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Understanding Research Orientation in Academic Institutions: The Influence of Motivations and Moderating Factors

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Abstract

The central ambition of this doctoral research is to advance theoretical understanding on the factors, both internal and external, that motivate and influence an individual’s research orientation around basic, applied and/or commercial research.

Through the literature review, three broad themes emerged: intrinsic and extrinsic motivations as drivers of research orientation; the influence of the institution; and influence of the researcher profile.

To examine these themes, a conceptual model and a set of hypotheses were developed based on a review of extant literature, and data (n=270) were gathered through an online survey of researchers from across Europe. Hypotheses were tested through statistical analysis employing confirmatory factor analysis and hierarchical moderated linear regression.

The study shows that both extrinsic and intrinsic motivations impact the individual's research orientation, and each motivation has a distinct effect. Additionally, institutional and personal factors moderate the impact of these motivations on research orientation. The study's primary contribution is the empirical examination of the interplay between intrinsic motivations, extrinsic motivations, demographic characteristics, institutional environments and research orientation. This study is important due to its integrated approach, which is lacking in existing literature and is relevant to academic institutions' drive to increase research impact.

This contributes to scholarly understanding of the individual researcher and their place within systems of innovation and adds to the body of knowledge produced within the fields of research policy and evaluation.

The research has implications for policy and management, including the need to address gender inequality in researcher careers, as gender significantly moderates the relationship between researchers' motivations and their research orientation. The study findings also, for example, highlight limitations of the San Francisco Declaration on Research Assessment and suggest that future research assessment should consider additional motivations such as academic freedom, baseline funding, and socially/civically aware research programs.

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1. Introduction
   1. Background and Context

The central ambition of this doctoral research is to advance theoretical understanding of the factors (such as motivations, institutional policies, and the researcher’s profile), both internal and external, that influence individuals’ research orientation around basic, applied and/or commercial research, undertaken in the context of an academic institution.

Research is the cornerstone of innovation and technological progress. It plays a crucial role in the creation of new information, ideas, and technologies that fuel economic growth, societal advancement, and human wellbeing (Bornmann, 2013). Central in influencing the direction and impact of research efforts is the orientation of a researcher's career which may focus on basic, applied, and/or commercial research. An individual’s research orientation can be impacted by a number of factors, including the researcher's personal aspirations (Bercovitz & Feldman, 2006; Sitnicki, 2018), professional networks (Tijssen, 2018), institutional policies (Duval-Couetil et al., 2021), and financing climate (Ward & Ost, 2019). Accordingly, today’s researcher is faced with a plethora of options in terms of research orientation. Researchers often have the freedom to investigate a wide variety of topics and interests and to undertake research that coincides with their passions and expertise (Bilgrami & Cole, 2015). In addition, academic professions are becoming increasingly competitive, with a growing number of researchers contending for a limited number of posts, and others leaving academia as Doctorate degree requirements gain popularity in the business world (Kis et al., 2022). This is further exacerbated by the research field selected by the researcher, with some fields (for example technology and engineering) having a heavily applied-commercial slant, while others have a more basic research focus (Holloway & Herder, 2019).

Researchers are embedded within systems of innovation, described in frameworks (defined in Section 2.2.1) such as the Quintuple Helix (Carayannis et al., 2012) or the EU Knowledge Triangle (Soriano & Mulatero, 2011), which comprise multiple actors each with their own focus and role in terms of fostering innovation. For instance, a researcher may collaborate with industrial partners to develop and commercialise their research findings or with government agencies to ensure that their research serves social requirements and contributes to policy formation. By connecting with these actors, researchers can not only improve the impact and relevance of their study, but also build important networks and collaborations that can aid in their professional growth (Audretsch & Aldridge, 2012). These actors have varying levels of expectations, invariably in the form of key performance indicators, used to assess research excellence and impact and subsequently allocate funding and resources, at international, national and institutional levels (Hessels et al., 2009).

As will be discussed in Chapter 2, extant research related to systems of innovation often excludes the impact on, and role of, the individual researcher, focusing instead on broader themes such as societal impact. This translates into institutional policies within an academic context, particularly when one considers the recent focus on the ‘entrepreneurial university’ (Etzkowitz, 2003; Etzkowitz et al., 2000; Perkmann et al., 2021; Wardle et al., 2019). However, if an academic institution desires to focus on a particular set of impact indicators it is imperative that they understand the motivations that drive individual researchers towards research excellence aligned to their research orientation.

As will be highted in Chapter 3, the majority of prior work related to researchers, their career motivations, and research orientation, has focused on quite narrowly defined perspectives such as the impact of the researcher’s desire for reputational gain, the influence of gender, or the pursuit of research funding – with little to no attempt being made to develop a comprehensive perspective on the researcher, the relationships between their motivations and their research orientation, and the personal and institutional influences on these relationships. This is the gap in knowledge that this study seeks to address.

* 1. The study
     1. Positionality

This study stems originally from my own lived experiences and as such it is important to reflect on my own positionality relative to this body of research. I have extensive personal experience across all facets of the Triple Helix. Starting with Industry, I spent many years managing commercial research and development teams in a large-scale multinational ICT-focused organisation. This experience, combined with my education in electronic engineering has instilled an approach to research which may in turn have influenced the methodological (statistical) approach adopted in this thesis.

From a government perspective, I spent a number of years working for a government agency in Ireland, tasked with encouraging traditionally manufacturing organisations to embark on research and development programmes, often in conjunction with academic partners. This has enabled me to fully understand not only the importance of industry-academic collaboration but also the importance placed on it at a national level.

My current role is that of Executive Director of a large-scale ICT research institute based in Ireland. Within this context, over the past 20 years, I have established strategies and structures to drive and balance research outputs which arise from basic, applied and commercial research. I have an intense interest, coupled with pressures from various funding stakeholders, to drive innovation and creativity within the organisation by building strong and sustainable partnerships between industry, academic and government. Indeed, this is what drove me to adopt the research focus of this thesis from the outset. My research organisation operates within the confines and policies of a university and adopts a subset of research Key Performance Indicators coming from Science Foundation Ireland (for basic research), the European Commission (for applied research) and Enterprise Ireland (for commercial research). I have also worked as a researcher, seeking funding from multiple stakeholders, engaging with many industry and academic partners, and undertaking ICT research across multidisciplinary fields. Within that aspect of my role, I have engaged in scientific research through to creation of a spin-out company, and as such I have a deep understanding of the multiple motivations that drive researchers to undertake research in its various forms.

I recognise that, as a 53-year-old researcher, my personal and professional experiences have shaped my perspective on the influences that impact researcher career choices and orientations, however throughout this research I have made a conscious effort to review the evidence, interrogate the findings and consider counterpoints.

* + 1. Research questions

Based on my own interests and experiences and supported through the literature review work undertaken in this study (Chapter 2 and Chapter 3), this research addresses the following research questions:

*RQ1a - What are the primary intrinsic and extrinsic motivations that influence the research orientation of a researcher in an academic institution?*

*RQ1b - What is the interaction effect between intrinsic and extrinsic motivations and the research orientation of a researcher in an academic institution?*

*RQ2a - What role does a researcher’s personal profile play in moderating the relationship between their motivations and their research orientation?*

*RQ2b - What role does a researcher’s academic environment play in moderating the relationship between their motivations and their research orientation?*

* + 1. Approach, Scope and Limitations

To answer the above research questions, a conceptual model and a set of hypotheses were developed based on a review of extant literature, and data were gathered through an online survey of researchers from across Europe. Hypotheses were tested through statistical analysis employing confirmatory factor analysis and hierarchical moderated linear regression.

The scale of this study comprises an attained sample of 270 active researchers from 29 countries.

While sample demographics were sufficiently balanced (Chapter 6) there are a number of limitations associated with the sample however, in particular that the majority of survey respondents were from a field related to ICT or Engineering, which had an impact on the final analysis. Additionally, the length of the survey instrument itself had an adverse effect on the size of the sample acquired. While the statistical analysis, including power analysis of the produced model, verified that the sample was adequate, generalisability of findings has been approached with caution.

* + 1. Significance

The research, development and empirical verification of a modern, integrated model of an individual’s research orientation is the primary contribution made by this study. This model incorporates research orientation antecedents in terms of researcher motivations as well as multiple moderators.

This study consequently provides an important and timely addition to existing discourse and extant literature, due to the significance of the subject matter, particularly in terms of academic institutions’ drive to increase research productivity and impact, as well as the dearth of research that takes a comprehensive, integrated, approach.

This contributes to scholarly understanding of the individual researcher and their place within systems of innovation and adds to the body of knowledge produced within prior works within the fields of research policy and evaluation.

This research has a number of implications for both policy and management. For example, the study found that gender significantly moderates the relationship between researchers' motivations and their research orientation, which may provide insights that can support the European Commission's work to address gender inequality in researcher careers (European-Commission, 2021a).

The study also suggests that future work in the area of research assessment should pay additional attention to other motivations identified in this, and other, research such as the desire for academic freedom, provision of baseline funding to alleviate the need to relentlessly write research proposals to pursue funding rather than scientific breakthroughs, or the pursuit of socially/civically aware research programmes in which societal impact may outweigh scientific impact or monetary returns.

* 1. Thesis structure

The thesis begins with a review, in Chapter 2 of the literature associated with systems of innovation and highlights that the perspective of the individual researcher is somewhat lost within the broader conceptual milieu. It presents a discussion on how descriptive frameworks such as the Quintuple Helix, and their associated impacts on research policies impact on outputs of the individual researcher. The chapter concludes with an examination of extant researcher-centric literature and highlights the gap in knowledge associated with developing a comprehensive description of the researcher and their research orientation.

To address this identified gap, Chapter 3 presents a secondary literature review which identifies the critical factors to be researched in order to develop an analytical model, and associated hypotheses, of research orientation. The chapter discusses the research orientation of the individual researcher in terms of their focus on basic, applied and/or commercial research, the individual intrinsic and extrinsic motivations that influence the individual’s research orientation, and the multiplicity of factors that influence the relationship between the researcher's motivations and their research orientation. The chapter concludes with the conceptual and analytical framework developed for the study.

Chapter 4 discusses the research philosophy, design and methodology employed in this study and includes a review of literature to identify validated scales to be used for operationalisation of analytical constructs for the statistical model.

Chapter 5 details the plan for all elements of the analysis undertaken for this study comprising data collection and management, sample power analysis, multivariate techniques, and approach to hypotheses verification, while Chapter 6 describes the complete analysis and hypothetical validation relative to the research questions posed.

Chapter 7 discusses the findings for the research across three themes relative to extant literature: motivations as drivers of research orientation, the influence of the academic institution, and the impact of the individual researcher profile.

Finally, Chapter 8 summarises the research outcomes, contribution, managerial and policy implications, study limitations, and recommendations for future research.

1. Science, Systems and Researchers

This chapter highlights that while many studies have examined the impact of research policies within systems of innovation, the focus on the individual researcher within these frameworks is somewhat lost (Orazbayeva & Plewa, 2022), and requires significant investigation (Hmieleski & Powell, 2018).

This chapter starts with a description of the approach taken to the literature review, followed by a definition of key terms used in the thesis. Next it examines modes and systems of research and innovation, each of which can have an impact on the individual researcher. It then discusses the impact of the entrepreneurial and neoliberal university, and the associated pressures these place on researchers. Finally, the chapter focuses on the individual researcher as an entity within these systems, and highlights the research gap and associated research questions which form the basis of this thesis.

* 1. Literature review process

The literature review undertaken in this research was carried out in a number of distinct phases, each with a different goal, and follows the recommendations of Khan et al. (2003, p. 118): 1) Framing the questions for review; 2) Identifying relevant work; 3) Assessing the quality of studies; 4) Summarising the evidence; 5) Interpreting the findings (adapted from).

To frame the research questions and to establish the context of this thesis, an initial review was undertaken which focused on discourse related to systems of innovation. The ground work for this was completed during the first phase of the researcher’s EdD programme (Doolin, 2008a, 2008b), however it was necessary to expand this to determine what these publications had to say about the individual researcher in the context of an academic institution, and to consider the impact of paradigms such as the entrepreneurial and neoliberal university.

Next, in order to gather evidence (Victor, 2008) relevant to the research questions posed multiple academic databases/systems, such as Scopus and Web of Science, were searched for relevant materials, initially using a number of ‘wildcard’ searches (Papaioannou et al., 2010; Petticrew & Roberts, 2008). Wildcard searching was important as, as has been shown in this thesis, prior works sometimes use alternative terms to describe the same items (such as ‘drivers’ vs ‘motivations’), while different journals approach the discussion from varying perspectives (such as that of the researcher, their institution, or broader national and international systems of innovation). Table 51 in Appendix J provides an example of a search query used to find publications that could mention researchers in an academic institution, research orientation, drivers/motivation/performance and other terms.

Sourced publications were downloaded where appropriate for further analysis. Then, relevant cited materials within these publications, and newer publications citing these publications, were accessed and downloaded for examination. In addition, in cases for example where an identified publication was located in a special issue of a journal, the special issue content was checked to identify additional publications. All selected publications were catalogued and reviewed, and important statements/sections were summarised as notes.

This recursive process produced a significant body of literature to be examined. Tables were prepared in which publications were summarised relative to subject matter – for example, systems of innovations, researcher drivers/motivations and barriers, the nature of research in academic settings. During this process, the recommendations for future research in each relevant publication were noted – this process supported the justification and necessity for the model to be developed.

In order to operationalise the constructs used in the model (Chapter 4), the collected papers were revisited to identify potential sources of validated measurement scales applicable to the academic institution context. In cases where scales were not originally applied in an academic context a further search was undertaken to identify newer publications that cited the original paper and used its scales in an academic context – these are detailed in Section 4.4.1.

The literature *was drawn from multiple sources including Studies in Higher Education, Research* *Policy*, *The Journal of Technology Transfer*, *R&D Management*, *Scientometrics*, *Higher Education*, *Technological Forecasting and Social Change*, and *Science and Public Policy*.

* 1. Research and the nature of scientific outputs
     1. Definition of key terms

Throughout the literature, in academia, in industry and in government, multiple terms are used to broadly describe the process of knowledge production, for example Research and Development (R&D), Innovation, Basic / Applied / Commercial Research. Accordingly, to properly set the context for this thesis, definitional clarity is required.

* + - 1. The Researcher and the Academic Institution

Throughout the literature numerous terms have been used to describe individuals undertaking research in the context of an academic institution. Table 50 in Appendix I presents a sample taken from extant literature to illustrate this issue. While the terms “academic researcher” or “academic scientist” appear frequently and have been used to describe individuals undertaking multiple types of research (Glenna et al., 2011; Iglič et al., 2017; Lam, 2011; Link et al., 2017; Thursby et al., 2007), these can be problematic insofar as they imply a research career primarily focused on academic publications or basic research (Pather & Remenyi, 2019) and can exclude other activities such as engagement or technology transfer (Kyvik, 2013). This categorisation arises through the concept of academic research being “traditionally viewed as theoretical and restricted to an academic environment” (Devasia, 2020, p. 10). As this research strives to focus on individuals undertaking varying research types – basic, applied and/or commercial research – the umbrella term “researcher” is adopted throughout, to represent the population under study. More formally, a researcher is defined as an individual who undertakes research that is “as far as possible … controlled, rigorous, valid and verifiable, empirical, critical, reliable, systematic, arguable, and challengeable” (Abdulai & Owusu-Ansah, 2014). Researchers can, of course, operate outside the academic sphere undertaking research activities in industry for example (Soriano & Mulatero, 2011). Accordingly, for this context of this thesis, the term “researcher” applies to those who operate within an academic institution, unless otherwise stated. Additionally, an academic institution is defined as a higher education entity that provides teaching, research and/or scholarship such as a university or research institute.

* + - 1. Types of Research

The terms Research and Innovation are commonly used together to describe any situation in which new technology is being conceived or produced, however the differences between these terms need clarity. Broadly speaking, research is the development of new knowledge around a particular focal topic, while innovation is the adaptation of this knowledge towards commercial application. A suitable place to start defining these terms is through the OECD Frascati Manual (OECD, 2015), which is an internationally recognised and used tool for the categorisation and analysis of research performance statistics (Amadi-Echendu, 2021; Bentley et al., 2015; De Marchi, 2019; Doyar, 2020; Gaillard, 2010; Moustapha & Yu, 2020). Combining the Frascati Manual with the Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data (OECD & Communities, 2005), the following definitions emerge (Doolin, 2008a):

Research and experimental Development (R&D): “comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge to devise new applications” (OECD, 2015, p. 28) and can be applied to all science and technology fields (Gaillard, 2010).

Basic Research: “experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view” (OECD, 2015, p. 29), “curiosity driven research” (Calvert, 2006, p. 204) or “research undertaken with a primary purpose of the advancement of knowledge for its own sake” (Bentley et al., 2015, p. 690). Reflecting on the work of Nowotny et al. (2003), Bentley et al. (2015, p. 690) also note that basic research can be “variously described as ‘pure’, ‘blue-skies’, fundamental, or disinterested”. The OECD further subdivides the description of basic research by noting that in the case of “Pure Basic Research” the “researcher is expected to have some freedom to set goals. Such research is usually carried out in the Higher Education Sector” (OECD, 2015, p. 50). It adds another category, “Oriented Basic Research” to account for basic research carried out within, or for, a commercial entity. “Oriented basic research is carried out with the expectation that it will produce a broad base of knowledge likely to form the basis of the solution to recognised or expected current or future problems or possibilities” (OECD, 2015, p. 51). Calvert (2001) notes that basic research is increasing in importance, having somewhat fallen from grace in the 1970s and 1980s, particularly due to the emergence of new fields such as biotechnology which require significant basic research.

Applied Research: “original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective” (OECD, 2015, p. 29). The OECD manual notes that:

Applied research is undertaken either to determine possible uses for the findings of basic research or to determine new methods or ways of achieving specific and predetermined objectives. It involves considering the available knowledge and its extension in order to solve actual problems (p. 5).

Marotti de Mello and Wood Jr (2019, p. 339) discuss applied research in terms of “research that follows [the] Mode 2 production of knowledge … : it emerges from a relevant practical issue; … it results in an effectively implemented solution; and whose quality is evaluated by groups composed of researchers and managers. In short, a research that is demonstrably relevant and accurate”. Baimyrzaeva (2018, p. 6) present a somewhat simplified perspective indicating that “research that takes place in an everyday context to solve specific problems of individuals, organizations, and/or industries is called ‘applied research’”.

Experimental Development: “systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products [goods or services] or processes or to improving existing products or processes” (OECD, 2015, p. 29). Importantly, at least in terms of the OECD, the “D” in “R&D” refers to Experimental Development as distinct from, and a component of, “Product Development” which is “the overall process – from the formulation of ideas and concepts to commercialisation – aimed at bringing a new product (good or service) to the market” (OECD, 2015, p. 51).

Innovation: “the implementation of a new or significantly improved product (good or service), or process” (OECD & Communities, 2005, p. 38). The OECD Frascati Manual notes that it defines Innovation for the purposes of the business enterprise sector (p.60) and indicates that care needs to be taken when discussing innovation and its relationship with R&D activities - “R&D may or may not be part of the activity of innovation, but it is one among a number of innovation activities (p60)”. This is an interesting perspective, at least in the Irish research context, where Innovation Activities are heavily promoted and encouraged within the Higher Education Sector. For example, Enterprise Ireland (one of Ireland’s National Funding agencies for commercial research and development activities), provides the following definitions in its guide for an academic-industrial collaborative funding stream called the Innovation Partnership[[1]](#footnote-1):

Industrial Research….focuses on bringing together new knowledge and skills for developing new products, processes or services or bringing about a significant improvement in existing products, processes or services… (Enterprise\_Ireland, 2019, p. 7).

Experimental Development… focuses on bringing together existing knowledge and skills to produce plans designs for new, altered or improved products, processes or services (Enterprise\_Ireland, 2019, p. 7).

Bringing the above concepts together, Commercial Research refers to research activities conducted within academic institutions with the aim of generating economic value, fostering innovation, and promoting collaboration with industry and business (Caulfield & Ogbogu, 2015). Real-world problems are addressed through the application of academic knowledge, resulting in the development of new products and services, and the creation of intellectual property. Commercial research often leads to partnerships with private companies, licensing agreements, and spin-off ventures (Baydoun et al., 2022).

Another perspective on these categorisations is provided through Stoke’s Quadrant Model of Scientific Research (Doolin, 2008a; Fisher et al., 2001, p. 302), which defines the nature of research work being carried out relative to its level of application, as shown in Table 1.

Table 1   
*Stoke's Quadrant Model of Scientific Research*

|  |  |  |  |
| --- | --- | --- | --- |
| Research Inspired by: |  | Considerations of Use? | |
|  | No | Yes |
| Quest for Fundamental Understanding? | Yes | Pure basic research (Bohr) | Use-inspired Basic Research  (Pasteur) |
| No | Research directed to particular phenomena  (Wissenschaft) | Pure Applied Research  (Edison) |
| (Fisher et al., 2001 p.302) |  |  |  |

Earlier scholarly work on the nature of knowledge production tended to adopt a relatively static view of the process, in terms of a linear model (Benoît Godin, 2006), which posited a transition in research types from basic to applied to commercial research, and which could even today be implied through a reliance on the definitions used by OECD and others. More recent work (for example (Johnson & Taylor, 2019; Lambovska & Yordanov, 2020; Rossi et al., 2020; Slaughter, 2019)) has focused on further detailing these various descriptors of research types and has examined each through the lens of various stakeholders such as academia and government, resulting in a number of models of knowledge production as presented in Section 2.2.2, below.

For completeness, the concepts of trans-, multi- and inter-disciplinary research need to be considered (Doolin, 2008a), and can be summarised as shown below (Bruce et al., 2004)

Table 2   
*Research categorisations adapted from (Bruce et al., 2004)*

|  |  |
| --- | --- |
| **Research category** | **Description** |
| Transdisciplinary research | Knowledge is organised around heterogeneous domains, rather than in a traditional academic disciplinary structure |
| Multidisciplinary research | Research is approached from the perspective of a number of disciplines. Little cross-fertilisation of results or synergy of outcomes |
| Interdisciplinary research | Research is approached from the perspective of a number of disciplines. Contributions of disciplines are integrated to provide a systemic outcome |
| Mode 1 interdisciplinary research | Researchers from various disciplines work together to enable a particular discipline to move into new and productive areas of research. |
| Mode 2 interdisciplinary research | Researchers from various disciplines work together to address problem-oriented issues of social, technical and/or policy relevance. |

* + - 1. Research Orientation

The term ‘research orientation’, defined by Ooms et al. (2019) relative to Stokes’ quadrant model, as an individual’s focus on, and beliefs around the place of, basic, applied and/or commercial research, is chosen for this thesis as it is widely used in the literature (Perkmann et al., 2021; Plantec et al., 2023; Tagliaventi et al., 2020). For example, Beck et al. (2022) discuss the impact of knowledge transfer policies (such as the Bayh-Dole Act in the US) on research orientation of individuals. Their work also echoes that of Forliano et al. (2021) in which the effects of peer orientation are noted to impact on the individual’s research orientation. Hayter et al. (2021) present a negative perspective on this and note that in some cases senior researchers penalise postdocs that seek out training to support a research orientation towards entrepreneurship. This issue, related to social capital, is further discussed in Section 3.4.1.3. Heng et al. (2020) broaden the discussion to include the primary research orientation of an academic institution, and how it impacts on the individual researcher’s own research orientation. They also draw an association between research orientation, the impact of individual motivations, and research performance and suggest that having a strong basic research orientation is a key characteristics for high performing researchers. This research builds on the work of Heng et al. (2020) through an examination of the impact of institutional policies and supports related to research and technology transfer activities (Section 3.4.2). Lievens et al. (2022) found a correlation between an individual’s level of curiosity and their research orientation, particularly focusing on basic research. Suominen et al. (2021) echo the work of Beck et al. (2022) where they discuss that the orientation of an academic institution can limit researchers "ability to focus on the intrinsic motivations of scientific research, pushing researchers toward research activities for application and commercial exploitation" (Suominen et al., 2021, p. 2). Lam and de Campos (2015) and Lam (2011) undertook research that focuses on identifying the research orientation of individuals based on multiple factors, including motivations. This approach, which is adopted in this research, is further discussed in Section 3.2.

What is clear from the above is that today’s researcher is faced with a multitude of options in terms of research orientation. While research orientation is one aspect to consider, associated modes of knowledge production and systems of innovation are another, as discussed below.

* + 1. Modes of research and systems of innovation
       1. From Mode 1 to Mode 2

Beyond the fundamental definitions of research activities, extant literature has produced a number of models which define not only the nature of research, but also its application and external influencing forces.

The ‘Mode 1’, or ‘normal science’, (Kuhn, 1977; Kunseler, 2007) and ‘Mode 2’ research labels were coined by Gibbons et al (1999), as a means to distinguish between traditional single-discipline scientific research developed in relative isolation and multi-disciplinary science which is heavily influenced by external forces such as funding bodies.

Martin (2003) discusses the emergence of Mode 2 as a response to a new social contract for science and universities, whereby Governmental agencies required explicit research agendas rooted in social goals, in return for public funding. He notes that there is an incorrect perception that science is under threat:

In this respect, the traditional categorisation of research as either ‘basic’ or ‘applied’ is misleading; it implies that research which is in some way linked to an application cannot also be basic in nature, in turn suggesting (erroneously) that greater concentration of effort on the former can only be at the expense of basic research (p. 16).

Miller et al (2018) differ in their definition somewhat, indicating that Mode 2 represents a technology-push model. They suggest that while Mode 1 refers to “the traditional role of Universities in developing basic research leading to societal learning and education. Mode 2... refers to Universities’ newer role in [Technology Transfer activities] leading to the commercialisation of technology” (p. 10).

The table below briefly summarises the main characteristics and differences between these two modes of research (Doolin, 2008a).

Table 3   
*Comparison of Mode 1 and Mode 2 knowledge production*

|  |  |  |
| --- | --- | --- |
| **Mode 1** | **Mode 2** | **Comment** |
| Academic context | Context of application | Under Mode 1, research problems are governed by largely academic interests.  Mode 2 knowledge is developed in the context of an application i.e. is more focused on solving a specified problem |
| Disciplinary | Transdisciplinary | Under Mode 1, research agendas are determined within a disciplinary framework.  Mode 2 utilises the mobilisation of multiple theoretical perspectives and practical methodologies to solve a problem. |
| Homogeneity | Heterogeneity | Mode 1’s community of discourse is predominantly homogeneous, i.e. focused within a single organisation.  Mode 2 knowledge is produced using collaborative efforts across multiple organisations. |
| Autonomy | Reflexivity | Mode 2 relies on a dialogic process, as compared to Mode 1 where a researcher would often work in isolation. |
| Traditional quality control | Novel quality control | Mode 1 follows the traditional peer-review process for research results, whereas Mode 2 incorporates a wider set of quality criteria influenced by economic, political and social factors. |

Returning to Stokes quadrant model above, Fisher et al (2001) locate Mode 1 within Bohr’s Quadrant and Mode 2 in Edison’s Quadrant. Critically they note that the “Mode 1 / 2 distinction posed by Gibbons et al does not provide room for another Mode based on Pasteur’s Quadrant where research is ‘dedicated to both understanding and use’ (Fisher et al., 2001, p. 322). This notion is supported by Beesley (2003) who states that while Mode 1 and Mode 2 “allow society to create a distinction between basic and applied research, in reality the two kinds of research are ‘rarely so distinct from one another’ (Beesley, 2003, p. 1520)” (Doolin, 2008a, p. 11).

Other works have emerged which document the transition of scientific research from a purely linear model to a complex situation echoing, while not specifically referring to, Mode 1 or Mode 2 science. Caraça et al. (2009) discuss the various forces that can apply to a linear model of science, moving from a “chain-linked model” (Kline & Rosenberg, 1986) to what they call a “multi-channel interactive learning model” (Caraça et al., 2009, p. 4). Similarly, Chesbrough (2003) focused on the concept of open innovation in an enterprise setting. While these works present an interesting perspective of the innovation cycle, they are centred on research and innovation within the enterprise rather than academia, and so are out of scope for this thesis.

Carayannis and Campbell (2010) introduced the idea of a third mode of knowledge production (Mode 3) which somewhat blurred the lines between Mode 1 and Mode 2 by acknowledging the “pluralism and diversity of knowledge and innovation modes as being necessary for advancing societies and economies” (Carayannis et al., 2012, p. 3), or simply stated by identifying that Mode 1 and Mode 2 science have become ever more inter-reliant, particularly when external forces such as commercial need enter the fray.

Recently, Carayannis et al (2018) posited that:

'Mode 3' university represents … a type of open, highly complex, and non-linear knowledge production system that seeks and realises creative ways of combining, recombining, and integrating different principles of knowledge production and knowledge application (e.g., 'Mode 1' and 'Mode 2') (p. 1).

Their work, concurring with Nowotny et al (2003), suggests that Mode 2 research emerged as a result of three major influencing factors (Doolin, 2008a):

Stakeholder Steering: Across international, national and regional levels, providers of research funding are increasingly influencing specified research topics and priorities (Nowotny et al., 2003), and as will be discussed in Section 3.4 this in turn influences individual’s research orientation.

Research Commercialisation: The increase in value of research outputs has created an impetus for organisations to gain profits from their research activities. This is exacerbated by two main factors. Firstly, a reduction in public spend on research has driven researchers to find other sources and secondly, academic institutions are increasingly cognisant of, and measured by, the value of generated Intellectual Property (IP) (Doolin, 2008a; Gans, 2003). This then influences the focus of a researcher’s work, and has also been presented as the concept of Academic Capitalism (Slaughter, 2019), as discussed in Section 2.3 below.

Accountability: The increased emphasis on evaluating the outcomes and quality of scientific work has caused a competitive research environment to emerge throughout the research system (Nowotny et al., 2003). Calvert (2001, p. 2) highlights that:

the history of the funding of basic research from the 1950s to the 2000s has shown a move away from the idea that scientists should be supported as autonomous truth-seekers towards the idea that they should orient their work rather more toward social and economic objectives. Simply put, there has been a parallel decline in autonomy and an increase in accountability.

According to van Helden and Argento (2021) this has given rise to a situation whereby “competitive accountability has become an important facet of academic praxis, but it is harmful to the moral authority of academics and the societal contribution of science” (p. 330). Additionally, requirements for validation and measurement of research outputs and value has created a scenario whereby ‘safer’ research work is carried out, thereby reducing the level of higher-risk basic research (Doolin, 2008a). Accountability and risk aversion, from an individual researcher perspective, is further discussed in Section 3.3.1.

* + - 1. Triple, Quadruple and Quintuple Helix

The Triple Helix model emerged as a result of observed interdependencies between the research body (academia), government and industry (Doolin, 2008a; Leydesdorff & Etzkowitz, 1998; Leydesdorff & Meyer, 2006; van Rijnsoever et al., 2008). “It is essentially a complementary theory to the Mode 2 process of knowledge production whereby Mode 2 describes the emerging research process and the Triple Helix takes a broader perspective by describing the societal influences that have caused Mode 2 to be identified (Etzkowitz et al., 2000)” (Doolin, 2008a), and which effectively “replaces the more linear model of knowledge production and utilisation (i.e. theoretical/basic research leading to applied research leading to technology transfer and production of goods) (Macdonald & Maclntyre, 1997)” (Doolin, 2008a). Philpott et al. (2011, p. 161) support this contention and note that “historically accepted ‘linear’ models are now being surpassed by the contemporary and dominant view that innovation is most appropriately perceived as a systemic, networked phenomenon”.

Earlier academic work related to the Triple Helix has been relatively silent regarding the “institutional mechanisms that enable or hinder the development of new forms of knowledge production” (Benner & Sandström, 2000, p. 291), whereas Triple Helix “explicitly addresses concrete and pressing problems of government, academic and industrial policy” (Shinn, 2002, p. 604).

Benner and Sandström (2000) note that the normative boundaries of the university system, which included collegiate- rather than public- based evaluations of research quality and outputs, have been eroded due to industrial and political interests within the knowledge economy. This is echoed in the work of Calvert (2006) which examines what policy makers seem to want from basic research compared to, importantly, what researchers consider relevant to the ‘outside world’. This points to a tension in beliefs between academic and external stakeholders. Furthermore, Calvert (2006) posits that the definition of basic research is changing since:

if the intentions behind the research are to produce something that will result in an application, no matter how fundamental the research may be in an epistemological sense, the research will no longer be classified as basic (p. 204).

Benner and Sandström (2000) add to this discussion by highlighting three key spheres of influence on the researcher by stakeholders:

coercive, normative and cognitive: their operational routines and administrative structures form the basis for the researchers’ [research / funding] applications. Their criteria for evaluation can, to a large extent, be expected to influence the normative orientation among researchers. Finally, their decisions indicate for research groups the types of research performance and organization that are rewarded (p. 292).

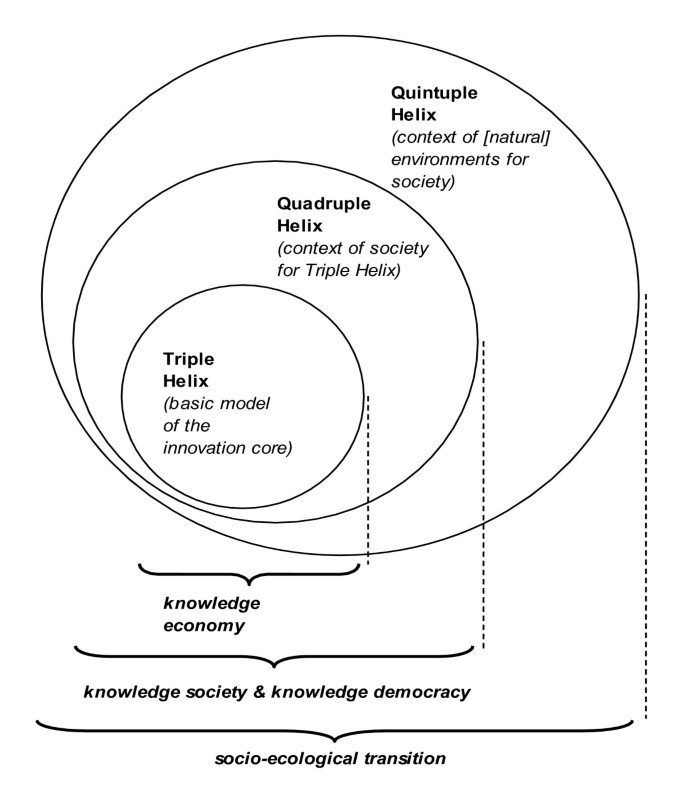
Benner and Sandström (2000) note that EU-funded research “is evaluated on the basis of its relevance for industrial interests and its connection to actors and research interests outside the academic system” (p. 297), reflecting a particularly applied research focus.

Adding another dimension to the discussion, Van der Meulen (2003) posit that “the position of research councils in the research systems changes and funding practices have to be adapted to the new needs of the main stakeholders: government; scientists; and, increasingly, industry” (p. 323), while in parallel researchers have become less reliant on Research Council funding.

Čadil and Kostić (2018) add another perspective to the mix when they discuss the concept of the ‘Engaged University’. According to them, the primary difference between the University in the Triple Helix and the Engaged University models, is that in the Triple Helix the University is seen as a driver of economic and social development, whereas in the Engaged University model it is seen as being subservient to the needs of society.

Addressing a perceived ineffectiveness of the Triple Helix from the perspective of the requirement to have a policy tool that supports “more open and co-creational [University Technology Transfer] involving societal based innovation” (Miller et al., 2018, p. 9), in 2009-2012, Carayannis et al. (2012) further expanded the reach of the Triple Helix model by introducing a fourth helix (Carayannis & Campbell, 2009) which accounted for ‘media-based and culture-based public / civil society’ and a fifth which includes ‘natural environments of society’ which serves to contextualise the fourth. They posited that these Quadruple and Quintuple Helix innovation models enabled a more comprehensive view of the complete knowledge production process (Carayannis et al., 2012), as shown below.

Figure 1   
*Quintuple Helix Model of Knowledge Production and Innovation (Carayannis et al, 2009, p4)*



Their work has gained some traction in contemporary literature, with multiple authors drawing on the Quintuple Helix model to characterise the evolution of knowledge development and transfer in Academia (Farinha et al., 2016; Galbraith et al., 2019; McAdam et al., 2017; Miller et al., 2014; Miller et al., 2018). For example, Galbraith et al (2019) draw on the concept of the quadruple and quintuple helix to contextualise the evolution of technology incubators which draw collaborators together to address sustainability challenges.

Miller et al (2018) highlight the importance of the quadruple helix model, but note the lack of a set of supporting conceptualisations and coherent frameworks to enable its use as an analytical tool. On their journey to produce a suitable framework, Miller et al (2018) identified a number of key themes which they deemed critical to understanding the intricacies of the quadruple helix and its influence on technology transfer in academia. Each of these in turn asserts influence on the individual researcher and their career decisions, for example:

Tension between basic research and commercialisation activities – the quadruple helix, which requires the involvement of multiple stakeholders in the research process, is likely to heighten tensions between the academic scientific community and the third parties seeking to exploit research results. Miller et al (2018) note that attempts have been made to ease this tension, such as the 1980 Bayh-Dole Act in the USA (which created opportunities for academics to benefit from the fruits of their research through patenting and licensing (Grimaldi et al., 2011)). However, they also note that this has created an over-reliance on technology-push, which in turn lessens the desired societal-pull effect of the quadruple helix.

Development of stakeholder relationships – here the authors note that “the ‘soft infrastructures’ based on societal based innovation user stakeholder interactions (networking, knowledge transfer, social capital) are just, if not more important” (Miller et al., 2018, p. 20) than hard-infrastructures. Additionally, they highlight the importance of the academic entrepreneur, and their ability to engage with multiple stakeholders outside the basic research setting. As will be discussed later (Section 2.4) this social capital is posited to play a significant influential role on the individual researcher’s career decisions.

Organisational structures for technology transfer – in this theme the authors highlight the importance of regional stakeholders (e.g., local government) being realistic in terms of the entrepreneurial capabilities of a particular region and note a reluctance in many regions for local industry to engage with researchers. They (Miller et al., 2018) also note the criticality of a well-funded, staffed and supported Technology Transfer Office (TTO) in the academic institution, as will be discussed in Section 2.4.2.

In pursuit of a research agenda relating to the quadruple helix, Miller et al (2018) note the “lack of research exploring issues of trust, relationship building and tacit knowledge sharing to reflect the increasingly complex ‘people’ based aspects of technology transfer in a quadruple helix ecosystem” (p. 27). They also call for research which identifies the importance of the academic entrepreneur when it comes to stakeholder engagement for technology transfer. Additionally, they say:

future research needs to explore how internal mechanisms, policies and structures can be designed to motivate academics to engage more collaboratively with industry and societal based innovation users. Furthermore, there is a need for future research to determine commonalties and differences between stakeholders’ perceptions of more collaborative technology transfer (p.27).

* + - 1. EU Knowledge Triangle

In 2011, Soriano and Mulatero (2011), while preparing a Joint Research Council policy brief, introduced the term Knowledge Triangle (KT), to represent the “integration of research, education and innovation” (Soriano & Mulatero, 2011, p. 2). Their work acknowledges the Triple Helix (and ‘Innovation Ecosystem’) as a means to:

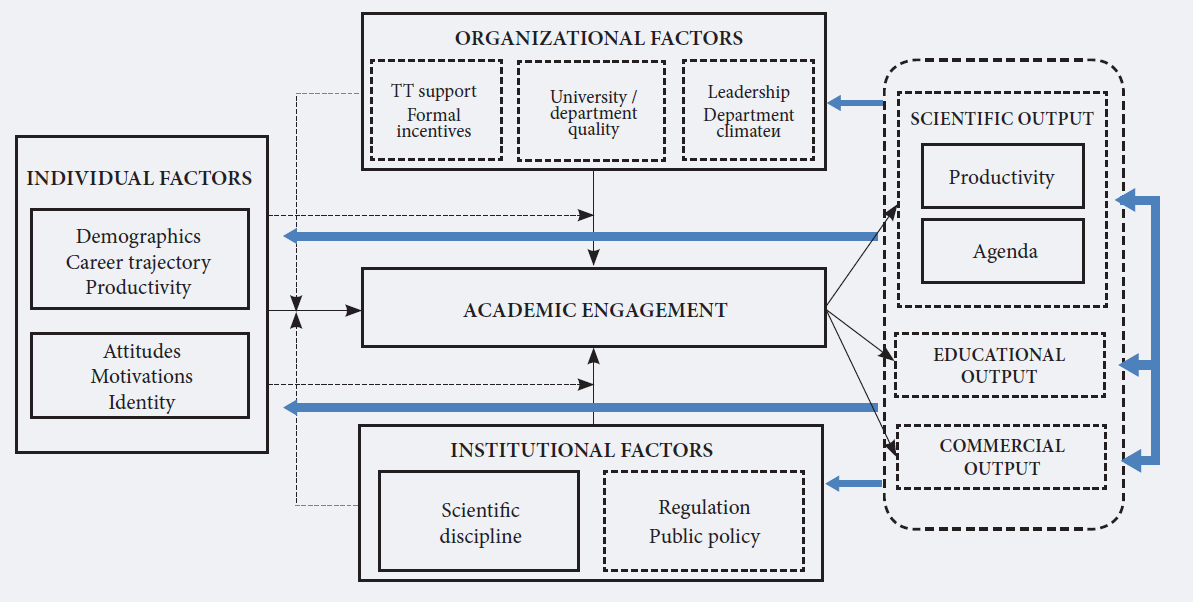
focus on the non-linearity of an innovation system and self-reinforcing trends, externalities leading to virtuous or vicious circles, and on the importance of not simply getting the single piecemeal policies right but also embody the linkages between them in policy action and pay enough attention to framework conditions (p.3).

However, Unger and Polt (2017) posit that the Triple Helix takes a less systemic view of innovation compared to the Knowledge Triangle, as it focuses on individual actors and dimensions (Unger et al., 2018). Additionally, they make the distinction between KT and TH, saying:

whereas the KT employs an activity-oriented approach to linking the spheres of education, research and innovation, the triple helix considers the actors in the respective national or sub-national innovation systems as a starting point. Hence, the concept of the KT is a functional model of interaction among these three areas (p. 11).

Importantly, Unger and Polt (2017) provide a useful framework for analysing the external engagement of researchers, relative to the KT paradigm, as shown in Figure 2. It is interesting to note that Individual Factors are proposed as antecedents to academic engagement, and that both organisational and institutional factors are proposed as moderators on this relationship.

Figure 2   
*Unger and Polt's (2017) analytical framework*



Soriano and Muatero (2011) provide another interesting perspective, identifying the bidirectional relationship between commercial innovation and research within academic institutions. They note that commercial innovation (which typically progresses at a more rapid rate than academic) often increases the pace of innovation in academia, and they note that:

On the policy side, while in many countries there has been an increase in the integration of research and innovation policies in recent years, the relation between R&D and innovation still seems to suffer from a unidirectional approach going from R&D to innovation (p. 5).

This implies an industry-pull mode of influence on an individual’s research orientation.

Čadil and Kostić (2018) examined how the Knowledge Triangle influenced national (Czech) policies and resulting university behaviours, through a combination of desk based research and interviews. Interestingly, Čadil and Kostić (2018) note a particularly low level of collaboration between industries arising from disinterest, and from the current Czech evaluation method for research outputs which focuses primarily on scientific publications. They also note that this is a symptom of the Czech Republic lagging behind the European average in terms of industry-academic engagement. This is reflective of the research orientation of an academic institution directly influencing that of an individual researcher. This view is echoed, in the Latvian context, by Purgailis et al (2017) who found that higher education levels do not have a strong impact on innovation and science.

Returning to the issue of examining whether policies/models such as the Knowledge Triangle are impacting on researcher outputs, Vonortas (2017) draws on the concept of ‘openness’ to highlight that there is an expectation that all (or at least the majority of) research outputs (publications and data for example (Chataway et al., 2017)) should be made open and freely available. Raunio et al (2018) clarify the concept by highlighting it as a “Knowledge Triangle policy tool” (p. 62). While openness is a laudable concept, it has raised some concerns, for example many researchers desire to publish in high impact journals that are not categorised as open access, while others consider open science activities to be too time-consuming and potentially less rewarding from a career perspective (Chataway et al., 2017). Building on the concept of openness, Beck et al. (2022) discuss the concept of open innovation which they define as a "distributed innovation process based on purposively managed knowledge flows across organisational and sectoral boundaries using pecuniary or nonpecuniary mechanisms" (Beck et al., 2022, p. 138). They note that policies such as the Bayh-Dole Act in the US have caused "increase in patenting and licencing activities at elite universities as well as at universities that were previously inactive in the area of knowledge transfer" (Beck et al., 2022, p. 157), which they note impacts on an individual’s research orientation - causing a shift from basic research towards applied and commercial work. Furthermore, Chataway et al (2017), discussing the impact of a researcher’s career stage, refer to a 2014 knowledge exchange report (Van den Eynden & Bishop, 2014) on data sharing which found:

that early career researchers feared getting scooped (having results published by someone else before the researcher has published them) and the potential embarrassment of publishing immature or potentially inaccurate data. Mid-career researchers did not fear embarrassment, but did worry about their research results getting scooped. Further, they hoped to maximize the number of publications they could get from a data source and hence may not have wanted to share it (p.49).

