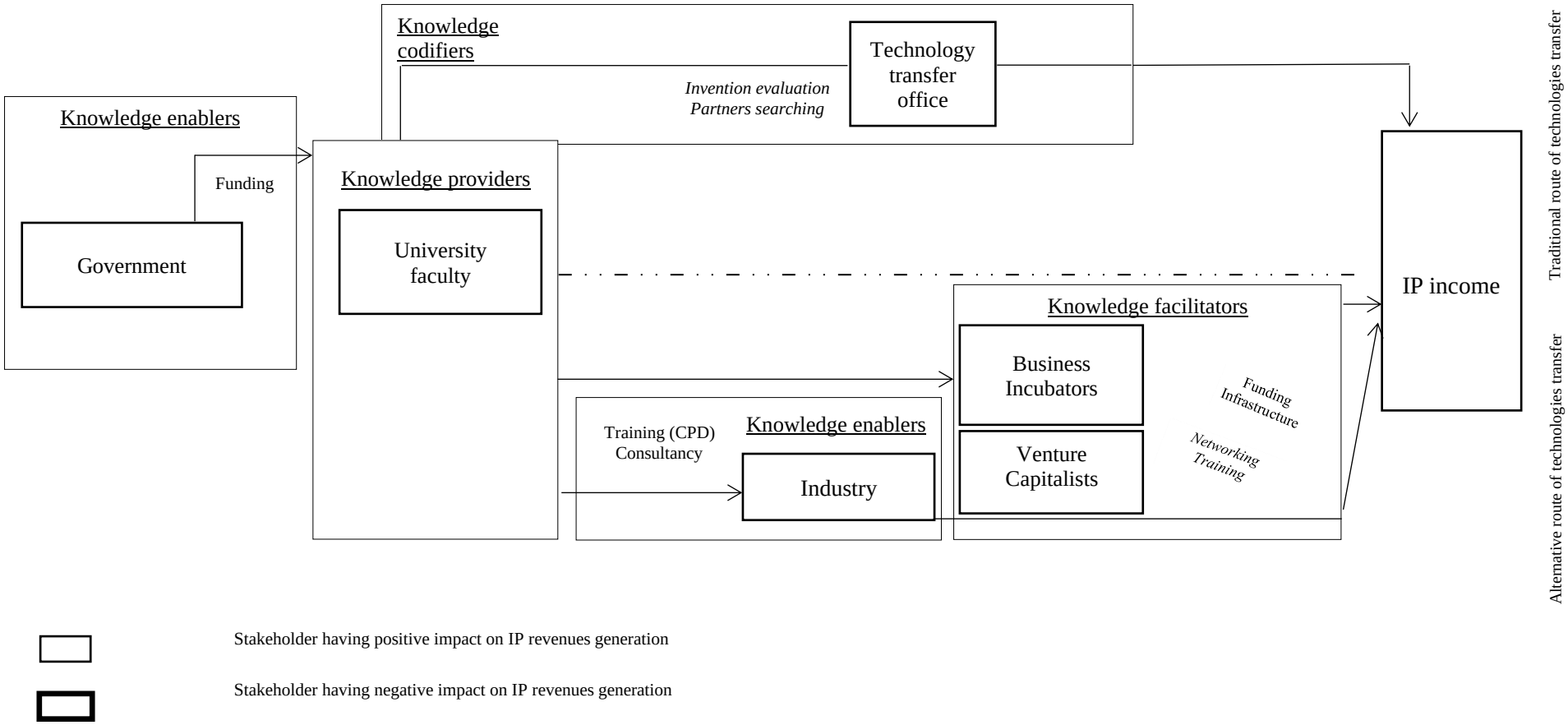

Figure B1: Conceptualisation of the university and stakeholder collaboration process for IP income generation (Entrepreneurial University)