While the KT’s ambition is to create bi-directional knowledge flows, there is not a strong body of evidence to acknowledge its implementation in practice (Bouras et al., 2016; Lassnigg et al., 2017), indeed there seems to be concentration on a unidirectional diffusion of knowledge.

There remains an alternate view however. Sitnicki (2018) for example, having studied a broad set of characteristics for the world’s top-ranked academic institutions concluded that pursuit of academic excellence and reputation, combined with top class scientific citations is the key to high rankings – notably technology transfer or industry engagement is not referenced in his categorisations.

* + - 1. National Systems of Innovation

Marques et al. (2006) draw comparisons between the Triple Helix and National Systems of Innovation, saying that these are conceptually different since the Triple Helix:

affirms the existence of a spiral pattern of relations and links between the three institutional actors: Industry, University and Government, in which the university tends to have a critical part to play in the context of a knowledge-based economy (p. 44).

Leydesdorff (2018) queries conventional definitions of National Systems of Innovation (NSI), positing that the Triple Helix (TH) provides a more holistic framework for examining the interplay between stakeholders in the innovation process:

NSI combines the claims that innovation is systemic, that innovation systems are evolving, and that they are organized institutionally, and therefore influenced by and susceptible to government policies at national or regional levels. NSI thus seeks to combine the perspectives of policy analysis, institutional analysis, and (neo-)evolutionary theorizing. However, the metaphor is misleading: innovation is not taking place within administratively bordered nations and innovation is not necessarily systemic (p. 1).

This view is supported by numerous theorists (Afzal et al., 2018; Sarpong et al., 2017; Sharif, 2006; Strand et al., 2017) who indicate that the difference between NIS and TH is that the NIS is more firm centric, while TH is systemic.

Bercovitz and Feldmann’s (2006) framework to illustrate the role of the university within systems of innovation strives to help understand the university/industry relationship. Their work identifies a number of what they call “sequential transactions such as sponsored research, licences, spin-off firms and the hiring of students” (Bercovitz & Feldman, 2006, pp. 176-177). Importantly, Bercovitz and Feldmann (2006) note that prior research into the university-industry relationship has had a relatively simplistic, narrow view, often neglecting the combined “formal and informal interactions” which:

are influenced by firm strategy and industry characteristics, university policies as well as the structure of the technology transfer operations and the parameters defined by government policy (p. 177).

Mansfield (1992) contends that approximately 10% of innovation emerges from academia, however he notes from the outset that his research ignores long-term effects of such research, thereby casting some doubt on the validity of this estimate. Spencer (2001) undertook a statistical analysis (using citation counts from research published by researchers versus industrial scientists) to determine whether academic or industrial/corporate research had a greater impact in terms of exploitation of results. His results identified (at least in the case of Japan and the USA) that in the case of Japan, corporate scientific publications received more citations, however in the USA there was relatively little difference between industrial and academic publication citations. This highlights that the diffusion of scientific research is highly contextual. These results can be taken with a degree of caution however, as they are based on the underlying assumption that higher numbers of citations (from corporate researchers) implies a higher relevance to corporate R&D activities. Raunio et al (2018), studying knowledge transfer in Finland (qualitative, interview based research) found, somewhat alarmingly, that:

while the share of the companies cooperating with HEIs was 33%, only 4.9% of firms announced that the interactions with the university mattered. Still, both figures are significantly higher than the average among EU .... In short, HEIs’ impact upon firms’ real innovative outcomes can be considered as rather moderate and typically more indirect and therefore perhaps difficult to recognize, than direct and linear (p. 65).

A 2012 Technopolis Report supports this contention, saying that:

Most patent transfers or licence agreements entail additional interactions and collaborative activities to transfer the complex ‘tacit’ knowledge required to fully understand technology and develop it further. In fact licences are often the result of much longer-term relationships between universities and businesses and IP is licensed to businesses already known to the university or academic inventor (Technopolis, 2012, p. 3).

Raunio et al (2018) shed some more positive light on the situation however, when they note that in terms of personal benefits accrued by researchers the act of being involved in helping to solve grand societal challenges can be as rewarding as financial gain. This is an interesting perspective that warrants further research and is expanded on in section 3.3 of this thesis relative to the impact of individual researcher’s motivations on their research orientation.

O’Shea et al. (2005) contend that greater levels of industry-level funding can be associated with higher levels of technology transfer, and that the same can be said for public funds dedicated to university-industry collaboration. Presenting an alternative perspective, Chataway et al (2017) highlight that increasing levels of patenting activity, driven by technology transfer initiatives and financial pressures, are causing a situation whereby patented research results are somewhat over-hyped, and that this leads to investor disillusionment.

At this juncture this thesis has examined the multiple models of research and innovation, from multiple theorists. The following section builds on this discussion by discussing the emergence of the related concepts of the entrepreneurial and neoliberal university.

* 1. The impact of the entrepreneurial and neoliberal university

Demeritt (2000), in his examination of the impact of social/economic relevance on the freedom to carry out basic science, cites the Triple Helix as a relevant model, and notes that “the call for increased public accountability comprises one major reason why academic inquiry is now increasingly conceptualized in terms of research outputs” (p. 310), and that “researchers are increasingly subject to the demands of paying customers in government and industry” (p.320). Etzkowitz et al. (2000) soften this perspective of impact somewhat when they note that the ‘entrepreneurial university’ (defined as “a university that embraces its role within the triple helix model and adopts the mission of contributing to regional/national development” (Philpott et al., 2011, p. 162)) enables basic science to carry on, but encourages new ways of engagement with stakeholders to boost external applicability of results. Despite the much-heralded era of the entrepreneurial university, however, this paradigm shift is not without its difficulties, particularly considering Etzkowitz et al.’s (2000) contention that the entrepreneurial university has become pervasive across all types of academic institutions, albeit in varying degrees.

Understanding participation in commercial science remains an important puzzle for those studying the academic-commercial boundary, including policymakers intent on increasing rates of technology transfer (Murray & Graham, 2007, p. 661).

Notwithstanding this entrepreneurial focus within academic institutions, based on their review of extant research Hossinger et al. (2020) suggest that “even though one third of scientists believe it is very attractive to establish a spin-off, just one in three of these eventually devotes him or herself to the process” (p. 98).

A substantial focus within extant research on the topic of the entrepreneurial university has been on the institutional goal of valorisation of research, and this can be seen as a response to political and social pressure in this regard (Wardle et al., 2019). Caulfield and Ogbogu (2015) acknowledge the importance of research valorisation, although they tie the concept firmly to a commercial research orientation, and examine the associated pressures on individual researchers, suggesting that:

there are very few research funding opportunities that are not touched by the commercialisation ethos. If researchers want funding, they will now need to frame their work in a manner that accords with the growing political view that universities ought to play a central role in the growth of economies, or to accord with national or regional economic priorities (p. 1).

Drawing the discussion back from the commercial perspective, Philpott et al. (2011, p. 163) identify multiple non-commercial ways in which the entrepreneurial university, and the researchers therein, can contribute to economic development and financial advantage, such as production of high quality graduates “capable of meeting current and future industry demands”, or publishing academic results and grantsmanship which can enhance the reputation of an academic institution and attract industrial engagement in a region. Audretsch and Belitski (2022, p. 286) concur, and posit that “the role of the university in the entrepreneurial economy is broader than simply investing in knowledge and then transferring it to industry”. Audretsch and Belitski (2022) identified a three-dimension model (Figure 3), drawing inspiration from modes of knowledge production and systems of innovation which demonstrates the interplay with, and influence on, the individual researcher and concur with (Philpott et al., 2011) insofar as

greater involvement in knowledge creation and commercialisation among researchers, sessional lecturers and students at university is possible when investment in knowledge is followed by the creation of a variety of entrepreneurial opportunities for scientists (e.g., conferences, research grants, publications, industry contracts) and students (e.g., starting their first business, consultancy, internships, and work placements) (Audretsch & Belitski, 2022, p. 292).

Figure 3   
*Audretsch and Belitski (2022) Three-dimension model of the entrepreneurial university*

A diagram of a diagram

Description automatically generated

A more extreme iteration of the entrepreneurial university is the ‘neoliberal university’ which seeks “to advance forms of thought and innovation that connect to market-driven and market-like opportunities, consistent to some extent with notions of academic capitalism” (Rhoads, 2018, p. 12).

Hodgins and Mannix-McNamara (2021, p. 11) describe the neoliberal university as having a preoccupation “with efficiency and output not only as part of the rankings game but also within other more localised ‘games’, such as quality reviews, research assessments exercises, strategic target reporting or performance appraisals”, and cite the resulting “regime of performativity” (p.11) as having significant direct and indirect impact on university staff. Similarly Hessels et al. (2009) highlight that expectations of ‘relevant’ research outcomes, by policy makers, causes a stress on the research ecosystem which is passed through academic institutions towards the individual researcher. Edwards (2022, p. 905) presents the situation as one where “individual academics embrace or are exhorted to comply with competitive ideas about what constitutes success, with both success and failure framed and understood as personal accomplishment, disconnected from the wider social, economic and political context”. Hessels et al. (2009) direct the problem of relevance back towards the policy-makers, indicating that they have a number of fundamental problems to overcome. These include pushing researchers to respond to politically specified requirements, prioritising the ‘best’ researchers for selection relative to funding calls, ensuring that researchers are doing their utmost to solve their delegated problems and tasks, and decision-making and priority-setting in terms of knowing what needs to be done.

Macfarlane (2021, p. 462) focuses the neoliberal university discussion on researchers’ identities and notes that being classified as ‘research-active’ is imperative. This status, he says, is “essential to academic prestige and the maintenance of career prospects, [and] is defined in terms of just three activities: producing ‘outputs’ (such as journal papers and books) judged to be of a high quality in national research evaluation exercises, the generation of research income external to the institution, and supervising doctoral students to completion” (Macfarlane, 2021, p. 462). Furthermore, Macfarlane (2021, p. 460) provides notable examples of the impact of neoliberalism in academia

the importance of obtaining research grants from prestigious funding organizations; pursuing a research agenda largely shaped by such organizations and universities keen to orientate their academics towards meeting society’s so-called grand challenges; and entering into the personal marketing and self-promotion of academic work to prove the ‘impact’ of one’s scholarship.

Building on this, Edwards (2022, p. 906) suggests that

the nature of knowledge production in universities also is altered, with funding bodies dictating institutional research priorities, and institutions shaping individual research priorities, diminishing researcher autonomy and stifling creativity. Researchers operate in a research marketplace driving the world of universities, where research is ‘bought’ and ‘sold’.

Tülübaş and Göktürk (2023) agree and highlight the resulting erosion of academic identity, which they describe as “the experiences, ideas, beliefs and values of academics regarding the core values and principles of academic work” (p139). In particular, they suggest that “corporate, business-like norms of neoliberalism permeating academy have begun to exchange the academic ideals of devoting oneself to intellectual inquiry, collegiality and freedom with competition, strong consumer orientation, devotion to economic rewards and decreased autonomy” (Tülübaş & Göktürk, 2023, p. 140). Philpott et al. (2011, p. 164) add a cautionary perspective and suggest that “achieving the right alignment between the missions of teaching, research and economic development is crucial in building an entrepreneurial university”.

The decline in the pursuit of intellectual inquiry and associated academic freedom (Macfarlane, 2023), is reflected by MacFarlane’s (2021, p.461) contention that “disinterestedness is now increasingly undermined by the twin forces of postmodernism and neoliberalism”, and that a demonstrable capability of researchers across all academic disciplines to secure grant funding is now essential for promotion to higher academic ranks (McAlpine, 2020) to the extent that “‘get grants or perish’ is fast replacing ‘publish or perish’ as the key performance practice of the academy under pressure from senior managers and administrators who, in turn, are responding to the tight financial environment prevalent in many higher education systems” (Macfarlane, 2021, p. 462). Edwards (2022) suggests that this drive for external funding and associated research outputs has given rise to some researchers undertaking ‘unfunded research’ (research which is not funded through external entities, but which researchers see as a requirement of their academic contract) as a form of resistance and a means to retain their academic identity and autonomy, with others undertaking ‘unfunded research’ as a means to contributing to the greater good of their host academic institution. Establishing a balance within the academic institution is imperative, as noted by Philpott et al. (2011, p. 167)

this movement by the university towards this third mission is perceived by certain academic disciplines as ‘a threat to the purpose of a university’ and thus efforts are failing to effectively leverage potential synergies with the traditional missions of teaching and research.

Indeed, research undertaken by Philpott et al. (2011, p. 168) highlighted that many researchers

misunderstood the term ‘entrepreneurial university’ and instead equated it primarily with research commercialisation. They also associated development towards the ideal with a reduction in the scope for basic research and educational freedom.

Aligned with the emergence of the neoliberal university is the impact agenda (which is embodied in initiatives such as the Research Excellence Framework (REF) in the UK (Reed et al., 2021)). Golhasany and Harvey (2022, p. 2) posit that the impact agenda “refers to the heightened expectations of academia’s contributions to society through the generation of more relevant knowledge to address contemporary challenges or concerns”, while Derrick (2019, p. 389) notes that empirical research is producing “indications of how an emphasis on impact beyond academia as a pervasive and/or formalised norm of research excellence has re-orientated the way contributions from research areas, or individual researchers, are valued, and therefore how knowledge is produced and research performed”. Echoing this discussion, and focusing on research orientation, Olssen (2016, p. 137) says

Putting aside the issue as to whether having a high impact makes one’s research better, it is likely to ‘marketise’ research in a chillingly-new way, for it will constitute a ‘structural selectivity’ or ‘pressure’ forcing every academic into hustling and hawking their wares to the media, and into fervent ‘networking’ to ‘end-users’ in society.

In recent years the categorisation of research outputs, and associated performance evaluation, has transitioned to a mixed model. Historically for example, basic research metrics consisted primarily of publications (of multiple types). Now, funding agencies have adopted a more blended approach to evaluation of research results (Azoulay et al., 2009; Borrego et al., 2010; Chataway et al., 2017). To exemplify this, consider the case in Ireland. The majority of nationally funded basic research comes under the remit of Science Foundation Ireland[[2]](#footnote-2) (SFI). SFI requires the following (Table 4) key performance indicators to be reported by the scientific centres it supports:

Table 4   
*SFI Research Output Metrics*

|  |  |  |
| --- | --- | --- |
| **Academic Outputs** | **Technology Transfer** | **Industry Engagements** |
| Refereed original articles | Invention Disclosures | Number of industry collaborators |
| Refereed review articles | Patent applications/awards |  |
| Refereed conference/meeting proceedings | Standards approved | **Outreach initiatives** |
| Edited conference/meeting proceedings | Number of spin-out companies founded | Number of outreach initiatives |
| Book chapters / books authored edited | Number of licences |  |
| Invited presentations | **Funding diversification** | **Human Capital Outputs** |
| Scientific awards won | Leveraged funding | PhDs awarded |
| Conferences/workshops organised | Diversified funding | Masters awarded |
|  |  |  |

At the other end of the (Irish) research spectrum lies Knowledge Transfer Ireland[[3]](#footnote-3) (KTI). KTI focuses exclusively on knowledge transfer from academia to industry, and its core research metrics are as shown below.

Table 5   
*KTI Research Output Metrics*

|  |  |  |
| --- | --- | --- |
| **Spin-outs/Licences** | **Industry Collaboration** | **Other Outputs** |
| Number of acquisitions of intellectual property | Number of live research collaborations with industry | Number of new patent applications from research performing organisations |
| Number of spin-outs thriving at least 3 years post incorporation | Number of consultancy agreements signed | Number of newly launched products and services |
| Number of new spin outs | Number of companies signed collaboration agreements with research performing organisations in Ireland |
| Number of jobs in spin outs |  |
| Number of new invention disclosures | Number of collaborations with SME sector |  |

There is clearly a high variance in stakeholder expectations in terms of research outputs, which leads to a multiplicity of motivations and influences on individuals’ research orientation. In a similar vein, applied research activities, for example supported through the Horizon Europe programme in the EU[[4]](#footnote-4) evaluate research outcomes through metrics encompassing both tables above depending of course on the nature of research being undertaken (e.g. projects funded under the Future Emerging Technology (FET) instrument are heavily weighted towards basic science, projects funded under the Innovation Action (IA) instrument are focused on industry outcomes, and projects funded under the Research and Innovation Action (RIA) instrument lie between both of these).

Discussing the impact of metricised performance measures, such as those exemplified above, on academic freedom, Golhasany and Harvey (2022, p. 3) note that researchers “have raised concerns about the impact agenda’s effect on a researcher’s autonomy in setting research agendas, funding for basic research, the narrow definitions and metrics for societal impact, and potential adverse impacts on academic quality (or research excellence)”. Additionally, Golhasany and Harvey (2022) discuss the impact of evaluation on broader academic life, devaluing the non-research aspects of academic work, forcing researchers to choose a particular topic of research, restricting knowledge mobilisation (which is about ensuring that all citizens benefit from publicly funded research.), and increasing academic misconduct. They suggest that further studies should examine the relationship between research field, academic environment and academic seniority relative to a researcher’s choices around their research orientation, as is undertaken in this thesis.

Chubb and Reed (2018, p. 298) discuss the associated political pressure of ensuring research impact and note it has been hailed as “an assault on academic freedom”, a view echoed by Walsh et al. (2015), where they contend that this:

kind of ‘academic capitalism’, the perceived over-management of knowledge and hyper competition for decreasing funds led some to associate impact with an instrumental view of research, dangerous to blue skies and pure/less applied modes of knowledge, where notions of knowledge for its own sake were seen to be diminishing (p. 297).

Martin-Sardesai et al. (2017, p. 373) discuss the influence of governmental focus on research valorisation on academic freedom and posit that:

the influence of GREs [government research evaluations] over funding [is] central to the commodification of academic labour. With universities forced to compete for a greater proportion of their funding, university managers have become increasingly concerned with the exchange value of their ‘product’ in terms of its ability to attract research funding.

Papatsiba and Cohen (2020) describe this situation in terms of ‘scientific capital’ and the Matthew Effect, whereby there is a risk of creating an imbalance in terms of “concentrating scarce funding in the hands of a few” researchers that have demonstrated strong impact (p. 185). This reflects the position of Martin-Sardesai et al. (2017) where it is suggested that:

academics are expected to deliver commodities that are calculable, marketable and tradable under the commercialised and managerialist regime (Gray et al., 2002). This undermines academic freedom, as academics are less able to exercise their professional discretion and expertise in choosing areas of research they consider relevant, potentially important or worth pursuing (p. 375).

Discussing academic capitalism relative to the Lisbon Agenda and the associated implications for the economic value of research, Slaughter (2019, p. 34) says:

rather than supporting the academy as a public space for education, the free flow of ideas, and curiosity driven research – all key components of academic freedom – many intermediating groups intervened to redefine state supported universities as engines of economic development, steering funds to fields and disciplines deemed to have entrepreneurial capacity, most often in STEM fields.

In earlier work, Sanz-Menéndez and Cruz-Castro (2003) note that the response of research organisations, to changing funding environments, can primarily be viewed as a function of management structure, political autonomy and researcher autonomy. They echo the call for research to investigate the impact of research funding policies on research actors and outputs. Laudel (2006) highlights that further research into these consequences is warranted, concluding with a sobering thought:

‘Crazy ideas’ (anything whose success is difficult to predict); spontaneous, ‘playful’ research, changes of research trails, and the search for new connections between fields might become ‘endangered species’ in science” (p. 503).

Geuna (2001) highlights a number of, potentially, unintended consequences arising from the trends insofar as “increasingly selective funding will reduce the availability of non-competitive public funds-i.e., funds allocated in a proportional way” (2001, p. 621). This implies that academic institutions lose the ability to leverage ‘baseline funding’ to carry out research in a manner of their own choosing, rather they carry out research in response to a pre-determined expected outcome. This then trickles down as an influence on individual researchers. This is a view echoed in extant literature, as will be discussed in Section 2.4. Guena (2001) highlights a knock-on, individual researcher-level, effect of this phenomenon:

the knowledge of researchers at institutions with few or no resources to conduct fundamental research will tend to become stale or obsolete, preventing them from teaching and carrying out targeted research in a way that is effective in terms of social needs (p. 622).

They note that this in turn will cause universities to focus more on research that responds to the short-term needs of industry. Later, Geuna and Nesta (2006) call for more empirical research to examine the impacts of funding policies and sources, on the research outputs from academic institutions and individuals therein, and is a topic that is addressed within this research thesis. Their contention is that the causality between researchers not applying for patents, resulting in less innovation has yet to be proven. They also caution against assuming a substitution effect between technology transfer and publishing.

Ranga and Etzkowitz (2015), revisiting the Triple Helix, note that:

due to their greater capacity to generate and transfer technology, universities are no longer just a traditional source of human resources and knowledge, but are also key innovation stakeholders, with ever increasing internal organizational mechanisms and resources allocated to this purpose rather than placing reliance solely on informal ties (p. 243).

Godin (2006), taking a different perspective, examined how the emergence of the knowledge based economy and its resulting statistics for measurement of research output, has shaped policy discourses. This indicates that further work is required to understand the factors that influence research orientation and outputs.

In summary, recent changes in the focus and priorities of academic institutions, how they are evaluated, and the associated expectations placed on researchers has given rise to a significantly more complex environment for the researcher to navigate and to locate themselves within. As academic institutions align with neoliberal agendas focused on impact-driven research and knowledge transfer, individual researchers are faced with evolving demands that can affect their research orientation and professional identities. The following section explores a number of interconnected influences on research orientation, with the aim of providing a clearer understanding of how personal, institutional and external factors shape an individual’s research orientation.

* 1. Individual research orientation within systems of innovation

The discussion above demonstrates that systems of innovation, in their multiple instantiations, are well documented in extant literature. Broadly speaking however, the majority of research relating to knowledge production, the impact agenda, performance evaluation and associated policies, takes a systemic view, or examines the impact at institutional level, with relatively little attention being paid to the individual researcher (Beck et al., 2022; Glenna et al., 2011; Jain et al., 2009; van Rijnsoever & Hessels, 2020). What is clear from extant research is that individual researchers are impacted in a multitude of ways (Beck et al., 2022; Hmieleski & Powell, 2018; Jain et al., 2009; Orazbayeva & Plewa, 2022; Perkmann et al., 2021; Plantec et al., 2023). Jain et al. (2009), for example, support this contention and highlight the need to provide:

a deeper understanding of the involvement of a key actor—the university scientist. We contend that in order to gain a better appreciation of the changes being wrought by academic entrepreneurship, it is critical to focus on the scientists (p. 922).

Indeed, prior works, which have primarily focused on the impact of external pressures on academic institutions, as discussed in Section 2.3, have highlighted the necessity for research to focus on the implications for individual researchers. For example, Tülübaş and Göktürk (2023) highlighted the impact of the neoliberal university on researchers’ identities, and call for research which investigates the relationship between institutional policies, peers/mentors, researchers’ personal characteristics and their research orientation. Focusing on the impact of research evaluation frameworks on individual academic freedom, Martin-Sardesai et al. (2017) indicate that future research should examine the relationship between institutional policies associated with research evaluation, academic freedom and research orientation.

The individual researcher has been the focus of certain studies, more prominently in recent years, with an exception being the work of Louis et al. (1989). In their paper, Louis et al. (1989) focus specifically on the entrepreneurial aspects of individuals’ research orientation and, through a survey of researchers and administrators across 50 institutions, they identify five types of academic entrepreneurship:

(1) large-scale science (obtaining large, externally funded research projects), (2) earning supplemental income outside the university, mainly through consulting (knowledge transfer for personal gain), (3) soliciting funds from industry (capitalizing on university-industry relationships to provide new sources of funding for research), (4) patenting the results of research, and (5) forming companies based on the results of research (1989, p. 5).

Their work identifies a subset of individual-level factors that influence this entrepreneurial drive, specifically, professional age, gender, scientific field, level of scientific risk (i.e. the risk that commercialisation activities could detract from ‘real science’), professional productivity, university-industry relations. Their work concludes with a statistical analysis looking at the interactions amongst these various factors with a view to ‘predicting entrepreneurship’.

More recent works, written in parallel to the emergence of the concept of the entrepreneurial university, have focused primarily on the drivers of ‘third mission’ knowledge transfer or valorisation type activities. Olaya Escobar et al.’s (2017) research is predicated on academic institutions implementing processes and supports in response to external factors such as research evaluations, however they note the importance of studies focusing on the intrinsic and extrinsic motivations, and organisational supports, that drive individuals to engage with industrial partners.

A related perspective is that many researchers seek tenured positions within their academic institutions, and this could be hampered by industrial engagement/technology transfer activities which are not included in the performance review process (Debackere & Veugelers, 2005; Siegel et al., 2003):

It's the height of hypocrisy for universities to claim that they value technology transfer, or that it's supposed to be a top institutional priority, and then fail to reward it in their promotion and tenure decisions. At some point, we've got to resolve this discrepancy (Siegel et al., 2003, p. 35).

This is reflected in the findings of Bozeman (2000) who states that “in both university and the larger government laboratories, the reward system is largely based on scientific publications, not commercial activity” (p. 634). Dietz and Bozeman (2005) note that industrial secondment or engagement can significantly enhance research outputs and performance, while Grimaldi et al (2011) query the linkage between industrial secondment and university promotion. Lockett et al. (2005) call for this to be addressed, saying that academic institutions:

need to modify procedures to align rewards with commercialisation goals, taking into account the characteristics, actions and motives of key stakeholders… [and that there are] … palpable differences in these areas that can potentially impede technology transfer (p. 1048).

Realigning the discussion around individual researchers and their research orientation, Agarwal and Ohyama (2013) note that a systematic study of individual research orientation is lacking, and particularly highlight that an examination of influences on decisions to undertake basic, applied and/or commercial research is needed, rather than examining the options as pairs such as basic vs applied research. Glenna et al. (2011, p. 958) posit that:

it is important to document the heterogeneity of scientists’ values. However, such work is of limited value until analysis demonstrates that heterogeneous scientist values affect research outputs. The challenge, then, is not simply to document the heterogeneity of scientists’ values, but to determine if that heterogeneity is linked to variation in basicness and proprietariness of research.

Broadening the discussion, Sauermann and Stephan (2013) call for research that examines other researcher characteristics, relative to their research orientation, such as “gender, or the desire for peer recognition” (p.906), noting “it may be instructive to examine how research choices themselves are shaped by other variables” (p.906), as do Wegner et al. (2019) where they call for an examination of a researcher’s biological age as an influence.

Other research takes a broader approach to the topic, for example Iglič et al. (2017) examined the influences on researchers which drive particular types of collaborations. In their study, they carried out statistical analysis on data collected from 343 respondents from multiple research fields (maths, sociology, physics and biotechnology). Their results indicated that 40% of the surveyed researchers tend to work alone and that, in terms of levels of collaboration in different fields, maths had the lowest with biotechnology having the highest. They explain this through the contention that, unlike maths, biotechnology is a heavily multidisciplinary activity.

Perkman et al. (2013) developed an analytical framework to discuss levels and types of external engagement by researchers, driven by universities’ third mission, and highlight the need for further research to examine their conceptual ideas on a more empirical level, as is done in this thesis particularly in relation to social capital. They note the importance of gaining a deeper understanding of the factors, such as researcher motivations and institutional policies, that drive individuals’ research orientation in terms of applied or commercial research.

` Similarly, van Rijnsoever and Hessels (2011) indicate that "an important avenue for further research is to gain more insight into how researchers from the basic sciences can be triggered more to engage more into interdisciplinary research collaboration” (p. 469). In a related later work, van Rijnsoever and Hessels (2020) note that “research has yet to examine how personal motivations and goals moderate the factors influencing researchers’ collaboration ... This lack of knowledge inhibits the development of effective policy instruments to promote university–industry collaboration” (p.22), a perspective echoed by Tartari and Breschi (2012) through their call for research that examines researchers motivations relative to the varying types of research they participate in. D’este and Perkmann (2011) call for future research to build on their work related to researchers’ motivations and modes of collaboration with industry, noting that their findings relating to the impact of industry engagement on research undertaken in academic institutions can differ depending on the underlying institutional and individual motivations and “future research should seek to provide more informed judgment on the potential benefits and drawbacks associated with the different channels of engagement with industry used by … researchers” (p.332). Similarly, Garcia et al. (2019, p. 347) state that “researchers’ motivation to collaborate with industry… require[s] deeper analysis”. This reflects the need to examine the motivations related to research orientation and the associated external factors that can have an impact.

Hayter and Feeney (2017) used statistical analysis to examine knowledge transfer in terms of patenting activity. Their results highlighted that training and departmental culture were significant predictors of researchers’ tendencies to patent their research, which in turn demonstrated a tendency to move research outputs towards commercial applicability.

Bringing researcher’s age and career stage into the mix, Nästesjö (2023, p. 666) focuses the neoliberal university discussion on Early Career Researchers (ECRs) noting the creation of “tensions between growing into a scientific vocation and adapting to a competitive selection process guided by entrepreneurial values”, while Derrick (2019) and Edwards (2022) highlight the erosion of researcher’s sense of professional identity arising from pressure to conform to competitive evaluation frameworks. Yin and Mu (2023) posit that, particularly for ECRs, the neoliberal ethos creates a system of ‘winners’ and losers’ where high-performers are commended, and low-performers are stigmatised. Furthermore, it has the potential to create a system of inequality where those who can afford to spend their free time on research (Beck et al., 2022) and associated productivity/impact are advantaged over others (such as female ECRs “thwarted by motherhood penalty” Yin and Mu (2023, p. 67) in terms of the availability of free time). Derrick et al. (2022, p. 8) provide a more nuanced perspective on this argument, noting that “parenting engagement is related with decreased research productivity and impact; however, the composition and management of the household plays an important role in mediating this effect”.

Boeren et al. (2015, p. 69), highlighting the importance of institutional supports such as mentoring for ECRs, note that in an academic context ECRs are “challenged as regards access to resources, supportive interactions and lack of transparent career prospectives” combined with “the underlying pressure … in terms of their opportunities for research and development”. Mula et al. (2022, p. 787) build on this contention discussing the highly vulnerable position of ECRs in academia, “exacerbated by political-economic issues, as well as by the demands of the new knowledge society” arising from the neoliberal social aims and objectives of universities.

Mula et al. (2022, p. 788) cite the expectations placed on researchers’ professional performance that “determine ‘their quality’ through quantification” and impact on their professional identity (of which research orientation is an element). They note for example, that doctoral students “are more focused on scientific production… than on actual completion of the doctorate” (Mula et al., 2022, p. 794) and that, for researchers, as age decreases they exhibit “greater levels of compliance and complicity with the new forms of academia” (p.794). Coupled with publication pressure, securing research funds and grants occupies the central space of ECRs’ action and Mula et al. (2022, p. 796) call for research that includes “international and multidisciplinary samples in order to expand and enrich the field of study of early academic careers”.

Beyond this complex array of personal characteristics, peer influences, and varying career stages, institutional frameworks and policies play a central role as influences on an individual’s research orientation. Recalling the discussion on the entrepreneurial/neoliberal university in Section 2.3 above, Caulfield and Ogbogu (2015) cite a number of researchers that have indicated that the pressure to commercialise, or to be seen to commercialise, has had an “undue influence on the direction [orientation] of their research” (p. 2) and “may undermine open paths toward novel technologies and hinder explorations of unknown fields” (p. 2), as reflected in the research of Beck et al. (2022), Edwards (2022), and Forliano et al. (2021). Fini et al. (2022) take an opposing position by examining the researcher-entrepreneur journey in reverse. Their work suggests that following a researcher’s transition to entrepreneurship they pursue research in new and varied explorative topics or decide to answer new interdisciplinary research questions inspired by their commercial endeavours. However, it must be acknowledged that these new research endeavours are typically applied in nature, and this situation applies mainly to those researchers who stay in academia following the establishment of a new venture (Fini et al., 2022). Fini et al. (2022) posit that embarking on interdisciplinary research can lead to advances in basic science – through the application of models and techniques from one discipline to another. Additionally, Fini et al. (2022) found a positive relationship between academic entrepreneurship and increased publications, driven by the fact that entrepreneurial activities open new avenues and disciplines of research for researchers.

Similarly, Huyghe (2016) provides a detailed analysis, based on statistical modelling, of the propensity of researchers to bypass formal technology transfer structures within institutions (based on levels of awareness of TTO activity, and experience engaging with industry), and they call for research to examine the influence of TTO related supports on individuals’ research orientation.

Goel and Göktepe-Hultén (2018) undertook a similar study, with a focus on risk aversion, and identified that the nature of researchers’ industry interactions, and their positive attitudes towards risk, had a direct influence on their decision to bypass TTOs, while researchers’ who favoured public access to research and were more risk averse tended to adhere to more formal institutional TTO practices. Concepts such as the third mission of universities or the impact of evaluation frameworks and associated performance expectations form a common thread through these studies, thereby reflecting the pervasive nature of the entrepreneurial university paradigm as discussed in Section 2.3.

Chiesa and Piccaluga (2000) promote the idea that “scientific knowledge is considered to be the most important raw material which generates economic growth” (p.4). Reflecting the neoliberal perspective, Bercovitz and Feldmann (2006) posit that licencing outputs from universities serves to demonstrate that the academic institution was actively engaged in industry-relevant research, and that “licensing activity conferred a certain degree of prestige” for universities (p. 179).

Interestingly, Chiesa and Piccaluga (2000) contend that universities are not particularly interested in the production of shorter-term, applied, research outputs that have immediate commercial appeal, rather, they say that the university sector is more interested in producing longer term results which may also have short and medium term effects on industrial innovation. The implication here, according to Chiesa and Piccaluga (2000), is that universities’ research outputs are primarily driven from the outside (industry)–in, rather than the other way around.

Bercovitz and Feldmann (2006) contend that:

life-cycle models of scientists suggest that scientists invest heavily in human capital early in their careers to build reputation and establish a position in a field of expertise … In the later stages of their career, scientists typically seek an economic return for their human capital (p. 180).

This economic return often comes through the establishment of spin-off companies, a view echoed by Chiesa and Piccaluga (2000) when they note that “both national culture and academic socialization can influence the degree to which individual scientists participate in technology-transfer activities” (p. 180).

Technology transfer, however, is not a given (Thursby & Thursby, 2002), nor a strict requirement for knowledge valorisation as discussed in Section 2.3. It can very much depend on a multiplicity of factors as summarised in the table below. Note, Bercovitz and Feldmann (2006) highlight that the factors influencing technology transfer are quite speculative and warrant further investigation, as addressed in this research. In the table below, these factors as summarised and the associated constructs examined in this research are highlighted (bold text).

Table 6   
*Influences of, and Barriers to, Technology Transfer*

| **Factors influencing the individual researcher to engage in technology transfer** | **Factors hindering the individual researcher from engaging in technology transfer** |
| --- | --- |
| Researchers that have been trained in institutions at the forefront in terms of technology transfer (Bercovitz & Feldman, 2006).  **[Policies and Supports - Section 3.4]** | Basic researchers may not be willing to spend time on applied research required to instigate a technology transfer (Thursby & Thursby, 2002).  **[Researcher Motivations - Section 3.3]** |
| Researchers reporting to a leader that is active in technology transfer activities (Bercovitz & Feldman, 2006).  **[Social Capital - Section 3.4]** | Academics may not engage in technology transfer due to the potential delay in securing critical publications, due to the patenting process (Thursby & Thursby, 2002). This is typical of the patent vs publish tension in research.  Interestingly, Geoghegan and Pontikakis (2008) note that:  the ‘culture clash’ between industry and academia (the ‘publish or patent’ dichotomy), though not exclusively an Irish phenomenon, is probably amplified by a lack of institutionalised rewards that recognise both basic and applied outcomes of research (p. 472).  **[Reputation vs Reward - Section 3.3]** |
| Researchers may be encouraged to engage in technology transfer based on having seen their peers do so (Bercovitz & Feldman, 2006).  **[Social Capital - Section 3.4]** | Researchers may believe that it is not appropriate for a researcher to engage in commercial activity (Thursby & Thursby, 2002).  **[Academic Freedom - Section 3.3]** |
|  | Researchers adhering to rigid disciplinary boundaries within funded research projects are inhibited from engaging with peers and creating valuable trans-disciplinary intellectual property (Bercovitz & Feldman, 2006).  **[Academic Freedom - Section 3.3]** |

Group level norms, and social capital, are another indicator of research orientation within individual researchers (Adams et al., 2005; Perkmann et al., 2013):

If their colleagues value patents and awards, academics are more likely to consult for private companies, while the opposite is true if their peers value traditional academic values (Perkmann et al., 2013, p. 427).

This perspective is reflected, and broadened, in more recent works such as Beck et al. (2022) and Forliano et al. (2021) where it is contended that younger researchers mirror the research orientation of their peers, and their peers’ research orientation is heavily influenced by an institutional focus on basic, applied and/or commercial research. Additionally, Perkmann et al (2013) and O’Shea et al (2005) note that this group effect is typically associated with research commercialisation (patenting, spinning out companies etc) as opposed to industry engagement (working with industrial partners in a collaborative setting). Perkmann et al (2013) go further to say that “individual academic engagement tends to be negatively correlated with the research quality of departments or universities” (p. 427). This contention stands at odds with more recent research that highlights the various entrepreneurial modes of knowledge production (Philpott et al., 2011) as discussed in section 2.3.

Siegel et al (2003), undertook an interview-based study to examine the impact of industrial engagement on researchers. Their results indicate that industrial engagement enabled research self-improvement in terms of new idea generation (through focusing their work on applied topics), and the securing of new lab equipment. This in turn led to increased scholarly output.

Similarly, Bozeman (2000) posits that enhanced reputational gains for a research lab is a key driver of industrial engagement, which in turn attracts additional budgets and equipment for the lab in question. A further effect of this type of gain for a research laboratory is increased political attention and public promotion, which can translate as enhanced reputation and funding for individual researchers, including funding which can support fundamental research activities.

Lockett et al. (2005) add weight to this argument, highlighting that a primary driver for many researchers is the potential gain in status and reputation (Lee, 1996) achieved as a result of high quality research:

The primary motivation for university scientists is recognition within the scientific community. Universities typically do not reward activities such as commercialising research and creating new spinoffs, in their promotion and tenure decisions. The performance evaluation process and publishing-orientation of researchers thus act as barriers to these activities (p. 1048).

Recent work by Watermeyer et al. (2022), discussed in section 2.3, brings this perspective into sharper focus, noting the primarily negative impact of ‘affective auditing’ of researchers relative to research assessment frameworks.

Siegel et al (2003) highlighted that in certain cases institutional organisational and administrative inflexibility was a significant barrier to engagement in commercialisation activities. This view is expanded by Schartinger et al (2006) and Grimaldi et al (2011) who note that researchers often lack the operational skills and support (Lockett et al., 2005; Nemet, 2009; Wright et al., 2006) required to engage in commercial activities. Additionally, Siegel et al (2003) noted that the role and competencies of the Technology Transfer Officer were crucial enablers of commercialisation, a view echoed by Lockett et al. (2005) and Perkmann et al (2013). Similarly budgetary control and human resource autonomy are seen as key drivers for multiple research activities (Debackere & Veugelers, 2005) as this enables researchers to actively manage and drive their research/research team towards greater results. Siegel et al (2003) call for future research into the impacts on research performance to factor in organisational issues as explanatory variables.

Neves and Brito (2020) and Sitnicki (2018) suggest that knowledge valorisation is driven in a bottom-up manner from the individual researcher to the institution, and that it is critical to include the individual researcher in any associated analysis. Additionally, Neves and Brito (2020) call for research that provides a systematic scrutiny of the induvial researcher’s motivations and influences and, concurring with Sitnicki (2018), suggest that the outcome of this could help universities to determine the most appropriate mechanisms, such as programmes and funding, to drive research outcomes.

Geuna and Nesta (2006), focusing on patenting activities amongst researchers, whilst being primarily interested in motivations for patenting activity (already discussed here), identified a number of perceived barriers: lack of openness amongst researchers (increased secrecy), decreased or delayed publications, increased research/equipment costs, diversion of research time and equipment away from longer term basic research, future research blocked by IPR issues associated with previous research. Geuna and Nesta (2006) call for future research to cast empirical light on a number of rhetorical statements which are based on “one-off observations” (p. 32), for example to dispel the myth that universities are acting as ivory towers with significant research outputs hidden in closets.

Bozeman (2000) notes a lack in competencies as a barrier to researchers pursuing practical (applied) investigations with industry. He also highlighted that academic institutions should instil a “diversity of research missions” (Bozeman, 2000, p. 640) if the institutional expectation is that all elements of the research lifecycle are to be embraced (basic, applied and commercial research) (Bruneel et al., 2010; Di Gregorio & Shane, 2003). Closely tied to this is the fact that different institutions provide different levels of royalty rates to researchers involved in commercialisation, with lower rates being a significant barrier to engagement in such activities (Debackere & Veugelers, 2005; Di Gregorio & Shane, 2003) and can drive researchers to adopt a spin-out versus licence mentality (Lockett et al., 2005).

With research freedom comes accountability which can act as a “direct incentive for the researchers themselves to actively manage and grow their portfolio of explorative and exploitative research activities” (Debackere & Veugelers, 2005, p. 329).

Jain et al (2009) provide an interesting alternative perspective which focuses on the internal role identity adopted by individual researchers based on their research orientation, as shown in Table 7 below. It is unusual that Jain et al (2009) ignore applied research in their analysis, however it would seem that applied research identities would readily fit as a mid-point between the academic and entrepreneurial elements below. Their research highlights the difficulties and challenges associated with maintaining a dual or hybrid role as a researcher and calls for empirical studies to examine this in more depth.

Table 7   
*Researcher role identities (Jain et al (2009))*

|  |  |  |
| --- | --- | --- |
|  | **Academic (basic research)** | **Entrepreneurial (commercial research)** |
| **Norms** | Universalism | Uniqueness |
|  | Communism | Private property |
|  | Disinterestedness | Passion |
|  | Scepticism | Optimism |
| **Processes** | Experimentation | Focus |
|  | Long-term orientation | Short-term orientation |
|  | Individualistic-small group | Team management |
| **Outputs** | Papers | Products |
|  | Peer recognition/status | Profits |

Cunningham et al. (2014) examined the factors that inhibit academics from leading publicly funded research projects, and note:

the danger for public funding of science is the balance may be more towards accountability and transparency, which is a threshold requirement and less on prioritisation of new knowledge which is at the heart of scientific discovery (p.11).

Simply stated they posit that when a researcher adopts the role of a Principle Investigator the majority of their time and effort is devoted to dealing with delivering pre-determined outputs on strict timelines, rather than having the luxury of taking a freeform, autonomous, approach to pure scientific discovery. A similar notion is reflected by Etzkowitz (2003):

Research groups operate as firm-like entities, lacking only a direct profit motive to make them a company. In the sciences, especially, professors are expected to be team leaders and team members, with the exception of technicians, are scientists in training … Often persons in this situation describe themselves as “running a small business”. To continue at a competitive level with their peers, they must maintain an organizational momentum. Once having attained this goal, it is extremely difficult to function again as an individual researcher (p. 111).

What is clear from the above discussion is that institutional expectations, and organisational culture can directly influence the research orientation of an individual researcher. However, external pressures such as the availability of funding and the competitive landscape also bear heavily on research orientation.

Laudel (2006) discussed the impact of contemporary funding frameworks, linked to research evaluations, on institutional decisions regarding research priorities and suggested that future research should examine the impact of availability of funding/resources on individuals’ research orientation.

Reflecting this discussion, Gulbrandsen and Smeby (2005) note a tendency amongst researchers to re-brand or depict the nature of their research activity based on availability of funding. This, they say, has a knock-on effect that, depending on the type of funding secured, the nature of research output (for example, published works or patents) will change substantially (Gulbrandsen & Smeby, 2005). It is interesting to note that Gulbrandsen and Smeby (2005) identified a statistically positive (albeit weak) relationship between producing papers and patents.Additionally, Laudel (2006) notes that:

a possible consequence of these changes is that scientists adapt to the new conditions by producing different knowledge. In a context where science policy intends to gain high-quality research without changing its direction, these thematic adaptations must be regarded as unintended side-effects. For example, the knowledge production could be affected in the basic vs applied, disciplinary vs interdisciplinary, or theoretical vs methodological vs empirical dimensions, or in the way results are communicated, for instance, with regard to scientists’ publication practices (p.489).

To examine this theory, Laudel (2006) interviewed 66 researchers and examined their research outputs in terms of citation data. Her results identified a forced shift to external funding, and multiple consequential effects. For example, Laudel notes that some researchers are applying to funding sources that are considered to be "simple" or employing what is known as a "scatter-gun strategy" to funding goals, which means they submit applications to numerous sources and base their research on whichever of the applications is successful. This is seen when researchers first compose research concepts and proposals, and only then look for suitable funding sources to approach. Laudel concluded that in order for researchers to obtain less constrained financing, they had a propensity to commercialise the outcomes of their research or consult directly with industry, rather than responding to specific funding calls. Worryingly, Laudel suggests that some researchers engaged in a practice known as "bootlegging," in which they obtained funds from one source and then utilized that funding to carry out research that was unrelated to the original project. Laudel also found that some researchers diversify their work and avoid research that may be considered risky, which suggests a decline in the amount of research / academic freedom. All of the aforementioned factors lead to a decrease in the quality of research outputs, which is a consequence of the time spent securing research funding, mixed with a reduction in innovation, which is a result of the elimination of more innovative research themes (Laudel, 2006).