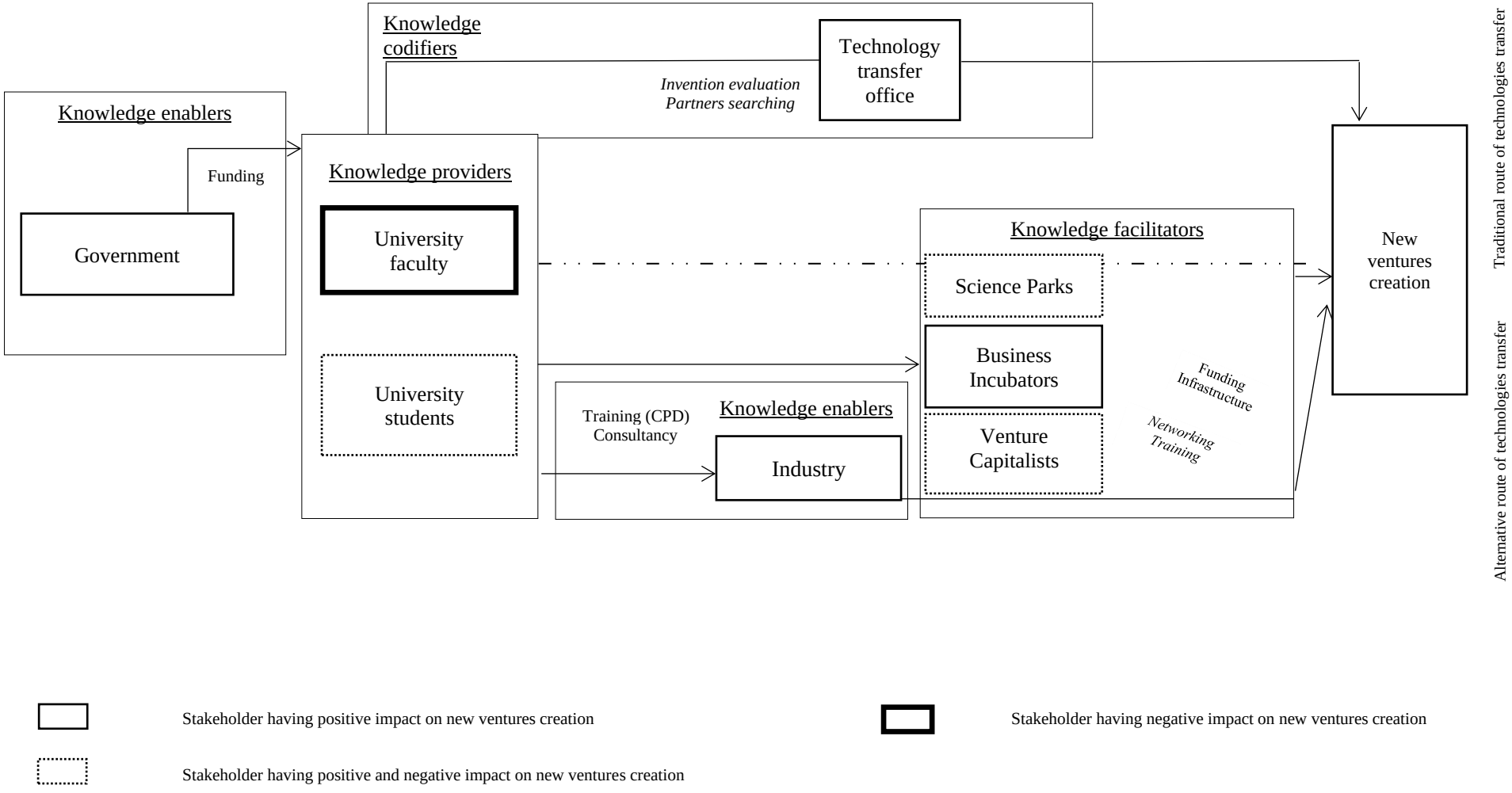

Figure B2: Conceptualisation of the university and stakeholder collaboration process for new ventures creation (Entrepreneurial University)

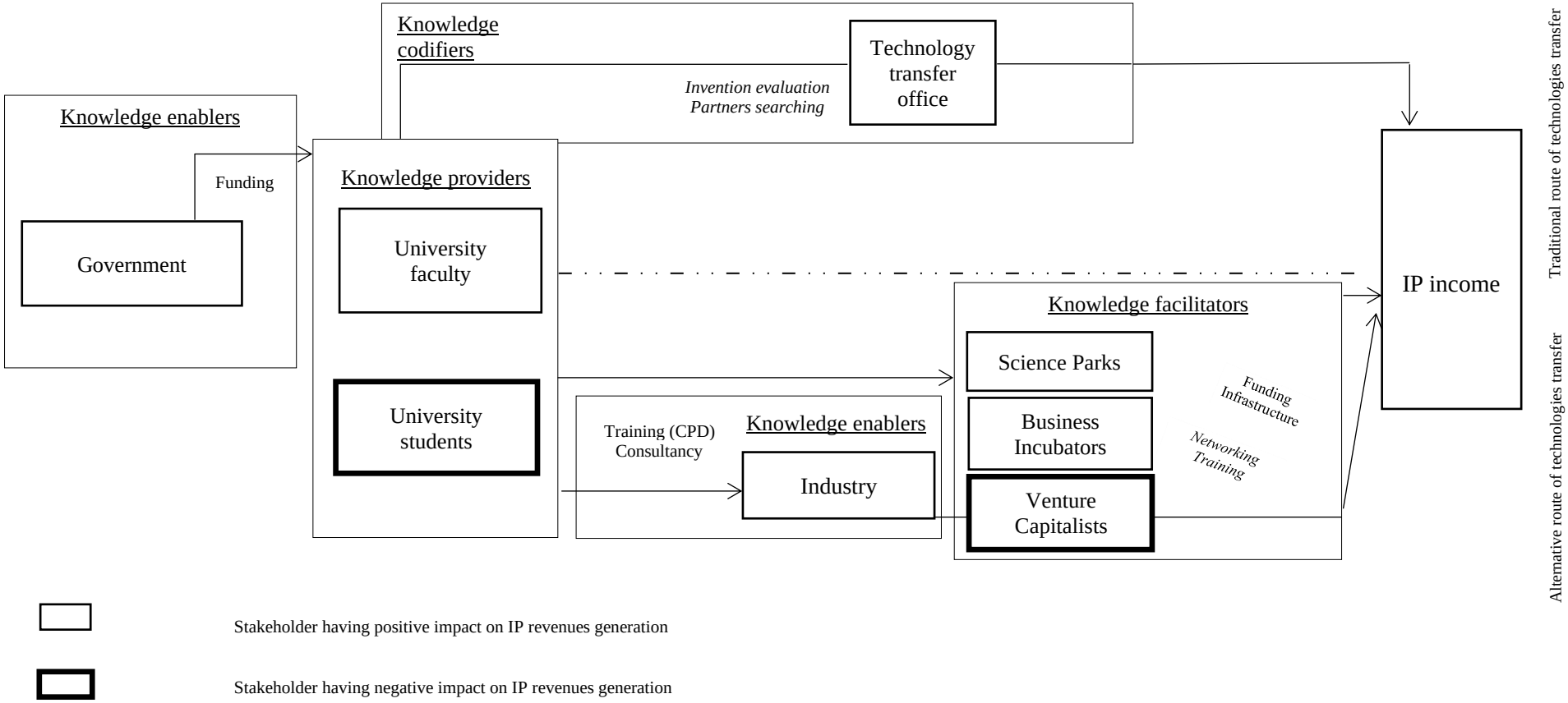

Figure B3: Conceptualisation of the university and stakeholder collaboration process for IP income generation (Russel Group University)