Investigating external impacts, Lepori et al. (2007) undertook a comparative analysis of the evolution of national research policies across six European countries. Their work, which followed a methodology of examining lists of national funding instruments over a 30-year period, highlighted a general shift towards funding of specified research projects rather than taking a carte blanche approach, and an increased focus on pre-determined thematic areas, which can result in a potential reduction in freedom of individual researchers’ career choices. Their research is reflective of the prescriptive nature of the entrepreneurial university environment, as discussed in Section 2.3. They also identified a shift in the management authorities of research funding at national levels, noting that the shifts in priorities for research related policies create a knock-on-impact on academic institutions, ultimately impacting the individual researcher’s beliefs and motivations related to their research orientation.

Accordingly, availability of research funding is another orientation-related perspective apparent in the literature, and one which is often intermingled with discussions around valorisation, engagement and performance. For example, Laudel (2006) discusses the impact of the changing research funding environment, which causes:

researchers to rely increasingly on … external funding of research projects, placing them in a resource environment that is characterised by scarcity, competition, and continuous evaluation (p. 489).

Perkmann et al (2013), discussing how researchers can experience conflicting pressures regarding their research orientation, examined the antecedents to industrial engagement/commercialisation by researchers, and discovered that gender and age need to be factored into any investigation. They also suggest that seniority in an organisation is a pre-cursor to commercial research (due to the collaboration/network effect that longevity in a research institution can create), a view supported by Murray (2004). Furthermore, Perkmann et al (2013) also posit that researcher output quality and funding success are predictors of research activity and orientation – as higher quality tends to attract funding (Debackere & Veugelers, 2005; Di Gregorio & Shane, 2003), and funding enables more research freedom. Conversely, they note that the act of engaging with industry is a significant attractor of governmental research funding. Lee (1996) notes that an increase in funding from industrial sources creates an increase in industrial steer of research orientation, and hence a reduction in academic freedom.

Interestingly, Perkmann et al (2013) posit that older, ‘higher quality’, academic institutions are less conducive to commercial research engagement, possibly due to the fact that such institutions have significant baseline research funding and as a result have less need to attract funding from industry. Conversely, Siegel et al (2003), reflecting the discussion in section 2.3, also note that in certain cases researchers were not willing to engage in commercially focused research as they felt too directed by industry and perceived a potential loss in academic control as a result. A further concern expressed was the possibility of losing out on revenue gains from generated Intellectual Property (IP).

Taking a similar stance, Etzkowitz (1998) cites funding as a key driver of research activity – with a lack of funding for basic science being posited as an impetus for researchers to move towards applied and commercial research as a means to attract required research finances.

Feola (2019) undertook a quantitative study to examine of the effects of the three elements of the Triple Helix (Government Support, University Support, and Industrial/Financial Support) on the intention of researchers to engage in commercial activities and discovered that each element had a distinct influential effect, albeit in varying degrees. Feola et al’s (2019) research is limited by their relatively low sample size (213) and confined geographic context (a region in Italy). They call for future research to broaden in terms of scale and location.

Autio et al (2014) provide a similar perspective (interestingly without referring to Triple Helix) in terms of the contextual factors that influence research orientation, namely: organisational context, industry/technology context, institutional context, and social context. They also call for research to examine the influence of these contextual factors on researchers.

What is clear from the literature is that extant research lacks a comprehensive, integrated, model of influences on individuals’ research orientation and this study seeks to address that. Zhou et al. (2022, p. 2) contend that the

practices of encouraging excellent research have been well established in many countries, such as Research Excellence Framework published in 2014 in the UK…, the Initiatives d’ Excellence started in 2010 in France, Clusters of Excellence in German …, and “Double World-Class” planning initiated in 2015 in China. However, the fundamental understanding of research motivations remains undiscovered.

Orazbayeva and Plewa (2022) note that “our understanding of the motivations that underpin academic engagement has improved, yet the inherent complexity and constellations of a multitude of relevant motivations remain unexplored” (p.1). Similarly, Suominen et al. (2021, p. 2) posit that understanding a researcher’s “motivation requires considering a large mix of motivational factors, and having a holistic understanding is central”. Finally, Duval-Couetil et al. (2023, p. 11) argue that extant research has primarily examined “macro-level processes” (such as incentives) that drive researcher orientation, “rather than micro-level, or individual characteristics” including motivations, and conclude that more research is needed in this area.

While a significant focus of contemporary literature is on the pursuit of commercialisation or valorisation of research outputs as discussed above, this research thesis builds a more comprehensive picture encompassing research orientation around basic, applied and commercial research. Additionally, recognising the many interrelated influences on research orientation, discussed above, underscores the need for a comprehensive, integrated analysis.

* 1. Scope of research and associated research questions

Drawing on the discussions above, this research strives to answer a number of key research questions. It must be acknowledged that external pressures, discussed in Section 2.3, have an impact on researcher motivations, and that relationship is a potential avenue for future research, however this thesis focuses on establishing a comprehensive framework through which the relationships between a researcher’s motivations, their personal attributes, their working environment, and their research orientation can be examined. This limitation is noted in Chapter 8 and associated recommendations for future research are presented. The rationale for this scope delineation is that extant research, discussed above, has called for an examination of the impact of researcher motivations on their research orientation, and focusing on this in particular provides a more nuanced, deeper understanding, of this topic. Indeed, prior works which have focused on pressures, within an academic context, imparted by evaluation frameworks and the entrepreneurial/neoliberal university paradigm have indicated that the relationship between motivations and research orientation needs particular attention (Forliano et al., 2021; Laudel, 2006; Martin-Sardesai et al., 2017; Mula et al., 2022; Neves & Brito, 2020; Olaya Escobar et al., 2017; Sitnicki, 2018; Tülübaş & Göktürk, 2023). From a methodological perspective, focusing on researcher motivations and resulting research orientation enables a more controlled environment for analysis to be established. From an analysis perspective, focusing on the particular research questions posed allows for more specificity in data collection and analysis, leading to more precise findings.

The research questions posed in this thesis addresses calls for research (Duval-Couetil et al., 2023; Garcia et al., 2019; Mula et al., 2022; Neves & Brito, 2020; Perkmann et al., 2021; Tartari & Breschi, 2012; van Rijnsoever et al., 2008; Wang et al., 2021; Zhou et al., 2022) into the relationship between researchers’ motivations and their research orientation. To investigate this, this research firstly seeks to identify the motivations that must be considered.

*RQ1a - What are the primary intrinsic and extrinsic motivations that influence the research orientation of a researcher in an academic institution?*

Next, with the prominent motivations established, the research examines the interplay between these individual motivations.

*RQ1b - What is the interaction effect between intrinsic and extrinsic motivations and the research orientation of a researcher in an academic institution?*

Following this, the research answers calls from extant literature to examine the impact of the researcher’s personal profile (Sauermann & Stephan, 2013; Wegner et al., 2019) and their working environment (Feola et al., 2019; Geuna & Nesta, 2006; Laudel, 2006; Perkmann et al., 2021; Sanz-Menéndez & Cruz-Castro, 2003; Siegel & Wright, 2015; Sitnicki, 2018) on the motivations - research orientation relationship.

*RQ2a - What role does a researcher’s personal profile play in moderating the relationship between their motivations and their research orientation?*

*RQ2b - What role does a researcher’s academic environment play in moderating the relationship between their motivations and their research orientation?*

* 1. Conclusion

In conclusion, this chapter has highlighted that current models such as the Triple Helix and paradigms such as the entrepreneurial university provide valuable perspectives on the economic and institutional dimensions of knowledge production, but often leave the researcher’s personal perspective in terms of motivations, influences and barriers related to their research orientation underexplored. To address this gap in knowledge, it is the intention of this research to develop a nuanced understanding of the complex factors that influence individuals’ research orientation, to provide insights that are critical for academic institutions striving to balance academic excellence with societal and economic impact.

The next chapter in this thesis will draw from multiple literary sources to develop a suitable framework within which the individual researcher is central, to identify key constructs and relationships associated with an individual’s research orientation, and to propose a set of hypotheses to be examined/verified.

1. Research Orientation, Motivations and Influences
   1. Introduction

The purpose of this chapter is to identify the key drivers of, and influences on, an individual’s research orientation. Chapter 2 has shown that extant research has taken quite a broad perspective primarily focused on national and international systems of innovation and highlights that relatively sparse attention has been given to the individual researcher.

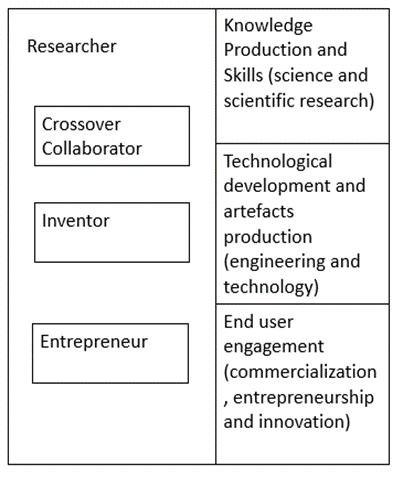
To address this, this chapter draws on extant literature and follows a linear structure starting with a discussion of the types of research activities undertaken by researchers. It then, taking Unger and Polt’s (2017) work as a guiding framework (Chapter 2, Figure 2), identifies a number of key drivers that are posited to motivate researchers towards particular research orientations. Following this, factors that influence the relationship between motivations and research orientation are discussed.

Within each subsection below, the literature is analysed with a view to forming hypotheses to be analysed within this study, culminating in a conceptual and hypothetical framework.

* 1. Individuals’ research orientation

Research orientation has long passed the simplistic, linear, basic-applied-commercial model, with many researchers acting across all three domains (Geoghegan & Pontikakis, 2008; Jain et al., 2009). Tijssen (2018) built on the well-established Pasteur’s Cube of researcher activities with a view to extending it to incorporate external (to the individual researcher) interactions. The purpose of the Pasteur’s Cube model is to “inform a larger-scale system for measuring academic entrepreneurship, commercialisation and user engagement” Tijssen (2018, p. 1637).

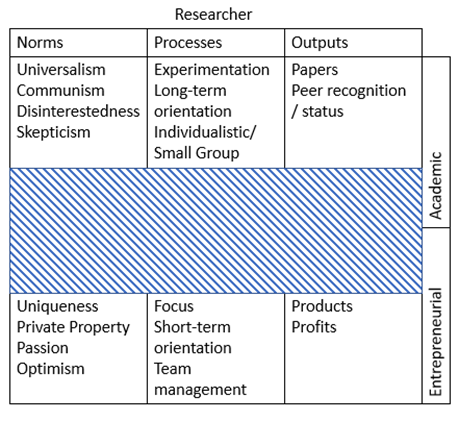
Figure 4   
*Pasteur's Cube, adapted from Tijssen (2018)*



Essentially, the Pasteur’s Cube model presents a taxonomy of researcher types combined with three broad categories of research activity, as shown in Figure 4. The Researcher category equates to those undertaking ‘pure basic research’ and is complemented by the other three categories individually or in combination. Crossover Collaborators span the border between basic and applied research activities. Inventors are more firmly positioned in the applied research arena, while Entrepreneurs are more commercially orientated.

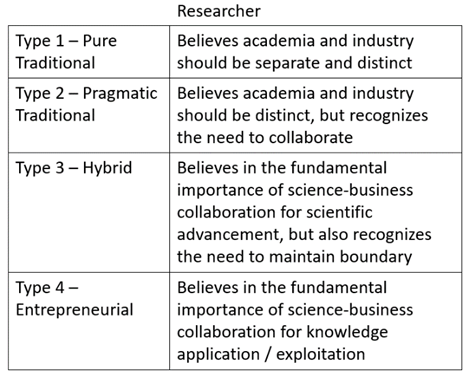
Jain et al. (2009) approach the topic from a different, but related perspective. In their work on academic role self-identification, they create a comparison between academic and entrepreneurial role identities. A drawback of this approach is that Jain et al. (2009) do not deal with the cross-over between academic and entrepreneurial identities thereby creating an identification no-mans-land between the two.

Figure 5   
*Typology of researcher self-identification, adapted from Jain et al. (2009)*



Bridging this gap, Lam (2011) interviewed 36 UK-based researchers, as part of a wider study into researcher motivations, and developed a typology of researchers covering 4 broad categories as shown in Figure 6.

Figure 6   
*Researcher Typology, adapted from Lam (2011, p1360)*



Lam’s (2011) analytical framework builds on prior work which posits that “individuals can be extrinsically or intrinsically motivated to different degrees in their pursuit of an activity depending on how far they have internalized the values and regulatory structures associated with it” (Lam, 2011, p. 1355). Within this typology, Type 1 researchers align with the Mode 1 perspective (Duval-Couetil et al., 2023; Kuhn, 1977; Kunseler, 2007) which is a purely basic research orientation, believing that “knowledge commercialisation is at odds with the fundamental nature of science” (Suominen et al., 2021, p. 2). Type 2 researchers focus on basic research with a recognition of “the need for industry collaboration for the good of science”, representing a basic-applied research orientation (Suominen et al., 2021, p. 2). Type 3 researchers align with an applied research paradigm, where academic-industry collaboration is seen as crucial for scientific and societal advancement (Blind et al., 2022; Lam, 2011, 2015), and Type 4 pursue research with a firm target of exploitation (Blind et al., 2022; Duval-Couetil et al., 2023; Lam, 2015). Perkmann et al. (2021), discussing individual researcher’s research orientation, note that "those motivated by the pursuit of fundamental understanding (basic research) have a lower breadth of engagement activities than those motivated to carry out user-inspired basic research or applied research." They call for research to examine external factors that impact on the individual's research orientation, such as availability of resources or physical context of the host academic institution, and cite Lam's typology (Lam, 2011) as a suitable scale for this (see also, Suominen et al. (2021)).

The categorisations provided from the extant literature, when combined, provide a more coherent researcher/research orientation typology as shown in Figure 7 (adapted from (Blind et al., 2022; Duval-Couetil et al., 2023; Jain et al., 2009; Lam, 2011; Suominen et al., 2021)).

Figure 7   
*Research orientation typology*

A blue and white rectangle

Description automatically generated

Note, many studies have employed the arguably simplified typology of basic, applied and commercial research as the basis for their quantitative studies (Agarwal & Ohyama, 2013; Sauermann & Stephan, 2013). However, Bentley et al. (2015) contend that while a smaller percentage of researchers today fit neatly into a basic or applied category, with many opting for blended approach, in general there is a “decline in fundamental research” (p.691), driven by “increased steering of research priorities; increased commercialisation of research (resulting from decreased public funding and increased attention to intellectual property ownership); and broader accountability of science” (p. 691). Ballabeni et al. (2014) surveyed 304 basic researchers in the biomedical field, and found that a large percentage of their respondents agreed that basic research “should not be conceptualised as being necessarily (or solely) driven by curiosity” (p. 3) and that potential practical applications for their basic research can be considered, without detracting from pure science per se. This lends weight to the Type2-Type3 classifications above.

* 1. Motivations

The topic of motivations for research orientation has received substantial attention in the literature albeit with differing terminology, such as inhibitors/facilitators (Davey et al., 2016), intrinsic/extrinsic motivations (Olaya Escobar et al., 2017), triggers (van Rijnsoever & Hessels, 2011) and drivers (Goel & Göktepe-Hultén, 2018).

This section draws on extant literature to define and identify these research orientation motivations on an individual researcher level, and to identify an associated hypothesis for each. Note, certain authors refer to factors such as social capital (Tijssen, 2018) as career motivations, however these cases are in the minority. It is important particularly when it comes to statistical analysis, to clearly distinguish between motivations and influencing factors, and the inability of prior research on the topic to do this has been noted as a weakness (Ryan, 2014).

Ryan (2014) describes motivation as a “psychological phenomenon, an internal state of a person that impels them towards action, and as such is an individual characteristic” (p356). Davey et al. (2016) define motivation as “the cognitive decision-making process through which goal directed decision-making behaviour is initiated energised, directed and maintained” (p3; see also Morris et al., 2022). This definition reflects others in the literature, for example motivations:

serve three important functions: 1) energizing us (i.e., turning the key and starting the motivational engine), 2) directing us (i.e., pointing us in a particular direction), and 3) helping us to select the behaviour most appropriate for achieving our goals (Kong, 2009, p. 45),

or more simply “motivation is the kick off and behaviour behind the strength” (Gopalan et al., 2017, p. 1) to carry out an activity.

Motivation can be further subdivided into two related constructs: ‘Intrinsic Motivation’ and ‘Extrinsic Motivation’ (Bhaduri & Kumar, 2011; Morris et al., 2022; Olaya Escobar et al., 2017; Ryan, 2014). Intrinsic motivations “stem from an innate sense of pleasure and satisfaction in the task or activity executed” (Olaya Escobar et al., 2017, p. 716), and come from within the individual (Putra et al., 2017). Importantly, intrinsic motivation “is non-instrumental in nature, that is, intrinsically motivated action is not contingent upon any outcome separable from the behaviour itself. Rather, the means and end are one and the same” (Legault, 2016p32). Following on from their earlier (Ryan & Deci, 2000) work, Ryan and Deci (2020, p. 3) define intrinsic motivation as “activities done ‘for their own sake,’ or for their inherent interest and enjoyment (Deci & Ryan, 2000). Additionally, Makitan et al. (2024, p. 7) define intrinsic motivations in terms of “play, exploration and curiosity-spawned activities [that] exemplify intrinsically motivated behaviours, as they are not dependent on external incentives or pressure, but rather provide their own satisfactions and joys”.

Conversely, extrinsic motivations “embrace personal or professional incentives” (Olaya Escobar et al., 2017, p. 717) or are “derived from factors outside an individual that lead to a specific outcome” (Putra et al., 2017, p. 4). Drawing from the work of Deci and Ryan (2008), Legault (2016) defines extrinsic motivation as

performance of behaviour that is fundamentally contingent upon the attainment of an outcome that is separable from the action itself. In other words, EM is instrumental in nature. It is performed in order to attain some other outcome (p32).

This definition reflects more recent literature (Dwivedi et al., 2022; Filgona et al., 2020; Krath et al., 2021; Ryan & Deci, 2000, 2020) on this topic and so is adopted for this research.

The intrinsic / extrinsic distinction is important as it allows for an analysis of the relative strengths of these motivational types and the influences of each, relative to research orientation. For example, researchers might be motivated not by monetary gain, wage increases, or promotions (extrinsic motivations (Ryan & Deci, 2020)) but rather by the pleasure, stimulation and personal satisfaction received (intrinsic motivations) when a particular goal is achieved (Olaya Escobar et al., 2017). Similarly, Ryan (2014) identifies intrinsic motivations “to be more related to innovative performance than extrinsic motives” (p357).

Table 38 (Appendix A) presents examples of prior research that examined the relationship between researcher motivations and various forms of research orientation (e.g. the desire to engage with industry), combined with the research methods used in each case. The table categorises the motivations as intrinsic and extrinsic, even though in some papers they are not referred to as such (these items are marked in the table).

Drawing on the above, the overarching hypotheses driving the research and analysis throughout this study are that

*H1 Intrinsic motivations directly influence an individual’s research orientation*.

*H2 Extrinsic motivations directly influence an individual’s research orientation.*

Note, it is not appropriate to specify directionality for the above hypotheses as “different motivational drivers can co-exist and scientists may be extrinsically or intrinsically motivated to different degrees” (Lam, 2011, p. 1358) in relation to their research orientation. According to Beck et al. (2022, p. 150)

the conventional assumption that scientists’ research activities are motivated by intrinsic satisfaction and reputational rewards, while their commercial activities are driven by the desire for financial gain, may reflect an oversimplified view of human motivation … Rather, scientists are driven by a wide variety of motivational factors, including the desire to produce new knowledge, solve a particular problem, and transform their discoveries into societal impact

Accordingly, the following sections provide a more fine-grained examination of the individual extrinsic and intrinsic motivations that are noted in the literature to impact on individuals’ research orientation, accompanied by hypotheses for each, incorporating directionality.

* + 1. Researchers’ intrinsic motivations

Appendix A / Table 38 presents a summary of prior research in which intrinsic motivations are referenced, while the most frequently recurring intrinsic motivations in extant literature related to an academic context are presented in the table below. Each of these motivations is defined and discussed in the following sections.

Table 8   
*Identified Intrinsic Motivations*

|  |  |
| --- | --- |
| **Intrinsic Motivation** | **Reference** |
| Academic freedom | Hsu et al. (2014); Liang and Chang (2014); Link et al. (2017); Olaya Escobar et al. (2017); Ryan (2014); Ryan and Berbegal-Mirabent (2016) |
| Intellectual stimulation | Jindal‐Snape and Snape (2006); Liang and Chang (2014); Olaya Escobar et al. (2017); Ryan (2014); Ryan and Berbegal-Mirabent (2016) |
| Sense of achievement / satisfaction | Jindal‐Snape and Snape (2006); Lam (2011); Olaya Escobar et al. (2017); Ryan (2014); Ryan and Berbegal-Mirabent (2016) |
| Risk aversion | Hossinger et al. (2020); Hsu et al. (2014); Johnson et al. (2016); Liang and Chang (2014); Schneider et al. (2021); Urbano et al. (2016); Würmseher (2017) |
| Social / civic responsibility | (Benneworth et al., 2018; Cvitanovic et al., 2015; Hayter et al., 2020; Pickernell et al., 2019; Rossi et al., 2020; Ryan, 2014; Ryan & Berbegal-Mirabent, 2016) |

Beyond these key motivations, others emerge more sporadically in the literature. Ryan (2014) discussed how researchers may have a high drive for self-actualisation, noting that this is “neutralised by barriers to the fulfilment of lower order needs” (p356), a view that echoes the importance of an organisation satisfying researchers’ basic needs as discussed above. Jindal‐Snape and Snape (2006) equate self-actualisation to the full development of one’s potential and competence. Closely aligned to this are the motivations of self-esteem (aligned by Olaya Escobar et al. (2017) with achievement) and self-confidence (Würmseher, 2017). Bhaduri and Kumar (2011) aligns the concepts of competence and self-confidence in researchers, saying:

It may be argued though that competence and confidence are not completely unrelated. In so far as competence is accumulated through past experience with a task, it can be seen as a source of confidence, to undertake further activities, when outcomes are uncertain. The latter, in turn, also helps augment competence for the task at hand (p36).

The sense of duty (Bhaduri & Kumar, 2011), doing good science (Ryan & Berbegal-Mirabent, 2016) or simply making a difference in society (Jindal‐Snape & Snape, 2006) are also mentioned in the literature as intrinsic motivations albeit with less focus than those discussed above.

* + - 1. Academic Freedom

The concept of scientific/academic freedom has been long debated in the literature and in policy (Braben, 2008; Metzger, 1978; Wilholt, 2010). In basic terms, scientific freedom represents the freedom of researchers to pursue research of their own choosing, whilst adhering to ethical and responsible principles (Jarvis, 2017), or as Lee (1996 p843) puts it “the freedom to pursue long-term, disinterested, fundamental research”. Ryan (2014) identifies “freedom to work in one’s own way” (p356) as one of many researchers’ career motivations, a view reflected by Lounsbury et al. (2012) and Bhaduri and Kumar (2011). An important distinction needs to be made between scientific freedom (also called freedom of science (Beiter, 2019)) and academic freedom. The difference between the terms is that academic freedom applies to individuals working within an academic institution, whereas scientific freedom applies to a broader range of researchers and scientists (Wilholt, 2010), insofar as it can include scientists and researchers in industry for example. Because of this, the term academic freedom rather than scientific freedom applies to this current research.

More formally, drawing on UNESCO definitions, Beiter (2019, p. 242) defines academic freedom as the right of a person working in an academic institution

without constriction by prescribed doctrine, to freedom of teaching and discussion, freedom in carrying out research and disseminating and publishing the results thereof, freedom to express freely their opinion about the institution or system in which they work, freedom from institutional censorship and freedom to participate in professional or representative academic bodies.

Karran (2009) introduces the concept of negative and positive freedom, as “negative freedom (the absence of constraint - ‘not being prevented from choosing as I do’) and positive freedom (the freedom and ability to act and be ‘one’s own master’)” (p273). Karran (2009) notes that prior research has demonstrated that researchers (interviewed in Bennich‐Björkman (2007)) had positive but not negative freedom, meaning they were “unconstrained in the choices they made for the subject of their research, but were unable to undertake their research through lack of resources” (p273).

As Karran (2009 p273) puts it, “academic freedom means nothing if professors cannot afford to do the research that they are supposedly free to do”. Lynch and Ivancheva (2015) concur with this perspective, noting that while individual universities and colleges proclaim academic freedom on an institutional level, the academic staff therein are constrained by the organisation’s policies and procedures:

While university autonomy matters for individual academic freedom, it does not guarantee it, and individualised academic freedom does not guarantee disciplinary freedom for communities of scholars or subjects (p. 74).

This contention reflects the issues apparent in the entrepreneurial university as discussed in Section 2.3.

Lynch and Ivancheva (2015) also note that researchers’ academic freedom is highly constrained by resources provided to them, and the sources thereof:

Academics who have the ‘freedom’ to research new ideas or to introduce new subjects are increasingly confined to fields of scholarship that are supported by government, which, in turn, are strongly influenced by business interests, especially those in science and technology. The impact of commercial interests is reflected especially in the funding of research (p76).

Similarly, potential loss of academic freedom has been highlighted by Garcia et al. (2019), echoing the research of Tartari and Breschi (2012), as a barrier for researchers’ embarking on academic – industrial collaboration. Similarly, Ramos-Vielba et al. (2016) note that “empirical studies have confirmed that a major concern of … researchers is the potential for external co-operations with private industry to have a negative impact on their freedom to pursue a relatively autonomous research agenda” (p.563).

The above indicates that the choice of research orientation for researchers is influenced by academic freedom but is constrained / moderated by resources, policies and supports, a view reflected in (Lee, 1996).

Olaya Escobar et al. (2017) build on this assertion when they highlight independence as a motivational driver present particularly in researchers with a ‘high taste for science’ (p717). Similarly, Roach and Sauermann (2010) posit that academic freedom is a significant diver of researchers’ desire to undertake basic research, while those with who care less about freedom can be driven towards deeper industry collaboration and commercialisation, a view reflected in Agarwal and Ohyama (2013) and Sauermann and Stephan (2013). Edwards (2022) agrees with this contention and suggests that researchers are more likely to embark on high-ambition, high-innovation, research relative to their perceptions of academic freedom. Perkmann et al. (2021, p. 5) concur and note a perception that engagement in commercial research “limits academic freedom and harms scientific credibility”. van Rijnsoever and Hessels (2020, p. 2) posit that a “large share of … researchers remain cautious about engaging with industry” and that this hesitation is “due partly to concerns about research integrity, reproducibility, academic freedom and possible neglect of more fundamental research”. Lam (2011) takes a less black and white perspective saying that freedom enables researchers to choose to undertake commercial as well as basic research as this creates “an additional avenue for realising the wider potential of their particular science” (p1364). Hsu et al. (2014) concurring somewhat, took a different perspective and identified freedom as one of four intrinsic motivations associated with innovation-oriented researchers (the other three being courage, interest and curiosity for the unknown). Link et al. (2017) posit that researchers view freedom as a result of issuing patents (thus giving the freedom to publish) or securing tenure (thus reducing the need to march to a particular drum). Azoulay et al. (2009) support this position in earlier research that demonstrated that an increase in patenting activity resulted in an increase in publication outputs and quality. Perkmann et al. (2013), however, counter this position, positing that:

researchers involved in commercialisation activities practice higher degrees of secrecy than their non-commercialising colleagues … and that academic entrepreneurship may hamper the accumulation of knowledge in the public domain. Related research suggests that increased academic patenting may slow the unencumbered diffusion of academic knowledge (p428)

This is an example of the interplay between extrinsic and intrinsic motivations. Similarly Roach and Sauermann (2010) highlight the tension between securing research funding (which more often than not results in research direction by the stakeholder) vs freedom.

Drawing on the above the following hypothesis emerges:

*H1a - A higher desire for academic freedom is directly related to a basic research orientation.*

*H1b - A lower desire for academic freedom is directly related to a commercial research orientation.*

* + - 1. Desire for intellectual stimulation / challenge

The basic desire for intellectual stimulation or challenge has been noted as a driving force for the decision to engage in a scientific career (Jindal‐Snape & Snape, 2006; Roach & Sauermann, 2010) particularly when combined with academic freedom (Ryan, 2014; Ryan & Berbegal-Mirabent, 2016). Other authors discuss problem solving as an impetus for scientific collaboration (Iglič et al., 2017) and innovation (Hsu et al., 2014). Ryan (2014) identifies the pleasure gained from ‘puzzle solving’ as a motivational driver for researchers engaged in pure science through to solving industrial problems. While (Lam, 2011) posits that the desire for intellectual stimulation is a key motivational driver of researchers with a basic research orientation. According to Blind et al. (2018, p. 1197), in addition to seeking peer recognition or financial gains researchers are also:

driven by solving intellectual challenges to further the stock of knowledge within their research discipline. This drive constitutes an intrinsic form of motivation, as the “puzzle”-solving activity is not undertaken for the external reward but for the pleasure of solving the problem.

This perspective reflects the discussion in van Rijnsoever and Hessels (2020), Olaya Escobar et al. (2017), Sauermann and Cohen (2010) and Sauermann and Stephan (2013). For example, van Rijnsoever and Hessels (2020), through a statistical analysis of 3145 US researchers, discovered that complex problem solving and stimulation were primary drivers of researchers’ for engaging in basic research, with career-development being less important. Similarly, Agarwal and Ohyama (2013) discovered, through statistical analysis, that researchers with a higher intellectual drive favoured a basic research orientation rather than applied or commercial, a perspective reflected in Ballabeni et al. (2014).

Additionally, the desire to learn from industrial problems (Davey et al., 2016), and to find new avenues for research (Olaya Escobar et al., 2017), thereby enabling intellectual stimulation, is noted as a precursor to researcher-industry engagement. Obschonka et al. (2019) build on this contention, through their study of researchers’ entrepreneurial intentions, and reported that the desire for intellectual stimulation was strongest in researchers with a basic research orientation, while researchers oriented towards applied and commercial research displayed lower levels of desire for intellectual stimulation but higher entrepreneurial intentions, thereby reflecting the work of Lam (2015). Accordingly, it can be hypothesised:

*H1c - A higher desire for intellectual stimulation/challenge is directly related to a basic research orientation.*

*H1d - A lower desire for intellectual stimulation/challenge is directly related to a commercial research orientation.*

* + - 1. Sense of achievement / satisfaction

Closely tied to the concept of intellectual stimulation is that of the researcher’s sense of achievement and satisfaction (Ryan, 2014; Ryan & Berbegal-Mirabent, 2016). Ryan (2014) highlights that if an organisation’s policies and structures do not address the basic needs of the researcher, then “the scientist’s behaviours will be directed towards such needs satisfaction and diverted away from the achievement of higher order needs (and grand scientific goals)” (p357). Jindal‐Snape and Snape (2006) position a researchers’ sense of achievement as an inherent motivator and a prelude to their satisfaction.

Olaya Escobar et al. (2017) identified that personal satisfaction had a higher influence on research performance and output, in terms of knowledge transfer and patent production, than financial reward. Lounsbury et al. (2012) documented a higher level of satisfaction/achievement, and indeed intrinsic motivations overall, amongst employees in scientific vs non-scientific careers. Satisfaction and enjoyment have also been linked to the inherent uncertainty that accompanies many scientific endeavours, thereby highlighting the link between challenge and satisfaction (Bhaduri & Kumar, 2011). Ballabeni et al. (2014) discovered that researchers were more driven by satisfaction than prestige or financial gain.

Basak and Govender (2015) identify multiple indicators of job satisfaction in academics, with policies, supports and finance being key. Ahmad and Jameel (2018) add empowerment to the list of influences on satisfaction, which draws a linkage between academic freedom and satisfaction. Taking this in conjunction with recent moves to boost TTO activities, policies and supports, improved financial rewards for commercial endeavours, and strong social capital, it becomes clear that these traits lean heavily towards an entrepreneurial orientation. The exception here is academic freedom, which as noted earlier, has been posited to diminish in the face of pressures to commercialise. However, it is possibly the case that financial rewards coupled with strong institutional supports (Ebrahim et al., 2019) towards commercial work, outweigh the influence of academic freedom on career choices – as reflected in the results of this research (Chapter 7). Dorenkamp and Ruhle (2019) present an alternative perspective and highlight that work-life conflict can have a substantial impact on job satisfaction for academics. As will be discussed in Section 3.4, work-life conflict is a particular pressure on females rather than males, and so may be another explanation for the preference in females to pursue more basic science activities. Summarising the above, it can be hypothesised:

*H1e - A higher desire for achievement/satisfaction is directly related to a commercial research orientation.*

*H1f - A lower desire for achievement/satisfaction is directly related to a basic research orientation.*

* + - 1. Risk Aversion

It should also be noted that certain motivations arise from the arguably more negative end of the motivational spectrum. For example, Johnson et al. (2016) discuss the impact of an individual’s risk aversion (‘prevention focus’), or what Urbano et al. (2016) call the ‘fear of failure’, on their decision to align with a particular research orientation, noting that some researchers are less inclined to commercialise their research as there is a high level of risk involved in terms of time commitment, reputation, job (in)stability (Würmseher, 2017) and uncertainty. Johnson et al. (2016), however, provide a more nuanced explanation, indicating that risk averse researchers are more likely to follow a more informal commercialisation path (e.g. through contract research where research project scope and associated outcomes are fully defined from the outset). Coupled with this, Hsu et al. (2014) and Liang and Chang (2014) discuss courage as an indicator, and in some cases as a pre-requisite, of research orientation.

Hossinger et al. (2020) note the impact of fear of failure and risk aversion as key barriers in the journey towards entrepreneurship, and further note that this is particularly pronounced amongst female researchers. Additionally, Schneider et al. (2021) note that female researchers have a higher risk aversion, when it comes to entrepreneurial activities, a view concurred with by Murray and Graham (2007). “Fear of failure has a smaller negative influence on men than women in their decision to participate in entrepreneurial activities, a finding in line with other studies of gender and risk” (Murray & Graham, 2007, p. 666).

Neves and Brito (2020) note that while personal motivations such as risk-taking propensity, curiosity and challenge appear in the literature as motivational drivers, more research is needed to explore these aspects. Perkmann et al. (2021) and Wang et al. (2021) support this call for further investigation on this topic.

As intention is deemed not only a bridge between conscious and actual behaviour, but also the proactive commitment to future behaviour, studying the factors that may influence entrepreneurial intention is crucial in the effort to support academic entrepreneurship (Wang et al., 2021, p. 2)

Bridging the argument concerning risk aversion and associated rewards, Siegel and Wright (2015) suggest that:

there are high opportunity costs of commercialisation for academic entrepreneurs. Thus, there is a strong need for universities to adapt promotion and tenure and remuneration systems for academics so that commercialisation activities are valued” and that “common sense dictates that having commercialisation activities matrixed into the university’s reward systems is likely to induce higher levels of academic entrepreneurship (p. 589).

In summary, as a hypothesis:

*H1g - A higher level of risk aversion is directly related to a basic research orientation.*

*H1h - A lower level of risk aversion is directly related to a commercial research orientation.*

* + - 1. Civic and Socially Responsible Research

Hayter et al. (2020) call for research that examines alternate pathways for knowledge exchange and valorisation, going beyond the now typical linear technology transfer route, while Audretsch et al. (2020, p. 9) note that recent literature highlights “the importance of non-financial goals, such as the desire to have a social impact”. These include community communication, often via social media. Additionally, Hayter et al. (2020) reflect on the career motivations behind researchers’ knowledge exchange, such as the desire to diffuse knowledge, to gain peer recognition, or to do a public service. Pickernell et al. (2019) add to this discussion by revisiting the ‘third mission’ of universities (i.e. knowledge exchange and entrepreneurial activities), and note that examinations of university knowledge exchange performance must progress beyond the bounds of technology transfer KPIs.

Cvitanovic et al. (2015) discuss the barriers faced by researchers in terms of engaging with (environmental) decision-/policy-makers. Their work examines the shift from the traditional knowledge transfer model, where researchers make new knowledge available to external entities, towards “contemporary approaches emphasising the need for the two-way exchange of information” (Cvitanovic et al., 2015, p. 38). This view has been brought into sharp focus in recent times, particularly during the COVID-19 pandemic – for example the British Academy’s (2021) report *“Shaping the COVID Decade: Addressing the long-term societal impacts of COVID-19”* called for UK policy to reinforce the need for multi-directional knowledge flows between science, academy, the public and the state.

Cvitanovic et al. (2015) note difference in priorities, with some researchers driven by intrinsic motivations compared to decision-makers driven by day-to-day operational issues. Their quantitative study demonstrated that while researchers believed they had “a personal responsibility to engage with decision-makers” (p.40), a barrier often faced was lack of visibility of their research. An additional barrier faced was the level of supports, or lack thereof, at an institutional level for such engagements – with no resources such as training, time or funding being made available by their host institutions. The issue of institutional priorities related to research outputs were also problematic insofar as “engagement and communication activities were not formally recognised as core capabilities in [researchers] job description and/or performance agreements” (p.40). The resulting lack of engagement resulted in a situation whereby researchers did not understand the information needs of their potential external stakeholders.

Benneworth et al. (2018), in producing a European Framework for university-community engagement, concurring with Cvitanovic et al. (2015), note that the introduction of targets, key performance indicators and benchmarks within scientific fields created a situation whereby “community engagement has become invisible in universities’ strategic priorities” (p. 16). They note the sharp contrast between how community engagement is measured and the measurement of technology transfer (spinouts, licences, patents...). Rosli and Rossi (2015) concur with this perspective, noting that institutional incentives can have a negative impact on knowledge exchange, for example in institutions where income generation through patent production is a primary focus, societally beneficial knowledge exchange may be considered a secondary, or lower, activity. Considering research assessment, Derrick (2019) notes that in recent years formal assessment criteria have shown an increased focus on assessing “the impact of research ‘beyond academia’” (p. 386) which, in turn, is expected to drive cultural change related to academic orientation and performance.

Another facet of this discussion is the concept of social innovation, defined as “a novel solution to a social problem that is more effective, efficient, sustainable, or just than current solutions and for which the value created accrues primarily to society as a whole rather than private individuals” McKelvey and Zaring (2018, p. 594). These knowledge exchange outputs are “not, or at least not primarily, motivated by private gain or business logic” (McKelvey & Zaring, 2018, p. 594). Building on the concept of academic engagement with industry (Perkmann et al., 2013), McKelvey and Zaring (2018) present the concept of ‘academic engagement with society’ (p.609) however their work does not examine the career motivations, or individuals’ research orientation, associated with this type of knowledge exchange.

Benneworth et al.’s (2018) definition of community engagement, as a separate concept to technology transfer, is as a:

process whereby universities engage with community stakeholders to undertake joint activities that can be mutually beneficial even if each side benefits in a different way (p. 28).

Rossi et al. (2017) use the term ‘knowledge co-production’ to encompass this non-linear model of knowledge exchange, and tie it to academics’ desire to diffuse their research and impact on, for example, socio-economic factors or the public good.

It can be hypothesised, based on the above, that a researcher’s desire to have a civic or socio-economic impact arising from their research can impact on their research orientation.

*H1i - A higher desire to create social/civic impact from research is directly related to a commercial research orientation.*

*H1j - A lower desire to create social/civic impact from research is directly related to a basic research orientation.*

At this juncture, hypotheses related to researchers’ intrinsic motivations and their impact on individuals research orientation have been proposed, as illustrated below.

Figure 8   
*Conceptual Framework - Intrinsic Motivations – Research Orientation*

A diagram of a research process

Description automatically generated

* + 1. Researchers’ extrinsic motivations
       1. Reputation vs Reward

The need for enhanced status and reputation (Ryan, 2014) resulting, in some cases, in increased organisational power (Ryan & Berbegal-Mirabent, 2016) is seen as a critical factor in researchers’ career choices (Davey et al., 2016). Ryan and Berbegal-Mirabent (2016) note that early research has identified that the need for recognition from one’s peers, through reputation building, is a key motivational driver for scientific excellence, to the extent that “even when the subject of the activity is the commercialisation of research, the motivations for engaging in such activities are still largely non-financial/reputational rewards and intrinsic motivations” (p. 5301).

Any discussion on researchers’ reputational aspirations has to take the emergence of the entrepreneurial and neoliberal university into consideration. Increasingly the pressure to create impact and commercial outputs are counted as significant arbiters of a researcher’s personal reputation (Goel & Göktepe-Hultén, 2019; Hossinger et al., 2020; Orazbayeva & Plewa, 2022; Rhoads, 2018; Wardle et al., 2019).

Blind et al. (2018) concur with the assertion above, however they note that these motivations are highly contextual. For example, they note the work of D’este and Perkmann (2011) who discovered that, for researchers in the field of engineering, financial gain was the primary motivator for knowledge transfer behaviour. This echoes the work of Bentley et al. (2015) and Hayter et al. (2018) who noted that specialism in basic research was more likely in life sciences, physical sciences, humanities and social sciences, whereas specialism in applied research was more typical in engineering, medical science, education and law.

Reluctance to engage in such knowledge transfer activities could be a result of the tendency of many research organisations to provide quite limited royalty percentages to researchers in return for commercial success (such as technology licencing, or spinning out a company) (Glenna et al., 2011; Link et al., 2017). Arqué-Castells et al. (2016) note that although the possibility of higher royalty shares serves as a motivation for certain researchers, it often has very little impact due to the fact that the researchers themselves see relatively low commercial value in their research outputs, and so are essentially happy to receive any form of financial reward. The perspective on rewards is further detailed by Olaya Escobar et al. (2017) who qualify, and de-personalise, the reward element. Their statistical analysis of extrinsic motivations identified that (for their sample) financial rewards to researchers had the lowest influence on research performance.

Researchers highly appreciate accessing new infrastructures for better development of research activities, such as laboratory equipment and the possibility of having research assistants, while personal monetary rewards are ranked lower (Olaya Escobar et al., 2017, p. 717).

van Rijnsoever and Hessels (2020) concur with this assertion, albeit with a blanket perspective that researchers are not motivated by financial gain, however their research draws a distinct link between engaging in commercial research activities and reputational motivation. This view reflects a study by Ballabeni et al. (2014) in which they discovered that curiosity, puzzle solving, and satisfaction were considered more important than financial gain or increased prestige.

` Olaya Escobar et al. (2017) and Blind et al. (2018) further note that researchers decide to patent their research outputs to secure academic recognition and prestige from commercial success, while others (Jindal‐Snape & Snape, 2006; Lam, 2011; Link et al., 2017) highlight the production of high quality publications as a means to achieving prestige and recognition. Lam (2011) presents an interesting perspective on the subject, saying that researchers are motivated:

by the recognition and prestige bestowed by their professional peers but also because other rewards such as salary and research funds are usually graduated in accordance with the degree of recognition achieved (p1357).

Rewards in terms of increased access to industrial resources (Davey et al., 2016), greater research funding (Lam, 2011; Olaya Escobar et al., 2017), or broader collaborative networks (Iglič et al., 2017) to support research activities have also been shown to be reward-related career motivations.

Agarwal and Ohyama (2013) note that researchers’ drive for rewards is offset by their “taste for non-monetary returns” (p.951). Their research identified that researchers with a higher desire for financial reward were more drawn towards applied-commercial research careers. This is reflected by Sauermann and Stephan (2013) when they say “ researchers' primary reward from research comes from peer recognition, status in the scientific community, or the pleasure to work on interesting projects of their own choosing” (p. 892). Ramos-Vielba et al. (2016), following a statistical analysis examining motivations and barriers to commercial engagement, found that “risk to scientific credibility” (p.568) was a significant barrier. Summarising the above as hypotheses:

*H2a - A lower desire for rewards is directly related to a basic research orientation.*

*H2b - A higher desire for rewards is directly related to a commercial research orientation.*

*H2c - A lower desire for reputational gains is directly related to a basic research orientation.*

*H2d - A higher desire for reputational gains is directly related to a commercial research orientation.*

* + - 1. Promotion and Tenure

Promotion and the possibility to secure tenure are two related career motivations (Chang et al., 2016; Iglič et al., 2017; Johnson et al., 2016; van Rijnsoever & Hessels, 2020) which influence individuals’ research orientation. For example, Link et al (2017) carried out empirical analysis about the propensity of academics to engage in technology transfer. Their statistical analysis indicated that tenured staff were more likely to engage in commercial activities than non-tenured staff. This reflects the ideas of Johnson et al. (2016) who note that, when tenure has been secured, researchers are less risk averse, and so are more likely to engage in commercial research activities. This is highly dependent, though, on the nature of the organisation in which the researcher finds themselves. Lynch and Ivancheva (2015), discussing the link between tenure and academic freedom, assert that tenure:

allows academics the freedom from necessity in order to think innovatively and independently, to resist negative administrative sanction, to collectively shape institutional decisions, and to secure certain liberties for non-tenured staff (p77).