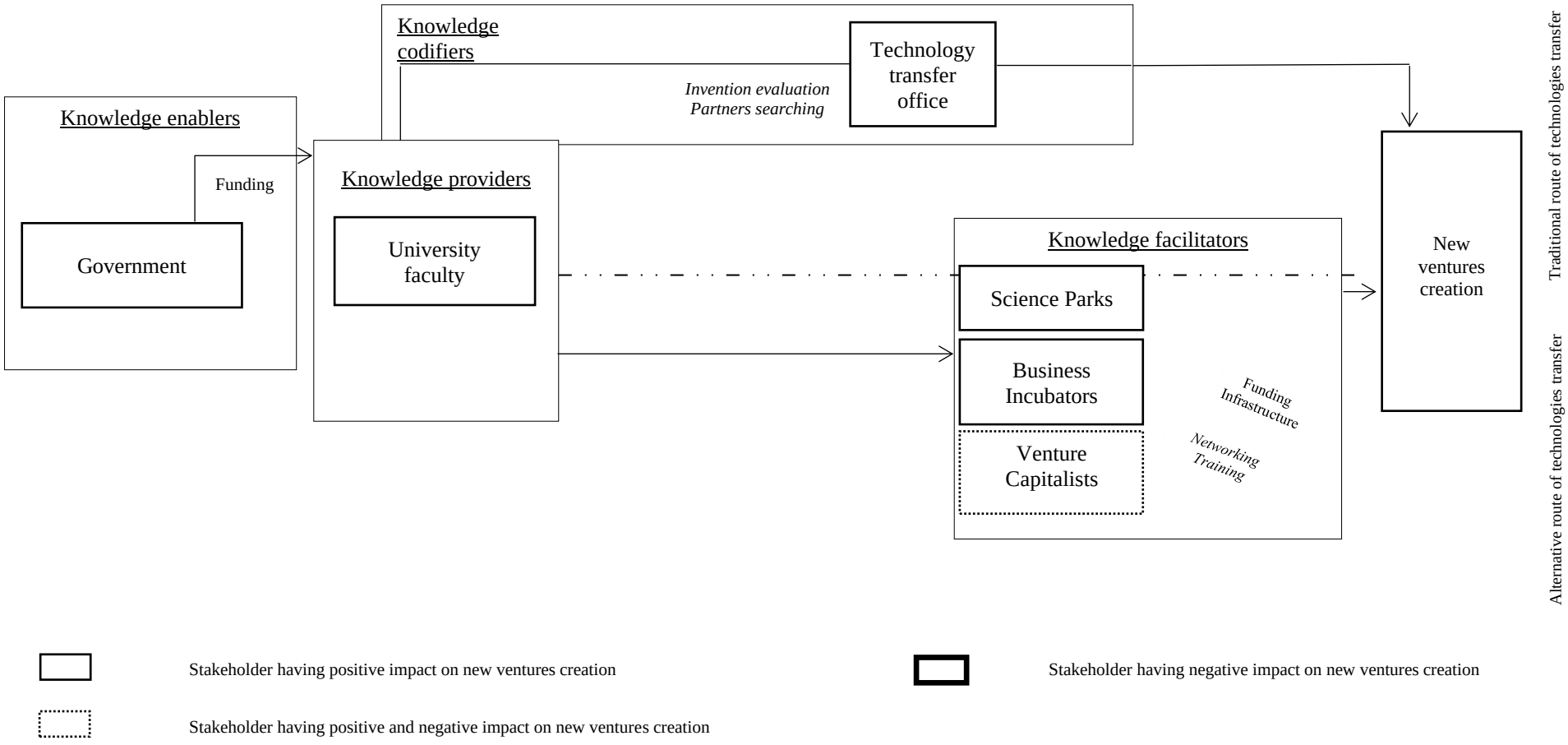

Figure B4: Conceptualisation of the university and stakeholder collaboration process for new ventures creation (Russel Group University)

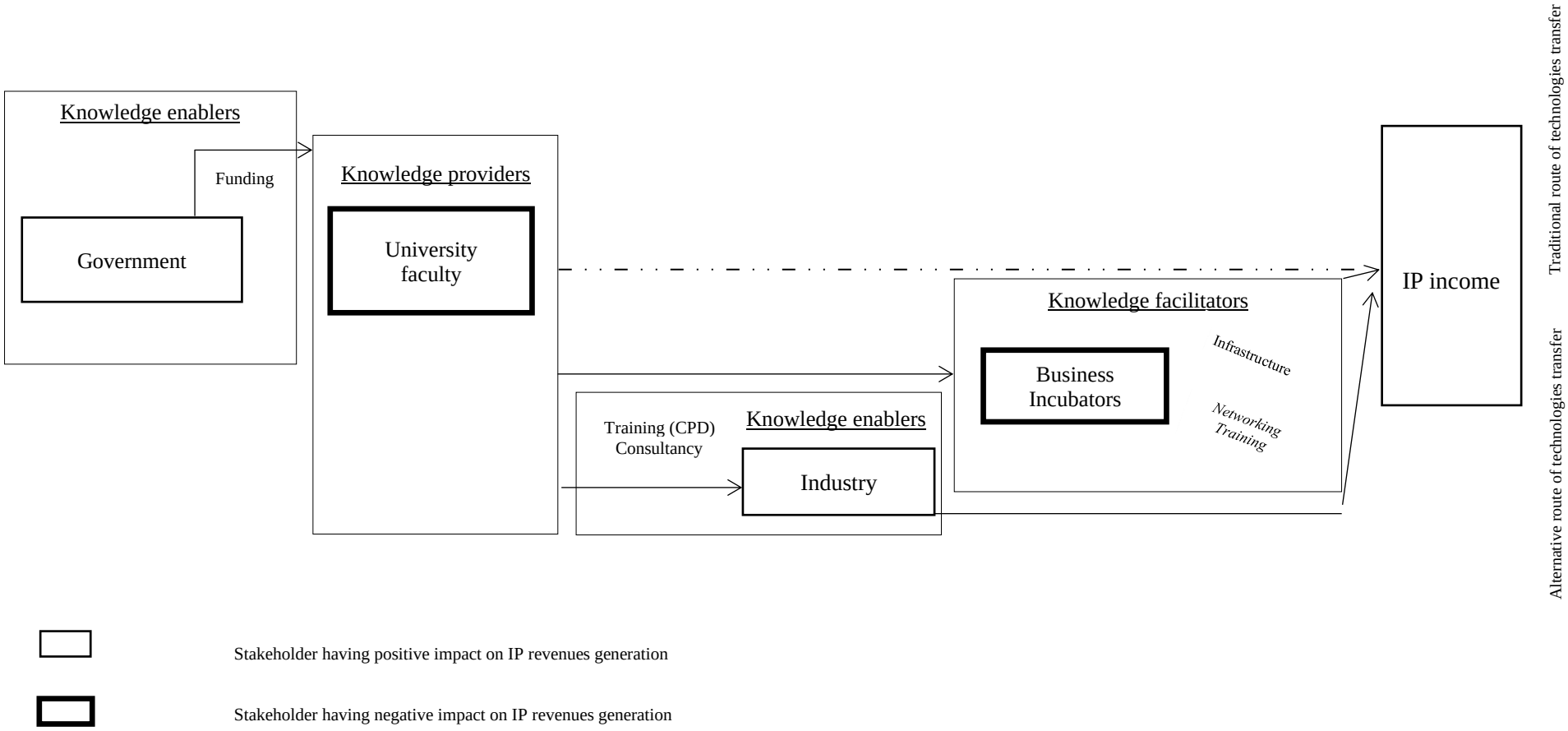

Figure B5: Conceptualisation of the university and stakeholder collaboration process for IP income generation (Polytechnic University)