Link et al. (2017) note that in certain organisations engagement with industry is a key performance indicator used to fulfil tenure requirements, while in others publications and presentations are the key. Blind et al. (2018) contend that knowledge transfer, in the form of patent submissions, is seen by some researchers as a means to attain academic promotion. Taking the organisational perspective, Olaya Escobar et al. (2017) suggest that when knowledge transfer (from academia to industry) “activities are not critical when evaluating the curriculum of a researcher in order to gain access to a senior position, the willingness to engage in such activities is limited” (p. 717). The takeaway from this is that organisation processes and culture are key influences on the relationship between researcher motivations and their research orientation, as discussed in section 3.4.2. Interestingly, Thursby et al. (2007) argue that academic productivity is lower in tenured versus non-tenured researchers – however that is outside the scope of this present study. They do however contend that researchers are motivated to undertake basic research in order to reach tenure, and this motivation dwindles once tenure is secured (Thursby et al., 2007). Hayter and Parker (2019) found that, within their research sample, a majority of postdocs indicated that their primary driver for pursuit of a scientific career was to secure a tenure-track faculty position, while others indicated a desire to secure significant publications and academic track record. Walter et al. (2018) disagree with this somewhat, finding that financial incentives, both direct and indirect, are dominant drivers of research commercialisation.

To conclude, returning again to the slightly negative facet of extrinsic motivations, the need to keep one’s job (Jindal‐Snape & Snape, 2006), to bow to peer-pressure or meet statutory requirements (Bhaduri & Kumar, 2011) have also been highlighted in the literature, albeit sparsely. From the discussion above it can be hypothesised:

*H2e - A lower desire for promotion/tenure is directly related to a commercial research orientation.*

*H2f - A higher desire for promotion/tenure is directly related to a basic research orientation.*

At this juncture, hypotheses related to researchers’ intrinsic and extrinsic motivations and their impact on individuals’ research orientation have been proposed, as illustrated below.

Figure 9   
*Conceptual Framework - Intrinsic and Extrinsic Motivations – Research Orientation*

A diagram of a research process

Description automatically generated

The above sections demonstrate that an individual’s research orientation is directly influenced by their intrinsic and extrinsic motivations, however the relationship is not straightforward as the motivations themselves can interrelate in terms of their levels of impact. In addition, multiple external influences on the motivation⬄research orientation relationship need to be considered, as detailed below.

* 1. Influences

External influences can have many forms, as discussed in Chapter 2. These can range from personal characteristics of the individual researcher’s profile (such as gender (Goel & Göktepe-Hultén, 2018; Würmseher, 2017), age (Gerbin & Drnovsek, 2016; Würmseher, 2017) and career stage (Hayter & Feeney, 2017; Lam, 2011)), to external factors (such as organisational priorities (Aldridge & Audretsch, 2017; Fini et al., 2017; Johnson et al., 2016) and culture (Hayter & Feeney, 2017; Link et al., 2017)). The following sections present the most commonly recurring themes related to these from the extant literature.

* + 1. Researcher Profile
       1. Age

Hmieleski and Powell (2018) call for research that undertakes a quantitative examination of moderation effects (of factors such as gender, age, tenure) on researchers’ propensity to embark on entrepreneurial activities, while Zhao et al. (2021) suggest that further research is needed to clarify the relationship between age and research orientation. However, extant research related to researchers’ age and their research orientation has produced mixed results.

Lam (2011) undertook a mixed method study (interviews and a survey comprising researchers from five UK based universities) to develop a typology of researchers, within which she identified that younger researchers, measured in terms of biological age, were less likely to engage in commercial work, and that “commercialisation activities are more likely to be performed by academics over forty” (Neves & Brito, 2020, p. 651). Lam (2011) suggests that this was primarily related to developed levels of experience, breadth of collegiate networks and focus on tenure / promotion during early career stages (Goel & Göktepe-Hultén, 2018). Beck et al. (2022, p. 149) concur with this assertion and posit that older, and male, researchers “are more likely to engage in open and collaborative practices” with industry with possible reasons being time availability, experience working in industry, low risk aversion, lower career pressure and collaborative network size.

Conversely, Giuliani et al. (2010) used researchers’ age as a control variable, and found a significant correlation between younger researcher’s age and propensity to engage with industry. Their research, however, employed a small (n=135) sample of researchers involved in wine-related research fields, meaning this is a single-industry study the results of which “may be specific to the wine industry” (Giuliani et al., 2010, p. 757). Additionally, Karlsson and Wigren (2012) found that a researchers’ biological age was negatively correlated to engagement in entrepreneurial or commercial activities. Their research comprised a large sample (n=7260) of researchers and focussed specifically on researchers’ intention to create a start-up.

Interestingly, Aldridge and Audretsch’s (2017) analysis determined that, for researchers, biological age had no impact on their propensity to become entrepreneurial, while it had a direct effect on the decision to become an entrepreneur for the population at large (i.e. outside the academic community). Their research involved developing a database of entrepreneurial researchers, particularly focused on grantees of the US National Cancer Institute (NCI), meaning the profile of researchers examined was quite limited. Accordingly, Aldridge and Audretsch (2017) note there is no reason “to expect the results from this exceptionally high performing group of scientists in a very narrow, specific scientific field to hold across other scientific fields” (p.1066), and call for subsequent research to expand their work across multiple fields. Additionally, Gerbin and Drnovsek (2016), through a literature review, determined that a researcher’s age is the least significant predictor of research orientation.

Perkmann et al. (2021), Hmieleski and Powell (2018) and Tartari and Breschi (2012) found a similar level of ambiguity in the extant literature, relative to researchers’ biological age. Perkmann et al. (2021) suggest that biological age has been shown to have both a positive and negative impact on research orientation depending on the location of the researcher and their discipline. They note however that older researchers typically “play a lead role in establishing and managing collaboration with industry” (p.4) and that “academics become advisors to a company later in their career, compared to founding a company” (p.4). Hmieleski and Powell (2018), through a literature review, identified past studies that have found both a positive and negative correlation between biological age and entrepreneurial intentions.

Interestingly, Tartari and Breschi (2012, p. 1131) note that older researchers may have received their training at a time when universities’ engagement with industry was less relevant or even discouraged (the age of the “Ivory Tower”), thus reducing the likelihood of a commercial research orientation.

Neves and Brito (2020) identified both a positive and a negative relationship between biological age and research orientation, through an extensive review of 66 publications focusing particularly on entrepreneurship. They note that prior research found a negative correlation between biological age and entrepreneurial intention – defined, in their research, as the intention to undertake spin-out activities, however they highlight that research which focused on research motivations found that older academics are “more likely to explore their reputation and knowledge commercially” (Neves & Brito, 2020, p. 651) and to engage in university-industry collaboration due to their typically more extensive collaboration networks and “more time to develop work applicable to the industry context” (p.651). Goel and Göktepe-Hultén (2019, p. 161) found that older researchers were more likely to have a commercial research orientation which they attribute to this cohort having a “better ability to foresee the dynamic synergies of research associated with both patenting and invention disclosures”. Their work concludes with a call for future research to draw from their conceptual framework, operationalise their constructs (such as age, gender, education level, motivations, social capital, organisational support and environment), and empirically examine the relationship between these constructs and research orientation, noting in particular that “individual variables remain an emerging topic” (Neves & Brito, 2020, p. 665), as has been undertaken in this research thesis.

de Lourdes Machado-Taylor et al. (2016, p. 550) note that extant research has “shown that [biological] age is associated with academic job satisfaction, and older individuals generally show greater satisfaction with their work”, while Martín-Sempere et al. (2008) found a positive correlation between a researcher’s age and both intrinsic and extrinsic motivations. Vantard et al. (2023) note that individuals’ research orientation towards applied or commercial research increases with age, however they caution that career age rather than biological age may be a stronger predictor. Römer-Paakkanen and Takanen-Körperich (2022) observe a similar effect, with a particular focus on the biological age of female researchers.

Drawing on the above it can be posited that the researchers’ age moderates the relationship between their intrinsic/extrinsic motivations and their research orientation such that:

*H3a – As a researcher’s age increases, the impact of their intrinsic motivations on their commercial research orientation increases, and the impact of their intrinsic motivations on their basic research orientation decreases.*

*H3b – As a researcher’s age increases, the impact of their extrinsic motivations on their commercial research orientation increases, and the impact of their extrinsic motivations on their basic research orientation decreases.*

Other research has applied ‘career age’ or ’career stage’ rather than biological age as a model construct. For example, Hayter et al. (2018) note that entrepreneurial tendencies increase with career age (measured in their work as total number of years since respondents completed their PhD), as career age is closely related to academic rank.

Addressing the conflict between research using biological age and ‘academic age’, which they define as “time elapsed since first publication” (p.3543), Kwiek and Roszka (2022) found that academic age can act as a strong proxy-measure for biological age in relation to STEMM (science, technology, engineering, mathematics and medicine) disciplines, however for non-STEMM disciplines it has a “dramatically worse performance” (p.3543) and suggest caution in its usage. Neves and Brito (2020) drew the same conclusion in their research, where they found that, “years at the academic institution follow the same pattern found with the academics' age” (p.655), a finding concurred with in the work of Costas et al. (2015). This is similarly reflected by Perkmann et al. (2021, p. 9) when they highlight that, for statistical analysis of individuals’ research orientation, “the role of both biological and academic age remains unclear” .

Goel and Göktepe-Hultén (2019) undertook research which applied this dual-model approach, firstly examining the effect of a researcher’s biological age on their engagement levels with the TTO within an academic institution, then looking at the effect of their “experience” measured as years working at the academic institution, and found no notable statistical difference – their results found that older or more experienced researchers were more inclined to bypass their TTO for entrepreneurial activities.

In order to address concerns from the literature regarding the usage of biological age versus career age and/or career stage in studies such as this, this research will undertake additional analysis (Section 6.4.2.1) which will examine and contrast the effects of biological age, career stage and career age on the hypothesised relationships.

* + - 1. Gender

The discussion on gender in relation to research orientation, particularly relating to the propensity of female researchers to pursue entrepreneurial / commercial engagement is an interesting one. On the one hand, researchers such as Aldridge and Audretsch (2017) and Goel and Göktepe-Hultén (2018) tested, and verified, hypotheses which showed that gender did not have a statistically significant impact on research orientation. Similarly, Jindal‐Snape and Snape (2006) undertook an interview-based study that found that gender had no impact on researchers’ career motivations.

On the other hand, scholars such as Chubb and Derrick (2020) argue that research impact evaluations are often highly gendered, with differing expectations in the minds of evaluators towards male and female researchers. Perhaps as a partial consequence of this, other works have concluded that female researchers were less likely to engage in commercial research (Gerbin & Drnovsek, 2016; Hayter et al., 2018; Lam, 2011), reflecting “divergent attitudes and opportunity structures” (Lam, 2011, p. 1362), that “systemic disadvantages lead female scientists to be less productive than male scientists” (Glenna et al., 2011, p. 962) or that female researchers were less aware of the supports provided by Technology Transfer Offices in university settings (Huyghe et al., 2016). It was also noted in the literature that male researchers receive more industry funding and consulting opportunities due to a deeper propensity to collaborate with industrial partners (Glenna et al., 2011; Perkmann et al., 2013). Interestingly, Link et al. (2017) factored the research organisation context into their research and discovered that females in dedicated research centres were more likely to commercialise than their counterparts in more traditional university settings. This reflects the need to include organisational norms, culture and policies into any integrated analysis. Iglič et al. (2017) demonstrated that female researchers tended to collaborate more with partners from the same institution, whereas male researchers focused more on external collaborations. Abreu and Grinevich (2013) undertook a statistical analysis in the UK from which they found that:

Female scientists are less likely to disclose inventions [(Sohar et al., 2018)], seek patents or otherwise commercialise their work... The risky nature of some ventures, such as spin-outs, may deter female academics who tend to be more risk averse than their male counterparts... The literature has also found that female academics are under greater pressure to achieve tenure while balancing family demands, and are less likely to have commercial experience or belong to networks that also include potential industrial partners, all of which can limit the potential for commercialisation (p. 412).

When it comes to research orientation, particularly in the area of entrepreneurship, patenting and commercialisation of research H. L. Smith et al. (2020, p. 242) note the “relative propensity for women academics so to do is significantly less than for men”, however this is caveated that research environments are likely to have an “impact on the choices that women make with regard to the kind of commercial activity they undertake”. Miranda et al. (2017) statistical analysis verified that the level of academic productivity was inversely related to the number of patents – thereby playing into the publish vs patent debate. H. L. Smith et al. (2020) also note that these differences arise due to field of research, which is more likely to be health and life sciences for women (Di Paola, 2021; Kuschel et al., 2020) compared to engineering and computer science for men, as well as personal motivations and levels of success in attracting venture capital and angel funding. Johnson and Taylor (2019) attribute this situation to the effect of academic capital whereby “reward structures emphasize science and engineering (S&E) fields for their potential to generate money and status. Masculine norms and male majority in S&E fields may create conditions for gender differences in faculty compensation” (p. 1).

Importantly, Schneider et al. (2021) found, following a survey of 1551 Swiss researchers, that:

even in disciplines that lack an affinity for spin-off activities and support a high proportion of women, it appears that entrepreneurship is more likely to be expressed by men. Consequently, the under-representation of female academic founders cannot be exclusively attributed to their under-representation within fields and cannot be explained by varying levels of entrepreneurship in universities (p.387).

Abramo et al. (2018) note a tendency for female researchers to have a broader, more diverse, research portfolio compared to their male counterparts. This suggested focus on less specialised, or niche, research could be a determinant of a negative inclination to undertake commercially focused research. However, conversely, the same authors note that female researchers have stronger formal networks and “engage in topics that not only draw on multiple fields and/or disciplines, but also serve multiple stakeholders and broader missions outside of academia” (Abramo et al., 2018, p. 2). Despite this contention, Murray and Graham (2007) discovered that male researchers receive a higher proportion of commercial collaboration invitations from industry, or ‘cold calls’. Related this, other research, such as the work of Borrego et al. (2010) contends that this situation cannot be analysed though a gender-centric lens alone, and that many other factors, such as age and rank (Schneider et al., 2021), need to be taken into account. Perkmann et al. (2021) revisited their earlier work on the drivers of academic engagement, through a revised literature review. Their work concurs with prior work where it was found that male researchers are more likely to engage with industry while females are more likely to engage more informally, through talks, meetings and provision of informal advice. They of course note this these conclusions are strongly related to research field, but note that this gender gap remains even in more technical or practical fields such as ICT or engineering. Wang et al. (2021) research refines this notion somewhat, based on a statistical analysis, finding that “male academic scientists are more likely to engage in spin-off creation and other activities, such as contracting research and consultation, but there is no significant gender gap in patenting and licensing intention” (p. 18).

It must be noted too that Abramo et al. (2018) posit that diversification of scientific focus across genders is highly field-dependent, while Murray and Graham (2007) highlight that gender stratification is particularly apparent in the most prestigious institutions, and that further research on this topic is required. Caviggioli et al. (2021) brings another perspective, concluding that female researchers are driven towards less technical fields due to cultural norms and expectations, or indeed their country of residence. Miranda et al. (2017), Schneider et al. (2021), H. L. Smith et al. (2020), Lerchenmueller and Sorenson (2018) and Kuschel et al. (2020) discovered that lower entrepreneurial intentions amongst female academics were also driven by barriers such as seniority, discrimination, culture, family circumstances and social differences. In relation to family circumstances, Derrick et al. (2022) note that engagement as a parent has a direct relationship to decreased research productivity and impact. They also note that the impact on parenting on research outputs is relatively gender agnostic, however they highlight that typically females are “more likely to serve in lead parenting roles and to be more engaged across time and tasks” Derrick et al. (2022, p. 8).

Zhang et al. (2021) found that male researchers are more interested in producing research that progresses science, whereas female researchers are more interested in progressing society, which they denote as impact versus usage. This is an important distinction as it may somewhat explain perceived differences in research productivity, measured by citation counts for example. Miranda et al. (2017) posit that females may have a more societal-impact driven commercial agenda than males. For example they suggest “that organisations could attract more women to engineering if the content were made more socially meaningful by reframing the goals of engineering research and the curriculum to be more relevant to societal needs” (p. 249).

Murray and Graham (2007) found that female researchers’ participation in patenting was dominated by opportunities generated by their male peers, another example of the ‘Matthew Effect’ discussed in Section 2.3. Their research found that, in a highly ranked US University, male researchers had the luxury of turning down commercial opportunities as they had no relevance to their research, whereas females had a relative paucity of invitations. This is somewhat at odds with the discussion earlier where it is posited that female researchers develop stronger formal networks and suggests that future research could examine the nature of professional networks developed by researchers.

Similarly, Schneider et al. (2021) posit that female researchers face a catch-22 type situation whereby they have very few female peers acting as entrepreneurial role models (Kuschel et al., 2020). Addressing this concern, Di Paola (2021) highlight the importance of engaging female entrepreneurs and role models within university training programmes. Building on this, Schneider et al. (2021) discovered that there is “little association between entrepreneurial success and the gender of the owner” (p. 374), which implies that the issue lies with encouraging female researchers to embark on an entrepreneurial journey, rather than the outcome of the entrepreneurial activity itself.

Miranda et al. (2017) found that entrepreneurial training in universities was a significant driver of entrepreneurial intentions, particularly amongst women. However, Murray and Graham (2007) note that levels of entrepreneurial training are lower in females than males, whereas entrepreneurial personality was a stronger driver for men. Schneider et al. (2021) add to this contention, as their research demonstrated that females had less awareness of institutional supports and policies related to commercial activities. According to Whittington and Smith-Doerr (2005, p. 366):

A wealth of previous research suggests that women receive less support and research attention from their universities, departments, and scientiﬁc discipline than their comparable male colleagues … Perhaps universities and their technology licensing offices are noticing the high impact inventions of female scientists after the fact but fail to support initial commercialisation for female scientists.

H. L. Smith et al. (2020) posit that the nature of entrepreneurial training requires further examination, as female motivational drivers towards entrepreneurship differ to their male counterparts.

Clearly, the gender perspective plays a significant role in any study of this nature, and indeed warrants further study as a standalone issue, however for the purposes of this particular research gender will be included as one of a number of moderating variables in the final model. Specifically, the above discussion suggests that researchers’ gender moderates the relationship between their intrinsic/extrinsic motivations and their research orientation, such that:

*H4a – For female researchers, as their intrinsic motivations increase their basic research orientation increases, whereas for male researchers as their intrinsic motivations increase their commercial research orientation increases.*

*H4b – For female researchers as their extrinsic motivations increase their basic research orientation increases, whereas for male researchers as their extrinsic motivations increase their commercial research orientation increases.*

* + - 1. Social Capital – Peers, Leaders and Culture

Social capital refers to “meaningful interactions and linkages the scientist has with others” (Aldridge & Audretsch, 2017, p. 157). Discussing the broader experience of undertaking research, and linking to social capital, Iglič et al. (2017, p. 157) posit that:

Research experience is individual endowments of human and social capital separate from, while influenced by, their research environments. The longer researchers engage in research, the more knowledge and skills they accumulate. Furthermore, the larger the number of potential collaborators, since engaging in past collaborations, the greater the access to social capital useful for engaging in future research projects.

Social capital can create academic freedom, or as expressed in (Chang et al., 2016) “on the basis of an individual's resource base in terms of social capital accumulation, it is comparatively easier for a senior faculty member to access research resources” (p13).

[Researchers] with an abundance of social capital find easier access to new tangible and intangible resources that may enhance opportunity recognition and collaborative behaviour. Such benefits may for instance increase the likelihood of starting a new company or sitting on scientific boards of business enterprises. Several studies have shown that social capital may boost academic entrepreneurial activity (Tijssen, 2018, p. 1627).

Perkmann et al. (2021) note the impact of both social capital (Ryazanova & Jaskiene, 2022) and social responsibility on research orientation. Sitnicki (2018) suggest that a researcher’s social capital serves as an impetus towards a commercially focused research orientation:

Greater levels of social networking between a researcher and key players in the industry contributes to the impetus of domain knowledge transfers and spillovers via the relationship by intensifying role of interactions, and thus evaluate pertinent knowledge by exchanging information (p. 282).

This perspective is reflected by Hmieleski and Powell (2018) where collaboration with industry has been shown to have a strong influence on a researcher’s commercially-focused intentions, including spin-out creation. Hmieleski and Powell (2018) also contend that social capital, in terms of peer influence, is a strong indicator of research orientation. Hossinger et al. (2020) concur with this perspective. Ryazanova and Jaskiene (2022) note the importance of promoting social capital as a means to drive research performance, particularly as it pertains to career choices and research focus.

Audretsch and Aldridge (2012) note the importance of transnational social capital in this regard:

In the case of scientist entrepreneurship, interactions and linkages involving scientists reflect social capital and would be expected to enhance the likelihood of a scientist engaging in entrepreneurial activity (p. 371).

Importantly, transnational social capital is particularly developed as a researcher engages with applied research activities, which by their nature are typically transnational collaborative efforts with multiple contributing entities. Audretsch and Aldridge (2012) posit that social capital arising from a researcher’s engagement with a counterpart in industry creates a greater impetus towards research commercialisation. This lends weight to the argument that engagement in applied research activities can be a precursor to commercialisation.

Grzegorczyk (2019) examined social capital through the lens of cultural norms and found that culture can have a significant impact. Cultural influences such as individualism/collectivism, high/low uncertainty avoidance and high/low long-term orientation, were each seem to have an influence on the development of social capital, and the resulting commercial collaborative research. Hayter and Parker (2019) found that social capital, in terms of working with world-renowned PIs, built researcher confidence and interest in remaining within the academic research sphere.

Research has shown the importance of social capital development but has also highlighted the difficulties that some researchers can experience in this regard (Al-Tabbaa & Ankrah, 2016). Often researchers are left to their own devices in terms of matchmaking, or finding suitable collaboration partners, and the result can be that inexperienced researchers develop collaboration agreements with overpowering partners that can hamper or potentially mis-steer the research direction for private commercial gains (Al-Tabbaa & Ankrah, 2016).

Furthermore, emerging research is looking at the potentially negative aspects of social capital, and this would warrant further study, for example Al-Tabbaa and Ankrah (2016, p. 2) suggest that social capital can “produce forms of collective blindness that sometimes have disastrous consequences” and that “in some cases shared norms may cause unnecessary expectations of obligatory behaviour which may result in problems of free riding and unwillingness to experiment beyond the network”. Situations like this can arise in cases, for example, where a university with very open science policies engages with a private company with an ethos of ringfenced intellectual property or of a patent-immediately approach to science, which can result in a collaborative lock-in causing an “inverse relationship between the level of university patenting and the overall quality of these patents” (Al-Tabbaa & Ankrah, 2016, p. 4). Other complications can arise when a researcher or team develops a tendency to frequently engage with the same cohort of partners, which can cause significant collaboration opportunities with new, or even better, prospective partners to dwindle. The key point here is that it cannot be assumed that social capital always leads to a positive outcome, and that significant institutional supports, such as ‘technology translators’, individuals who act as the academic – industry interface, are required in order to support researchers as they develop their social capital and to ensure that collaborative endeavours provide a benefit to all involved.

Gerbin and Drnovsek (2016) and Hayter et al. (2018) note that researchers are more influenced to engage in industrial/commercial research subject to their university/department culture, local groups norms, peer influence, and the number of colleagues involved in similar activities (Baroncelli & Landoni, 2019). Similarly Bhaduri and Kumar (2011) highlight peer group pressure as a significant influence. Furthermore Hayter et al. (2018) posit that, due to their limited commercial experience, researchers with strong external networks find themselves to be more entrepreneurially motivated.

The role of leader figures in academic settings cannot be ignored (Würmseher, 2017). Stuart and Ding (2006) hypothesize “that physical proximity to adopters of commercial science will influence scientists’ attitudes toward the practice” (p105), and:

When a colleague across the hall has transitioned to commercial science, he is able to provide advice on practical matters, including how to navigate the university’s technology transfer office. He may also offer introductions to resource holders in the commercial sector, or assume the role of angel investor to support a firm started by a colleague (p105).

Johnson et al. (2016) posit that courageous leaders can impact their subordinates’ feelings towards risk taking behaviour, such as embarking on commercial engagements. Stuart and Ding (2006) also note that the presence of academic entrepreneurs in an organisation can directly influence other researchers’ opinions about undertaking “for-profit science” (p105):

Pioneer academic entrepreneurs influence potential academic entrepreneurs by example, leading ultimately to an accepted view that starting a new firm is a desirable activity for a researcher (Baroncelli & Landoni, 2019, p. 7).

Johnson et al. (2016) support this assertion, noting that academic leaders can “directly (through role modelling effects) and indirectly (through the level of colleague engagement within their group)” (p182) affect their colleague’s research orientation. They go further to demonstrate (through statistical analysis) how researcher’s risk aversion is impacted by peer behaviour – “As prevention-focused individuals have values aligned with security and responsibility, they should in turn be motivated to match the level of informal commercialisation activity of their colleagues, in order to maintain their ‘group membership’” (p187). This reflects Glenna et al. (2011) and Karhunen et al.’s (2017) discussions about researchers’ core beliefs about academic-industrial collaboration, developed in part through peer engagement, as a direct influence on career choices. Similarly, Urbano et al. (2016) highlight that researchers with a strong social image (which is a reflection of the researcher’s public actions) generate significant social capital. Cantner et al. (2017) identified (in a study of Finnish and Russian researcher entrepreneurs) that, in terms of entrepreneurial behaviour, the majority seem to ‘follow the crowd’ while a low, but not negligible, proportion have entrepreneurial intentions based on a ‘Schumpeterian attitude’ (“acting against all odds” (p190)). This reflects Chang et al.’s (2016) notion of the courageous researcher.

Of course, it goes without saying that there can also be a negative perspective on social capital. For example, Jindal‐Snape and Snape (2006), through a series of interviews with UK researchers, identified that ‘cliquey’ behaviour, ‘difficult characters’, and poor collaboration outside small teams all detracted from their ability to engage in multiple research directions.

To conclude, the relationship between researchers’ intrinsic/extrinsic motivations and their research orientation is moderated by social capital, such that:

*H5a – As a researcher’s social capital increases, the impact of their intrinsic motivations on their commercial research orientation increases, and the impact of their intrinsic motivations on their basic research orientation decreases.*

*H5b – As a researcher’s social capital increases, the impact of their extrinsic motivations on their commercial research orientation increases, and the impact of their extrinsic motivations on their basic research orientation decreases.*

* + - 1. Field

The next influential factor to be examined in this research is that of research discipline or field. Irzik (2013) highlights that the commercialisation of academic science is:

especially conspicuous in disciplines such as genetics and genetic engineering, biomedicine, pharmacology, computer science, communication and information sciences, it refers to the fact that academic scientific research is being done increasingly for profit and that its results are commodified through mechanisms of intellectual property, primarily patents, copyrights and licensing (p. 2376).

This perspective is reflected in the work of other researchers such as Markman et al. (2008), Goldfarb and Henrekson (2003), Holloway and Herder (2019) and Nikulainen and Tahvanainen (2013). For example, Nikulainen and Tahvanainen (2013) note that researchers in fields such as natural sciences or engineering are more likely to commercialise their research outputs, whereas in “other areas, such as social sciences, discoveries with commercial potential may also emerge, but on a much smaller scale, and often in a less tangible form” (p. 4). Similarly, Powers (2003) posits that because of the nature of research involved, the fields of medicine and engineering are the “most important source of university licences” (p. 32), thereby indicating their preferential stance towards commercialisation.

Hayter and Parker (2019) posit that in less applied disciplines, such as life sciences, approximately 89.4% of graduating PhDs move on to tenured faculty positions or leave the academic arena to pursue non-academic careers which often do not fully utilise their scientific or research capabilities. They further contend that this trend represents “the underutilization of publicly-funded human capital therefore limiting knowledge-based economic growth” (p. 4).

Accordingly, concurring with works such as that of Perkmann et al. (2013), and recalling (2022) discussion on the relationship between STEMM (ICT and Engineering, in the case of this research) disciplines and research orientation (Section 3.4.1.1) it can be hypothesised that the relationship between researchers’ intrinsic/extrinsic motivations and their research orientation is moderated by their field of research, such that:

*H6a – For researchers in STEMM fields, the impact of their intrinsic motivations on their commercial research orientation increases, whereas for researchers in other fields the impact of their intrinsic motivations on their basic research orientation increases.*

*H6b – For researchers in STEMM fields, the impact of their extrinsic motivations on their commercial research orientation increases, whereas for researchers in other fields the impact of their extrinsic motivations on their basic research orientation increases.*

Adding hypotheses related to the individual research profile, to the proposed conceptual model, results in the following figure.

Figure 10   
*Conceptual Framework - Influence of Research Profile*

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* + 1. Organisational Context

The researcher’s work context is a multifaceted element in the research orientation discussion. Multiple elements play a role in influencing the researcher’s career choices such as institutional policies and culture (Bhaduri & Kumar, 2011; Hayter & Feeney, 2017; Jindal‐Snape & Snape, 2006; Link et al., 2017), leadership styles, researcher supports (Jindal‐Snape & Snape, 2006; Olaya Escobar et al., 2017) such as training (Hayter & Feeney, 2017) or the availability of a Technology Transfer Office (Goel & Göktepe-Hultén, 2018; Huyghe et al., 2016; Stuart & Ding, 2006)). These, and others, are discussed below.

* + - 1. Policies and Supports

Blind et al. (2018, p. 1185) discuss the impact of state funding on the expected outputs of academic institutions, noting that:

knowledge transfer is a declared goal to further the state of the art of technology….. because of the objective of increasing the social impact and the requirement of raising more financial resources in addition to the basic funding, the range of transfer activities of researchers in the last decades has expanded to include academic engagement and, more recently, commercialisation.

Considering the importance of institutional supports for knowledge transfer in terms of patenting behaviour in researchers, Blind et al. (2018) note that a common barrier to such behaviour is the lack of knowledge and supports related to the patenting process.

The activity of commercialisation is actually separate from doing science. The science can be very dispassionate – the reaction either worked or not. But how you sell it and position it and handle it, that’s a completely human endeavour (Judith Giordan in (Morrissey, 2012, p. 1)).

Taking a broader perspective, Audretsch and Belitski (2022, p. 290) contend that “individual researchers are more likely to create and capture value if the ecosystem where the university operates is growth-oriented and supportive”.

Critically, while universities are streamlining their technology transfer supports and associated institutional resources, there is a perceived lack of education and training being provided during a student’s PhD programme (Hossinger et al., 2020). Duval-Couetil et al. (2021) posit that:

traditional Ph.D. training is not designed to prepare researchers to participate in entrepreneurial activity, and therefore its relevance to scientific work may not be evident. Conventional science and technology entrepreneurship education (STEE) models often position the activity of commercialisation (i.e. business) as separate from discovery (i.e. science), resulting in gaps in knowledge across disciplines (p. 289).

As noted earlier (Section 2.3), institutional policies related to support for research output licencing or spinout support (e.g. “willingness [of an institution] to take an equity stake in exchange for paying patenting and licensing costs” (Gerbin & Drnovsek, 2016, p. 988)) are significantly influential in terms of research orientation. Interestingly, while the role (and behaviour) of the Technology Transfer Office is positively related with all forms of knowledge transfer, the effectiveness can be lessened somewhat if researchers establish independent informal industry engagements (Gerbin & Drnovsek, 2016; Goel & Göktepe-Hultén, 2018; Olaya Escobar et al., 2017). Hayter et al. (2018) posit that extant research highlights that typically TTO resources and networks are generally quite limited.

Fini et al. (2019) found that introducing university regulations to govern spinout activity resulted in an almost doubling (80%+) of entrepreneurial events per department per year. Perkmann et al. (2013) posit that the age of a university is negatively related to the quality of supports for research commercialisation activities, thus reflecting debates about the stifling nature of more traditional academic institutions (Chang et al., 2016; Etzkowitz et al., 2000; Etzkowitz & Zhou, 2017; Meyer et al., 2011; Razak & Murray, 2017). Additionally, certain TTO policies can drive researchers towards patenting and spinning-out rather than engaging directly with industry (Geoghegan & Pontikakis, 2008; Gerbin & Drnovsek, 2016). Importantly, prior research has shown that “researchers working in universities incorporating a TTO with a traditional structure, and those employed at [Swedish] universities which have the professor’s privilege, are less likely to be aware of the TTO’s existence” (Huyghe et al., 2016, p. 599), thereby reflecting the importance of considering university structures and regulations in any analysis related to this topic. Professor’s privilege is essentially a regulation that allows a researcher to retain full ownership of the intellectual property they develop in an academic setting, and has been largely replaced across Europe with TTO processes, equity stakes and regulations in academic institutions (Lissoni et al., 2009).

Recent research has not only examined the role of the TTO (Garcia et al., 2019), but the tendency of some researchers to bypass the TTO function in some cases intentionally due to influences such as direct industry contact or consulting activities (Goel & Göktepe-Hultén, 2018) and in other cases due to lack of awareness about available TTO supports (Huyghe et al., 2016).

Chang et al. (2016) posit that flexibility within a research organisation/university, in terms of policies supporting multifaceted research careers, leads to increased research ambidexterity (“the ability to which academic scientists can simultaneously achieve research publication and research commercialisation at the individual level” (p9)) in researchers:

policies attempting to foster entrepreneurship ensure employees continue to generate new ideas to maximize the sharing of information. Rather than passively waiting for research disclosure, universities may cultivate an active and supportive administrative context to reconcile the tensions at departmental and individual levels (p10).

Guerrero et al. (2016) undertook a statistical analysis of researchers / students in Catalonia, Spain in which they discovered that supports and policies for entrepreneurial activities had a stronger influence on research orientation than intrinsic motivations such as the fear of failure, or other influential factors such as social capital. Conversely, Bentley et al. (2015) found that while most academics follow a blend of basic and applied research, those researchers located in institutions where applied research is not emphasised tend to remain in the basic research sphere. Wegner et al. (2019), through an analysis of researchers in two universities, found that contrary to the majority of related literature, institutional policies had little to no impact on research orientation in terms of entrepreneurial intentions – however, they do call for broader research to validate their findings. Ryan (2014) highlights that:

the potential for scientific achievement is reduced if scientists are overly concerned with meeting basic needs rather than focusing their energies on satisfying higher order needs…. If organisational structures and policies do not satisfy the basic needs of the scientist, then the scientist’s behaviours will be directed towards such needs satisfaction and diverted away from the achievement of higher order needs (and grand scientific goals) (p356/7).

Additionally, according to Agarwal and Ohyama (2013) “the basic scientist has greater access to physical capital than the applied scientist within academia” (p954). Similarly, Bentley et al. (2015) concluded that university emphasis on applied research is a significant driver of researcher career choices.

Gerbin and Drnovsek (2016) discuss training in terms of its effect on commercialisation behaviour and note “training in business skills is shown to be positively correlated with involvement in collaboration with industry and academic entrepreneurship, but not with invention disclosing, patenting and licensing” (p988). Providing another perspective, Hayter and Feeney (2017) highlight that “students trained in an environment that values commercialisation activities are more likely to later engage in technology transfer activities” (p6). Similarly, Hayter and Feeney (2017) demonstrated that “training and patenting experiences during a university scientist’s PhD training [are] related to increased propensity to patent externally” (p15). This is supported by research that identified a direct relationship between training (specifically entrepreneurship training) and research career choices (Bercovitz & Feldman, 2006; Saeed et al., 2015; Urbano et al., 2016). Additionally, Link et al. (2017) verified that training / work placement prior to graduation had a significant influence on research orientation.

Aberbach and Christensen (2018) contend that the role of the university scholar / professor has diminished significantly over time, and that managerial and administrative functions of academic institutions play a dominant role in decision making and steering of research agendas. Neves and Brito (2020) suggest that institutional policies and the level of TTO activity are key drivers of commercially focused research. Wang et al. (2021, p. 8) support this contention:

university missions that support the creation of entrepreneurial activities have a direct effect on the intention to be active in commercialisation activities through the construction of support mechanisms, such as a technology transfer office, facilities such as incubators, and incentives for engaging in knowledge transfer activities.

As K. Smith et al. (2020, p. 2) put it, “others [researchers] feel the kind of work that motivated them to enter academia is now being side-lined in favour of that with more immediate, obvious or ‘sellable’ impacts”, a view concurred with by Lynch and Ivancheva (2015). Additionally, “the impact agenda is no less than a threat to academics’ ability to contribute to social justice and critical citizenship … and an opponent of curiosity-​ driven, ‘intrinsic’ research” (K. Smith et al., 2020, p. 3).

Through their interview-based research Chubb and Reed (2018) discovered that many academics now prioritise more impactful applied research, across multiple disciplines, out of necessity to secure funding, to the detriment of basic science. Additionally, they found that academics expressed deep concerns about how:

impact might be changing the motivations of researchers: specifically, where intrinsic and altruistic motives for engaging with impact (e.g. a desire to benefit others or the personal satisfaction from benefitting others) were increasingly crowded out by extrinsic motivations for impact (e.g. to get research funding, promotion or improve institutional rankings or reputation) known as ‘motivational crowding’ (Chubb & Reed, 2018, p. 303).

Wu et al. (2015) and Schneider et al. (2021) discuss the influence of researcher training and institutional ethos and policies, on research orientation, noting in particular that researchers trained in more traditional university settings, where open science is promoted to diffuse scientific knowledge, are more likely to align with a basic-applied orientation, with the opposite being the case for institutions with an effective TTO and IP policy. K. Smith et al. (2020) suggest however, that TTO influence on entrepreneurial intentions has less of an impact than organisational culture and ethos, while Hossinger et al. (2020) highlight the importance of having a well-resourced and well-functioning TTO service. Wu et al. (2015) also support the contention that increased industry – academic engagement, and industry-provided funding, drives research in a commercial direction.

Hayter and Parker (2019) note the importance of institutions ensuring inter-departmental consistency of policies related to treatment of researchers and their IP. They also note the importance of peer support – meaning PIs need to support their postdocs to pursue commercialisation for example. Similarly, Broström (2019) puts forward the position that, starting as far back as early PhD training “a lack of opportunity to be mentored in the form of direct scientific collaboration with seniors leads to long-term career disadvantages” (p. 1648).

The above suggests that institutional policies and supports impact on the influence of researchers’ intrinsic and extrinsic motivations on their research orientation, leading to the hypothesis that the relationship between researchers’ intrinsic/extrinsic motivations and their research orientation is moderated by organisational policies and supports, such that:

*H7a – For researchers experiencing higher levels of policies and supports for knowledge transfer/TTO activity, the impact of their intrinsic motivations on their commercial research orientation increases, whereas for researchers experiencing lower levels of policies and supports for knowledge transfer/TTO activity the impact of their intrinsic motivations on their basic research orientation increases.*

*H7b – For researchers experiencing higher levels of policies and supports for knowledge transfer/TTO activity, the impact of their extrinsic motivations on their commercial research orientation increases, whereas for researchers experiencing lower levels of policies and supports for knowledge transfer/TTO activity the impact of their extrinsic motivations on their basic research orientation increases.*

* + - 1. Financial resources

The availability of financial resources, and the need to write grants, has been suggested to have a significant impact on academic freedom (Aldridge & Audretsch, 2017; Davey et al., 2016; Gerbin & Drnovsek, 2016). Additionally, the nature of the financial resources available (e.g. industry funding vs baseline research funding) has a direct impact (Link et al., 2017) essentially because grants provided by stakeholders are typically tied to specific research programmes, whereas baseline funding provides more research freedom (Vaesen & Katzav, 2017; Ward & Ost, 2019).

According to Behrens and Gray (2001, p. 182) researchers “who received industry support were more likely to report that their choice of research topic was influenced by the project’s commercial potential”. Similarly Bentley et al. (2015) undertook a quantitative analysis which showed that the nature of research funding was a significant “differentiator for research specialisation, but mostly in its negative relationship with pure basic research” (p702). Their research demonstrated that where researchers are reliant on commercial funding their research orientation is steered accordingly as noted in Tartari and Breschi (2012). Banal-Estañol et al. (2015, p. 3) raise concerns that industry involvement in research “might come at the expense of basic research: growing ties with industry might be affecting the choice of research projects, “skewing” academic research from a basic toward an applied approach”. They do, however, acknowledge that certain academics note that industry interactions “improved the quantity and quality of their basic research” (Banal-Estañol et al., 2015, p. 3). Bentley et al. (2015) support Nowotny et al.’s (2003) contention that “inadequacy of public funding has caused universities to shift their research preoccupation away from basic research” (Bentley et al., 2015, p. 694). van Rijnsoever and Hessels (2020), concurring with Hayter et al. (2018), Garcia et al. (2019) and D’este and Perkmann (2011) take a perhaps more positive view on the matter, noting that researchers can be driven towards commercial collaboration as it provides them with access to additional resources, labs and infrastructure through which they can carry on their basic research activities. A further driver that has emerged in more recent times is the provision of ‘gift-funding’ to researchers. This typically comes from large industrial organisations and recipient researchers are free to use such funding to carry out their own chosen research. The benefit to industry is an increase in scientific knowledge that may find its way into technology/product roadmaps in future (Rosenberg, 2010).

Focusing on the role of financial resources for researchers, Munari and Toschi (2021) suggest that typical financial supports for research valorisation fall short in their applicability in the promotion of research commercialisation or academic engagement:

Traditional financing instrument from either private (i.e. banks, business angels, venture capitalists) or public (i.e. R&D subsidies) sources have only limited relevance for universities’ early-stage research valorisation projects, due to the latter’s immature phase of development and high levels of risks (p. 1).

They refer to the ‘valley of death’, or ‘funding gap’, between basic research and commercialisation, caused by the fact that more basic research activities need to be accompanied by research maturation activities (such as prototype building) that are typically “not eligible for traditional public funding programmes oriented to basic research activities” (Munari & Toschi, 2021, p. 4). This then acts as a potential blocker to those researchers who may be interested in changing their research orientation from basic science towards commercialisation. This gap is being somewhat addressed by valorisation funding in various forms, such as proof of concept funding, or translational funding, across the world. The contention in this research is that the relationship between researchers’ intrinsic/extrinsic motivations and their research orientation is moderated by finance / resources available to them, such that:

*H8a – As the level of finances/resources available to a researcher increases, the impact of their intrinsic motivations on their commercial research orientation increases, and the impact of their intrinsic motivations on their basic research orientation decreases.*

*H8b – As the level of finances/resources available to a researcher increases, the impact of their extrinsic motivations on their commercial research orientation increases, and the impact of their extrinsic motivations on their basic research orientation decreases.*

* + - 1. Physical Environment

Olaya Escobar et al. (2017), Hayter et al. (2018) and Link et al. (2017) discuss the impact of the direct research environment on researcher careers, highlighting that researchers associated with dedicated research centres / research parks (which are typically co-located with industry) engage in commercial activities more so than their university-bound counterparts. Baroncelli and Landoni (2019) and Wegner et al. (2019) concur with this, and note that developing a concentration of university spin-offs, which typically happens in research centres/parks, drives a culture of academic entrepreneurial behaviour. Stuart and Ding (2006) support this contention, albeit in the context of researchers in medical school vs university science departments. Wegner et al. (2019) argue that so called ‘entrepreneurial universities’ that host researchers within technology parks, have little impact on researchers’ focus on entrepreneurial behaviour. In essence, they say, it comes down to human capital and personal aspirations.

Aberbach and Christensen (2018) discuss academic freedom in the context of the industrial proximity of an academic institution and note that industrial ‘think-tanks’ and steering boards have an explicit impact on the mission of many universities, on the focus of research, and in turn on academic freedom.

Walsh et al. (2015) approach this conversation from a different perspective, by factoring in the geographical location, and associated culture, of researchers. Their study found that researchers (doctoral students) in China were very predisposed to embarking on an entrepreneurial trajectory, seeing it as imperative for economic growth. On the other hand, British researchers exhibited an alternative approach, with quite negative perceptions on the need to valorise research. Interestingly, the Chinese students reported that undertaking their PhD prepared them for an entrepreneurial orientation, whereas the British students effectively said the opposite. This would imply a difference in approach in education and training, between the two countries, as a PhD programme progresses. This is reflected in the work of Duval-Couetil et al. (2021) where new educational programmes for PhD students, specifically targeting entrepreneurial skills development, are proposed. Soetanto and Jack (2016) point to a gap in existing institutional policies to support and train potential entrepreneurs. They highlight that many researchers with a desire to create a spin-out company lack the basic business skills required. While constructs such as incubators can help address this situation, earlier intervention in the form of education, training and supports, would seem to be imperative if that aligns with the university mission.

In a similar vein, Ryazanova and Jaskiene (2022) call for more research to look at the impact of the physical environment on research performance. Soetanto and Jack (2016) present a more positive take on this situation and discuss the importance of universities establishing incubators as a means to encourage and support entrepreneurial activities, particularly as a means to combat the high failure rate experienced by many fledgling commercial endeavours.

At a general level, the environment incubators are perceived to offer tends to be seen as one which nurtures commercial ideas in a way which makes them more likely to become marketable products. As a consequence, incubators are linked to helping to overcome the failure rate too often associated with newly established firms (Soetanto & Jack, 2016, p. 25).

Soetanto and Jack (2016), adding to the discourse around the relationships between these elements, highlight that strong levels of support provided through incubation centres leads to an increase in social capital. Beyond the commercial incubator, this concept applies to all instances where an academic institution is co-located with, or close to, industry. Lyken-Segosebe et al. (2020) concur, and note the impact of industry proximity on researchers’ orientation towards entrepreneurial and commercial endeavours.