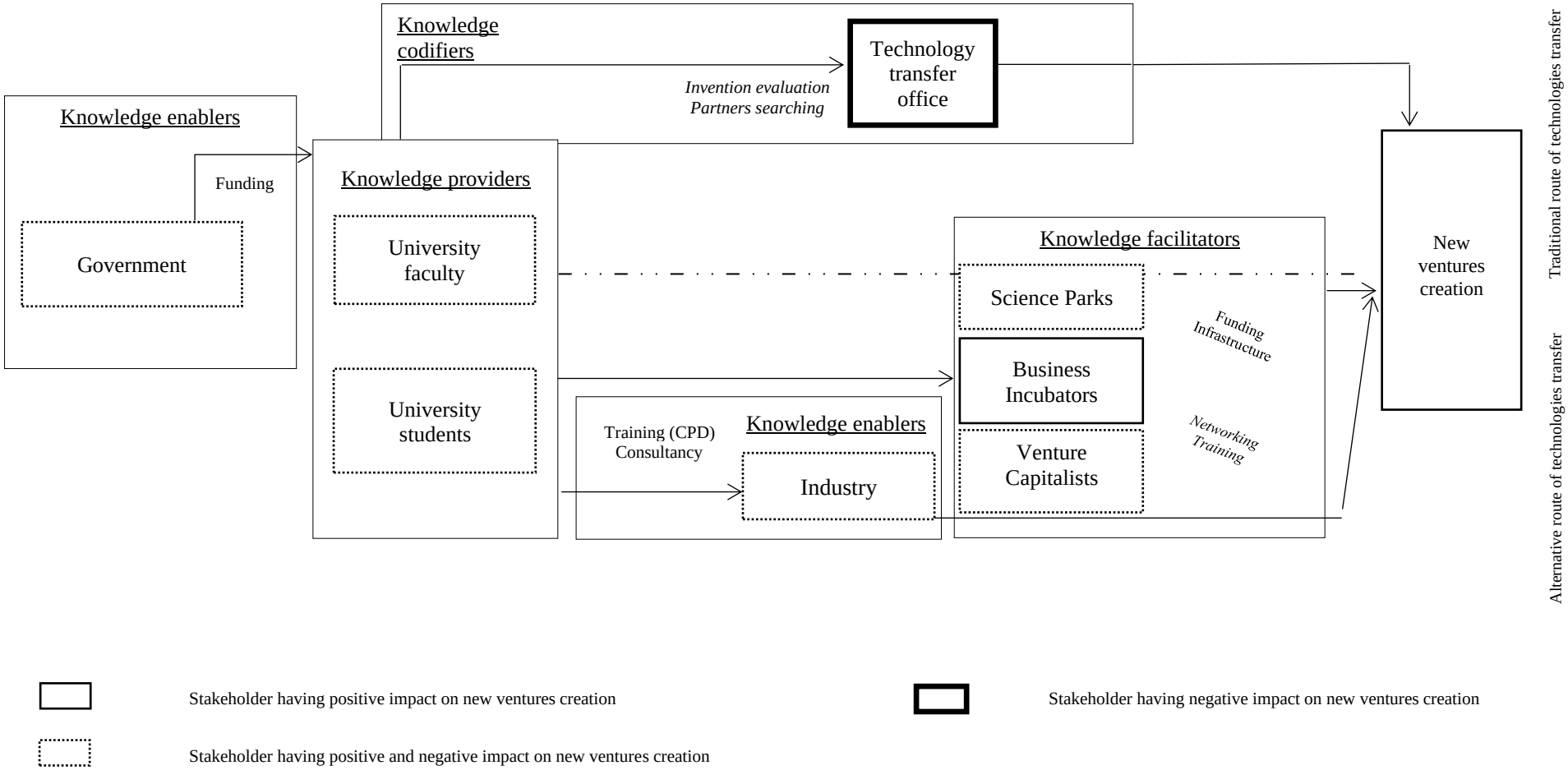

Figure B6: Conceptualisation of the university and stakeholder collaboration process for new ventures creation (Polytechnic University)