This research therefore proposes that the relationship between researchers’ intrinsic/extrinsic motivations and their research orientation is moderated the researchers’ physical environment, such that:

*H9a – As the level of industry in the vicinity of an academic institution increases, the impact of researchers’ intrinsic motivations on their commercial research orientation increases, and the impact of their intrinsic motivations on their basic research orientation decreases.*

*H9b – As the level of industry in the vicinity of an academic institution increases, the impact of researchers’ extrinsic motivations on their commercial research orientation increases, and the impact of their extrinsic motivations on their basic research orientation decreases.*

* 1. Conclusion - Conceptual and Hypothetical Framework

Bringing the above strands together results in the following conceptual framework which forms the basis for the remainder of this research (Figure 11). As shown in the diagram, it is proposed that researchers’ motivations directly influence their research orientation. Additionally, the researcher profile and organisational context are proposed to moderate the relationship between motivations and research orientation.

Figure 11   
*Conceptual Framework: Motivations, Influences and Research Orientation*

A diagram of a diagram

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The complete set of hypotheses to be analysed in Chapter 6 are presented graphically in Figure 12.

Figure 12   
*Hypothetical Framework: Motivations, Influences and Research Orientation*

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1. Research Philosophy, Design and Methodology
   1. Introduction

The purpose of this chapter is to firstly discuss my epistemological stance as a researcher. Following this the chapter sets out the research design used in this study. Following that construct operationalisation is discussed, which then leads to questionnaire design. The chapter concludes with a discussion on content analysis undertaken to verify and refine the survey instrument.

* 1. Philosophical position

As the researcher's conception of reality, ontologies serve as the bedrock upon which all other assumptions are built, and they therefore serve as the basis for their ideas about society and science as a whole (Doolin, 2008b; Fox et al., 2007). An objectivist philosophy is the intellectual basis for this study, which uses a positivist methodology. Accordingly, a mind-independent world exists, which supports the author's ontological belief in theories that may be used to conceptualize reality and explain reality (Doolin, 2008b).

This position is consistent with positivism's objectivist/dualist epistemology since I and the topic of investigation are separate entities (Doolin, 2008b). I agree with conventional realists that reality exists irrespective of the observer's perceptions and acts in accordance with the cause-and-effect form of unchanging natural laws (Guba et al., 2005). The goal of this study is to produce meaningful, accurate statements that may be used to describe the researcher's career path and its cause and effect links, and so observations and phenomena must agree in order for resulting statements that accurately describe reality (Easterbrook et al., 2008) to be considered true (Lincoln & Guba, 2000).

Following an extensive literature review, my ontological premise is that numerous variables influence the relationship between a researcher's motivations and their research orientation and comprehending these factors will lead to a more comprehensive understanding of the individual’s research orientation around basic, applied and/or commercial research.

* + 1. Epistemological stance

How we know what we know, how we know its validity and where our knowledge comes from are all aspects of epistemology (Guba et al., 2005). When a researcher adopts a specific epistemology, they are more likely to use research techniques that are in line with that philosophy (Easterby-Smith et al., 2008). As such, the link between the researcher and the topic of the investigation is an important consideration in epistemology.

This study takes a positivist approach in terms of epistemology. This means that the researcher and the subject of the research are treated as separate entities, and the focus and techniques of the research are determined by objective standards. To verify a theory, experiments or extensive surveys with exact measurements of essential variables are necessary, according to this epistemological position, which holds that only observation and measurement can provide reliable knowledge (Guba et al., 2005). In addition, this viewpoint holds the belief that each issue can be simplified down to a bare minimum of the most fundamental components, and that the purpose of this study is to offer a connection between the causes and effects therein (Doolin, 2008b).

Positivists believe that science advances by hypothesizing basic rules and then deducing what type of data would validate these hypotheses and researchers experiment to guarantee that their hypotheses are supported by facts (Doolin, 2008b). In particular, Comte (1875, p. 7) asserted that "there can be no genuine knowledge save that based on seen facts." Moreover, according to this approach, precision, clarity, logic, and evidence are of the highest significance (Creswell & Poth, 2016; Lincoln & Guba, 2000).

This study takes a deductive approach, which is appropriate given that the fields from which this thesis draws concepts and arguments consist of extensive collections of knowledge that have been established but are still evolving. These collections of knowledge explain the relationship between a researcher's motivations and their research orientation, and support the development of a holistic model. The analytical approach taken in this study seeks to identify associations or relationships between multiple variables in order to verify proposed hypothetical relationships. Therefore, this study is guided by a positivist viewpoint which entails researching and evaluating the varied processes of how and why distinct interactions related to research orientation occur, with associated claims about inter-variable relationships.

* + 1. Methodological Approach

Methodology is referred to as the systematic approach to studying a subject. It includes processes and tools used in research, as well as theoretical and methodological frameworks for investigating phenomena.

Research design entails making choices about the organization of research activities that are most likely to meet the aims of the research (Hair et al., 2010). Following the positivist position, quantitative research techniques give an objective methodology and a strong basic for the generalisation of theoretical concepts. To retain this stance, this research’s hypotheses have been conceptualized in a way that permits quantitative measurement of facts (Creswell & Poth, 2016).

Bulmer (2017) posits that the standard positivist procedure is to build a theoretical position from an analysis of the literature following which a series of hypotheses are developed. Subsequently, these hypotheses are subjected to assessment procedures in order to identify potential relationships. In line with this, the focus of this research is on determining relationships between factors tying researcher motivations to their career paths. Moreover, this study utilizes a theory testing approach which relies on previously stated conceptual linkages to create, and then test and verify hypotheses connected to researcher orientation. By embracing existing information about these orientations, the present study adopts an objectivist perspective.

* 1. Research Design

The purpose of research design is to develop an overarching framework for the collection and analysis of data (Burkholder et al., 2016; Fabrigar & Wegener, 2016) to answer a specified set of research questions (Rahi, 2017). In broad terms, as this research adopts a positivist stance, both an experimental design, and non-experimental, design approach would be suitable for the current research being undertaken (Lincoln et al., 2011).

* + 1. Non-experimental Design

In this research respondents will be answering survey questions, thereby reflecting on their past experiences, feelings and decisions, which makes non-experimental design an appropriate choice:

Most non-experimental designs are retrospective in nature and are sometimes called “ex post facto” (after the fact) research. Because a retrospective study is examining activities that have already occurred, manipulation of independent variables and randomization is not possible. In addition, the dependent variable (i.e., the outcome) has occurred before study initiation (Thompson & Panacek, 2007, p. 178).

This research design choice is also driven by practical considerations. Experimental research designs, typically involving subjects who are living the situation being studied (Thompson & Panacek, 2007), can be difficult to implement due to heightened costs and complexity coupled with problems in securing sufficient sample sizes (Bryman, 2016) which is a requirement for more complex research models. These limitations, particularly related to sample sizes, can negatively impact on the potential generalisability of results (Firebaugh, 2018; Kotrlik & Higgins, 2001).

Considering the practicalities of the research being undertaken, the general unknown of the current Covid-19 pandemic (which directly affects the possibility to undertake face to face research with humans), and the need to observe interactions between variables without manipulation and the associated need for a suitable (n>200) sample size, non-experimental design is more suitable for this research (Lincoln et al., 2011).

Figure 13   
*Research Design Process Adapted from Hair et al. (2010)*



For this research it is necessary to gather a sample of data from researchers, at various career stages, and with varying views on their research orientation. As such, a cross-sectional study implemented via an online survey is a suitable method. The cross-sectional design has the potential limitation that causality in relationships cannot be demonstrated definitively, however potential causal interpretations, and their direction and strength, can be obtained (Bryman, 2016).

* + 1. Research Instrument

A web-based questionnaire was employed to capture the data for this study, because it is an efficient method of accessing a large potential respondent group, in a short time frame, regardless of geography (Hochheimer et al., 2016).

This method also mitigates against the potential problem of receiving partial or incomplete responses, if a large enough cohort of potential respondents is reached (John et al., 2004). Additionally, being web based, means that the survey respondents’ internet (IP) addresses can be captured, which can serve to demonstrate the uniqueness and validity of each response if required. A deeper advantage, important for this research, is that the anonymity provided to respondents via the web-based survey can serve to overcome inhibitions, or to behave in ways (and provide opinions) that go against social norms (Frippiat et al., 2010).

Hair et al. (2010), and later Sarstedt (2019), propose a structured process for data collection, to be employed for multivariate data analysis. For this research the process was subdivided into two main stages: Questionnaire Generation and Questionnaire Pre-testing, as shown above.

The literature review undertaken in Chapter 3, including the development of the conceptual framework constitute the first two elements of the Questionnaire Development process. The next stage is the operationalisation of constructs, as discussed below.

* 1. Construct definition and operationalisation

Based on the conceptual model developed in Chapter 3, and following the advice from Hair et al. (2010) and Iacobucci and Churchill (2010), prior to operationalising constructs a clear definition of each is critical. Accordingly, Table 9 below presents the definition of each construct as applied in this research.

Table 9   
*Construct Definitions and Sources*

| **Construct Group** | **Construct Name** | **Definition** | **Source(s)** |
| --- | --- | --- | --- |
| Motivations | Intrinsic Motivation | Intrinsic motivations are “activities done ‘for their own sake,’ or for their inherent interest and enjoyment (Deci & Ryan, 2000). Play, exploration and curiosity- spawned activities exemplify intrinsically motivated behaviours, as they are not dependent on external incentives or pressure, but rather provide their own satisfactions and joys”. | (Ryan & Deci, 2000); Ryan and Deci (2020, p. 3) |
| Extrinsic Motivation | “Extrinsic motivation refers to performance of behaviour that is fundamentally contingent upon the attainment of an outcome that is separable from the action itself. In other words, EM is instrumental in nature. It is performed in order to attain some other outcome” | (Legault, 2016, p63). |
| Intrinsic Motivation | Academic Freedom | Academic freedom is the right of a person working in an academic institution “without constriction by prescribed doctrine, to freedom of teaching and discussion, freedom in carrying out research and disseminating and publishing the results thereof, freedom to express freely their opinion about the institution or system in which they work, freedom from institutional censorship and freedom to participate in professional or representative academic bodies.” | Beiter (2019, p. 242); (Jarvis, 2017) |
| Stimulation | The researcher’s level of pleasure gained from solving problems and finding new avenues for research. | (Lam, 2011; Olaya Escobar et al., 2017; Ryan, 2011, 2014) |
| Satisfaction | The researcher’s job satisfaction is a “related constellation of attitudes about various aspects or facets of their work”. | (Spector, 1997, p. 2) |
| Risk Aversion | The degree to which a researcher avoids taking a risk or making a decision where “(a) the expected outcomes are uncertain, (b) decision goals are more difficult to achieve, or (c) the potential outcome includes extreme consequences” (Sitkin & Pablo, 1992, p. 11)) in relation to their research. | (Goel & Göktepe-Hultén, 2018; Goel & Göktepe-Hultén, 2019; Sitkin & Pablo, 1992; Sitkin & Weingart, 1995) |
|  | Social/civic responsibility | The degree to which a research seeks to achieve “non financial goals such as the desire to have a social impact” (Audretsch et al., 2020), to diffuse knowledge or to do a public service (Hayter et al., 2020) | (Audretsch et al., 2020; Hayter et al., 2020) |
| Extrinsic Motivation | Reputation | The researcher’s expected enhanced status and recognition. | (Ryan, 2014; Ryan & Berbegal-Mirabent, 2016) |
| Reward | The level of expected personal gain (financial, access to new resources, broader collaborative networks) resulting from a researcher’s work. | (Davey et al., 2016; Iglič et al., 2017; Olaya Escobar et al., 2017) |
| Promotion-Tenure | The perceived possibility to secure promotion and/or tenure arising from researcher performance. | (Chang et al., 2016; Iglič et al., 2017; Johnson et al., 2016) |
| Organisational | Policies and Supports | The researcher’s perceived level of organisation supports, and related policies, within their host institution. | (Fini et al., 2019; Urbano et al., 2016) |
|  |  |  |
| Physical Environment | The type of physical environment (dedicated research centres co-located with industry, vs university centric settings) in which the researcher typically operates. | (Baroncelli & Landoni, 2019; Link et al., 2017) |
| Financial Resources | The nature of financial support provided to the researcher (baseline grants – funding agency support – direct industry funding). | (Aldridge & Audretsch, 2017; Link et al., 2017; Ward & Ost, 2019) |
| Personal Attributes | Age | The biological age of the researcher |  |
| Career Stage | The career stage of the researcher | European-Commission (2011) |
| Career Age | Number of years’ experience as a researcher |  |
| Field | The research field of the researcher |  |
| Gender | The gender of the researcher |  |
|  | Social Capital | “The resources – for example, social support, information channels, social credentials – that are embedded within an individual’s social networks. (Villalonga-Olives & Kawachi, 2015, p. 63)” | (Villalonga-Olives & Kawachi, 2015) |
| Research Orientation | Type 1 – Pure Traditional | Believes academia and industry should be separate and distinct (basic research orientation) | (Duval-Couetil et al., 2023; Kunseler, 2007; Lam, 2011, 2015; Suominen et al., 2021) |
| Type 2 – Pragmatic Traditional | Believes academia and industry should be distinct, but recognises the need to collaborate (basic – applied research orientation) | (Lam, 2011, 2015; Suominen et al., 2021) |
| Type 3 – Hybrid | Believes in the fundamental importance of science-business collaboration for scientific advancement, but also recognises the need to maintain boundary (applied research orientation) | (Blind et al., 2022; Lam, 2011, 2015) |
| Type 4 – Entrepreneurial | Believes in the fundamental importance of science-business collaboration for knowledge application/exploitation (commercial research orientation) | (Blind et al., 2022; Duval-Couetil et al., 2023; Lam, 2011, 2015) |

Following the definition of each construct, operationalisation requires a review of prior usage of each construct in the extant literature to identify the most suitable scale items, to update them if required, and to verify their validity. The following sections discuss the operationalisation of constructs used in this research.

* + 1. Construct Operationalisation

When developing a model of statistical analysis, typically two types of construct, formative and reflective, are utilised. A reflective construct represents the effects of its measurement items, whereas formative measures comprise items that cause the construct (Éthier et al., 2006). Arshi (2017) notes that “if the measures are conceptualized reflectively, variation in a construct leads to variation in its measures. On the other hand, formative measures indicate that the variation in the measures have a causal effect on the construct” (p4). All factors in this study are reflective and are discussed below. For each construct below, a description is provided explaining the origins and context of the construct items, accompanied by justifications for wording changes from the original items where changes were made. In cases where a construct item was not originally verified in the context of academic research, verification of its use in this context in subsequent literature is provided. As a number of items for each construct were ultimately removed in the final analysis (for statistical reasons as detailed in Chapter 6) only those items which contributed to the final analysis are listed at the end of each section, while the complete set of items is provided in Appendix C.

* + - 1. Intrinsic Motivations

As discussed in Chapter 3, intrinsic motivations for research orientation include Academic Freedom, Stimulation, Satisfaction, Risk Aversion and Social/Civic Responsibility. Each of these is operationalised below.

**Academic Freedom:**

Romanowski and Nasser (2010) undertook a statistical study of faculty perceptions of their academic freedom, in the context of Gulf Cooperation Council countries academic institutions. As part of their work they developed a scale to measure academic freedom. While this scale contained a number of applicable items, certain items were less relevant as they were teaching / classroom focused, rather than research focused. Behrens and Gray (2001) undertook a quantitative study which examined the impact of collaborative research on the individual researcher’s academic freedom, and in doing so developed a validated scale for academic freedom assessment, based around two broad constructs of “Freedom in conducting the research” (p197) and “Freedom in communicating about the research” (p198). Their scale has been deployed and analysed in an academic context with a particular focus on early-stage engineering researchers in six US universities. Behrens and Gray’s work is subsequently referenced by notable authors in this space such as Perkmann and Walsh (2007) and Lee and Bozeman (2005). Behrens and Gray’s (2001) scale is more comprehensive than that of Romanowski and Nasser (2010), while a number of scale items overlap.

Some slight modification of scale item wording was made in order to reflect the focus of this study, as presented in Appendix C, specifically wording such as “this project” has been changed to “my project(s)”, “sponsor” has been changed to “sponsor/funding body”, “I have been asked” has been changed to “I have been instructed to” in order to present respondents with a more generalised set of questions.

Table 10   
*Academic Freedom - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| I think research design is slanted to give results favourable to the project sponsor/funding body. | AF2\_r | Behrens and Gray (2001) | Sampled early career researchers in a university context. | I think the research design is slanted to give results favorable to the project sponsor. |
| I am free to choose the research tools/methods which I feel are most appropriate for my project(s). | AF3 | I have been free to choose the research tools/methods which I feel are appropriate for the project. |
| I have been instructed to write up results or otherwise interpret them in ways I do not agree with. | AF5\_r | I have been asked to write up results or otherwise interpret them in ways I do not agree with. |

**Stimulation:**

Barbuto and Scholl (1998) prepared a detailed scale for measurement of motivation, comprising multiple items related to stimulation in the workplace, called the Motivation Sources Inventory (MSI), through a literature review. Following this, Ryan (2011) developed a comprehensive analytical framework, referred to as the “Measure of Motivational Sources (MMS)”(p360), building on the work of Barbuto and Scholl (1998), and verified it through a quantitative study, using structural equation modelling, of working professionals (N=330). The scale was subsequently tested and revalidated in an academic context in a further study by Ryan (2014), which involved a sample of 405 UK-based research researchers. Gagné et al. (2010) developed a similar scale, building on the work of Ryan and Deci (2000) however, their scale condensed the factors proposed by Ryan (2011) into quite broad categories which arguably would provide a less comprehensive set of survey items for this particular study. Drawing on Ryan’s (2011, 2014) work then, this study equates job stimulation with a sense of enjoyment and personal achievement, and accordingly uses Ryan’s scale items.

Table 11   
*Stimulation - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| If something is not enjoyable, then it is not worth doing. | Stim1 | (Ryan, 2011) | Developed a generic scale to measure worker motivations. Tested and verified the scale with a set of PhD level researchers employed in a university context (Ryan, 2014). | If something is not enjoyable, then it is not worth doing. |
| It is important that I work in a job that allows me to use my skills and talents. | Stim3 | It is important that I work in a job that allows me to use my skills and talents. |
| I like to do work that challenges me and gives me a sense of personal achievement. | Stim4 | I like to do work that challenges me and gives me a sense of personal achievement. |

**Satisfaction:**

Macdonald and MacIntyre’s (1997) generic “job satisfaction scale” was developed in order to provide a measurement construct that could be applied to multiple employment contexts. They developed the scale through a literature survey coupled with a quantitative analysis to verify the selected constructs. In 2003, Van Saane et al (2003) undertook a comprehensive review of instruments designed to measure job satisfaction, testing each for structural validity and internal consistency. Their work determined that, from a total of 29 scales examined, only 7 were considered to be sound for statistical purposes. Following this, Van Saane et al. (2003) examined the 7 scales from a usability and usefulness perspective, and in their conclusion the MJS (Measure of Job Satisfaction (Traynor and Wade (1993)) was selected as being the most appropriate for use. This scale can be seen in Appendix C, and it is clear that this scale, while comprehensive, includes multiple items that are associated with other intrinsic and extrinsic motivations (such as available funding, for example). Additionally, having being developed for a medical context, this scale contains multiple items which are not applicable to an academic context. Ultimately, while scale items from Traynor and Wade (1993) were included in the survey deployed for this research, these were removed from the final analysis for statistical reasons (Chapter 6).

MacDonald and MacIntrye’s (1997) scale provides the most comprehensive measure of satisfaction, and has been tested and verified in an academic context through a number of subsequent publications such as Tesfaye et al. (2022), Hassan et al. (2020), Pasha and Aftab (2020) and Ishaq and Khalid (2014). Additionally, the extracted scale reflects other works such as Olaya Escobar et al. (2017 p719) and Lounsbury et al. (2012). Minor scale wording changes were made (Table 12) to provide a more generalised and applicable set of questions for respondents, such as changing “this company” to “my current organisation” and “supervisors” to “supervisors/managers”.

Table 12   
*Satisfaction - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| I receive recognition for a job well done. | Satis5 | Macdonald and Maclntyre (1997) | Developed a generic satisfaction scale and tested across a sample encompassing multiple occupation types.  The scale was used in an academic context by, for example, Hassan et al. (2020), Tesfaye et al. (2022), Ishaq and Khalid (2014), and Pasha and Aftab (2020). | I receive recognition for a job well done |
| I feel close to the people I work with. | Satis6 | I feel close to the people at work |
| I feel good about working at my current organisation. | Satis7 | I feel good about working at this company |
| All my talents and skills are used at work. | Satis10 | All my talents and skills are used at work |
| I get along with my supervisors/managers. | Satis11 | I get along with my supervisors |

**Risk Aversion:**

Bran and Vaidis (2020) undertook a literature review focused on analysing the numerous ways in which risk-taking can be measured in research studies. Their core position is that any study that examines a person’s risk-taking propensity needs to factor in that person’s context. For example, a person might not be willing to take risks in their employment setting, yet they may have a propensity to gamble heavily. Interestingly a 2018 study by Goel and Göktepe-Hultén (2018), in which risk taking amongst researchers was a central tenet, employed a generic risk question based on an individual’s predilection to take a financial gamble, which would seem unrelated to their day to day research activities. Goel and Göktepe-Hultén (2019) built on this work a year later, and added an additional measure of an individual’s self-reported risk aversion. This was a 10-point scale which asked respondents:

“How do you see yourself: Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? Please indicate a risk value on a scale from 0 to 10 where the value 0 means “risk averse” and the value 10 means “fully prepared to take risks”. You can use values in between to make your estimate. (p165)”.

Goel and Göktepe-Hultén (2019) undertook data analysis, with a sample of German researchers employed in multiple academic institutions, which demonstrated that this broader risk assessment correlated highly with their previous, gambling-specific, measure, meaning that the 2019 revision was classified as a suitable measurement of risk.

Johnson (2016) undertook a quantitative study, with a sample of researchers based in Scottish academic institutions, to examine the relationship between an individual’s prevention-focus (i.e. risk aversion) and their personal ambitions using Lockwood’s (2002) promotion/prevention scale. This scale is reflective of that used by Goel and Göktepe-Hultén (2019) and, considering the strong statistical validity of the scale, can be readily adapted for the purposes of this resaerch. As an additional measure, this research adds Goel and Göktepe-Hultén’s (2019) risk aversion construct to the adapted Lockwood (2002) scale, as shown in Appendix C. Alterations to survey items were made (Table 13) in order to align the tense and style of the questions with the broader survey used in this research.

Table 13   
*Risk Aversion - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| I am generally a person who is fully prepared to take risks. | Risk1 | Goel and Göktepe-Hultén (2019) | Tested on a sample of German researchers employed in multiple research institutes. | How do you see yourself: Are you generally a person who is fully prepared to take risks |
| I am generally a person who tries to avoid taking risks. | Risk2\_r | or do you try to avoid taking risks? |
| I am more oriented toward preventing losses than I am toward achieving gains. | Risk3\_r | Lockwood et al. (2002) | Tested and verified on a sample of students in Canadian universities. | I am more oriented toward preventing losses than I am toward achieving gains. |

**Social/Civic Responsibility**

While it is clear that institutional support is a driver of social/civic knowledge exchange (Cvitanovic et al., 2015), what is not currently clear from the literature is the impact of the desire to undertake socially driven research activities (Audretsch et al., 2020), or indeed the impetus to address key performance indicators within research assessments containing a social impact component, on research orientation. Accordingly, this research includes a measure of knowledge exchange (with external stakeholders) based on the work of Cvitanovic et al. (2015), and undertakes an exploratory analysis to determine whether or not this construct plays a role in determination of research orientation. Cvitanovic et al.’s (2015) scale was developed and verified with a sample of researchers in Australian Universities. Modifications (Table 14) to the scale were made to broaden the scope of questions used by changing “decision-makers” to “decision-makers/stakeholders”/public” and changing “my science” to “my research”.

Table 14   
*Social/Civic Responsibility - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| Engaging with and communicating to decision-makers/stakeholders is important to me personally. | Sociv1 | Cvitanovic et al. (2015) | Developed and verified scale with a sample of researchers employed in Australian Universities and Research Institutes. | Engaging with and communicating to decision-makers is important to me personally |
| I believe that my research is important for decision-makers/ stakeholders/ public. | Sociv3 | I believe that my science is important for decision-makers |
| As a researcher, I have a responsibility to engage with, and communicate to, decision-makers/stakeholders/public. | Sociv4 | As a scientist, I have a responsibility to engage with and communicate to decision-makers |

* + - 1. Extrinsic Motivations

Extrinsic motivations for research orientation include Reputation, Reward and Promotion/Tenure.

**Reputation and Reward:**

Göktepe-Hulten and Mahagaonkar (2010) undertook a study to determine the drivers of researchers’ patenting activities, with a particular focus on expected reputational benefits versus expected financial rewards. Following a statistical analysis based on the results of a 2,500 researcher survey they determined that reputation rather than financial reward was the dominant driver. Goethner et al. (2012) built on this work through a statistical model that contradicted the work of Göktepe-Hulten and Mahagaonkar (2010) insofar as their research concluded that, for their sample of 496 researchers based in German academic institutions, expected reputational and financial gain only had an indirect effect on researchers’ academic entrepreneurial tendencies. This presents an alternative perspective that will be discussed in the analysis and discussion chapters (Chapters 6 & 7). Both studies used a relatively simple construct to measure expected reputational gain, as presented in Appendix C.

As discussed above, Ryan (2011) developed a measure of motivational sources, reflected in later work by Olaya Escobar et al. (2017), and verified in an academic context, which includes items for personal reputation and financial reward, as career motivations. These items fit well with the other works referenced here (Goethner et al., 2012; Göktepe-Hulten & Mahagaonkar, 2010; Saeed et al., 2015) and have been combined to provide the measurement items used in this research (Table 15, Table 16).

Table 15   
*Reputation - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| When I have done a good job, it is important to me that my contribution is recognized by others. | Reput2 | Ryan (2011) | Developed a generic scale to measure worker motivations. Tested and verified the scale with a set of PhD level researchers employed in a university context. | When I have done a good job it is important to me that my contribution is recognized by others. |
| I give my best effort when I know that it will be seen by the most influential people in an organization. | Reput4 | I give my best effort when I know that it will be seen by the most influential people in an organization. |
| I work harder on a project if public recognition is attached to it. | Reput5 | I work harder on a project if public recognition is attached to it. |

Table 16 *Reward - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| The best aspects of any job are the financial rewards and associated financial benefits. | RwrdF1 | Ryan (2011) | Developed a generic scale to measure worker motivations.  Tested and verified the scale with a set of PhD level researchers employed in a university context. | The best aspects of any job are the financial rewards and associated financial benefits. |
| I only work for the financial reward that it provides me. | RwrdF2 | I only work for the financial reward that it provides me. |
| I would readily leave any job if I were offered an alternative that pays more. | RwrdF3 | I would readily leave any job if I were offered an alternative that pays more. |

**Promotion/Tenure:**

Examining the broader topic of job choice in academia, Janger and Nowotny (2016) undertook a statistical analysis, of 10,000 researchers, which included a perspective on the value of tenure to researchers as a motivational driver for a career in research vs a career in industry. Their results indicated that the possibility of tenure, if dependent on research performance, was a stronger motivation than potential financial gain. To measure tenure they employed a 4-point scale, asking respondents what the possibility of tenure was for their particular case, with the answer choices being: ‘ “not possible”, “[contract extension] for 3 years”, “tenure possible contingent on performance and job avail-ability”, and “tenure contingent purely on research performance” ’ (Janger & Nowotny, 2016, p. 1676).

Jordan et al. (2018) carried out a mixed methods study, with 42 researchers and 204 educators in America, that focused on the barriers to academic scholarship. Within the study, the possibility of promotion/tenure as a driver for research outputs was significant yet not as important, to the respondents sampled, as stimulation and recognition. Their survey used a single item to measure the possibility of promotion as a driver of undertaking research (with 0 meaning not important and 10 meaning very important). Lambovska and Yordanov (2020) carried out a literature review related to researcher motivations, and their results indicated that financial reward could be seen as equivalent to potential for tenure, in terms of research career drivers. Johnson et al. (2016) posited that the possibility of promotion/tenure was a significant driver of individuals research orientation. Their promotion focus measurement item was derived from Lockwood et al. (2002) “My major goal [in school] right now is to achieve my academic ambitions” (Johnson et al., 2016, p. 200). Olaya Escobar et al. (2017) focused particularly on career prospects and potential for promotion as drivers of knowledge transfer activities, identifying three scale items that can be utilised in this research. Their scale was verified in the context a Spanish academic institution. All of the above are combined to create the Tenure/Promotion scale as presented in Appendix C. Scale items were modified to align with the broader research survey (from “Does the possibility of promotion/tenure drive your research work?” to “The possibility of promotion / tenure is a major driver of my research work”) and to expand on the meaning of “KTT” (to knowledge transfer) as shown in Table 17.

Table 17   
*Promotion/Tenure - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| The possibility of promotion / tenure is a major driver of my research work. | RwrdPT1 | Jordan et al. (2018) | Developed and verified scale with a sample of “education researchers” operating in American medical educational institutions. | Does the possibility of promotion/tenure drive your research work? |
| I am more likely to be considered for promotions if I engage in knowledge transfer activities. | RwrdPT3 | Olaya Escobar et al. (2017) | Developed and verified scale with a sample comprising academics / faculty in a Spanish University. | I am more likely to be considered for internal promotions if I engage in KTT activities |

* + - 1. Influences – Organisational Context

**Policies and Supports / Education and Training**

Numerous studies have examined the impact of institutional policies and supports on the quality and intensity of scholarly outputs (Chang et al., 2016; Davey et al., 2016; Di Gregorio & Shane, 2003; Feola et al., 2019; Hayter & Feeney, 2017; Johnson et al., 2016; Olaya Escobar et al., 2017; Saeed et al., 2015; Scott & Bruce, 1994).

Chang et al.’s (2016) research examined the influence of organisational research ambidexterity on research outputs, with a specific focus on entrepreneurial behaviour. Their research instruments, verified with a sample of 634 respondents based in multiple universities, include a number of items that captured the level of support provided for commercialisation, IPR protection, publishing and research excellence. Olaya Escobar et al.’s (2017) research utilised a series of questionnaire items to evaluate the level of institutional support and encouragement for knowledge and technology transfer (KTT) activities. Their scales were validated through a statistical analysis comprising 249 researchers in a Spanish university. Feola et al. (2019) employed similar questionnaire items, again with a focus on entrepreneurship. Hayter and Feeney (2017) bring a particular focus of the role of the TTO within an academic institution as a driver for research behaviour, verified with a respondent set of 736 researchers in US universities. Scott and Bruce (1994), and later Johnson et al. (2016), created a verified (n=395) scale for assessing the institutional resources in place to support research and innovation. While this scale was originally deployed in the context of American corporations, it was subsequently verified in multiple academic contexts (Dai et al., 2022; Hassan et al., 2020; Hassan & Din, 2019; Lashari et al., 2022; Lee et al., 2019).

Saeed et al. (2015), while focusing primarily on entrepreneurship, produced a set of items to examine the level of education and training provided to researchers. Arqué-Castells et al. (2016) bring the final element to this portion of the survey, with their focus on the impact of availability/level royalty shares for academic patenting. All of above are combined to create the Policies and Supports scale (Appendix C). Minor modifications were made to these scales to encompass a wider range of respondents (changing “faculty” to “researchers” and “the university” to “my organisation”) as shown in Table 18 ,Table 19.

Table 18   
*Policies/Supports KTT - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| The importance of knowledge and technology transfer is clearly communicated. | PolKTT4 | Olaya Escobar et al. (2017) | Developed and verified scale with a sample comprising academics / faculty in a Spanish University. | The importance of knowledge and technology transfer is clearly communicated |
| My department has provided sufficient assistance and incentives for researchers to engage in creating spin-offs. | PolCom2\_r | Chang et al. (2016) | Developed and verified scales using a sample of faculty members across multiple universities. | My department has provided sufficient assistance and incentives for faculty to engage in creating spin-offs. |
| There is adequate time available to pursue creative ideas here. | PolCom3\_r | Scott and Bruce (1994) | Developed and verified scale with a sample of engineering staff across multiple US corporations.  The scale was subsequently verified in an academic context by researchers such as Lashari et al. (2022), Dai et al. (2022), Lee et al. (2019), Hassan et al. (2020), and Hassan and Din (2019). | There is adequate time available to pursue creative ideas here |
| My organisation actively promotes entrepreneurial activities. | PolCom4\_r | Olaya Escobar et al. (2017) | Developed and verified scale with a sample comprising academics / faculty in a Spanish University. | The university actively promotes entrepreneurial activities |

Table 19   
*Policies/Supports TTO - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| The Technology Transfer Office (TTO) at my organisation provides high quality service to researchers. | PolTTO1 | Hayter and Feeney (2017) | Developed and verified scale with a sample of researchers based in multiple US universities. | The TTO at my university provides high quality service to faculty. |
| The TTO at my organisation has sufficient scientific and technological knowledge. | PolTTO4 | The TTO at my university has sufficient scientific and technological  knowledge. |

**Social Capital:**

Focusing on why certain researchers are more likely to create spin-offs, Landry et al. (2006) developed a verified (n=1554) measure of a respondent’s social capital by assessing the “intensity of the linkages that the researcher had with managers and/or professionals from three types of organizations: (1) private firms; (2) government departments; (3) university communication department (media relations, public affairs)” (p1605). Aldridge and Audretsch (2017) approached this topic from a qualitative perspective, focusing instead on bibliometric counts of university-industry co-published articles, an approach similar to others such as Baroncelli and Landoni (2019) and Gerbin and Drnovsek (2016). Martín-Alcázar et al. (2019) undertook an analytical study using structural equation modelling with a sample of 1798 researchers based on multiple Spanish universities, with the explicit purpose of developing a scale to measure social capital within teams. The scale evaluates social capital along three dimensions: Structural (patterns of connections), Relational (behaviours within relationships), and Cognitive (‘systems of meaning among parties’ (p922)). As can be seen in Appendix C and Table 20 below, the scale was adapted to suit an individual researcher rather than a team (changing “we” to “I” and “synergies” to “research synergies”).

Table 20   
*Social Capital - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| I hold regular meetings to advance my team’s research activity. | SocapC1 | Martín-Alcázar et al. (2019) | Scales were developed and verified using a sample of researchers employed in multiple Spanish universities. | We hold regular meetings to advances the team’s research activity |
| I share our advances in research. | SocapC2 | We share our advances in research |
| I seek out, and capitalise on, research synergies. | SocapC3 | We seek and take advantage of synergies |
| I exchange ideas with many professionals outside our institution. | SocapC4 | We exchange ideas with a large number of professionals from outside our  institution |

**Physical Environment:**

To characterise researchers’ physical environment, this research draws on the work of Friedman and Silberman (2003) who undertook a statistical analysis of the rate of invention disclosure and patent production , as a measure of technology transfer. In their research they employed a composite measure of location based high technology concentrations in American metropolitan areas (DeVol, 1999). Accordingly, a measure of the level of concentration of applicable industry relative to the researcher’s work location has been included in this research. As a suitable scale was not available, a new survey item was developed which determines “level of industry concentration in the geographic vicinity of my research organisation”, ranging from “very low” to “very high”. This is based on the work of Friedman and Silberman (2003); Link et al. (2017) and Olaya Escobar et al. (2017).

Table 21   
*Physical Environment - Final Construct Item*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| The level of industry concentration in the geographic vicinity of my research organisation is… | Phyenv2 | New Constructs Created | Scales developed based on work from Link et al. (2017), (Friedman & Silberman, 2003) and (Olaya Escobar et al., 2017) | |

**Financial Resources:**

This construct evaluates the level of financial resources made available to researchers. Scott and Bruce’s (1994) study identified a number of applicable measures which focus on the adequacy of resources, and the provision of time to innovate. However their research did not factor in the nature of financial supports in terms of baseline funding, won funding, philanthropic funding, and consultancy funding, and approach taken in a number of prior works (Aldridge & Audretsch, 2017; Davey et al., 2016). Accordingly, an additional construct was developed, which queries respondents on the nature of their research funding. However, this additional construct was excluded in the final analysis (as discussed in Chapter 6) due to statistical incompatibility.

As noted above, Scott and Bruce’s (1994) scale was originally verified in an corporate context, however subsequent research deployed and verified it in multiple academic contexts (Dai et al., 2022; Hassan et al., 2020; Hassan & Din, 2019; Lashari et al., 2022; Lee et al., 2019). The scale was modified (Table 22) to be more representative of research undertaken within an academic institution by changing “resources devoted to innovation in this organisation” to “resources devoted to research and innovation in my organisation”.

Table 22   
*Finance/Resources - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| There are adequate resources devoted to research and innovation in my organization. | FinresR1 | Scott and Bruce (1994) | Developed and verified scale with a sample of engineering staff across multiple US corporations.  The scale was subsequently verified in an academic context by researchers such as Lashari et al. (2022), Dai et al. (2022), Lee et al. (2019), Hassan et al. (2020), and Hassan and Din (2019). | There are adequate resources devoted to innovation in this organization. |
| Lack of funding to investigate creative ideas is a problem in this organization. | FinresR2\_r | Lack of funding to investigate creative ideas is a problem in this organization |

* + - 1. Influences - Personal Attributes

The personal attributes included in this research include age (Gerbin & Drnovsek, 2016; Goel & Göktepe-Hultén, 2018; Lam, 2011; Roman & Paraschiv, 2019) and gender (Glenna et al., 2011; Link et al., 2017; Perkmann et al., 2013), as both have been previously posited to impact on research orientation. In the demographic section of the questionnaire the respondent’s level of education, type of research institution, and country of employment are also captured as these may produce additional noteworthy results.

Table 23   
*Demographics - Final Items*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Demographics** | | | | | |
| **Variable** | **Question** | **Descriptor** | **Variable** | **Question** | **Descriptor** |
| Age | What is your age group? | Age | Gender | Gender: How do you identify? | Gender |
| Qual | What is your highest academic qualification? | Qualification | Employ | What is your employment status? | Employment status |
| Country | In what country do you work? | Country | CareerS | What research career stage are you in ? | Career Stage |
| Field | What is your field of research ? | Field | CareerYr | How many years have you been active as a researcher (following your initial degree qualification)? | No. years in career |

* + - 1. Research Orientation

The purpose of this construct is to identify the research orientation of survey respondents. Essentially this reflects basic, applied and/or commercial research however it is often the case, as discussed in Chapter 2, that a blend of these research categories may apply. Glenna et al. (2011) undertook statistical analysis to determine researchers’ attitudes towards the orientation of their research. Their research instruments, verified with a sample of n=912 in American academic institutions, probed the issue of whether the research community, the market, or industry should influence researcher agendas. This is a useful construct in the context of this research as it provides a means to determine respondents’ attitudes towards research in a funding-agnostic manner. Despite its inclusion in the deployed research survey, the items from Glenna et al. (2011) were excluded from the final analysis due to statistical incompatibility (Chapter 6).

Lam (2011) took a more direct approach in their analytical work and verified (n=676 researchers in multiple UK universities) a scale that categorises individuals’ research orientation using the Type1-4 framework discussed in Chapter 2. This measurement scale provides a strong researcher typology, and when combined with items from Karhunen et al. (2017), is used as the dependent variable in this research. Similarly, Karhunen et al. (2017), through a series in interviews with Finnish and Russian entrepreneurs (all of whom had engaged in research in academic institutions during their careers), developed a measurement scale which examined researchers’ propensity towards entrepreneurship. Within their scale they included items that focused on researcher attitudes. Minor modifications were made to this scale (Table 24) to improve readability (removing “activities” in “but I pursue industrial links activities”), to broaden the applicability of questions (changing “I pursue industrial links activities for scientific advancement” to “I pursue industrial links activities for scientific/research advancement”) and to change tense in one instance (from “Science as source of commercial opportunities” to “I engage in research to pursue commercial opportunities”.

Tijssen’s (2018) typology also has a value here, as a further confirmation of the individual’s research orientation, where respondents are asked to select one, or a combination of, classification (such as researcher collaborator, or researcher entrepreneur). While not used in the final statistical analysis, this item provides additional context to the discussion of respondent demographics (Chapter 7).

Table 24   
*Research Orientation - Final Construct Items*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Construct Items Used in Final Analysis** | | | | |
| **Survey Question** | **Variable Item Name** | **Source** | **Context of Source Research** | **Original Question + Adjustments** |
| I believe that academia and industry should be distinct, and I pursue success strictly in the academic arena. | RO6 | Lam (2011) | Developed and verified scale with a sample of researchers across multiple UK universities. | I believe that academia and industry should be distinct and I pursue success strictly in the academic arena |
| I believe that academia and industry should be distinct, but I pursue industrial links mainly to acquire resources to support academic research. | RO7 | I believe that academia and industry should be distinct but I pursue industrial links activities mainly to acquire resources to support academic research |
| I believe in the fundamental importance of academic-industry collaboration and I pursue industrial links activities for scientific/research advancement. | RO8 | I believe in the fundamental importance of academic-industry collaboration and I pursue industrial links activities for scientific advancement |
| I believe in the fundamental importance of academic-industry collaboration and I pursue industrial links for application and commercial exploitation. | RO9 | I believe in the fundamental importance of academic-industry collaboration and I pursue industrial links activities for application and commercial exploitation |
| I engage in research to pursue commercial opportunities. | RO13\_r | Karhunen et al. (2017) | Verified scales with entrepreneurs across Finland / Russia. All respondents engaged in academic research during their careers. | Science as source of commercial opportunities |

Following operationalisation of each construct to be used in the model, verification and validation of the scale items for each was undertaken as discussed below.

* + 1. Content Analysis

Content analysis for model constructs, based on underpinning theoretical work, is a critical step to be taken prior to any data capture activity (Dixon & Johnston, 2019; Hair et al., 2010). Content analysis comprises two core elements: “*content validity* refers to the degree to which elements of an assessment instrument are relevant to and representative of the targeted construct for a particular assessment purpose” (Dixon & Johnston, 2019, p. 478), while face validity is the “appropriateness, sensibility, or relevance” or the survey items (Holden, 2010).

Content validity is a required first step in questionnaire development, however it must be followed by other validity tests, such as discriminant validity (Dixon & Johnston, 2019) as discussed later.

To establish content validity for the constructs proposed for this research, a group of ‘judges’ was established, as suggested by Dixon and Johnston (2019) and Hair et al. (2010). Each judge reviewed the constructs and provided feedback. The judges included an expert in the development of surveys for structural equation modelling, a research-focused HR Business Partner, a Vice President of Research within a university, two research support staff from a university, a research Director, and a research professor from a country where English is not the primary language. Resulting from their review feedback, any scale items that were considered too similar or irrelevant were removed, any text that was overly complicated or not well phrased was clarified, and the survey was shortened in places. Additionally, a number of survey items were added in order to potentially enrich the work – such as adding a question regarding a respondent’s tenure/non-tenure status.

* 1. Ethical Considerations

This study has received full ethical approval from the University of Sheffield Ethics Committee (ref. no. 037040). Full details are available in Appendix G. In addition, potential survey respondents were provided with a participant information sheet (Section 15.1) which detailed the purpose of the study and plans for management of data.

Furthermore, the online survey opened with two questions to establish informed consent with participants. Any respondent who answered “no” to the initial survey questions were automatically exited from the survey.

Finally, to protect respondents’ identities, no personally identifying information (name, address, email etc) was gathered in this research, and all data were deleted from SurveyMonkey once the survey period had ended.

* 1. Conclusion

This chapter focused on my philosophy as a researcher, combined with research design and operationalisation of key constructs to be used in the analysis undertaken in this research. The following chapter presents the approach to data collection, validation and analysis.

1. Data Collection Design and Analysis Plan

This chapter describes the approach taken to data collection design, sample size requirements and sample contextual selection. It then discusses the multivariate technique employed and the associated plan for model construct verification and data analysis.

* 1. Data Management

This section discusses the approach taken to collect the data used for this research. It also presents details of the sample size requirements and contextual sample selection.

* + 1. Data Collection Design

SurveyMonkey was chosen as the tool to create the questionnaire for this research, based on past experience with usage, pricing, and usability.

In terms of the flow of questions, care was taken to ensure that respondents were ‘funnelled’ from general to specific questions (Kazi & Khalid, 2012). Questions for each scale item were phrased using clear and simple language, with each question being singular to avoid confusing double-barrelled questions (Krosnick & Presser, 2010).

To mitigate non-response bias a number of steps were taken. Firstly, a short personalised introduction was included which stressed the importance of the survey and how valuable the respondent’s inputs were considered to be. The survey title page also included a button to provide respondents with a more detailed overview of the research, and a link to be informed about any research outcomes, as suggested by Stern et al. (2014). Bearing GDPR requirements in mind, informed consent was ensured prior to the survey proper, and respondents were assured confidentiality in terms of their responses (no personal identifying information was requested for example) (Greene et al., 2019).

Following the advice from Awang et al. (2016), which suggests that a 5 point scale is too short to adequately capture fine grained data for analysis, and which notes that a 10 point scale can be frustrating to users (Taherdoost, 2019), a 7 point Likert Scale was used for each question. Exceptions to this were the demographics questions, questions around physical environment, and the final research orientation question.

Note also that some questions were negatively phrased, and their related responses were reverse coded on the Likert Scale, to avoid the potential effects of response pattern bias (Dillman et al., 2016; Stern et al., 2014), which is a situation whereby some respondents might just click blindly through to the end of a survey (Reips, 2000).

Each of the questionnaire sections opened with a brief introduction, to create a degree of disconnectedness between each in the minds of the respondents, to avoid situations whereby respondents answered their next question based on their previous responses (Krosnick & Presser, 2010). The administered questionnaire is replicated in Appendix D – Final Survey Version.

* + 1. Sample size requirements

The sample size required to undertake model analysis is dependent on the number of constructs utilised in the model (Hair et al., 2010). The literature provides some guidance in this regard, with samples of between 200 (Byrne, 2005; Hair et al., 2010) and 400 (Schumacker & Lomax, 2004) being required in order to estimate the degrees of variation between the model variables, and to identify patterns which represent hypothesised relationships. Additionally, recent research suggests that an excessive sample size is not ideal as this can lead to overstating unimportant effects/relationships in the analytical model. Relying on a rule of thumb alone is not sufficient however, and as such a power analysis (which determines whether or not a sample size if suitable to provide statistically significant results) will be carried out during model fit testing (see Section 5.3.3.3).

* + 1. Sample Contextual Selection

The sample population required for this research comprises researchers working in academic institutions. To ensure a relevant sample, a purposive sampling strategy is required (Etikan et al., 2016) as this strategy can be “used to select respondents that are most likely to yield appropriate and useful information” (Kelly, 2010, p. 317). Additionally, as this research seeks to investigate research orientation across multiple research fields the maximum variance sampling technique was applied (Etikan et al., 2016). Accordingly, the administered questionnaire includes the question *“Are you an active researcher working in an academic institution?”* in order to establish respondent suitability. Purposive sampling can cause instances of researcher bias (Sharma, 2017), however this is not applicable in the case of this research as the data set required for analysis, and associated respondent selection criteria, are clear.

To gather the required population, personal contacts and their extended social networks were targeted (through LinkedIn messaging and email groups, with links to the survey site). In the case of the author’s LinkedIn contact network, potential respondents were messaged individually with a request to participate, with a further request to circulate the online survey link to their own networks of contacts. Approximately 2,000 potential respondents were targeted.

* 1. Method of Data Analysis

This research adopts a deductive approach, as discussed in Chapter 4, and accordingly a multivariate analysis is required in order to holistically examine the complex relationships between intrinsic and extrinsic motivations and research orientation. To achieve this, the starting point (Hair et al., 2010) is to develop the conceptual model to detail these relationships (Chapter 2). Once the conceptualisation is complete issues such as selecting the multivariate technique to be employed can be addressed, as discussed below.

* + 1. Multivariate Technique

Hair et al. (2010) indicate that the starting point for multivariate analysis is to complete all conceptual work, before specifying any variables or measures. Chapter 3 presented the hypotheses to be investigated in this study. In order to determine cause → effect relationships all model parameters must be identified a priori (Chen et al., 2008; Hair et al., 2010). In other words, the directionality of all relationships must be established, wherein an *effect* is preceded by a *cause* (Bollen, 1989). As discussed in Chapter 3, all variable directions of influence have been drawn from the extant literature.

**Measurement Model Analysis:** To evaluate the measurement model proposed for the research SEM (Structural Equation Modelling) /CFA (Confirmatory Factor Analysis) was selected as the optimal multivariate technique. SEM combines multiple regression and factor analysis to estimate a series of interrelated dependence relationships simultaneously (Hair et al., 2010). Briefly, multiple regression is used to examine dependence relationships, while factor analysis is used to measure concepts/factors that have multiple variables. This, then, provides “the appropriate and most efficient estimation technique for a series of separate multiple regression equations estimated simultaneously” (Hair et al., 2010, p. 22). SEM’s importance and relevance as a technique is further heightened as it not only highlights how well predictor variables (e.g. intrinsic motivations) explain a criterion variable (e.g. research orientation), but it adds depth by identifying the relative predictive strength of the predictors (Maruyama, 1997).

Within SEM itself, two tracks can be taken: CBSEM (covariance-based SEM) or PLS (Partial Least Squares). Roldán and Sánchez-Franco (2012) note that a critical difference is CBSEM estimates “a set of model parameters so that the theoretical covariance matrix implied by the system of structural equations is as close as possible to the empirical covariance matrix observed with the estimation sample” (p196) whereas PLS estimates model parameters using blocks of variables and composite variables which has the potential to overestimate loadings and underestimate path coefficients. CBSEM, with its emphasis on overall model fit, has been noted as being more suited to confirmatory (theory testing) research, whereas PLS is often utilised in exploratory (theory building) research (Goodhue et al., 2013). Finally, CBSEM allows for a simultaneous analysis of an entire system of variables (Byrne, 2005), to assess the goodness of fit between the model and its data. An adequate goodness of fit lends weight to the validity of the proposed interrelations between constructs and conversely a poor goodness of fit indicates that relationships are tenuous at best.

As will be seen in Section 6.4, while CBSEM was initially selected as the analytical method deployed to validate the measurement model / constructs using Confirmatory Factor Analysis, regression testing was adopted to examine the various path relationships and proposed moderators (as SEM tools such as AMOS are not ideal for this purpose) (Gaskin, 2020).

* 1. Analysis Plan

Following specification of the conceptual model and selection of the multivariate analysis technique, the next step was to establish the analysis plan to be followed. Hair et al. (2010) provide a six stage process applicable to model development, as shown below.

Table 25   
*Hair et al's (2010) analysis process*

|  |  |
| --- | --- |
| # | Stage |
| 1 | Construct definition |
| 2 | Measurement model construction |
| 3 | Survey design |
| 4 | Data and measurement model validity assessment |
| 5 | Model development |
| 6 | Model validity and hypotheses testing |

Stages 1-3 have been discussed earlier. Following the specification of each scale’s items (Chapter 3), the measurement items for each latent construct were assigned (Appendix C), and this allowed for the creation of the overall measurement model, as discussed below. Next, the data analysis plan (reflecting stages four to six above) was developed as discussed in the following sections.

* + 1. Reviewing Collected Data

In order to produce a set of data which was suitable for statistical analysis, an initial examination of the collected data was required, as detailed below.

* + - 1. Missing Data

The first action to take upon reception of a body of data is to determine if any data is missing. This is a problem that can often occur in quantitative research and can arise in cases where for example a respondent misses a question during a survey, or simply doesn’t answer everything (Hair et al., 2010). An initial preventative measure to avoid this was to ensure that all online survey items were marked as mandatory, meaning that respondents either completed the entire survey or exited during the process. This guaranteed that no individual question went unanswered.

This then left the potential problem of unfinished surveys. In certain quantitative situations it may be valid to impute data (e.g. if a small number of questions were not completed). Imputation involves estimating responses based on previous inputs to the survey – however this is not an accurate technique (Byrne, 2005), and would be exacerbated by the volume of questions in the survey, so the decision was made not to use this technique. For simplicity then, any respondent that did not complete all answers was deleted. This is an application of the listwise deletion strategy favoured in the literature (Byrne, 2005; Hair et al., 2010). Listwise deletion has a number of advantages. In particular, this strategy ensures that all data employed in the analysis are true representations of respondents' inputs and are not based on imputation of data from others. Furthermore, while listwise deletion removes some degrees of freedom from the statistical analysis, it provides a less biased and more accurate estimate of the outcome and therefore is an suitable alternative to other methods of data imputation. Following this process, a complete set of data (n=270) was available for analysis.

* + - 1. Identifying Communalities

Testing for communality produces a measure that describes the total variance of a measured variable relative to the construct on which it loads. The recommended communality threshold is 0.5 (Hair et al., 2010), and any item below this threshold should be noted as potentially problematic later in the analysis.

* + - 1. Assessing the Sample Adequacy

It is critical to ensure that the sample gathered is adequate for the model to be tested, and for each variable therein. The test for this is called the Kaiser-Meyer-Olkin (KMO) test, and it requires a value of greater than 0.5 in order for factor analysis to proceed (Franzen & Meyer, 2010). Coupled with this is a test called Bartlett’s test of sphericity which essentially determines the strength of the relationships within a model. The threshold for this test is based on significance values of p<0.05 (signifying that relationships between the variables exist) and p>0.1 (signifying that relationships are not strong enough for factor analysis).

* + - 1. Individual Cases

To determine if an individual respondent has answered questionnaire items in an incoherent manner (e.g. clicking through the survey at random), a boxplot can be created for all data. The boxplot identifies all items for each construct that can be considered as outliers relative to the overall data set. Specifically an outlier is defined as “as an observation in a data set which appears to be inconsistent with the remainder of that set of data” (Ben-Gal, 2005, p. 132).

* + - 1. Normality Analysis

Extant literature proposes that the shape of the collected data must be examined through kurtosis and skewness, in order to determine the level of data normality (Hair et al., 2010; Jung et al., 2009). Kurtosis is the height of the data compared to a normal distribution, while skewness is the amount of balance within the data (i.e. is it centred and symmetrical on both sides, or is it shifted left or right) (Hair et al., 2010). Benchmark thresholds for skewness and kurtosis are +-2.58 (p<0.01) and +-1.96 (p<0.05) respectively (Hair et al., 2006), and data values outside these ranges are considered to be non-normal.

Following analysis of the data set itself, the next stage in the process is to evaluate the model constructs for validity, reliability and consistency.

* + 1. Model Construct Examination

A number of established tests for construct reliability, consistency and validity are recommended (Hair et al., 2010) prior to evaluation of the measurement model. These are discussed below.

* + - 1. Construct Consistency

Cronbach’s Alpha (reliability measure of consistency between measurement items for a variable) for each latent variable (model construct represented by a number of measurement items) in the model was calculated using IBM SPSS 25. The recommended lower limit of this measure is 0.70 with the maximum being 1.0 (Hair et al., 2010). Cronbach’s Alpha shows whether a measurement item is consistent with the construct being measured and can be improved if below-threshold items are removed.

* + - 1. Discriminant Validity

Hair et al. (2010) describe discriminant validity as a measure of distinction between two similar concepts. Fornell and Larcker (1981) proposed a technique for establishing the degree of discriminant validity between latent constructs. Their process for testing for discriminant is as follows:

1. Calculate the Average Variance Extracted for each construct (calculated as the Sum of Squared Factor Loadings / number of items, or AVE) (Hair et al., 2010)
2. Calculate the Squared Inter-construct Correlations (SIC) by taking the inter-construct correlations (from IBM SPSS AMOS) for each inter-construct relationship, and squaring it (Gaskin, 2020).
3. Checking that the AVE for each construct is greater than its SIC with any other construct (Fornell & Larcker, 1981; Gaskin, 2020)
   * + 1. Convergent Validity

Hair et al. (2010) posit that Convergent Validity (CV) must determine that measures of a construct must be correlated to a value (standardised regression weight) of at least 0.5, although CV > 0.7 is more desirable. This validates that all items associated with a particular construct are indeed correlated.

* + - 1. Construct Reliability

Construct Reliability (CR) measures the internal consistency of items that load onto a latent construct, and is calculated as CR = (Sum of Factor Loadings)2 / ((Sum of Factor Loadings)2 + (Sum of Construct Error Variance Terms) (Hair et al., 2010). The recommended threshold for CR values is 0.6-0.8 (Hair et al., 2010).

* + 1. Measurement Model Analysis

Following verification of the measurement model constructs, the measurement model itself must be validated. Maximum Likelihood (ML) estimation is the technique applied in this case, because it has been noted in prior research as being unbiased for higher order likert scales (greater than 4 scale items) and medium size samples (Hair et al., 2010). Analysis of the measurement model is achieved through the following tests.

* + - 1. Identifying Model Fit

Model Fit is an estimation of how well a hypothesised model fits the sample data. Model fit is calculated by running the model through IBM SPSS AMOS. To properly verify model fit, a number of model fit indices must be applied. The chosen set of indices, based on recommendations from extant research (Hair et al., 2010; Hooper et al., 2008; Schreiber et al., 2006) is provided in Table 26.

Table 26   
*Selected Model Fit Indices*

|  |  |  |
| --- | --- | --- |
| **Model Fit Index** | **Description** | **Thresholds for good fit** |
| Chi-square (X2) Degrees of Freedom (Df) | Absolute fit index: The “magnitude of discrepancy between the sample and fitted covariances matrices” (Hooper et al., 2008, p. 53) | 1.0< X2/Df<3.0  (Hooper et al., 2008) |
| Root Mean Square Error of Approximation (RMSEA) + PClose | Absolute fit index: assesses how far the hypothesised measurement model is from a perfect model. | 0.03 < RMSEA < 0.08  Pclose (associated probability value) > 0.5  (Byrne, 2005) |
| Standardised Root Mean Square Residual (SRMR) | Badness-of-fit index: square root of the difference between the sample and hypothesised covariance models. | 0.05 > SRMR < 0.08 range  (Hair et al., 2010) |
| Comparative Fit Index (CFI) | Goodness-of-fit index: tests the null hypothesis that there is no correlation between model variables. | CFI > 0.90  (Hooper et al., 2008). |

* + - 1. Nomological Validity

Nomological Validity estimates the degree to which a scale demonstrates a previously posited/verified relationship (Hair et al., 2010), and is determined by manually examining the correlations between constructs within the measurement model to verify that they are acting as expected in theory.

* + - 1. Model Power

The final step in the measurement model analysis is to estimate the model power. Preacher and Coffman (2006) proposed a technique based on RMSEA with a required threshold of 0.8 or higher in order for analysis to proceed.

Only once all of the above tests are completed and satisfactorily passed can path analysis begin.

* + 1. Model Path Analysis

With the measurement model and its constructs validated, the next step in the process is to examine the proposed path relationships for the proposed structural model. Each proposed path is then verified through statistical analysis (in this case through regression, as discussed in Section 6.4).

* + 1. Moderation Tests

Moderation can be examined using hierarchical moderated linear regression which involves determining the amount of variance in a model observed between predictor and dependent variables with and without the interaction in place, using uncentered interaction items (i.e. the predictor \* the moderator) (Preacher & Hayes, 2008). The model is tested with and without the interaction construct. Significant R2 changes with the introduction of the interaction term indicate that moderation is taking place. Hayes (2012) ‘PROCESS’ toolset can then be employed to document the moderation effect graphically and numerically.

* + 1. Hypotheses Verification

Once all of the above tests are complete, a table is generated to show the paths that equate to the hypothesised relationships and moderation effects. Each relationship must be statistically significant, and directionally correct, in order for a hypothesis to be verified.

* 1. Conclusion

The purpose of this chapter was to discuss the methodological approach to be adopted within this body of research. This included a discussion on approaches to data collection, and appropriateness of sample sizes, multivariate techniques to be applied during the analysis phase, and the detailed analysis plan to be followed.

The next chapter focuses entirely on testing the measurement, structural and moderation models in order to provide evidence upon which the discussion in Chapter 6 can be based.

1. Model analysis and hypotheses verification

Adhering to the analysis plan discussed above, this chapter discusses the data/respondent profile, and sets out the results of the analysis and hypotheses testing relative to the research questions posed in this thesis. Note, for brevity, detailed analysis outputs for tests undertaken in this research are available in a separate supplementary information document, see link in Appendix E.

* 1. Initial data analysis
     1. Sample recruitment period and participant flow

The survey used for this research was deployed from May 18 2021 to 11 July 2021 via Surveymonkey, as described in Section 5.1.3. In total, 421 responses were received with 270 complete answer sets, representing a 65% completion rate. The direct email contact proved to be more effective as it gathered 75.5% of responses compared to 24.6% via social networks. Unfortunately, a number of respondents dropped out of the survey before completion. Accordingly, in addition to undertaking an analysis of fully completed surveys, it is important to also examine those respondents who did not finish the survey, to determine if factors such as non-response bias need to be considered, as discussed below.

* + 1. Survey attrition analysis

To understand the survey attrition rates, the following steps were undertaken: 1) Prepared collected data for analysis, exported to a new Microsoft Excel file; 2) Counted answers completed for each respondent; 3) Sorted non respondents based on number of questions answered; 4) Undertook analysis based on groupings of respondents (early dropouts, dropouts after demographics, and so on) as these clusters were clear; 5) Graphed the stages at which each part of the survey was exited; 6) For each cluster of respondents (clustered by level of survey completion) analysed: gender ratio, country, field, career stage, academic qualification, years in research (academic age), employment status - generated tables of data for each; 8) Analysed the tables for each cluster and examined literature for possible explanations where anomalies appeared.

Firstly, the number of questions answered per respondent was determined. Next respondents with fully and partially completed surveys were compared. It should be noted that this could only be undertaken for respondents that had at least completed the initial demographics questions.

In total 151 incomplete responses were received, however 101 (66.9%) respondents dropped out following the initial screening questions. Of this number, 73 dropped out as they were ineligible to participate, while 28 were eligible to continue but dropped out at this initial stage before proceeding to the first set of survey questions on Demographics. As this set of respondents dropped out before answering any questions it is not possible to analyse their reasons for doing so. Another 25 (16.6%) respondents dropped out following the Demographics questions, leaving just 25 respondents for further analysis.

It is important to note that the survey was designed in a manner that only presented a new section of questions to respondents once they had fully completed the section they were currently in – so, for example, respondents who dropped out during the demographics questions would not have seen the academic freedom section. This means that the majority of partially complete respondents dropped out without viewing any questions related to the main focus of the survey. Indeed, analysis shows that none of the unfinished respondents progressed far enough through the survey to see the final set of questions relating to research orientation. Appendix H provides tables and graphs to support the analysis that follows. Table 41 and Figure 39 show the stage of survey completion and the number of respondents remaining after each survey stage.

Analysis of demographics respondents (50 respondents)

Firstly, the countries from which respondents came from for both sets (fully and partially complete) were compared (Figure 40). It can be seen that from the 11 countries listed for partial completion that the response rates, from a location perspective, are very similar to those with fully completed surveys. Additionally, data shows that the percentage of respondents with fully completed surveys, from the same set of countries as those with partial completions, represents 84.7% of the total sample.

The graphs in Figure 41-Figure 44 present the results of the further analysis of respondent demographic data for fully versus partially completed surveys. From a gender perspective, the sample of partial respondents is very similar to the sample of full respondents as can be seen in Figure 41. It can be seen that slightly more females (4%) dropped out of the survey than completed it, while slightly more males (1%) completed the survey than those who dropped out.

Examining the field of research of respondents it can be seen from Figure 42 that the majority of partially complete surveys came from fields associated with engineering, manufacturing, construction and ICT. In all other fields the number of partial versus complete surveys is relatively balanced. This indicates that the spread of respondents across fields in both partial and fully complete data sets is comparable.

The data shows that for respondents with a PhD or equivalent qualification the percentage of completed surveys is higher than the percentage of partially completed surveys. The opposite is the case for respondents with a post-graduate qualification (but not at PhD level). The dropout comparison for researchers with a bachelor’s degree or equivalent is relatively similar.

Figure 44 shows that the majority of non-complete responses came from respondents classified as “R1 Early Stage” researchers. In the remainder of cases response rate percentages are similar (considering the small sample under consideration).

* + - 1. Non-Response Bias

The above demonstrates that, from a demographic perspective, the set of respondents who fully and partially completed the survey is broadly similar. While recent works, such as that of Hendra and Hill (2019) and Rothbaum and Bee (2021) posit that there is very little correlation between research response rates and non-response bias, in any survey such as that employed for this research non-response bias is a factor that needs consideration. Describing non-response bias, Rothbaum et al. (2021, p. 2) suggest that “nonresponse bias can occur when the people who agree to complete the survey (respondents) differ from sampled people who do not complete the survey (nonrespondents)”, this assertion is echoed by Bianchi et al. (2019). It can be seen from the analysis of full and partial respondents above that non-response bias cannot be assumed on this basis, as demographics for both groups are similar. However, drawing on the work of Bethlehem (2020, p. 647) it should be noted that non-response bias can also be observed in cases where “some groups in the population are over- or under-represented, and these groups behave differently with respect to the characteristics being investigated”. Since the majority of respondents with fully completed surveys come from the fields of ICT and Engineering, it can be inferred that some level of non-response bias has impacted the sample and subsequently the implications that can be drawn from the results in terms of generalisability. Additionally, the over-representation of respondents from Ireland can also impact on generalisation of analysis outcomes. Both of these findings are noted as limitations of this research, in Chapter 8.

For completeness, the remaining tables in Appendix H present details of respondent profiles for those respondents who completed various stages of the survey. In each case colour coding (light to dark red) was used to highlight majority figures. The key takeaway from these tables (and from Figure 39) is that the majority of partial respondents dropped out before they arrived at questions regarding research orientation. Accordingly, it can be concluded that these types of questions did not impact on the dropout rate of respondents.

* + - 1. Other considerations – survey structure and potential Covid pandemic impact

Considering the high dropout rate from the outset of the survey following the demographic questions stage, it is useful to refer to extant literature to uncover potential reasons for this. One reason, posited by Galesic (2006), could be that the positioning of personal/demographic questions at the start of the survey might be off-putting for certain respondents, yet she notes that prior research has also found a correlation between early requesting of personal data in a survey and stronger completion rates. However, as the demographic questions posed were not personally invasive this is an unlikely reason (Frick et al., 2001).

Another potential explanation for the observed response rates is the COVID-19 pandemic. There was a significant overlap between the timing of the survey for this research and the pandemic, which was a time when people all around the world were living under the strain of lockdowns of varying degrees. The global community was forced to work in an environment that was primarily online as a result of these lockdowns. One phenomenon arising from this scenario is that of online fatigue (Manea et al., 2020) which Gregersen et al. (2023, p. 969) define as “frustration and apathy with using digital devices”, which can result in “visual fatigue [aggravation when using a digital screen], social fatigue [wanting to be alone], motivational fatigue [lack of motivation to undertake an activity] and emotional fatigue [feeling irritable and moody]” (Romero-Rodríguez et al., 2023, p. 168). Gregersen et al. (2023) undertook a study which addressed this phenomenon and found that individuals reported getting easily distracted, manifested as endless scrolling on social media rather than undertaking their originally planned task, or becoming increasingly bored and resentful when having to work on a digital device. De Koning et al. (2021) and Field (2020) researched the impact of the pandemic on survey fatigue, and noted that it results in an increase in attrition bias - described as the situation whereby respondents fail to complete some or all of a survey (Nunan et al., 2018). These factors could provide some additional explanation regarding the attrition rates in this research.

* + 1. Data screening

The initial fully complete data set was exported from Surveymonkey into Microsoft Excel. From there conditional formatting was used to identify any rows with incomplete data. Employing a listwise deletion strategy all rows that were incomplete were deleted. Next, the standard deviation (STDEV) for all responses for each respondent was calculated. The purpose of this was to identify cases of unengaged respondents (i.e., respondents that simply clicked through the same answer value for each question). Any STDEV with a value near zero would indicate a problem area, however, none were found.

Finally, any survey items that required reverse coding were dealt with in Excel (for each item represented by a 7-point likert scale, to reverse code the formula [8-itemvalue] was used). Following this step all data were imported into IBM SPSS Statistics v25 for further analysis.

* + 1. Variable screening

In SPSS, Skewness and Kurtosis descriptive data was calculated for each survey item. To identify problematic data a range of 2.58<item value<-2.58 was used to detect Skewness, and a arrange of 1.96<item value<-1.96 was used to detect Kurtosis (Hair et al., 2010). Only “stim4” had values outside these limits, and so this item was noted as being potentially problematic. For all other variables normal distributions were observed.

* + 1. Kaiser-Meyer-Olkin / Bartlett and Communalities tests

The table below presents the results of the KMO and Bartlett test. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.717 (recommended threshold 0.6 (Hair et al., 2010)) and the Bartlett test of sphericity was significant (x2(270)=19088.677, p<0.05), thereby verifying the level of correlation and suitability of the size of the data sample for analysis.

Table 27   
  
*KMO* Measure *and Bartlett*’s *test*

|  |  |  |
| --- | --- | --- |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy |  | .717 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 19088.677 |
|  | df | 4465 |
|  | Sig. | .001 |

Communalities (Supplementary Information Section S2.1) were above the recommended cut off value of 0.3 ((Hair et al., 2010).

* + 1. Respondent Demographics

The tables below presents the respondents’ demographic profile, while Appendix F provides detailed graphs for each category below.

Table 28   
*Respondent demographics*

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | % | Variable | % |
| Age |  | Field |  |
| 21-25 | 4.8 | Education | 4.1 |
| 26-30 | 15.2 | Arts and Humanities | 4.1 |
| 31-35 | 17.8 | Social Sciences, Journalism and Information | 4.8 |
| 36-40 | 12.2 | Business, Administration and Law | 8.1 |
| 41-45 | 15.9 | Natural Sciences, Mathematics and Statistics | 13 |
| 46-50 | 14.8 | Information and Communication Technologies | 44.4 |
| 51-55 | 11.1 | Engineering, Manufacturing and Construction | 6.7 |
| 56-60 | 4.4 | Agriculture, Forestry, Fisheries and Veterinary | 4.8 |
| 61-65 | 3.3 | Health and Welfare | 9.3 |
| 66+ | 0.4 | Services | 0.7 |
| Gender |  | Employment status |  |
| Female | 41.4 | Permanent / Tenured | 50 |
| Male | 56.7 | Renewable Contract | 23.7 |
| Other | 1.9 | Temporary | 19.6 |
| Education Level |  | Other | 6.7 |
| Bachelor's Degree or equivalent | 4.8 | Host institution type |  |
| Post-graduate qualification (e.g. Masters) | 27.4 | Traditional University | 35.2 |
| PhD or equivalent | 67.8 | University with industrial linkages | 37 |
|  |  | Research campus co-located with industry | 27.8 |
| Note: *n=270* |  |  |  |

Table 29   
*Respondent research profile*

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | % | Variable | % |
| Research experience |  | Self classification |  |
| 0-5 years | 28.5 | R | 10.4 |
| 6-10 years | 19.3 | R + C | 5.9 |
| 11-15 years | 17.4 | R + I | 7 |
| 16-20 years | 18.1 | R + E | 5.2 |
| 20+ years | 16.7 | R + C + I | 7 |
| Research stage |  | R + C + E | 64.4 |
| R1 Early Stage | 26.3 | R + I + E | 0 |
| R2 Recognized Researcher | 23 | R + C +I + E | 0 |
| R3 Established Researcher | 33 |  |  |
| R4 Leading Researcher | 17.8 |  |  |
| Education Level |  |  |  |
| Bachelor's Degree or equivalent | 4.8 |  |  |
| Post-graduate qualification (e.g. Masters) | 27.4 |  |  |
| PhD or equivalent | 67.8 |  |  |
| Note: *n=270; R=Researcher, C=Collaborator, I=Inventor, E=Entrepreneur* | | |  |

**Age and gender**: A broad age-range for respondents was apparent in the sample, representing researchers at various career stages. Similarly, gender within the sample was well balanced with 57% male, 41% female and the remaining 2% identifying as other.

**Qualifications and employment status**: All respondents had attained a Bachelor’s Degree or equivalent, with the majority of respondents having a PhD or equivalent qualification. Interestingly, in terms of employment status, the majority (50%) of respondents had permanent/tenured positions. This would seem to reflect the qualification profile already noted.

**Career Stage and Years’ Experience:** A broad spread of respondents was found in terms of career stage (Figure 32). While 50.8% of respondents considered themselves to be established (33%) or leading (17.8%) researchers, this is balanced by the number of early stage (26.3%) and recognised (23%) researchers in the sample. Additionally, the number of years’ experience (Figure 33) as an active researcher had a relatively even spread amongst respondents.

**Research Fields:** Respondents were asked to identify their research fields (UNESCO, 2013). Researchers in the field of Information and Communication Technologies were in the majority amongst respondents, representing 45% of the total as shown in Figure 34, this is primarily due to the author’s own field and network of contacts and is a limitation of this research, as discussed in Section 8.3. It is worth noting however that due to the volume of respondents from other fields, a comparison between ICT/Engineering and “others” was possible when the moderation analysis took place, as discussed in Section 6.5.5. Respondents were also asked to specify the type of research organisation in which they are employed. The mix of respondents from traditional universities (35.2%), universities with industrial linkages (37%) and research centres collocated with industry (27.8%) was well balanced.

**Location:** Respondents were located in a total of 29 countries (as shown in Figure 36 and Figure 37), with respondents from Ireland being in the majority (41%). This distribution arises as a result of the researcher’s personal networks and contacts, and is noted as a limitation in Section 8.3.

**Self-Classification:** The final demographic chart, Figure 38, presents respondents’ responses to the survey item on self-classification. Of particular interest here is that no respondents selected the “Researcher + Collaborator + Inventor + Entrepreneur” or “Researcher + Inventor + Entrepreneur” options, while the majority selected the “Researcher + Collaborator + Entrepreneur” option. This is reflective of the main field of research (ICT) and the collaborative nature of research therein.

* 1. Item reliability and initial factor analysis

Using SPSS, Cronbach’s Alpha was generated for each proposed construct as a means to test construct reliability. In each case if Cronbach’s Alpha showed a significant improvement should an item be removed this was done, and testing was repeated. For brevity, the tables presented in Supplementary Information (Section S2.2) detail this analysis for each proposed factor, with items for removal highlighted in red.

Following item reliability testing, a pattern matrix was generated via SPSS for all variables, to verify the proposed factors (Supplementary Information Section S2.3). Based on the factors identified, and re-examining the survey items it was decided to combine items from the PolKTT (knowledge transfer policy) and PolCom (commercialisation policy) constructs as the survey items were very similar. This decision was verified in the subsequent confirmatory factor analysis, below.

* 1. Confirmatory Factor Analysis
     1. Initial Model Fit

IBM SPSS AMOS 26 Graphics was used to build the measurement model. Once developed, model fit statistics were generated. Initial results highlighted a number of problematic items which caused unsuitable model fit, based on the thresholds specified in Section 5.3.3.1. Hair et al. (2010) and Byrne (2001) recommend an analysis of modification indices as a first means to improving model fit, when applied with caution. To that end a table of modification indices with values greater than 20 (Byrne, 2001) was generated, and suggested modifications were applied to the model. Following this, with model fit still outside recommended thresholds, standardised residuals were examined and items with residuals greater than 4.0 (Hair et al., 2010) were noted.

* + 1. Discriminant Validity and Convergent Validity

To test Discriminant Validity (DV) and Convergent Validity (CV) a matrix was generated to cross-check problematic constructs relative to the noted problematic standardised residuals from the preceding analysis. The result of this exercise was that additional items had to be removed (note items were removed one at a time and the analysis for CV and DV was repeated): AF1, Satisf8, Sociv7, Sociv5, Sociv6, Sociv8, Sociv2, Finres1, Finres3, PolTTO4\_r, PolRes1\_r, PolRes4\_r, PolCom4\_r. Due to the required removal of the additional PolRes items, the PolRes construct was deemed unsuitable for further analysis.

The table below shows the final CV/DV output:

Table 30   
Convergent Validity and Discriminant Validity Analysis Results

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | CR | AVE | MSV | MaxR(H) | AF | Stim | Satis | Risk | Sociv | Reput | RwrdF | RwrdPT | SocapC | Finres | PolKTT | PolTTO | RO |
| AF | 0.874 | 0.712 | 0.280 | 1.086 | **0.844** |  |  |  |  |  |  |  |  |  |  |  |  |
| Stim | 0.903 | 0.758 | 0.571 | 0.938 | 0.516\*\*\* | **0.871** |  |  |  |  |  |  |  |  |  |  |  |
| Satis | 0.908 | 0.664 | 0.537 | 0.914 | 0.447\*\*\* | 0.600\*\*\* | **0.815** |  |  |  |  |  |  |  |  |  |  |
| Risk | 0.890 | 0.731 | 0.337 | 0.987 | 0.307\*\*\* | 0.564\*\*\* | 0.363\*\*\* | **0.855** |  |  |  |  |  |  |  |  |  |
| Sociv | 0.880 | 0.710 | 0.571 | 0.900 | 0.529\*\*\* | 0.755\*\*\* | 0.546\*\*\* | 0.581\*\*\* | **0.842** |  |  |  |  |  |  |  |  |
| Reput | 0.911 | 0.777 | 0.152 | 1.022 | 0.174\*\* | 0.319\*\*\* | 0.340\*\*\* | 0.190\*\* | 0.266\*\*\* | **0.882** |  |  |  |  |  |  |  |
| RwrdF | 0.803 | 0.578 | 0.152 | 0.821 | 0.068 | 0.249\*\*\* | 0.247\*\*\* | 0.195\*\* | 0.198\*\* | 0.389\*\*\* | **0.760** |  |  |  |  |  |  |
| RwrdPT | 0.969 | 0.944 | 0.148 | 1.641 | 0.303\*\*\* | 0.280\*\*\* | 0.384\*\*\* | 0.202\*\*\* | 0.286\*\*\* | 0.289\*\*\* | 0.247\*\*\* | **0.972** |  |  |  |  |  |
| SocapC | 0.910 | 0.717 | 0.537 | 0.923 | 0.447\*\*\* | 0.704\*\*\* | 0.733\*\*\* | 0.496\*\*\* | 0.690\*\*\* | 0.263\*\*\* | 0.224\*\* | 0.284\*\*\* | **0.847** |  |  |  |  |
| Finres | 0.781 | 0.642 | 0.482 | 0.800 | 0.311\*\*\* | 0.356\*\*\* | 0.694\*\*\* | 0.244\*\*\* | 0.367\*\*\* | 0.290\*\*\* | 0.144† | 0.281\*\*\* | 0.457\*\*\* | **0.802** |  |  |  |
| PolKTT | 0.861 | 0.610 | 0.442 | 0.874 | 0.204\*\* | 0.476\*\*\* | -0.058 | 0.241\*\*\* | 0.316\*\*\* | 0.093 | 0.318\*\*\* | 0.032 | 0.141\* | -0.222\*\* | **0.781** |  |  |
| PolTTO | 0.885 | 0.793 | 0.442 | 0.887 | 0.190\*\* | 0.462\*\*\* | 0.147\* | 0.300\*\*\* | 0.321\*\*\* | 0.159\* | 0.261\*\*\* | 0.063 | 0.252\*\*\* | -0.021 | 0.665\*\*\* | **0.891** |  |
| RO | 0.871 | 0.578 | 0.134 | 1.015 | 0.342\*\*\* | 0.373\*\*\* | 0.255\*\*\* | 0.065 | 0.248\*\*\* | -0.024 | -0.149\* | 0.131\* | 0.208\*\* | 0.179\*\* | 0.149\* | 0.150\* | **0.763** |
| **Notes:** Significance of Correlations: † p < 0.100, \* p < 0.050, \*\* p < 0.010, \*\*\* p < 0.001  Required thresholds (Fornell & Larcker, 1981; Hair et al., 2010; Hu & Bentler, 1999): AVE (Average Variance Extracted) > 0.5. AVE > MSV (Maximum Shared Variance). CR > AVE. AVE > Squared Inter-construct Correlation (highlighted in **bold** in table above). | | | | | | | | | | | | | | | | | |

With the above changes made, the resulting model fit adhered to the required limits: CMIN/DF=2.415, Comparative Fit Index (CFI)=0.91, Standardised Root Mean Square Residual (SRMR)=0.07, Root Mean Square Error of Approximation (RMSEA)=0.061, PClose=0.023. This result confirms the validity of the constructs used in the following analysis.

The final step in Measurement Model validation was to determine the Power of the Study.

* + 1. Power of the Study

Preacher and Coffman’s RMSEA based technique (Fadlelmula, 2011; Preacher & Coffman, 2006) was applied to estimate model power, which proposes >=0.8 as the recommended model power level.

Using (Df=748, RMSEA=0.061, RMSEA (null)=0, N=270) (from the measurement model) the model power was calculated for Alpha = 0.05 (Preacher & Coffman, 2006) as being 1.0, which confirms model statistical power is suitable for analysis to proceed (Fadlelmula, 2011).

The final, verified, CFA model is shown below in Figure 14 (without covariances) and Figure 15 (with covariances):

Figure 14   
*CFA Measurement Model (without covariances)*

A screenshot of a computer

Description automatically generated

Figure 15   
*CFA Measurement Model*

A computer screen shot of a diagram

Description automatically generated

With the measurement model fully validated, structural/causal analysis can proceed.

* 1. Structural Analysis and Hypotheses Testing

In the case of this research, it was necessary to move the next stage of analysis to SPSS rather than AMOS. The reason for this is that AMOS is not capable of supporting moderation analysis (apart from basic groupwise moderation which is not sufficient for the constructs under consideration (Gaskin, 2020)). To support this process, the next step was to create imputed factors within AMOS, which were then imported into SPSS for the analysis that follows (Gaskin, 2020).

* + 1. Examining the effects of intrinsic and extrinsic motivations on research orientation

The primary direct relationships proposed in this research are the effects of Intrinsic and Extrinsic motivations on the individual’s research orientation. To address research question RQ1a *“What are the primary intrinsic and extrinsic motivations that influence the research orientation of a researcher in an academic institution?”,* the operationalised intrinsic and extrinsic motivations were verified to be valid through the statistical analysis that follows, in which communalities were reported (to verify individual questionnaire items used for each construct) (Supplementary Information Section S2.1 Communalities table), and through the extracted R2 values established during moderation analysis (Table 34) which represents the variance in the dependent variable (research orientation) accounted for by the predictor variables (direct paths and moderators) (Hair et al., 2010). To verify these relationships a regression analysis was undertaken in SPSS, with the results (Table 31 and Supplementary Information Section 2.4) verifying the statistical significance of these paths. In terms of path directionality, a positive β represents an influence towards basic research, while a negative β represents an influence towards commercial research.

Table 31   
*Intrinsic / Extrinsic -> RO Regression analysis*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Regression Analysis | | | Significance | |
| Dependent variable | Predictor | β | t(276) | p | F(2,267) | p |
| RO | Intrinsic | 0.603 | 12.104 | 0.000 | 119.092 | 0.000 |
|  | Extrinsic | -0.141 | -2.823 | 0.000 |  |  |

Results of the regression analysis for the impact of Intrinsic (β=0.474, t(267)=12.104, p<0.000) and Extrinsic (β=-0.147, t(267)=-2.823, p<0.000) motivations on RO (Research Orientation) confirm both relationships to be statistically significant: F(2,267) = 119.092, p<0.000. This result provides the first part of the answer to RQ1b *“What is the interaction effect between intrinsic and extrinsic motivations and the research orientation of a researcher in an academic institution?”* as it verifies the existence of an interaction effect between intrinsic / extrinsic motivations and research orientation and provides statistical support for hypothesis H1 and H2.

To fully answer this research question however, and to support the discussion that follows in Chapter 7, an additional regression analysis was undertaken to determine the relative influence of each of the proposed individual motivations on research orientation, with statistical outputs presented in Supplementary Information (Section S2.8). Summary results (Table 32) show that the constructs proposed as extrinsic motivations accounted for a greater variance in the dependent variable RO (R2=0.246) than the constructs proposed as intrinsic motivations (R2=0.126).

Arrow

Description automatically generatedThe results of this analysis, in order of influence strength (path values) of each proposed motivation are shown in Table 32 below. Note, a negative path value indicates that a motivation influences research orientation towards commercial research, while a positive path value influences research orientation towards basic research. Note also, results for Sociv (social/civic responsibility) and RwrdPT (promotion/tenure) were not statistically significant (p>0.05).

Statistical non-significance can have a number of causes. Visentin et al. (2020) suggest that this can arise due to effect sizes being too small, standard deviation being too large, sample sizes being too small, or simply that no effect exists. Considering the analysis undertaken in the preceding sections it is clear that sample size and standard deviation did not cause an issue with these constructs. The effect size for both constructs was indeed quite small (Sociv -0.14 and RwrdPT 0.054) and this may have had an impact. Section 7.2.3 in Chapter 7 presents a discussion on other potential causes for these non-significant results.

From the results above, it can be said that all hypotheses (H1 and H2) and sub-hypotheses related to motivations are supported (with the exception of H1e and H2c).

Table 32   
*Relative Influence of Motivations*

|  |  |  |  |
| --- | --- | --- | --- |
| Motivation Construct | Beta | Absolute Value Beta | Hypothesis |
| RwrdF (Extr) | -0.557 | 0.557 | h2a |
| Stim (Intr) | 0.385 | 0.385 | h1b |
| Reput (Extr) | -0.353 | 0.353 | h2b |
| Risk (Intr) | -0.326 | 0.326 | h1d |
| AF (Intr) | 0.312 | 0.312 | h1a |
| Satis (Intr) | -0.173 | 0.173 | h1c |
| Sociv (Intr) | -0.14 | 0.14 | h1e |
| RwrdPT (Extr) | 0.054 | 0.054 | h2c |

* + 1. Examining the effect of proposed moderators on the relationship between Intrinsic/Extrinsic Motivations and Research Orientation

Moderation analysis is required in order to provide answers to research questions RQ2a *“What role does a researcher’s personal profile play in moderating the relationship between their motivations and their research orientation?”* and RQ2b *“What role does a researcher’s academic environment play in moderating the relationship between their motivations and their research orientation?”.*

To test each proposed moderator, interaction terms were created within SPSS, using the formula [interaction term = predictor \* moderator] (Hair et al., 2010). Next, each proposed moderator was tested in SPSS, with the results presented in Table 34 (detailed statistical results are provided in Supplementary Information, S2.5). Table 34 below presents the direct effect of each predictor and moderator on the dependent variable (RO), followed by the influence of the interaction term on the dependent variable. If a statistically significant R2 change (ΔR**2**) is determined, then moderation is observed.

Following verification of the moderators, (Hayes, 2012) ‘PROCESS’ was applied to generate the moderation graphs (interaction plots) discussed in the following sections (full results from PROCESS are available in Supplementary Information, S2.7). Moderation analysis and the associated interaction plots provide results using “low”, “medium” and “high” values for the constructs under examination. The majority of constructs are based on a 7-point Likert Scale, and one approach to this categorisation is to propose that values of 1-3 represent “low”, values of 4 represent “medium” and values of 5-7 represent “high”, however as the distribution of data for each construct is not the same, and this technique assumes equal intervals between each data point (Wu & Leung, 2017), this categorisation technique is not sufficient. Drawing on standard practice (Preacher & Hayes, 2004; Sullivan & Artino Jr, 2013; Warmbrod, 2014; Wu & Leung, 2017) for moderation analysis, and using Hayes (2012) PROCESS module in SPSS, construct values were calculated based on “low” being less than one standard deviation below the mean, “high” being greater than one standard deviation above the mean, and “medium” being values in between. The corresponding values for each construct are provided in Table 33 below. The exceptions to this are the Gender and Field constructs. Due to the nature of these constructs, applying a Likert scale for respondents was not appropriate.