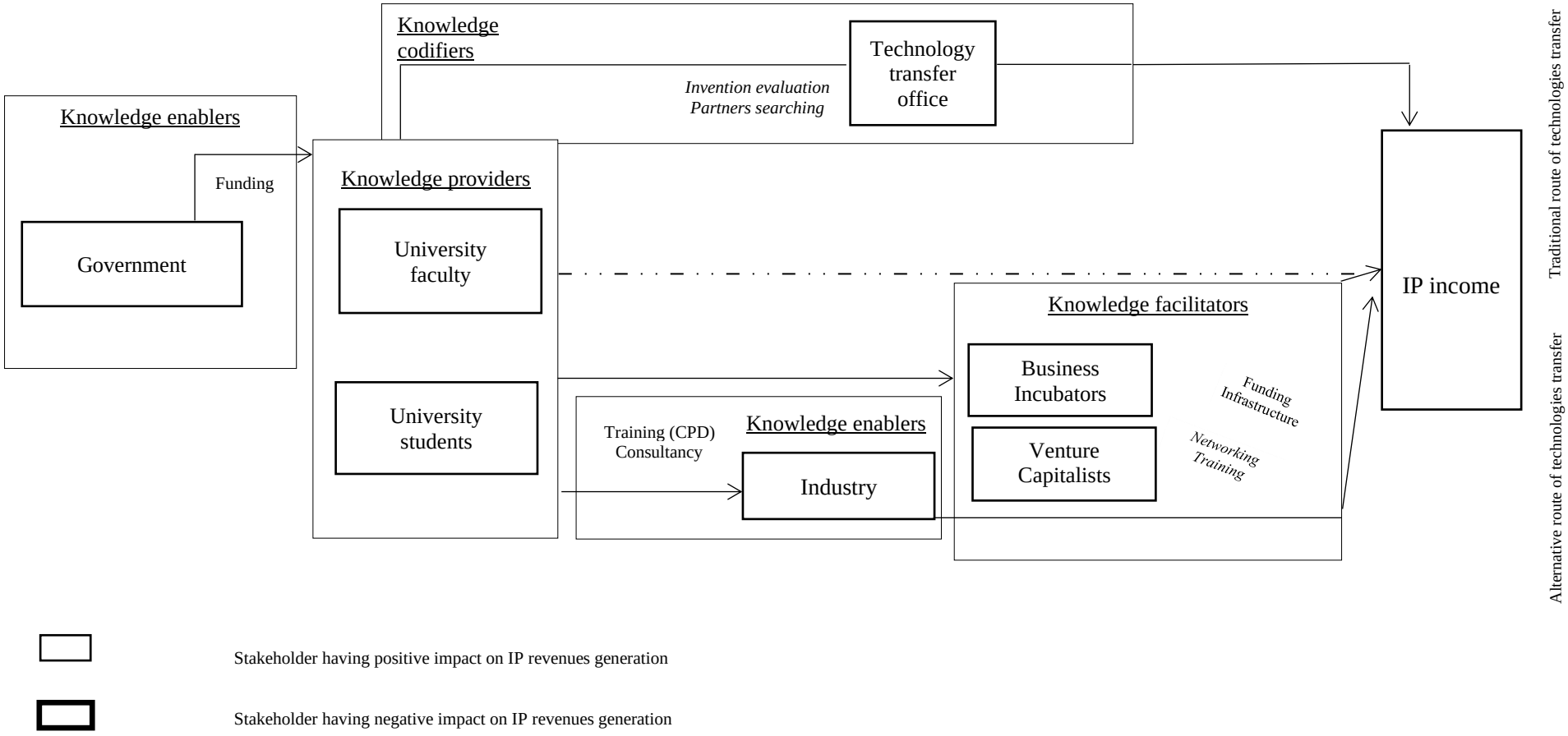

Figure B7: Conceptualisation of the university and stakeholder collaboration process for IP income generation (Rest Teaching University group)