Table 33   
*Construct means, standard deviations, and moderation levels*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | **Moderation Levels** | | | |
| Variable | Minimum  Response | Maximum  Response | Std.  Deviation | | Low  <(Mean-1SD) | Medium  (Mean) | High >(Mean+1SD) |
| Age | 2.000 | 11.000 | 1.968 | | 3.828 | 5.796 | 7.764 |
| PhEnv | 1.000 | 7.000 | 1.554 | | 2.861 | 4.415 | 5.969 |
| Finres | 1.000 | 6.500 | 1.404 | | 2.293 | 3.696 | 5.100 |
| PKTT | 1.000 | 7.000 | 1.298 | | 2.617 | 3.916 | 5.214 |
| PTTO | 1.000 | 7.000 | 1.304 | | 2.489 | 3.793 | 5.097 |
| SocapC | 2.000 | 7.000 | 1.101 | | 4.179 | 5.280 | 6.381 |
| Intrinsic | 2.920 | 6.867 | 0.624 | | 4.749 | 5.373 | 5.997 |
| Extrinsic | 1.167 | 6.056 | 0.946 | | 2.828 | 3.774 | 4.720 |
| RO | 2.600 | 5.000 | 0.425 | | 3.566 | 3.991 | 4.417 |
| Career | 1.000 | 4.000 | 1.063 | | 1.359 | 2.422 | 3.485 |
| CareerYrs | 1.000 | 5.000 | 1.459 | | 1.293 | 2.752 | 4.211 |
| AF | 1.333 | 7.000 | 1.183 | | 4.516 | 5.699 | 6.882 |
| Stim | 1.000 | 7.000 | 0.779 | | 5.282 | 6.062 | 6.841 |
| Satis | 1.400 | 7.000 | 1.183 | | 3.884 | 5.067 | 6.251 |
| Risk | 1.000 | 7.000 | 1.331 | | 3.270 | 4.601 | 5.932 |
| Sociv | 2.000 | 7.000 | 1.035 | | 4.400 | 5.436 | 6.471 |
| Reput | 1.000 | 7.000 | 1.478 | | 2.629 | 4.107 | 5.585 |
| RwrdF | 1.000 | 6.333 | 1.267 | | 1.770 | 3.037 | 4.304 |
| RwrdPT | 1.000 | 7.000 | 1.473 | | 2.704 | 4.178 | 5.651 |

Table 34   
*Moderation Analysi*s

| Proposed Moderator | Dependent Variable: RO | Predictors | Interaction Term | R2 | ΔR2 | F | p | Sig |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Age | Main Effects Model | Age, Intrinsic |  | 0.461 |  | F(2,267)=117.868 | <0.001 | Y |
|  | Interaction Effects Model |  | AgeXIntr | 0.678 | 0.217 | F(3,266)=193.119 | <0.001 | Y\*\* |
|  | Main Effects Model | Age, Extrinsic |  | 0.327 |  | F(2,267)=67.083 | <0.001 | Y |
|  | Interaction Effects Model |  | AgeXExtr | 0.615 | 0.288 | F(3,266)=146.345 | <0.001 | Y\*\* |
| Gender | Main Effects Model | Gender, Intrinsic |  | 0.468 |  | F(2,267)=121.269 | <0.001 | Y |
|  | Interaction Effects Model |  | GenxIntrin | 0.663 | 0.195 | F(3,266)=179.971 | <0.001 | Y\*\* |
|  | Main Effects Model | Gender, Extrinsic |  | 0.224 |  | F(2,267)=39.905 | <0.001 | Y |
|  | Interaction Effects Model |  | GenxExtrin | 0.548 | 0.323 | F(3,266)=111.041 | <0.001 | Y\*\* |
| Physical | Main Effects Model | PhyEnv, Intrinsic |  | 0.448 |  | F(2,267)=111.876 | <0.001 | Y |
| Environment | Interaction Effects Model |  | PhyxIntrin | 0.694 | 0.247 | F(3,266)=208.298 | <0.001 | Y\*\* |
|  | Main Effects Model | PhyEnv, Extrinsic |  | 0.225 |  | F(2,267)=40.075 | <0.001 | Y |
|  | Interaction Effects Model |  | PhyEnvxExtrin | 0.568 | 0.343 | F(3,266)=120.600 | <0.001 | Y\*\* |
| Finance / | Main Effects Model | Finres, Intrinsic |  | 0.448 |  | F(2,267)=112.056 | <0.001 | Y |
| resources | Interaction Effects Model |  | FinresxIntrin | 0.692 | 0.244 | F(3,266)=206.254 | <0.001 | Y\*\* |
|  | Main Effects Model | Finres, Extrinsic |  | 0.238 |  | F(2,267)=44.534 | <0.001 | Y |
|  | Interaction Effects Model |  | FinresxExtrin | 0.572 | 0.328 | F(3,266)=122.466 | <0.001 | Y\*\* |
| Policy KTT | Main Effects Model | PKTT, Intrinsic |  | 0.495 |  | F(2,267)=135.473 | <0.001 | Y |
|  | Interaction Effects Model |  | PKTTxIntrin | 0.675 | 0.18 | F(3,266)=190.566 | <0.001 | Y\*\* |
|  | Main Effects Model | PKTT, Extrinsic |  | 0.287 |  | F(2,267)=55.554 | <0.001 | Y |
|  | Interaction Effects Model |  | PKTTxExtrin | 0.618 | 0.331 | F(3,266)=148,446 | <0.001 | Y\*\* |
| Policy TTO | Main Effects Model | PTTO, Intrinsic |  | 0.472 |  | F(2,267)=123.223 | <0.001 | Y |
|  | Interaction Effects Model |  | PTTOxIntrin | 0.675 | 0.203 | F(3,266)=190.481 | <0.001 | Y\*\* |
|  | Main Effects Model | PTTO, Extrinsic |  | 0.279 |  | F(2,267)=53.351 | <0.001 | Y |
|  | Interaction Effects Model |  | PTTOxExtrin | 0.598 | 0.32 | F(3,266)=136.588 | <0.001 | Y\*\* |
| Social Capital | Main Effects Model | SocapC, Intrinsic |  | 0.449 |  | F(2,267)=112.267 | <0.001 | Y |
|  | Interaction Effects Model |  | SocapCxIntrin | 0.722 | 0.273 | F(3,266)=238.096 | <0.001 | Y\*\* |
|  | Main Effects Model | SocapC, Extrinsic |  | 0.344 |  | F(2,267)=72.372 | <0.001 | Y |
|  | Interaction Effects Model |  | SocapCxExtrin | 0.68 | 0.336 | F(3,266)=195.234 | <0.001 | Y\*\* |
| Field | Main Effects Model | Field, Intrinsic |  | 0.472 |  | F(2,267)=123.229 | <0.001 | Y |
|  | Interaction Effects Model |  | FieldxIntrin | 0.691 | 0.219 | F(3,266)=205.166 | <0.001 | Y\*\* |
|  | Main Effects Model | Field, Extrinsic |  | 0.281 |  | F(2,267)=53.833 | <0.001 | Y |
|  | Interaction Effects Model |  | FieldxExtrin | 0.566 | 0.286 | F(3,266)=119.642 | <0.001 | Y\*\* |
| Notes: \*\* Denotes statistical significance | | | | | | | | |

The table below ranks the statistically significant moderation effects based on the strength of the interaction, from strongest to weakest. These results will frame elements of the discussion in Chapter 7. These results answer research questions RQ2a and RQ2b as they present details, graphically and statistically, on how the researcher’s personal profile (age, gender, field, social capital) and their research environment (physical environment, finance/resources, supports and policies) moderates the relationship between their intrinsic/extrinsic motivations and their research orientation.

Table 35   
*Interaction effects model*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Dependent variable RO | Interaction term | ΔR2 | F | p | [[5]](#footnote-5)Sig |
| Extrinsic | PhyEnvxExtrin | 0.343 | F(3,266)=120.600 | <0.001 | Y\*\* |
| motivations | SocapCxExtrin | 0.336 | F(3,266)=195.234 | <0.001 | Y\*\* |
|  | PKTTxExtrin | 0.331 | F(3,266)=148,446 | <0.001 | Y\*\* |
|  | FinresxExtrin | 0.328 | F(3,266)=122.466 | <0.001 | Y\*\* |
|  | GenxExtrin | 0.323 | F(3,266)=111.041 | <0.001 | Y\*\* |
|  | PTTOxExtrin | 0.32 | F(3,266)=136.588 | <0.001 | Y\*\* |
|  | AgeXExtr | 0.288 | F(3,266)=146.345 | <0.001 | Y\*\* |
|  | FieldxExtrin | 0.286 | F(3,266)=119.642 | <0.001 | Y\*\* |
| Intrinsic | SocapCxIntrin | 0.273 | F(3,266)=238.096 | <0.001 | Y\*\* |
| motivations | PhyxIntrin | 0.247 | F(3,266)=208.298 | <0.001 | Y\*\* |
|  | FinresxIntrin | 0.244 | F(3,266)=206.254 | <0.001 | Y\*\* |
|  | FieldxIntrin | 0.219 | F(3,266)=205.166 | <0.001 | Y\*\* |
|  | AgeXIntr | 0.217 | F(3,266)=193.119 | <0.001 | Y\*\* |
|  | PTTOxIntrin | 0.203 | F(3,266)=190.481 | <0.001 | Y\*\* |
|  | GenxIntrin | 0.195 | F(3,266)=179.971 | <0.001 | Y\*\* |
|  | PKTTxIntrin | 0.18 | F(3,266)=190.566 | <0.001 | Y\*\* |
| Notes: \*\* denotes statistical significance | | | | | |

To further support research questions RQ2a and RQ2b, the diagram below (Figure 16) presents a stylised representation of the moderation comparison table (Table 35) and illustrates the influence of each moderating construct on the Intrinsic/extrinsic motivations - Research Orientation relationship. This shows that the extrinsic motivations – research orientation relationship is impacted more by the proposed moderators than the relationship between intrinsic motivations and research orientation. The implications of this are discussed in Chapter 7.

Figure 16 *Comparison of Moderation Strengths*

A diagram of a research process

Description automatically generated with medium confidence

Beyond the set of moderators selected for this research, and as discussed in Section 3.4.1.1,certain studies employ the construct Career Age or Career Stage rather than a person’s biological age. Accordingly, it is important to examine the effect of these variables as alternative moderators, applying the same analysis technique as above, compared to the main hypothesised model, as discussed below.

* + - 1. Alternative Model – comparing the effects of age, career age and career stage

Applying the same process for moderation analysis, the table below compares the moderation effects of career age and career stage compared to biological age. As can be seen, while the observed moderation effects are statistically close in value (represented by a minimal variation within ΔR2 values), the researcher’s career stage has the strongest influence on both the relationship between intrinsic motivations and RO and between extrinsic motivations and RO. Interaction plots for these moderators are provided in Appendix J and verify that, from a hypothesis directionality and moderation effect perspective, the effects are the same.

Table 36   
*Comparison of age-related moderators*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Dependent Variable: RO | Interaction Term | ΔR2 | F | p | [Sig](file:///C:\Users\kdool\Dropbox\EdD\THESIS%20ReSubmission\New%20Analysis\tables.xlsx#RANGE!_ftn1) |
| Biological age (Age) | AgeXIntr | 0.217 | F(3,266)=193.119 | <0.001 | Y\*\* |
| Career Stage (CareerS) | CareerSxIntr | 0.225 | F(3,266)=189.470 | <0.001 | Y\*\* |
| Research Career Years (CareerYr) | CareerYrxIntr | 0.211 | F(3,266)=182.793 | <0.001 | Y\*\* |
| Biological age (Age) | AgeXExtr | 0.288 | F(3,266)=146.345 | <0.001 | Y\*\* |
| Career Stage (CareerS) | CareerSxExtr | 0.313 | F(3,266)=119.952 | <0.001 | Y\*\* |
| Research Career Years (CareerYr) | CareerYrxExtr | 0.252 | F(3,266)=104.942 | <0.001 | Y\*\* |
| Notes: \*\* denotes statistical significance | | | | | |

* 1. Hypotheses Validation

The following sections present statistical validation of the hypotheses proposed in this research.

Figure 17   
*Hypothesised relationships*

A diagram of a chemical reaction

Description automatically generated

Note, detailed discussion related to all findings and their relevance for extant literature will follow in Chapter 7.

* + 1. The impact of Intrinsic and Extrinsic Motivations on Research Orientation

Hypotheses (H1 and H2) related to the impact of intrinsic and extrinsic motivations on research orientation, and the associated sub-hypotheses, have been verified and discussed in Section 6.4.1.

The hypotheses related to the proposed moderators and their respective effects on these relationships are examined below.

* + 1. The impact of proposed moderators on the intrinsic/extrinsic motivations – research orientation relationship.

The table below summarises the results of the analysis undertaken to test each hypothesised moderation effect (H3a,b to H9a,b). Note complete statistical results from this analysis are available in Supplementary Information Section S2.5. The sections that follow present findings for each proposed moderated relationship in turn.

Table 37   
*Summary of moderation analysis results*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Hypothesis | Predictors | Moderation results | | | | |
| ΔR2 | df1 | df2 | F | Sig. F change |
| H3a | Intr, Age, AgexIntr | 0.217 | 3 | 266 | 193.119 | < .001 |
| H3b | Extr, Age, AgexExtr | 0.288 | 3 | 266 | 146.345 | < .001 |
| H4a | Intr, Gender, GenderxIntrin | 0.195 | 3 | 266 | 179.971 | < .001 |
| H4b | Extr, Gender, GenderxExtrin | 0.323 | 3 | 266 | 111.041 | < .001 |
| H5a | Intr, SocialC, SCapxIntrin | 0.273 | 3 | 266 | 238.096 | < .001 |
| H5b | Extr, SocialC, SCapxExtrin | 0.336 | 3 | 266 | 195.234 | < .001 |
| H6a | Intr, Field, FieldxIntrin | 0.219 | 3 | 266 | 205.166 | < .001 |
| H6b | Extr, Field, FieldxExtrin | 0.286 | 3 | 266 | 119.642 | < .001 |
| H7a | Intr, PKTT, PKTTxIntrin | 0.18 | 3 | 266 | 190.566 | < .001 |
|  | Intr, PTTO, PTTOxIntrin | 0.203 | 3 | 266 | 190.481 | < .001 |
| H7b | Extr, PKTT, PKTTxExtrin | 0.331 | 3 | 266 | 148.446 | < .001 |
|  | Extr, PTTO, PTTOxExtrin | 0.32 | 3 | 266 | 136.588 | < .001 |
| H8a | Intr, FRES, FinResxIntrin | 0.244 | 3 | 266 | 206.254 | < .001 |
| H8b | Extr, FRES, FinResxExtrin | 0.328 | 3 | 266 | 122.466 | < .001 |
| H9a | Intr, Phyenv2, PhyxIntrin | 0.247 | 3 | 266 | 208.298 | < .001 |
| H9b | Extr, Phyenv2, PhyxExtrin | 0.343 | 3 | 266 | 120.600 | < .001 |
| Notes: n=270, dependent variable: RO | | | | | | |

* + 1. Age moderating the Intrinsic/Extrinsic motivations – Research Orientation relationship

H3 relates to the proposed moderating effect of Age on the relationship between Intrinsic/Extrinsic motivations and Research Orientation.

The interaction plots (Figure 45, Figure 46) confirm that age moderates the relationship between intrinsic motivations and research orientation (ΔR2 =0.217 F(3,266)=193.119 p<0.001), and the relationship between extrinsic motivations and research orientation (ΔR**2**=0.288 F(3,266)=146.345 p<0.001). In both cases it can be seen that higher age levels strengthen the relationship between intrinsic/extrinsic motivations and an applied/commercial research orientation, while lower levels strengthen the relationship between intrinsic/extrinsic motivations and a basic research orientation.

* + 1. Gender moderating the Intrinsic/Extrinsic motivations – Research Orientation relationship

H4 relates to the proposed moderating effect of Gender on the relationship between Intrinsic/Extrinsic motivations and Research Orientation.

Moderation results confirm that Gender moderates the relationship between intrinsic motivations and Research Orientation (ΔR**2=**0.195 F(3,266)=179.971 p<0.001). Figure 47 presents the interaction plot for this moderation effect. Note, the gender category “other” has been included in this part of the analysis for completeness and coherence with the rest of this study, however as the number of respondents identifying as “other” represents 2% of the total sample, statistical conclusions cannot be drawn from this element of the result. According to the generated results, for Male researchers progression from lower to higher levels of intrinsic motivations causes an increases commercial research orientation, while for Female researchers the opposite is observed. The same pattern (Figure 48) is observed in terms of Gender moderating the relationship between extrinsic motivations and Research Orientation (ΔR**2=**0.323 F(3,266)=111.041 p<0.001).

* + 1. Social Capital moderating the Intrinsic/Extrinsic motivations – Research Orientation relationship

H5 relates to the proposed moderating effect of Social Capital on the relationship between Intrinsic/Extrinsic motivations and Research Orientation. Moderation results confirm that SocapC moderates the relationship between intrinsic motivations and Research Orientation .

The interaction plots (Figure 49 and Figure 50) show that increasing levels of Social Capital strengthens the relationship between both intrinsic motivations (ΔR**2=**0.273 F(3,266)=238.096 p<0.001) and extrinsic motivations (ΔR2=0.336 F(3,266)=195.234 p<0.001) and an applied/commercial research orientation, with lower Social Capital levels strengthening the relationship with a basic research orientation.

* + 1. Field moderating the Intrinsic/Extrinsic motivations – Research Career Orientation relationship

H6 relates to the proposed moderating effect of Research Field on the relationship between Intrinsic/Extrinsic motivations and Research Orientation. Moderation results confirm that Field moderates the relationship between intrinsic motivations and Research Orientation (ΔR**2=**0.219 F(3,266)=205.166 p<0.001), and between extrinsic motivations and Research Orientation (ΔR**2=**0.286 F(3,266)=119.642 p<0.001). The interaction plots (Figure 51, Figure 52) demonstrate that for researchers in ICT/Engineering fields, the impact of their intrinsic motivations on their applied and commercial research orientation increases, whereas for researchers in other fields the impact of their intrinsic motivations on their basic research orientation increases.

* + 1. Policies and Supports moderating the Intrinsic/Extrinsic motivations – Research Orientation relationship

H7 relates to the proposed moderating effect of Knowledge and Technology Transfer policies on the relationship between Intrinsic/Extrinsic motivations and Research Orientation. Moderation results confirm that PKTT moderates the relationship between intrinsic motivations and Research Orientation (ΔR2=0.18 F(3,266)=190.566 p<0.001), and between extrinsic motivations and research orientation (ΔR2=0.331 F(3,266)=148.446 p<0.001) in which case a stronger moderating effect can be observed. The interaction plots (Figure 53, Figure 54) demonstrate that researchers experiencing lower levels of policies and supports related to knowledge transfer favour a basic research orientation, with the opposite being the case when increased levels of policies and supports for KTT are available.

Also related to this hypothesis, moderation results confirm that PTTO (TTO supports) moderates the relationship between Intrinsic (ΔR**2=**0.203 F(3,266)=190.481 p<0.001)/extrinsic motivations (ΔR**2=**0.32 F(3,266)=136.588 p<0.001) and Research Orientation, and follow a trend (Figure 55, Figure 56) very similar to the effect of PKTT on both the Intrinsic and Extrinsic – RO relationship.

* + 1. Finance/resources moderating the Intrinsic/Extrinsic motivations – Research Orientation relationship

H8 relates to the proposed moderating effect of Finance & Resources on the relationship between Intrinsic/Extrinsic motivations and Research Orientation. Results confirm that Finres (the level of finance and/or resources available to the researcher) moderates the relationship between intrinsic motivations and Research Orientation (ΔR**2=**0.244 F(3,266)=206.254 p<0.001). Moderation results confirm that Finres also moderates the relationship between extrinsic motivations and Research Orientation (ΔR**2=**0.328 F(3,266)=122.466 p<0.001).

In both interaction plots above (Figure 57, Figure 58), it is apparent that Finres directly influences the researcher’s research orientation such that at higher levels of Finres an orientation towards Applied->Commercial research is observed, while at lower levels of Finres the opposite is the case. The effect is particularly strong in the case of Finres moderating the Extrinsic – RO relationship.

* + 1. Physical Environment moderating the Intrinsic/Extrinsic motivations – Research Orientation relationship

H9 relates to the proposed moderating effect of Physical Environment on the relationship between Intrinsic/Extrinsic motivations and Research Orientation. Moderation results confirm that PhyEnv (the level of industry in the vicinity of the academic institution) moderates the relationship between intrinsic motivations and Research Orientation (ΔR2=0.247 F(3,266)=208.298 p<0.001) and the relationship between extrinsic motivations and Research Orientation (ΔR2=0.343 F(3,266)=120.600 p<0.001).

In both interaction plots (Figure 59, Figure 60) it is apparent that higher levels of PhyEnv directly influences the researcher’s commercial research orientation, while at lower levels of PhyEnv the opposite is the case.

* 1. Conclusion

This chapter documented the analytical procedures used within this research study. It began with confirmation of the data set gathered, analysis of non-respondents, and the constructs and items used in the study. It then verified the measurement model before progressing with the hypothetical analysis, in alignment with the proposed research questions. All but two hypothesised relationships were confirmed as statistically significant, with full details of all tests being provided in Supplementary Information (Sections S2.4-S2.8). The following chapter discusses the results of this analysis relative to extant literature.

1. Discussion

The central ambition of this doctoral research is to advance theoretical understanding on the factors, both internal and external, that motivate and influence researchers’ research orientation around basic, applied and/or commercial research. To realise this ambition, the following research questions were posed, and are answered below.

*RQ1a - What are the primary intrinsic and extrinsic motivations that influence the research orientation of a researcher in an academic institution?*

*RQ1b - What is the interaction effect between intrinsic and extrinsic motivations and the research orientation of a researcher in an academic institution?*

*RQ2a - What role does a researcher’s personal profile play in moderating the relationship between their motivations and their research orientation?*

*RQ2b - What role does a researcher’s academic environment play in moderating the relationship between their motivations and their research orientation?*

These questions were answered through the development of a conceptual model and associated set of hypotheses, and through a statistical analysis of data gathered through an online survey of 270 researchers from 29 countries.

This is the first study that quantitatively examines the moderating influence of the researcher's work environment and institutional characteristics, along with their personal profile (comprising age, gender, social capital and research field), on the relationship between motivations and research orientation – within the context of a comprehensive model. Specifically, the study focuses on how these factors interact with one another. This is in response to calls from the literature for “a more integrated perspective, paying more attention to joint impact, the interplay between different predictors across various levels… as well as within a certain level, so that an optimal combination might be found” (Hossinger et al., 2020, p. 124). As discussed in Section 2.4, these calls for research encompass the influence of motivations on individuals’ research orientation (Duval-Couetil et al., 2023; Garcia et al., 2019; Mula et al., 2022; Neves & Brito, 2020; Perkmann et al., 2021; Tartari & Breschi, 2012; van Rijnsoever et al., 2008; Wang et al., 2021; Zhou et al., 2022), and the moderating impact of the researcher’s personal profile (Sauermann & Stephan, 2013; Wegner et al., 2019) and their working environment (Feola et al., 2019; Geuna & Nesta, 2006; Laudel, 2006; Perkmann et al., 2021; Sanz-Menéndez & Cruz-Castro, 2003; Siegel & Wright, 2015; Sitnicki, 2018) on the motivations-research orientation relationship.

The majority of research hypotheses were supported through statistical validation, as discussed in Chapter 6, resulting in a set of emerging themes and issues which are presented briefly below, and discussed in the subsequent sections.

* 1. Broad Findings and Emerging Themes

The figure below presents a stylised representation of the scope of this study, with three broad themes emerging: intrinsic and extrinsic motivations as drivers of research orientation; the influence of the institution; and the influence of the researcher profile.

Figure 18   
*Stylised Research Scope*

A diagram of a diagram

Description automatically generated

Firstly, this research confirms that both extrinsic and intrinsic researcher motivations play a role in influencing the individual’s research orientation, with different motivations each having a direct influence.

Extrinsic motivations were found to have less of an impact on research orientation than intrinsic motivations when analysed collectively, according to the findings. When individual extrinsic and intrinsic motivations were examined and compared, however, the picture becomes more complex, with the pursuit of financial reward (extrinsic) having the strongest influence followed by stimulation (intrinsic), reputation (extrinsic) and risk aversion (intrinsic). The intrinsic motivations academic freedom, and satisfaction also played a lesser, albeit statistically significant, role as drivers of research orientation. This study reveals that it is not enough to just analyse a researcher's motivations at a broad extrinsic versus intrinsic level, but that a deeper dive into individual motivations is needed.

This is demonstrated through the outputs of the statistical analysis undertaken in Chapter 6, and in particular through the moderation analysis (Section 6.5.3-6.5.9) which highlights the relative impact that researchers’ host institutions and individual profiles have on the relationship between their motivations and their research orientation. In addition, unlike many recent studies (Afzal et al., 2018; Aldridge & Audretsch, 2017; Amadi-Echendu, 2021; Audretsch et al., 2020; Balven et al., 2018; Davey et al., 2016; Di Paola, 2021; Fini et al., 2022; Forliano et al., 2021; Hayter et al., 2021; Kuschel et al., 2020; Lyken-Segosebe et al., 2020; Neves & Brito, 2020; Schneider et al., 2021), this research encompasses basic applied and commercial research rather than singularly focusing on potential drivers of commercialisation behaviour. This is an important consideration in light of the emergence of the entrepreneurial and neoliberal university which have been posited as strong proponents of research valorisation (Audretsch & Belitski, 2022; Wardle et al., 2019) and of research performance/evaluation frameworks, and the impact agenda (Golhasany & Harvey, 2022), which apply performance-related pressures on researchers (Edwards, 2022; Tülübaş & Göktürk, 2023), coupled with the need to produce ‘relevant’ research outcomes (Golhasany & Harvey, 2022; Hessels et al., 2009).

Next, taking a researcher profile view, results show that as a researcher ages, higher levels of intrinsic and extrinsic motivations both influence a commercial research orientation. For younger researchers in the sample, higher levels of extrinsic and intrinsic motivations influence an orientation around applied and basic research, and this may be attributable to higher levels of intellectual curiosity, seeking academic recognition, and availability of resources. This research also confirms the contention (Neves & Brito, 2020) that biological age, career age and career stage are analogous in terms of their respective impact on the relationship between a researcher’s motivations and their research orientation, particularly for researchers in STEMM disciplines (Kwiek & Roszka, 2022). The caveat here, noted in Section 8.3 (Limitations), is that the sample analysed in this research is heavily aligned with STEMM disciplines and this may have had an impact on results.

Results for gender are similarly interesting and show a clear distinction between the effect of intrinsic and extrinsic motivations on research orientation depending on the gender of the respondent. Essentially results show that high intrinsic and/or extrinsic motivations orient male researchers towards commercial research, while females orient towards basic research, with the most noticeable effect coming from intrinsic motivation. This outcome adds to the body of literature related to gender profiles in research careers, and has multiple practical implications, as discussed later (Chapter 8). It must be noted however that an additional inspection of the data showed that of the male respondents 65.8% specified ICT/Engineering as their field of research, while only 31.2% of female respondents specified this as their field. As the fields of ICT and Engineering are typically higher in terms of entrepreneurial activity (Perkmann et al., 2013; Schneider et al., 2021) this may have had some impact on the final analysis results. Somewhat predictably, results confirm that researchers in the fields of ICT and Engineering had the highest likelihood of undertaking commercial research compared to other fields such as life sciences – this concurs with Bentley et al. (2015), Hossinger et al. (2020), and Hayter et al. (2018). In addition, researchers’ social capital is shown to have a strong influence on their research orientation.

Finally, closely related to the above, results show the impact of the researcher’s working environment on their research orientation. Financial resources, TTO supports/policies and a conducive physical setting, such as proximity to industry, are all found to have a moderating effect when it comes to the link between a researcher's motivations and their research orientation. Considering that the results show that these influencing moderators have varying impacts depending on whether they are relative to extrinsic or intrinsic motivations, the discussion that follows goes into more depth on this topic. These conclusions have consequences for the current body of knowledge and for institutional practice.

The remainder of this chapter presents a detailed discussion of the results outlined above within the context of extant literature.

* 1. Intrinsic and extrinsic motivations as drivers of research orientation

The first theme of this research examines how researchers’ motivations shape and influence their research orientation. As discussed in Chapter 3 intrinsic motivations stem from within the individual and are associated with a sense of pleasure or satisfaction from undertaking a particular task (Olaya Escobar et al., 2017; Putra et al., 2017), whereas extrinsic motivations relate to behaviours that derive from factors external to the individual and that lead to personal or professional outcomes (Legault, 2016; Putra et al., 2017). In this research, intrinsic motivations comprise stimulation, academic freedom, satisfaction and social/civic responsibility; while extrinsic motivations comprise reward, reputational gains, and securing promotion/tenure.

The findings of the statistical analysis undertaken in this study demonstrate that both intrinsic and extrinsic motivations have a direct impact on the research orientation of a researcher in terms of whether or not they undertake basic, applied, or commercial research. In addition to this, it appears from the findings that the intrinsic motivations of the researchers sampled have a higher influence in comparison to their extrinsic motivations. This suggests that, in an academic context, it is not sufficient for an organisation to focus solely on extrinsic career motivations, such as increased salaries or promotion, but rather to take a broader view that includes intrinsic factors such as job satisfaction, support for risk taking, and intellectual stimulation. This focus is of course highly dependent on the nature of the academic institution and its research-related policies, as will be discussed in Section 7.3.

These findings build on the work of academics such as Chubb and Reed (2018), discussed in Section 7.2.3, who contend that researchers are increasingly being encouraged to produce commercially oriented outputs (Golhasany & Harvey, 2022) by external influences such as the need to secure funding (McAlpine, 2020) or increase personal reputation in order to maintain status within the research community (Edwards, 2022). These researchers are driven by a desire to undertake impactful and meaningful research and current discourse suggests that these researchers are increasingly being pushed in this direction (Chubb & Reed, 2018; Edwards, 2022; Ryazanova & Jaskiene, 2022). However, while the aforementioned findings are helpful in understanding the broad drivers of research orientations, it is important to note that this perspective is simplistic and calls for more in-depth and nuanced analysis.

To address this, this study investigated the influence of individual intrinsic and extrinsic motivational factors and compared their relative impact on research orientation. This was done in response to the numerous calls for additional research on this subject noted above (see also Section 2.4). The figure below presents a stylised representation of the influential strength, and directional (towards basic, applied, or commercial research) influence of, these career motivations, as determined by the statistical analysis undertaken in this research.

Figure 19 *The Directional Influence of Individual Motivations*

A screenshot of a computer

Description automatically generated

The results reveal that financial reward (extrinsic), the securing of increases in personal income, is the most influential motivator in terms of pursuing a basic, applied or commercial research career, followed by the desire for stimulation (intrinsic), concern for one's reputation (extrinsic) and risk aversion (intrinsic). Note that the risk aversion construct has an inverted effect insofar as lower levels of risk aversion orient a researcher around commercial research, while higher levels orient a researcher around basic-applied research. These extrinsic motivations are significant contributors to an orientation in research that is primarily focused on commercial applications, while others such as stimulation (intrinsic) or academic freedom (intrinsic) are influences on a basic and/or applied research orientation.

* + 1. Reward, Risk, and Reputation

The finding regarding financial reward being the strongest motivation is not surprising given that prior research indicates that personal financial gain is a key driver within commercially oriented research careers (Walter et al., 2018), and that this gain is greatly facilitated through engagement in activities like spin out creation, patenting, and engagement with industry (Beck et al., 2022). This could also be a result, or symptom, of the entrepreneurial university in which researchers are pushed towards commercial activity (Tülübaş & Göktürk, 2023; Wardle et al., 2019). While research has shown that some researchers are reluctant to align with a commercial research orientation (Audretsch & Belitski, 2022; Caulfield & Ogbogu, 2015), the resulting financial gain may serve as a further impetus to this activity (Tweheyo et al., 2022).

Importantly, however, the result for financial gain does contradict a number of prior works in which it is argued that the quest of financial reward is only a side-effect of academic commercial activity rather than a motivation for it (Hossinger et al., 2020). Agreeing with this Neves and Brito (2020), taking a broader perspective, contend that potential financial reward has a lower impact as a motivator, but that this can vary as a “function of knowledge transfer activity” (p.658). This conflict may be due to the research field of the survey respondents (D’este & Perkmann, 2011), which was predominantly ICT and engineering – both fields that have a heavy commercialisation ethos. Returning to the discussion regarding research evaluation, this result presents somewhat of a conundrum for institutional management. As discussed in Macfarlane (2021), the increased emphasis on knowledge valorisation, and the associated required impact factors expected from academic institutions are driven particularly through an emphasis on production of high quality academic publications, securing research grants, doctoral supervision and contributing to society through relevant research (Golhasany & Harvey, 2022). Aligning these factors with researchers’ desire for financial reward is a difficult task and requires clarity and coherence in terms of researcher incentivisation (Debackere & Veugelers, 2005; Duval-Couetil et al., 2023; Ouellette & Tutt, 2020). Building on this discussion, Henrekson and Rosenberg (2001) argue that the effects of national incentives for commercialisation of research through entrepreneurial endeavours, such as tax incentives or investments, are rendered practically impotent if appropriate commercialisation incentive schemes, i.e. addressing extrinsic motivational values, are not implemented in the university system. These schemes would need to be implemented within institutions in order for the effects of national incentives for commercialisation of research through entrepreneurial endeavours to be realized. As an example, the mean response gathered, in the survey for this study, for the question “The inventor royalty share (the share of any royalty payment, resulting from research outputs, given to the researcher) in my institution has a strong influence on my decision to generate patentable inventions” was 4.49/5, signifying the high importance respondents placed on rewards associated with commercial endeavours.

A similar finding can be anticipated for risk aversion based on the characteristics of the sample collected for this study. According to the data presented in Chapter 6, individuals who reported lower levels of risk aversion were more likely to take chances professionally. Considered alongside the substantial impact of financial rewards, the results of this study suggest that researchers are likely to undertake riskier research in a more commercial orientation in the hopes of reaping financial benefits (Hossinger et al., 2020) or indeed for reputational gains. Revisiting the work of Laudel (2006) in which it was posited that certain researchers avoid research activities that could be considered risky or focus their grant-writing activities on more “simple” targets, the result associating risk aversion and an orientation towards commercial research could signal a potential decline in research focus and outputs associated with basic or applied research. This contention aligns with Caulfield and Ogbogu (2015) in which it is suggested that pressure to commercialise research might steer researchers away from a research orientation that embodies innovation and novel research.

Data reveal that researchers who were motivated by reputational gains were more likely to engage in commercial research activities, which is an interesting aspect to consider in contrast to the views of academics such as Hossinger et al. (2020) who contend that, within less commercially oriented fields:

Scientific acceptance and recognition within the scientific community may be achieved almost exclusively through the publication of research results; therefore, the success and recognition of a scientist is measured primarily by the number and ranking of his publications (‘publish or perish’). Due to the fact that the scientific community has up to now rarely been made aware of the issues of starting a business, there is a lack of appreciation for the commercialisation of research results. Subsequently, scientists focus more on publishing their research findings and less on the opportunity to commercialise them (p. 114).

It must be noted that the same authors do however indicate that “intangible extrinsic rewards, such as traditional academic recognition, reputation and promotion, are the primary motives for most academics when participating in entrepreneurial activities” (Hossinger et al., 2020, p. 107). This finding supports Bozeman (2000) and Hossinger et al. (2020) where it is suggested that engagement with industry has been identified as means to increase the reputation of a research group and the members therein in terms of increased public and political attention, resulting in potentially increased funding for researchers and equipment. This suggests a somewhat cyclical paradigm whereby researchers undertake commercial research in order to secure funding to pursue basic and applied research activities (Karran, 2009; Laudel, 2006; Perkmann et al., 2021).

This result is also reflective of current international practices whereby commercial success, or research valorisation, is increasingly growing in strength as a reputational marker (Caulfield & Ogbogu, 2015; Goel & Göktepe-Hultén, 2019; Macfarlane, 2021; Orazbayeva & Plewa, 2022), as well as the associated impact of research evaluations (Martin-Sardesai et al., 2017) and the emergence of the entrepreneurial university (Etzkowitz et al., 2000).

As noted by Hossinger et al. (2020), a lack of appreciation, within the academic community, for the commercialisation of research discoveries can be attributed to the fact that the scientific community has only seldom been made aware of the challenges, rather than the advantages, associated with beginning a business up to this point. As a consequence of this, many researchers concentrate more on disseminating the results of their research and less on the possibility of making a profit from it. It is critical to take note of this, since it demonstrates quite clearly that the provision of entrepreneurship related supports and training plays a key role in influencing researchers as their careers grow. Sitnicki (2018) suggests that the outcome of research such as this could help universities to determine the most appropriate mechanisms, such as programmes and funding, to drive research outcomes.

* + 1. Satisfaction, Stimulation, and Freedom

According to the findings of this study, the degree to which their career provides the researcher with both stimulation and satisfaction has a direct bearing on the orientation of their research. Findings reveal that stimulation can be interpreted as the strongest driver of a basic research orientation (Lam, 2011; van Rijnsoever & Hessels, 2020), whereas satisfaction can be interpreted as an influence on entrepreneurship and commercialisation (Olaya Escobar et al., 2017). A possible explanation for this comes from the work of Szromek and Wolniak (2020) who conject that because the results of the research do not immediately translate into profits, it is difficult to evaluate them. Additionally, “the associated lack of proper recognition of scientific work that cannot yet be put into practice is discouraging when it comes to treating it as something more than an occasional occupation” (Szromek & Wolniak, 2020, p. 1). To put it another way, involvement in commercial activity might make it possible for the researcher to receive more rapid acknowledgement for their work, which would subsequently result in a sense of fulfilment or satisfaction. Furthermore, as the sample gathered in this research consists of a significant proportion of researchers that self-classified as ‘established’ or ‘leading’ researchers, it can be inferred that these more senior, higher-ranking, academics have already attained higher levels of job satisfaction in general (Bataineh, 2014).

Stimulation is closely tied to satisfaction in research careers (Blind et al., 2018), and the results of this research suggest that stimulation drives researchers towards more basic research activities. In the context of research in an academic institution, stimulation reflects the desire to generate new knowledge as well as fulfilling scientific curiosity. This relationship, between stimulation and research orientation, is heavily influenced by the researcher's field, with the effect being more pronounced in fields that are not related to information and communication technology or engineering. Essentially, as will be discussed in Section 7.4.3, researchers in non-ICT/engineering fields with high levels of intrinsic and/or extrinsic motivations tend to favour a more basic or applied research orientation. As can be seen from the findings of this research, higher levels of stimulation motivate researchers to engage in basic research. These findings lend support to the work of Perkmann et al. (2021) who contend that individuals who are more scientifically minded and who are motivated by the pursuit of fundamental understanding and problem resolution are less likely to exhibit a research orientation that is commercially focused.

The third and final motivation that will be covered in this section is academic freedom. It can be extrapolated from the findings that researchers who have reduced concerns about academic freedom may be more prone to seek commercial endeavours, as the results show that researchers who have a strong desire for academic freedom are motivated towards a basic research orientation. This study contributes to the current debate, which says that the pursuit of research impact, and the corresponding income creation by institutions, is a driving force behind the replacement of "academic autonomy - a fundamental aspect of academic freedom – with managerial autonomy" Holmwood (2018, p. 3), and that the influence of external forces such as governmental expectations for research valorisation negatively impact on academic freedom (Martín-Alcázar et al., 2019; Slaughter, 2019). Academic freedom was found to have a stronger influence on research orientation than satisfaction, but less of an influence compared to reward, stimulation, reputation and risk aversion. The findings build on the work of Tülübaş and Göktürk (2023), Golhasany and Harvey (2022), Macfarlane (2020) and Macfarlane (2023) who suggest that academic freedom is being superseded by the necessity to comply with institutional expectations (Chubb & Reed, 2018; Walsh et al., 2015) related to knowledge valorisation. Additionally, this provides empirical support for Macfarlane’s (2023) suggestion that scientific disinterestedness is being replaced by egoism. Explaining this phenomenon, Macfarlane (2023) argues that the more traditional form of academic egoism was the pursuit of breakthrough discoveries in research, whereas the emergence of contemporary evaluation frameworks can drive egoism related to performativity measures.

The manner in which scientific research is governed and regulated, as well as external constraints on the research process, can influence the types of research questions addressed, the methods employed to answer those questions, and the interpretations of the results (rather than being influenced by academic freedom) (Chubb & Reed, 2018; Karran, 2009; Macfarlane, 2021). For instance, if funding organizations prioritize research with immediate practical applications, researchers may do more applied research as opposed to basic research. As discussed in Papatsiba (2013, p. 444)

this integrative link [between research collaboration and external imperatives and influences] means that potential changes in the social structure of science through funding, policies and institutional governance are bound to have an effect on the types of knowledge that are produced, through modification of the systems of regulation of scientific rationality and individual behaviours.

* + 1. Promotion/Tenure and Social/Civic Responsibility

As noted in Section 6.5.1, analysis results related to the intrinsic motivations of promotion/tenure and social/civic responsibility proved to be not statistically significant. Also, as discussed, this non-significance does not appear to be caused by standard deviation or sample size issues, and therefore may be due to the small effect size observed or that an effect does not exist (Visentin et al., 2020).

In the case of Promotion/Tenure, the effect size (β=0.054) suggests that the pursuit of tenure or promotion did not have a significant impact on research orientation for the sample of respondents involved in the analysis. To investigate this further, a review of the associated descriptive data reveals that the average value linked with the opportunity to get promotion or tenure was 4.4 (in the range 1-7). This corresponds to the response option of ‘neither agreeing nor disagreeing’, and it demonstrates that, on average, the respondents did not view securing of promotion or tenure as a particularly significant criteria that shapes their research orientation. In addition, data about the job status of respondents reveals that approximately fifty percent of respondents already held permanent or tenured positions in their place of employment, which infers that securing tenure was not a key issue. Furthermore, from this subset of respondents all self-classified as either established (65%) or lead (35%) researchers, which implies that promotion was no longer a major concern. When taken together, these factors contribute to a relatively low degree of interest in tenure and other forms of academic permanence among the respondents as a reward for their scholarly efforts. Future research in this particular regard should narrow the respondent set to earlier stage researchers.

In a similar vein, results pertaining to Social/Civic Responsibility exhibited a small effect size (β=-0.14) suggesting that completing research as a tenet of social and/or civic responsibility did not have an effect on research orientation for the sample of respondents that was taken into consideration. This may be an effect of institutional policies that have not yet realised their full potential influence due to their relatively early stages of introduction (Edwards, 2022) with many prioritising technology/knowledge transfer (Benneworth et al., 2018) rather than social/community engagement (Rosli & Rossi, 2016). Additionally, it may be the case that social/civic responsibility is more prevalent in social sciences and arts at present, rather than in fields such as ICT or Engineering (Hayter et al., 2020). Further to this, an examination of the descriptive data collected in this research found that the average level of researchers’ ideals around social and civic responsibility was (on a scale of 1-7) 5.5 for males, and 5.1 for females, which is a miniscule difference between genders. Additionally, the mean response across the social/civic responsibility scale was 5.26. As the results for the impact of social / civic responsibility on research orientation were statistically insignificant it can be said that, for the respondents sampled, this construct did not have any impact – this however, is a rudimentary result, and deeper research and analysis is clearly needed on this topic. To investigate this further, mean values for social/civic responsibility were generated for the respondents in fields other than ICT/Engineering and then for respondents in ICT/Engineering fields alone. From this exercise it was observed that the mean values fluctuated by approximately 10% between these two respondent groups, insofar as ICT/Engineering respondents attributed less importance to social/civic responsibility than their counterparts in other fields. Critically, Caulfield and Ogbogu (2015) found that increased commercialisation of research, which has been shown to be strongly related to ICT/Engineering fields has contributed to a decline in public trust in science. This is very much at odds with the growing movement to undertake science for social and civic responsibility reasons (Benneworth et al., 2018; Cvitanovic et al., 2015).

As noted by Chubb and Reed (2018), through their interview based research, they found that researchers expressed deep concerns about how:

impact might be changing the motivations of researchers: specifically, where intrinsic and altruistic motives for engaging with impact (e.g. a desire to benefit others or the personal satisfaction from benefitting others) were increasingly crowded out by extrinsic motivations for impact (e.g. to get research funding, promotion or improve institutional rankings or reputation) known as ‘motivational crowding’ (p. 303).

This finding is critically important and goes against the growing trend of conducting scientific research for the sake of social and civic responsibility in a significant way.

The above discussion provides some interesting insights into the relationship between motivations and research orientation, however, as noted throughout this thesis, these relationships warrant further investigation in terms of the external influences and forces that change their respective influences. To that end the analysis undertaken in Chapter 6 highlighted the relative strengths of each proposed moderator on the intrinsic/extrinsic – research orientation relationship (Section 6.4.2, Figure 16).

There are a number of noteworthy findings that have been uncovered here. To begin, it is clear that the proposed moderating constructs all had a greater impact on the relationship between extrinsic motivations and research orientation than they did on the relationship between intrinsic motivations and research orientation. This shows that the extrinsic motivations of a researcher's career choices are more readily influenced by factors that are external to the researcher. The fact that extrinsic motivations represent a set of goals or incentives that a person wants to achieve, such as securing financial gains, and that the achievement of these goals in terms of research orientation is more susceptible to external forces, is one possible explanation for this phenomenon. On the other hand, supporting this contention, intrinsic motivations are those that are formed from the act of performing a certain activity; hence, it can be anticipated that these are less influenced by external influences.

In addition, the data reveals that the respective strength of these external forces changes depending on the relationship being scrutinised. So, in the case of the relationship between extrinsic motivations and research orientation, physical environment and social capital and have the strongest moderating effect, followed by policies/supports, resources, gender, TTO activity, age and field. In the case of the relationship between intrinsic motivations and research orientation a different order can be observed: social capital, physical environment, resources, field, age, TTO activity, gender and policies/supports. What is particularly noteworthy here is that the proposed effects (Aberbach & Christensen, 2018; Neves & Brito, 2020; Wang et al., 2021) of institutional technology transfer policies and TTO supports are in the bottom three, in terms of strength of effect, in both cases. This suggests that institutions need to look beyond implementation of research related policies and training, and promote technology transfer activities if they wish to influence the careers of their research community, as will be discussed in Section 8.4.2.

It could also be the case that respondents placed little to no importance on the role or value of the TTO function in their organisation or were simply not aware of this function. Indeed, the descriptive data gathered highlighted that, in terms of the quality of service provided by the TTO, the mean response from respondents was circa 3.5/7 which implies that respondents were not over-enamoured with their TTOs. This supports the position of Perkmann et al. (2021, p. 7) who highlight that “academic engagement is driven by individual motivation and characteristics, rather than university characteristics”. Similarly, Neves and Brito (2020, p. 664) posit that the combination of identified career motivations can enable the university to “partially control its outcomes” and that university managers can address these elements in order to drive research outcomes in line with institutional policies and strategy. Perkmann et al. (2021, p. 11) concur with this, and note that a focus from policy makers and universities on technology transfer “privileges commercialisation over academic engagement”.

The following sections examine the role of the academic institution and of the researcher profile as moderators on these relationships.

* 1. The Influential Institution

According to Perkmann et al. (2021), because the findings of previous studies are still inconclusive, it is necessary to do additional research into the impact that the researcher's host institution has in terms of its policies, supports and reputation. To address this issue, this research posed research question RQ2b *What role does a researcher’s academic environment play in moderating the relationship between their motivations and their research orientation?* The associated findings demonstrate the impact of institutional policies and supports, provision of finances/resources, and geographic location on the relationship between a researcher’s motivations and their research orientation. The following sections address each of these in turn.

* + 1. Policies, supports and TTO

The constructs employed in this research focused on institutional policies in terms of the promotion, or lack thereof, of entrepreneurial and knowledge transfer activities, coupled with measured levels of TTO supports.

Findings (Section 6.5.7) from this research lend weight to the contention that strong levels of TTO activities and knowledge transfer policies influence the impact of researchers’ career motivations (both intrinsic and extrinsic) on their chosen research orientation and demonstrate in particular a correlation between high levels of TTO/KTT policies and supports which refocus research efforts towards industry engagement and commercialisation. This is important, as noted in Ryazanova and Jaskiene (2022) where the criticality to policy makers and academic leaders of having evidence-based understanding of the organisational-level factors that drive research outcomes is discussed. Taken too in the context of the earlier discussion on academic freedom (Section 7.2.2), this implies that institutions may need to step back and take stock of their overall mission, particularly if that mission includes research excellence (Ryazanova & Jaskiene, 2022), and perhaps to reconsider their performance-driven focus in light of the perceived erosion of academic freedom. This, in turn, adds to the discussion around the impact agenda, performance evaluation, and the entrepreneurial university in which the provision of valorisation related policies and supports are posited to enhance research performance and increase associated outputs (Philpott et al., 2011).