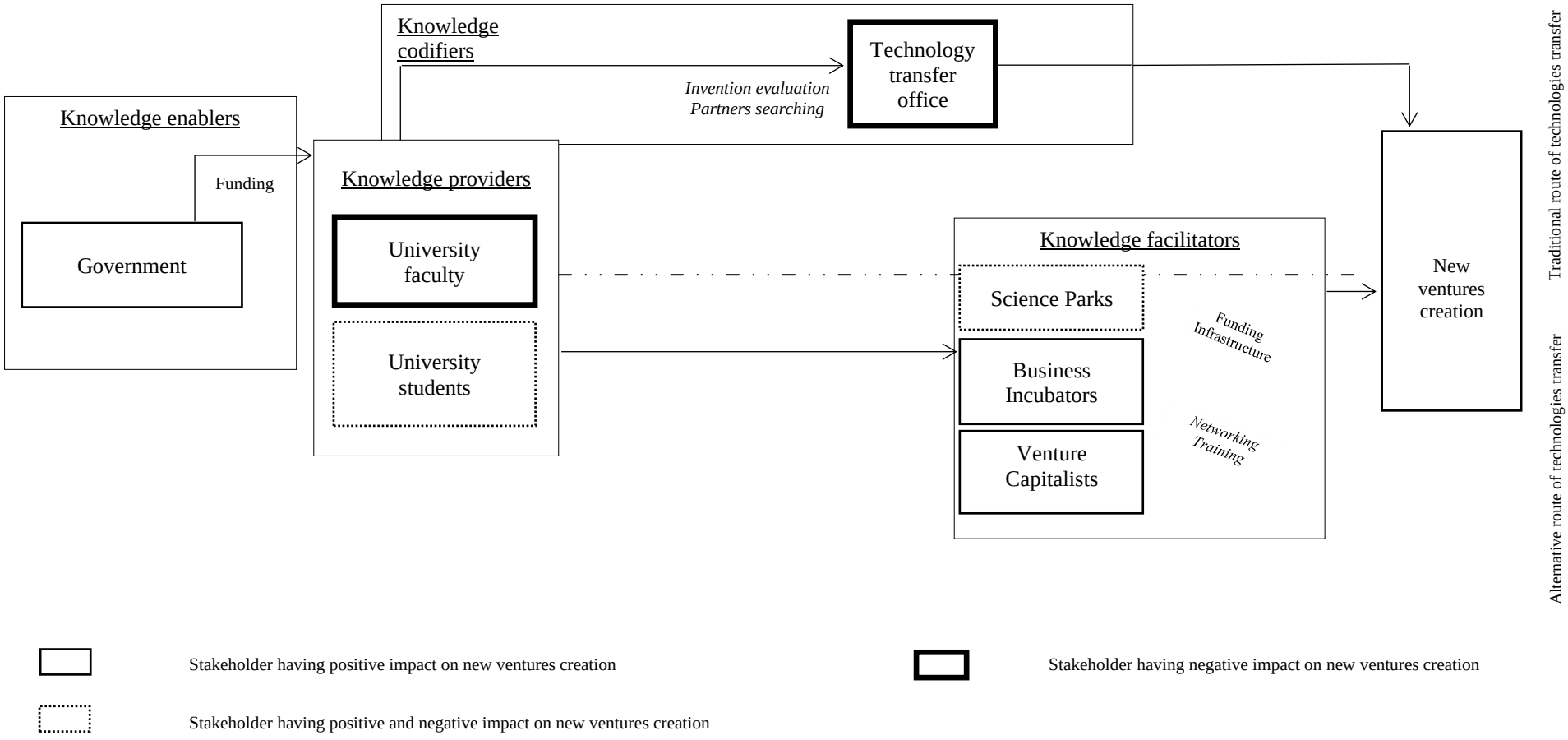

Figure B8: Conceptualisation of the university and stakeholder collaboration process for new ventures creation (Rest Teaching University group)

Appendix C

Table C1. Descriptive statistics of the sample

Variable	Observations	Mean	Std. Dev.	Min	Max
Interest in commercialisation (DV)	382	3.651	1.226	1	5
Engagement with stakeholders at Professorship position (F1)	391	1.74E-09	0.988	-0.62	5.299
Engagement with stakeholders at junior, middle and senior positions (F2)	391	-5.03E-10	0.988	-0.605	6.946
Engagement with stakeholders at middle position (F3)	391	1.57E-09	1.000	-0.946	13.840
Engagement with stakeholders at tenure-track position (F4)	391	-2.23E-10	0.989	-0.892	8.921
Engagement with stakeholders at junior level (F5)	391	-8.90E-10	0.977	-0.754	7.728
Engagement with stakeholders at middle and senior positions (F6)	391	-1.68E-09	0.981	-1.423	16.795
Engagement with investors at junior and middle positions (F7)	391	4.98E-10	0.994	-1.475	14.211
Engagement with stakeholders at junior and middle positions (F8)	391	3.63E-10	0.947	-2.821	7.203
Engagement with business incubator at middle and senior positions (F9)	391	-6.76E-10	0.938	-1.722	8.538
TTO provide advice on commercialisation	326	3.300	0.801	1	5
TTO provide support on seeking out licensing opportunities	325	3.110	0.827	1	5
IP protection management support from TTO	324	3.037	0.910	1	5
TTO awareness about commercialisation	326	3.144	0.992	1	5
TTO's assistance in connection with industry	324	2.953	0.948	1	5
TTO's assistance in spin-offs creation	321	2.940	0.880	1	5
Science park provide me with possibility to rent space for starting a business	286	3.020	0.632	1	5
Science park help me to enhance my business skills	286	2.982	0.618	1	5
SP provides me with access to finance	283	2.922	0.631	1	5
SP enhance my managerial skills	283	2.932	0.629	1	5
SP help me with marketing expertise	283	2.943	0.610	1	5
SP helps me to expand my network	282	2.982	0.672	1	5
Business incubator provides me with facilities	299	3.066	0.778	1	5
Business incubator enhanced business skills	302	3.039	0.746	1	5
Business incubator offers mentorship support	301	3.089	0.775	1	5
Business incubator helps to expand the network	302	3.109	0.809	1	5
Business incubator provides me with/provide opportunities for seed corn investment	299	2.946	0.792	1	5
Business incubator connects me with market and industry	299	3.030	0.820	1	5

Business incubator encourages me to start a new venture	298	2.963	0.821	1	5
Enough funding from government that leads to research commercialisation	331	2.897	0.997	1	5
Government programmes are supportive for research commercialisation	327	2.853	0.954	1	5
Government policy for IP rights	319	3.028	0.887	1	5
Government is engaging with other stakeholders when it comes to commercialisation	320	2.971	0.831	1	5
I have enough knowledge and skills for commercialisation	335	3.752	0.896	1	5
Industry is ready to fund R&D as a basis for commercialisation	331	3.111	1.085	1	5
Industry is ready to engage with academics in teaching	328	3.259	1.082	1	5
Industry is open for implementing new technologies from research	330	3.287	0.935	1	5
Industry has enough capabilities to absorb new technologies	329	3.364	1.015	1	5
Conflicts of interest in IP ownership diminished my motivation	327	2.938	0.973	1	5
Time for commercialisation numerical	378	2.404	1.122	1	5
Academic experience, full years	375	17.536	12.190	0	58
Strategic orientation of the university towards entrepreneurship	376	3.279	1.080	1	5
Administrative support for commercialisation	374	2.799	1.203	1	5
Age of the respondent	380	3.400	1.298	1	6