Specifically, findings suggest that higher concentrations of knowledge- and technology-transfer policies within an institution cause extrinsically motivated researchers in particular to align with an entrepreneurial/commercial orientation. Relating to intrinsic motivations, Olaya Escobar et al. (2017, p. 723) posit that “researchers are aware that the overall performance of a university is the sum of individual contributions. The intrinsic motivation is therefore manifested in the form of an emotional tie with the university. Researchers’ success is the university’s success” and can be driven through provision of knowledge transfer challenges that evoke feelings of satisfaction, stimulation, achievement and broader responsibility. This is to be expected as the very act of implementing a knowledge transfer policy implies a stronger level of interaction with industry by researchers, which is a well-documented precursor to commercial activities (Hayter et al., 2018; Link et al., 2017; Olaya Escobar et al., 2017), as discussed in Section 3.4.2.

Introduction of a knowledge transfer policy within an academic context goes hand in glove with development of a strong technology transfer office, the goal of which is to drive commercial engagement and entrepreneurial activities. Prior work has shown that knowledge transfer policies are destined to fail should an institution not provide sufficient resources to the TTO function (Gerbin & Drnovsek, 2016). Importantly, findings suggest that researchers with high levels of intrinsic motivation can be steered towards commercial endeavours though the efforts of the TTO office. This contention is further exemplified when one considers that the intrinsic motivation of satisfaction has been found to be a key driver of entrepreneurship, and satisfaction can come directly from meeting the motivational needs of extrinsic motivations (Dave et al., 2011) such as financial reward and increased reputation.

Findings highlight that, as expected, extrinsically motivated researchers are pulled towards a commercial research orientation through the engagement of a strong TTO within the institution. This provides empirical support for the prior works in this space, such as that of Blind et al. (2018), Olaya Escobar et al. (2017) and Gerbin and Drnovsek (2016).

There is a contradiction between these findings and those of Hmieleski and Powell (2018), who point out that research conducted by Audretsch and Aldridge (2012) found no connection between the level of activity of a TTO office and researchers' propensity to become entrepreneurs. However, Hmieleski and Powell (2018) note that higher levels of social capital developed through TTO contact networks were positively associated with researcher’s exhibiting a commercial research orientation. As will be discussed in Section 7.4.4, researchers’ social capital had one of the strongest moderating effects on their research orientation, thereby providing empirical support to Hmieleski and Powell (2018) and Audretsch and Aldridge (2012). Indeed, more recent work by Audretsch and Belitski (2022, p. 299) supports this when they acknowledge the “intense collaborative relations with industry through knowledge transfer partnerships” that TTO offices develop.

Findings from this research cast doubt on the claims by Wegner et al. (2019), who found no linkage between institutional policies and entrepreneurial intentions in researchers. In their empirical research Wegner et al. (2019) undertook a statistical analysis to compare the research orientation of researchers in two Brazilian universities (in which one university had an entrepreneurial push policy and the other had a more traditional management structure), with a particular focus on entrepreneurial intentions. Their statistical analysis found no distinct difference in research orientation amongst researchers in the two universities. Interestingly, the authors contend that the reason for this could be that providing entrepreneurial training and support for researchers may have served to illustrate to them how difficult a path the entrepreneurial journey is.

In a similar vein, Sitnicki (2018) discovered that a lack of trust in matters such as intellectual property or confusion about the benefits of collaboration may result in a reluctance to participate in commercial operations. This may be a symptom of institutions underinvesting in TTO type supports and personnel (Hayter et al., 2018). However, it must be noted again that respondents in this research were relatively ambivalent regarding the quality of knowledge and supports emanating from their respective TTOs.

* + 1. Finances and Resources

The results arising from the analysis in Chapter 6 suggest that the availability to researchers of higher levels of finances/resources create a moderating effect which aligns researchers with an applied/commercial orientation, and that this applies to the relationship between both extrinsic/intrinsic motivations and research orientation. One explanation for this finding has been discussed in Section 7.2.1 where it was noted that certain researchers undertake commercial research as a means to securing resources to undertake more basic and applied research (Karran, 2009; Laudel, 2006; Perkmann et al., 2021). As noted by Hmieleski and Powell (2018, p. 59) “financial outcomes do not appear to be of importance to academic scientists, but generally as a secondary factor that is viewed as useful for the purpose of supporting their research agenda”.

These findings need to be examined relative to the profile of the researchers in the sample. As noted, the majority of respondents sampled come from an ICT/Engineering discipline which has been verified as being more applied/commercially oriented. These findings support prior work such as that of Ryazanova and Jaskiene (2022) who found that provision of adequate financial resources and equipment directly impact on research performance, and note the importance of providing well-funded and structured research support offices in academic institutions.

While it has to be expected that provision of finance/resources to researchers would certainly drive their research activities, it is perhaps a little unusual that lower levels of finance/resource support have the reverse effect, with researchers aligning to a basic research orientation. This result supports the contention, and findings discussed in 7.2.2, that researchers with higher levels of the intrinsic motivations of stimulation and academic freedom, meaning those researchers that are less concerned with extrinsic rewards, tend to exhibit a basic research orientation. Again, this may be an effect of the sample in question, but also may be driven by a cyclic phenomenon whereby researchers target a particular research orientation because these have the potential to secure greater levels of future funding. For example, through their interview-based research Chubb and Reed (2018) discovered that many academics now prioritise more impactful applied research, across multiple disciplines, out of necessity to secure funding, to the detriment of basic science.

These results also need to be examined in light of the discourse related to research impact, and the influence of TTO and knowledge transfer policies. As entrepreneurial institutions are more driven towards industry engagement and commercial activities, it is a natural assumption that the majority of provided finances and resources for researchers will have an expectation of commercial activity and knowledge valorisation attached (Wardle et al., 2019), which in turn creates a performance related pressure on researchers (Caulfield & Ogbogu, 2015). This also supports the discourse related to the provision of baseline funding as a means to drive basic research in academia (Sitnicki, 2018).

* + 1. The impact of location

This research investigated the impact of geographical proximity to industry as an influencing factor on the relationship between a researcher’s motivations and their research orientation (Sections 3.4.2.3, 4.4.1.3 and 6.5.8). Providing empirical support for extant research, findings (Section 6.5.8) show that the level of industry concentration in the vicinity of the research organisation directly influences the individual’s research orientation (Baroncelli & Landoni, 2019; Wegner et al., 2019), for both extrinsic and intrinsic motivations, such that at higher levels of industrial concentration an alignment with a applied/commercial research orientation is observed, while at lower levels the opposite is the case. Additionally, findings suggest that the observed moderation effect is stronger in the case of extrinsic motivations compared to intrinsic motivations. This is to be expected, as the topmost influential extrinsic motivations have a primarily commercial focus. Specifically, financial reward and reputation are both strongly linked to creation of impact through commercial engagement. Findings also suggest that, in the case of intrinsic motivations, lower levels of industry concentration tend to align researchers towards a basic research orientation, with higher industry concentration causing the opposite effect. The same effect can be observed in the case of extrinsic motivations.

Descriptive results for the sample in this research show that the majority (64.8%) of respondents work in what they classified as non-traditional universities, meaning their host institution had a mid-to-high level of industry presence within their geographic vicinity, and this could account for the results demonstrated here (Hayter et al., 2018; Link et al., 2017; Olaya Escobar et al., 2017). The key output arising from this aspect of the analysis is the importance of the academic institution establishing a strong collaboration base with industry if their mission focuses on industry-driven impact.

Additionally, these results lend weight to the contention of scholars such as Soetanto and Jack (2016) who point to a gap in existing institutional policies to support and train potential entrepreneurs. They highlight that many researchers with a desire to create a spin-out company lack the basic business skills, networks and infrastructure required and suggest that entities such as incubators and co-location centres can help address this situation (Soetanto & Jack, 2016), however earlier intervention in the form of education, training and supports, would seem to be imperative if that aligns with the university mission. It has also been noted that industry co-location and incubation centres create a critical mass of social capital for researchers which, as will be discussed below, is another essential element in the mix of influences on research orientation (Perkmann et al., 2021).

The final section discusses the moderating impact of the researcher’s profile which comprises their age and gender, their field of research, and their levels of social capital.

* 1. Researcher Profile

In response to calls from extant literature, for research that undertakes a quantitative examination of moderation effects of factors such as gender and age on the relationship between researchers’ motivations and their research orientations (Hmieleski & Powell, 2018), this final section discusses the moderating effects of personal factors such as the researcher’s age and gender, as well as their field of research and their accrued level of social capital. Results suggest that each of these constructs has a moderating influence on the motivations - research orientation relationship, as discussed below.

* + 1. Age

The results reported in Section 6.5.3 indicate that age may have a moderating influence on the relationship between the motivations of researchers (both intrinsic and extrinsic) and the research orientation that they choose in their careers. As discussed in Section 6.4.2.1 the moderating effect of biological age, career age and career stage all exhibited the same directional influence on the relationship between motivations and research orientation.

The findings imply that researchers in lower age brackets have a tendency towards a basic research orientation, while medium-high age brackets satisfy their intrinsic and extrinsic motivations through applied and commercial research. A possible explanation for this is that typically, at lower age levels, researchers are just starting their research careers and are focused on their post graduate endeavours such as Masters and Doctoral level studies. Descriptive data related to the age profile of respondents confirms that the 28.5% have been actively involved in research for less than five years, which further adds to the explanation of this result. The discourse related to early career researchers (ECR) provides some explanation of these findings. Pressure to publish and secure grant funding are particularly prevalent in the ECR cohort (Mula et al., 2022), and orienting around basic research is a means to achieve this. Additionally, this finding supports the work of Lam (2011) and (Karlsson & Wigren, 2012) in which it is contended that younger researchers are more likely to avoid a commercial research orientation, but that this is highly correlated with the researcher’s level of social capital and associated institutional focus on basic, applied and/or commercial research. Furthermore, in the sample taken, respondents in the 21-25 and 26-30 age groups were on average more risk-averse than their older counterparts. As noted in Section 7.2.1, lower levels of risk-taking behaviour are strongly associated with basic research careers. In addition, the desire for academic freedom was stronger in this age cohort than the higher age brackets, which again points towards a basic research orientation.

It is widely accepted that seniority increases with age in academic circles (Hayter et al., 2018; Lam, 2011), and that it is this seniority that encourages scholars to engage in entrepreneurial activity as a consequence of increasingly accrued social capital, for instance in the form of increased industrial contacts and collaboration. However, in contradiction to this, an inspection of the descriptive data collected in this research shows that for this group of respondents, the average level of social capital across all ages is relatively equal, as shown below.

Figure 20   
*Respondent's Social Capital*

Chart, bar chart

Description automatically generated

The moderating effect of social capital is discussed in Section 7.4.4, below.

* + 1. Gender

This research includes gender as a moderating variable within the analysis model. It is important to note that the purpose of this research is to verify that many variables including gender and age have an effect on research orientation, however it is not the purpose to statistically identify the reasons for this. However, given that the results of this research demonstrate a clear difference in effects when gender is introduced as a moderator, some further discussion is warranted.

Findings suggest that gender has a significantly stronger influence on the relationship between intrinsic motivations and research orientation, than on the extrinsic motivations and research orientation relationship. Concurring with Neves and Brito (2020) this research found that male researchers are more likely to have a commercial research orientation than their female counterparts, and that this applies relative to the influence of both intrinsic and extrinsic motivations. Supporting this finding, prior work from Borrego et al. (2010) and Whittington and Smith-Doerr (2005) found that research outputs from female researchers had a significantly higher impact, in terms of citations, than those of their male counterparts. This suggests that female researchers have a stronger propensity, or preference, for more basic research. Building on this, Perkmann et al. (2021) note the importance of funding agencies placing greater emphasis on the development and support of female researchers. This finding supports the work of Caviggioli et al. (2021), Di Paola (2021), Miranda et al. (2017), Audretsch and Aldridge (2012), Murray and Graham (2007), and Whittington and Smith-Doerr (2005) where it is noted that male researchers produce significantly more patents than females, or the research of Kuschel et al. (2020) and Kou et al. (2020) which found that female researchers were more efficient when it comes to conducting scientific activities, whereas males were more efficient in more technology development type work. Descriptive data from this research suggest that male respondents have a higher average risk-taking propensity than females, and findings show that low risk aversion is a predictor of a commercial research orientation.

Indeed, the descriptive data for gender in general in this study presents an interesting picture. The figure below shows the level of intrinsic and extrinsic motivations reported, grouped by gender. It can be seen clearly that, regardless of gender, respondents were more intrinsically motivated than extrinsically. Additionally, viewing the motivations collectively, females on average had higher levels of intrinsic motivations, while males reported higher average levels of extrinsic motivations.

Figure 21 *Intrinsic and Extrinsic Motivations, Grouped by Gender*

Chart, bar chart

Description automatically generated

When the individual motivations are examined in the descriptive data, an even more interesting picture emerges. As can be seen in Figure 22 female researchers reported higher levels of academic freedom and job satisfaction, whereas male researchers were in the majority for stimulation and risk taking propensity, which supports extant findings such as Hmieleski and Powell (2018) who suggest males are higher “on average, than females in entrepreneurial self-efficacy, risk propensity, diversity of personal networks and access to financial capital” (p. 60).

Figure 22 *Intrinsic Motivations by Gender*

Chart, bar chart

Description automatically generated

The figure below illustrates that females favour the extrinsic motivation of securing promotion/tenure, whereas their male counterparts favour reputational gains and financial reward.

Figure 23 *Extrinsic Motivations by Gender*

Chart, bar chart

Description automatically generated

The results suggest a preference among male researchers for research careers more associated with financial gains and taking risks, both factors which are associated more with technical fields such as ICT/Engineering. Examining the descriptive data for survey respondents adds weight to this contention, at least for this sample of researchers, as it can be clearly seen that the majority of male respondents favour research in these fields as shown below.

Figure 24 *Field by Gender*

Chart, bar chart

Description automatically generated

It can be seen above that ICT and Engineering are also heavily favoured among the female cohort in the sample. The figure below presents a simplified view of this data with ICT/Engineering respondents clustered compared to all other categories.

Figure 25 *Clustered Research Fields by Gender*

Chart, bar chart

Description automatically generated

In this case clearly female respondents report a preference for non ICT/Engineering research, thereby bolstering extant research findings (Di Paola, 2021; Johnson & Taylor, 2019; Kuschel et al., 2020). Adding to this discussion, Zhang et al. (2021) found that male researchers are more interested in producing research that progresses science, whereas female researchers are more interested in progressing society, what they denote as impact versus usage. This is an important distinction as it may somewhat explain perceived differences in research productivity, measured by citation counts or example. Miranda et al. (2017) posit that females may have a more societal-impact driven commercial agenda than males. For example they suggest that “organisations could attract more women to engineering if the content were made more socially meaningful by reframing the goals of engineering research and the curriculum to be more relevant to societal needs” (p. 249).

While results from this research support many preceding research works, they contradict Miranda et al. (2017) who undertook research to examine the gender differences in entrepreneurial intentions in an academic context. Their results indicate that the regional environment, and university supports, had no influence on explaining entrepreneurial intentions, regardless of gender.

* + 1. Field

It has been posited throughout this thesis, and in extant literature (Perkmann et al., 2013; Schneider et al., 2021), that the researcher’s field plays a key role in moderating their research orientation, and indeed the results confirm this to be the case. Results in Section 6.5.6 highlight that researchers with high levels of intrinsic motivations, in non ICT/Engineering fields, favour basic research significantly, with the opposite being the case for the remaining respondent cohort. The results are similar for the case of extrinsic motivation but are less prominent. It is essential to have a solid understanding of the demographics of those who participated in the survey, specifically how they self-identified as researchers in each of the ten different areas of study included by the survey. This information is provided in the diagram that follows, and it is easy to see that while many research fields had researchers who considered themselves to be entrepreneurs, the fields of information and communication technology (ICT) and engineering had the clear majority of researchers who considered themselves to be inventors (I). This is indicative of engaging in commercial endeavours through the development of intellectual property that resulted from research.

Figure 26 *Researcher Self-Classification per Research Field (R=Researcher, C-Collaborator, E=Entrepreneur, I=Inventor)*

Chart, bar chart

Description automatically generated

There is an interesting correlation to be found between academic stimulation and research field. As discussed in Chapter 3, specialism in basic research is more likely in fields such as life sciences, humanities, and social sciences. Stimulation is closely tied to satisfaction in research careers (Blind et al., 2018) and, in the context of academic research, is predicated on scientific curiosity and the desire to solve complex problems. As can be seen from the findings of this research, higher levels of stimulation orient researchers around basic research, and this relationship is heavily influenced by the researcher’s field, with the effect being more pronounced in non ICT/engineering fields.

* + 1. Social Capital

According to the findings (Section 6.5.5), the extent of researchers' social capital is one of the most powerfully influential factors on their research orientation. Specifically, the findings indicate that alignment with an entrepreneurial or commercial research orientation is influenced by researchers exhibiting moderate to high levels of social capital, while an alignment with lower levels of social capital influencing an orientation around basic research. While the same impact has been observed in the case of researchers who are motivated extrinsically, this is particularly true for researchers who are highly intrinsically motivated.

This is not surprising given that it has been established that social capital is strongly associated with intrinsic motivations. For instance, Degli Antoni (2009) proposes that greater levels of social capital are produced in persons who are motivated inwardly rather than outwardly, and cites evidence to support this hypothesis.

These findings, related to the influence of social capital as a moderator, provide empirical support for the work of scholars such as Ryazanova and Jaskiene (2022) who note the importance of promoting social capital as a means to drive research performance, or (Goel & Göktepe-Hultén, 2019), Hmieleski and Powell (2018), Hossinger et al. (2020) and (Perkmann et al., 2013) who contend that social capital, in terms of academic peer influence, is a strong indicator of research orientation.

This phenomenon might be viewed as an impact of the entrepreneurial university in action, whereby a considerable number of researchers have built strong social relationships with entrepreneurial peers and industrial colleagues (Audretsch & Belitski, 2022; Philpott et al., 2011). Analysing the descriptive data that was acquired for this study adds support to this contention. Specifically, it is important to note that although many respondents indicated that they were situated in a more traditional university environment, all respondents indicated a level of industry presence that ranged from moderate to high in their general vicinity, as is demonstrated in the figure below.

Figure 27 *Industry Concentration Relative to Institution Type of Respondents*

Chart, bar chart

Description automatically generated

This result supports Grzegorczyk (2019, p. 134) who contended that “increases in social capital contribute more than any other explanatory variable to increase the likelihood” of university-firm innovation. Additionally, Audretsch and Aldridge (2012) contend that social capital is a key driver of researchers’ entrepreneurial behaviour, while Hossinger et al. (2020) position social capital more as a potential success factor for post-entrepreneurial behaviour, for example as a success factor for a start-up company.

* 1. Conclusion

This chapter discussed the primary issues that emerged from this research and elaborated on each in relation to existing literature. The findings of this study indicate that assessing the research orientation of an individual researcher is a multifaceted problem and that a number of variables have a substantial impact both as independent constructs and, more significantly, relative to one another.

The claim that the research orientation of a researcher is driven by many motivating factors is supported. Moreover, the results indicate that external factors, such as institutional policies, and personal factors, such as the respondent's age and gender, alter the impact of these motivating elements.

A number of key outcomes have emerged whereby it has been verified that, when viewed collectively, a researcher’s intrinsic motivations have the strongest influence on their career choices, but that individual extrinsic motivations have a stronger influence when these motivations are examined separately. Additionally, it has been demonstrated that availability of finance/resources, social capital, and physical environment have the strongest moderating influence on research orientation.

In light of the findings of this study, their applicability to existing literature, and the research questions posed, it can be stated that the analytical model developed provides an appropriate method for evaluating the key factors that influence a researcher's decision to pursue a basic, applied or commercial research orientation.

This study finishes in the following chapter with a summary of significant research findings, their contribution to knowledge, associated management and policy implications, research limitations, and suggestions for further research on this topic.

1. Conclusion
   1. Introduction

This chapter starts by summarising the most important arguments presented in this thesis and outlines the pertinent findings from this investigation. This summary is based on the analysis and findings that were discussed in Chapters 6 and 7 respectively. Following this, limitations of the study are discussed.

The chapter then outlines the contributions of these findings to the field and discusses the significance of the research and its impact on future research, policy and practice. The chapter concludes with an agenda for potential future research.

* 1. Summary of research outcomes

The orientation of a researcher's research is a complicated phenomenon that may be driven by both extrinsic and intrinsic motivations and is impacted by personal as well as institutional factors. As discussed in Chapters 2 and 3, there have been multiple calls for a detailed examination of this phenomenon; however, to date, the research that has been conducted has focused on individual forces such as motivations alone, the influence of gender in research careers, TTO practices, and so on, without attempting to bring all of these elements together to provide a more comprehensive view.

Developing a comprehensive view of an individual’s research orientation is vital for a number of reasons, with significant consequences for addressing real-world issues and promoting social objectives. Understanding the complex interplay of human, institutional, and social factors that determine researchers' career choices can drive the development of policies and interventions that increase their effectiveness in producing research outcomes that correspond with larger societal goals (Slaughter, 2019; Wright & Phan, 2018). By considering all of the elements that influence the orientation of researchers, we can acquire a deeper knowledge of what motivates them, how they prioritize different areas of their work, and the obstacles they experience in reaching their objectives. This information can assist institutions and stakeholders in developing strategies to support researchers in their work and allow them to realize their full potential (Laudel, 2006).

Second, a comprehensive perspective of an individual’s research orientation can aid in addressing challenges such as those pertaining to gender parity in research professions (Abreu & Grinevich, 2013; H. L. Smith et al., 2020). Studies indicate that women are frequently underrepresented in senior research positions, and that this gender disparity is caused by a variety of factors, including biases in recruitment and promotion, lack of access to mentoring and career development opportunities, and the difficulties of balancing work and family responsibilities.

Furthermore, a detailed examination of an individual’s research orientation helps to increase the societal effect and valorisation of research (Munari & Toschi, 2021). By gaining a deeper understanding of the factors that influence the orientation of researchers, strategies can be developed that promote the translation of research into real-world applications and the engagement of researchers with industry and other stakeholders, thereby enhancing the societal impact of research and fostering economic growth and innovation.

Also, a detailed picture of an individual’s research orientation can aid in addressing work-life balance and wellness issues in research (Dorenkamp & Ruhle, 2019). By recognizing the factors that contribute to researchers' stress, burnout, and work-life conflict, as well as the motives that drive researchers to success, institutions and stakeholders can establish policies and practices that foster a healthy and supportive work environment for researchers. This can improve researchers' well-being and job satisfaction, which can lead to greater research productivity and impact.

Overall, offering a comprehensive view of an individual’s research orientation has extensive implications for advancing knowledge, improving gender parity, enhancing the social impact of research, and promoting the well-being of researchers. Institutions and stakeholders can establish policies that assist researchers in their work, encourage research excellence, and contribute to the development of society as a whole by taking into account all of the elements that influence researchers' career decisions.

The sparsity of extant research in this field was emphasised through an analysis of relevant literature, in Chapters 2 and 3, which uncovered that a focus on the individual researcher within various systems of innovation was lacking.

To address this gap, this research began with a review of extant literature, resulting in the establishment of four overarching research questions:

*RQ1a - What are the primary intrinsic and extrinsic motivations that influence the research orientation of a researcher in an academic institution?*

*RQ1b - What is the interaction effect between intrinsic and extrinsic motivations and the research orientation of a researcher in an academic institution?*

*RQ2a - What role does a researcher’s personal profile play in moderating the relationship between their motivations and their research orientation?*

*RQ2b - What role does a researcher’s academic environment play in moderating the relationship between their motivations and their research orientation?*

To answer the above questions, Chapter 3 began by examining extant literature related to the individual researcher and their research orientation. It then proceeded to identify the key intrinsic and extrinsic motivations that influence researchers to align with a particular research orientation: focused on basic, applied or commercial research, or a combination of these. Next the chapter examined suggested key influences on the relationship between a researcher’s motivations and their research orientation and concluded that their personal profile and their host institution were critical factors to investigate. The chapter culminated with the development of a conceptual framework and associated hypotheses designed to answer the research questions above.

With the hypothesised relationships established, Chapter 4 focused on operationalisation of the multiple statistical constructs to be used in the analytical part of this research, drawing in all cases from extant studies and adapting where necessary. Particular care was taken to ensure that all constructs selected for this research came from prior research in which they had been deployed in the context of an academic institution.

Data for the study were collected through an online survey administered from May 18, 2021, to July 11, 2021 via Surveymonkey. A total of 270 completed, usable, survey responses were gathered, and all required pre-analysis data verifications were undertaken. Following this, as presented in Chapter 5 a statistical analysis employing a combination of structured equation modelling and hierarchical moderated linear regression was performed to verify or refute the thesis’ hypotheses.

In terms of results, firstly this study has validated that both extrinsic and intrinsic researcher motivations have a direct impact on the individual researcher’s research orientation, and that each motivation has a distinct direct effect. When evaluated collectively, extrinsic motivations had less influence than intrinsic motivations, however when individual extrinsic and intrinsic motivations were contrasted, a different perspective emerged, with the pursuit of financial reward (extrinsic) having the strongest influence followed by stimulation (intrinsic), reputation (extrinsic) and risk aversion (intrinsic). The intrinsic motivations academic freedom, and satisfaction also played a lesser, albeit statistically significant, role as drivers of research orientation.

Next the results of the moderation analysis verified that all proposed institutional factors (institutional policies, research finances and resources, environment) and personal factors (age, gender, research field, social capital) played a role in moderating the impact of researchers’ motivations on their research orientation.

* 1. Limitations

This research furthers our understanding of the individual researcher within the context of the movement towards entrepreneurial universities, however as with any research work there are limitations that need to be highlighted.

First, as can be seen from the collected descriptive data, the majority of respondents were from fields related to ICT or Engineering. As these fields are dominant in terms of entrepreneurial endeavours it may be the case that results present a less accurate picture of individuals’ research orientation in other fields. This implies that some level of caution is needed in terms of results generalisation. However, when demographic data is considered, it is clear that a broad spread of demographics were well represented. An additional limitation must be noted in relation to the geographic location of survey respondents. As a majority of respondents came from Ireland it may be the case that national and institutional policies related to research in academic institutions, and the perspectives and attitudes of researchers in Ireland, could differ from those in other countries and this may have had some impact on results attained, as noted in Davey et al. (2016).

Regarding the scope of the research undertaken and the associated analytical model, as discussed in Section 2.4 extant research calls for research that examines the impact of other pressures such as research evaluation and performance expectations, in addition to the impact of motivations, on researchers in academic institutions in relation to their research orientation. As this research seeks to examine the relationship between researcher motivations and research orientation, as per the stated research objectives and research questions, consideration of additional external pressures on this relationship would require a substantially broader and potentially longitudinal study, and so this exclusion must also be considered as a limitation.

Next, although the sample size was statistically shown, through power analysis and model fit indices, to be suitable for the model being analysed a larger sample would enable deeper investigations into the relationships identified in the research. For example, with a larger sample detailed moderation analysis on the impact of external forces (such as the institution) on the relationship between individual motivations and research orientation, or a deeper cross-comparison between male and female respondents, would be possible. Additionally, Chapter 6 highlighted that a number of constructs had to have survey items removed. While a review of the survey was undertaken by a group of experts, had time allowed for a pilot run of the research and analysis - as part of a longitudinal study for example, a more concise survey would have been produced. This then, could lead to the generation of a larger sample of respondents, however as discussed in Section 6.1.1.1 (survey attrition analysis) the majority of respondents who exited the survey before completion did so at a very early stage, and so survey length was not a significant factor for these individuals. Additionally, the survey timing overlapped significantly with the global Covid-19 pandemic, which may have had an impact on response rates, as discussed in Chapter 6.

The construct Career Age deployed in the research survey was based on the European Commission categorisation of research career stage with the earliest being *“R1 First/Early-Stage Researcher (up to the point of PhD, primarily carries out research under supervision)”*. This may have caused some confusion with respondents and should more properly be defined as number of years’ experience as a researcher post-PhD (Costas et al., 2015) or time elapsed since first publication (Alchokr et al., 2022; Kwiek & Roszka, 2022). Accordingly, results relying this on this construct should be approached with caution. However, as discussed in Section 3.4.1.1 and 6.4.2.1 the analysis undertaken in this research examined the moderating effects of biological age, career age and career stage and found that from a hypothesis directionality and moderation effect perspective, the effects are analogous, thus minimising the impact of this particular limitation.

Associated with career age is the researcher’s tenure and, as noted in Section 6.2.4 and 7.2.3, the impact of the tenure construct on the motivations-research orientation relationship was not statistically significant. Demographic data shows that for a majority of respondents the potential to secure promotion or tenure was not a key issue, and this may had caused this non-significant result. In terms of a limitation, the research would have been improved if respondent selection criteria called for non-tenured/non-permanent researchers, however the caveat to that is the potential impact on the sample size gathered.

Finally, respondents in this research were sampled at a unique point in time. While this provided valuable results, a more longitudinal study (for example, spanning multiple years/stages of a researcher’s career) could produce different results, particularly when one considers constructs such as social capital, or internal institutional policies.

* 1. Contribution

This study advances understanding of the factors that shape individual researchers’ orientation towards basic, applied and commercial research. This is achieved through the empirical examination of the interplay between intrinsic motivations, extrinsic motivations, demographic characteristics, institutional environments and research orientation. Through the development and verification of an integrated conceptual model, this research provides a theoretical synthesis of extant fragmented studies to offer a comprehensive and empirically grounded explanation of research orientation in the context of academic institutions. This study consequently provides an important and timely addition to existing discourse and literature, due to the significance of the subject matter, as discussed in 8.1 above, as well as the dearth of research that takes a comprehensive, integrated, approach (Duval-Couetil et al., 2023; Feola et al., 2019; Mula et al., 2022; Neves & Brito, 2020; Perkmann et al., 2021).

* + 1. Theoretical and empirical contribution

This work combines multiple conceptual strands into a unified theoretical perspective on research orientation. Prior works have typically examined these constructs in isolation or relied primarily on qualitative methods. This research departs from those approaches by conceptualising research orientation as the product of both individual agency and structural context.

In particular, the theoretical contribution of this thesis has several elements. Firstly, the work advances a multi-level theoretical perspective that incorporates intrinsic motivations, extrinsic motivations and external moderators (e.g. gender, age, research field, institutional context) in shaping individuals’ research orientation. By doing so, it responds to calls in the literature (as discussed in Section 2.3 and summarised in Chapter 7) for research that accounts for the complexity and context-dependence of individuals’ research orientation. This multi-level approach combines extant perspectives, which have focused on topics such as: drivers of and barriers to entrepreneurship (Hossinger et al., 2020); the motivations that underlie the desire to undertake research (Jindal‐Snape & Snape, 2006); the relationship between demographics, motivations and commercial research orientation (Neves & Brito, 2020); the relationship between researchers’ profiles, policies and tenure and engagement in knowledge transfer (Gerbin & Drnovsek, 2016); the relationship between gender, institutional policies and commercial orientation (Murray & Graham, 2007); demographics as determinants of academic engagement (Perkmann et al., 2021); the impact of social capital and researcher demographics on commercial research orientation (Hmieleski & Powell, 2018); the relationship between social capital and research impact (Ryazanova & Jaskiene, 2022); institutional factors that drive research orientation (Bercovitz & Feldman, 2006); the impact of institutional policies on motivations and research orientation and impact (Chubb & Reed, 2018; Hayter & Parker, 2019); and the relationship between institutional policies and technology transfer activities (Miller et al., 2018).

Additionally, this research adds new perspectives to extant research which has focused exclusively on influences that drive commercial research and entrepreneurial activities in researchers (Audretsch & Aldridge, 2012; Bentley et al., 2015; Bhaduri & Kumar, 2011; Davey et al., 2016; Goel & Göktepe-Hultén, 2018; Hayter & Feeney, 2017; Johnson et al., 2016; Miranda et al., 2017; Olaya Escobar et al., 2017; Schneider et al., 2021) by presenting the impact of multiple factors on the individual’s research orientation which can be focused on basic, applied and/or commercial research.

This thesis refines current theoretical understanding of how research orientation is shaped by motivations and external systems of influence, therefore helping to move the field forward toward more explanatory and predictive frameworks.

In terms of empirical contribution, this thesis provides robust empirical evidence that both supports and extends prior theoretical claims about the drivers of research orientation. By analysing quantitative data from a broad sample of academic researchers, this research delivers a number of novel findings.

Specifically, it serves to quantify the differential effects of intrinsic versus extrinsic motivations on basic, applied, and commercial research orientation. It demonstrates the moderating influence of personal and institutional variables, on the motivation-research orientation relationship, highlighting nuanced variations which are not captured in extant qualitative or theoretical studies. It also provides evidence on the role of social capital in shaping research orientation, supporting the position that peer networks, research leadership and institutional culture play a significantly affective role.

Beyond this, this research contributes to construct validation efforts by statistically verifying key concepts such as academic freedom (Behrens & Gray, 2001); stimulation, financial reward and reputation (Ryan, 2011); satisfaction (Macdonald & Maclntyre, 1997); risk aversion (Goel & Göktepe-Hultén, 2018; Lockwood et al., 2002); social/civic responsibility (Cvitanovic et al., 2015); promotion/tenure (Jordan et al., 2018; Olaya Escobar et al., 2017); policies/supports (Hayter & Feeney, 2017; Scott & Bruce, 1994); social capital (Martín-Alcázar et al., 2019); finance/resources (Scott & Bruce, 1994); and research orientation (Lam, 2011), within the academic context, thereby adding empirical rigour to these relatively under-tested constructs.

* + 1. Managerial and policy implications

This research, and its outcomes, resonates with a number of ongoing policy related initiatives and narratives, and carries a number of managerial implications.

Building social capital

The findings from this research have demonstrated the significant influence of a researcher’s social capital on their research orientation (Perkmann et al., 2021). Researchers “follow the lead of their departmental peers, and others in their proximate networks (both within their institution and outside)” (Perkmann et al., 2021, p. 11) in terms of the research activities they undertake. Accordingly, concurring with Jindal‐Snape and Snape (2006), academic institutions should develop mechanisms to increase the social capital of their researchers through, for example, establishment of communities of interest, providing opportunities for researchers to engage in national and international networks (Jindal‐Snape & Snape, 2006), encouraging sabbaticals (Hossinger et al., 2020) and visits to other institutions, funding conference attendance and supporting researchers to take up positions on advisory/editorial boards (Johnson et al., 2016). Supporting researchers to physically attend networking events and conferences is critically important, particularly following the global Covid pandemic during which almost all conference presentations were carried out virtually, resulting in the loss of spontaneous communication and networking opportunities (Johnson et al., 2016).

Additionally, as a key component of social capital development is the access to, and support from, research leaders, academic institutions should re-examine the evaluation criteria applicable to the selection of research leaders. This could be done through rewarding formal and informal engagement activities, which can in turn influence these activities in the broader research community (Johnson et al., 2016), or through a more nuanced focus on research performance metrics that align with the strategic goals of an institution, such as the number of high quality publications or the level of patenting / spin-out activity (Fini et al., 2022; Perkmann et al., 2021). Academic institutions could provide additional focused training for research leaders, relative to institutional goals for research activities and impact, such as commercialisation. Beyond research leaders, academic institutions should identify and celebrate high performing researchers as a means to drive peer performance relative to their research orientation and organisational goals (Johnson et al., 2016; Neves & Brito, 2020; Perkmann et al., 2021). It has been suggested that provision of such roles and structures, at institutional and departmental levels, enables an academic institution to partially control its expected research outcomes in terms of research focus, performance and impact (Neves & Brito, 2020). As noted by (Perkmann et al., 2021, p. 11) in relation to development and application of policies in academic institutions, researchers’ “behaviour is conditioned by the relational context in which [they] operate”.

Aligning this discussion on social capital with findings from this research related to the importance and influence of the researcher’s physical environment, the “need for communication can be supported by designing [a] physical environment on campuses which facilitates serendipitous conversations between researchers from the same or, even better, from different disciplines” (Ryazanova & Jaskiene, 2022, p. 15). Expanding this towards a national policy perspective, this research has shown that the proximity and concentration of industry relative to an academic institution can influence the research orientation of the researchers therein. Perkmann et al. (2021) highlights that “an approach based on social influence and setting examples could be complemented by facilitating the formation of hybrid organisational structures. These structures, such as university-industry centres, enable industry to collaborate with established university research leaders in ways that maximise the distinctive capabilities that academia brings” (Perkmann et al., 2021, p. 12). This is particularly the case if the mission of an academic institution includes entrepreneurship and commercialisation, but also in instances where industry can engage with researchers focusing on fundamental science. Examples of such an approach, supported through government-provided research funds, include the UK Catapult Centres (Perkmann et al., 2021) or the SFI (Science Foundation Ireland) Research Centres in Ireland (Mulligan et al., 2022). Structures such as these can encourage academic institutions “to adopt strategic organisational and collaborative engagement practices and hence opportunities for self-selection by academics into such environments” (Perkmann et al., 2021, p. 12).

Gender considerations

From a gender perspective, this research has identified that gender significantly moderates between researchers’ motivations and their research orientation. While the purpose of this research was not to determine why this moderation effect occurs, nonetheless it has added weight and support to extant literature which discusses the gender dimension in research careers in depth, as discussed in Section 3.4.1.2. Considering the increased attention placed on entrepreneurship and commercial engagement of academic institutions in conjunction with the findings of this research, it is important to ensure that entrepreneurial opportunities and activities are accessible to women (Schneider et al., 2021). Schneider et al. (2021) suggest that academic institutions should ensure strong collaboration between equality and diversity officers and their technology transfer/research support offices, monitored through specialised measures, to create a more inclusive research culture. Perkmann et al. (2021) concur and suggest that policy levers such as tying funding awards to the global Athena Swan initiative, which is a global framework to focused on the transformation of gender equality within higher education (HE) and research. Murray and Graham (2007) provide a number of suggestions to enhance inclusivity and gender equality in research, with a particular focus on supporting and encouraging women to engage in commercial research. These suggestions are equally applicable in terms of encouraging research participation regardless of research orientation and include provision of mentoring and leveraging existing institutional networks to ensure that research ideas are brought to the fore regardless of the gender of the researcher. In addition, recognition of the challenges faced by female researchers in particular and establishment of mechanisms to mitigate these, such as enhanced focus on work-life balance, is critical (Kuschel et al., 2020; Murray & Graham, 2007; Perkmann et al., 2021).

Accordingly the outputs from this research support work such as that of the European Commission which has started to better address gender inequality related to researcher careers (European-Commission, 2021b). In particular the European Commission has published a new set of requirements for organisations under the Horizon Europe and Digital Europe programmes. Two measures in particular are pertinent here. Firstly, any public / research organisation seeking European Union research funding is required to produce a Gender Equality Plan (GEP) from 2022 onwards. Secondly, equality will be enforced as an evaluation measure for research proposals, to help ensure gender balance in participating organisations, additionally evaluation panels, advisory bodies and expert groups will have a renewed focus on gender balance. Formal requirements for the Gender Action Plans stipulate that, for example, research active organisations such as universities must examine the means by which they evaluate research proposals (from an equality assurance perspective) and must implement GEP information and communication sessions across the entire organisation as a means to raise awareness (European-Commission, 2021a). Finer grained requirements include the need to track and disseminate the gender balance across project teams, across research project tasks and the equal allocation of Principal Investigator roles in organisations.

Closely associated with gender is work-life balance, and the proposed GEPs must ensure that organisations pay attention to parental leave policies, flexible working time arrangements, support for staff with caring responsibilities, workload management and reintegration of staff after career breaks. This is important, as highlighted in the literature review of this research where it has been noted that while gender related initiatives in organisations strive to support female research careers, family circumstances (for example) present a significant barrier to career achievements and progression. The impact of the above flows down through research organisations into policy reform at an organisation level.

Research assessment and performance

Strongly associated with researcher motivations are the research assessment/evaluation tools and frameworks that are applied in national and international contexts, as discussed in Chapter 2. In a recent review of the broader space of research assessment, Curry et al. (2020) highlighted a number of areas of concern related to the application of systemic research assessment and associated metrics, for example:

A reduction in diversity of research missions and purposes, as an emphasis on these narrow criteria and indicators leads institutions and researchers to adopt similar strategic priorities, or to focus on lower-risk, incremental work. Systemic biases against those who do not meet—or choose not to prioritise—narrow criteria and indicators of quality or impact, or to conform to particular career pathways (Curry et al., 2020, p. 7).

Similarly, a review of the UK Research Excellence Framework (REF) highlights that “while the REF acts as an external assessment at the organisational level, its implementation is thought to impact academics by affecting work demands and feedback” (Weinstein et al., 2021, p. 150). Additional concerns and implications related to research evaluation have been discussed in Section 2.3.

In recent years, many organisations have signed up to the San Francisco Declaration on Research Assessment (DORA). DORA proposes a reduced emphasis on Journal Impact Factors as a measure of scientific output quality but, it must be said, falls short when it comes to recognition of other research outputs as valid quality measures (such as patenting or production of open data). So, while DORA as a concept is laudable, it fails to address the multiple motivations that drive researcher orientation by focusing primarily on the reputational gains associated with academic publishing. Curry et al. (2020) note that signing up to agreements such as DORA is merely a starting point for many organisations, and that in certain cases a complete overhaul of institutional policies, to address assessment requirements for change, is required. Echoing the findings from this research Curry et al. (2020, p. 43) posit that:

Many [researchers] are driven by curiosity and wonder, but also by a desire to bring evidence and scholarship to bear on the challenges facing our societies. These noble goals are what draw many people into a research career. Typically, such goals are then modulated by extrinsic motivators rooted in the need for career advancement. This involves seeking jobs and promotions, which have come to depend primarily on sustained success in the interlinked and highly metricised activities of academic publishing and obtaining grant funds. These narrow indicators in turn feed into university league tables, which have grown over the past fifteen years to become unaccountable arbiters of what a research university should look like, loading further pressures onto researchers and institutions. As a result, careers in research have too often become unhealthily competitive.

Future work in the area of research assessment should pay additional attention to other motivations identified in this, and other, research, such as the desire for academic freedom, provision of baseline funding to alleviate the need to write research proposals to chase funding rather than scientific breakthroughs, or the pursuit of socially/civically aware research programmes in which societal impact may outweigh scientific impact.

In mid-2022 an “Agreement on Reforming Research Assessment” was published as an output of the Coalition on Advancing Research Assessment (CoARA) and would seem to pave the way towards a more holistic approach to research output evaluation. In particular, CoARA proposes a significant shift from more traditional models of publication based assessments, towards a recognition of the breadth of research outputs that should be factored into any assessment exercise including public dissemination and outreach, science diplomacy, science advisors and communicators, and technical roles. These changes, if implemented well, should go some distance towards addressing researchers’ intrinsic as well as extrinsic motivations relative to their research orientation. Interestingly, CoARA also advocates for a move away from international rankings for research organisations and assessment criteria set by external commercial companies.

Addressing researcher motivations

Another cross-European initiative that aims to address many of the issues highlighted in this thesis is the Human Resource Strategy for Researchers (HRS4R) (Euraxess, 2022). The HRS4R charter specifies a set of guiding human resource related principles applicable to researchers and to their respective host organisations. The findings from this research align well with the overall HRS4R charter. In terms of addressing extrinsic motivations, for instance, the HRS4R charter mandates that researchers must be recognized as professionals no matter what stage of their careers they are in. The development of researchers' careers is another crucial area, and it is important to note that the Charter stipulates that, regardless of their contractual standing, researchers should be provided with well-defined career paths as well as sufficient support, mentoring, and training to advance in their careers in order to lessen the amount of uncertainty they feel regarding their professional futures.

Regarding the importance of intrinsic motivations, the Charter stipulates that employers and/or sponsors of researchers are obligated to take measures to guarantee that the research community has access to the most stimulating research environment possible. In addition, the Charter encourages responsible and ethical academic freedom, public involvement, and accountability as a means of supporting social and civic responsibility.

Specifically addressing the host institutions, the Charter mandates that there may be no discrimination of any kind against researchers on the part of their employers, regardless of age, ethnicity, gender, social origin, or any other factor. It is also required that there be an equal number of men and women in all levels of personnel and responsibilities. The Charter also requires that working conditions include (in accordance with national legislation) a flexible working environment that must include provisions to support researchers who have various familial circumstances. These provisions include flexible working hours, part-time working, remote working, and sabbatical leave. In addition to this, the significance of having a secure and long-term employment situation is emphasized. Furthermore, the Charter stipulates that there must be equitable and enticing circumstances regarding salaries and finance, as well as measures for social security that are sufficient. As an aside, it is an interesting (but disappointing) aspect of the current situation in Ireland that researchers who have entered the system after 2006 do not have rights to pension benefits.

Looking beyond international initiatives and policies, there are a number of outcomes from this research that apply directly to researchers’ host institutions. As discussed in Section 7.2 findings from this research highlight that, in an academic environment, relying only on external incentives like salary increases and promotions may not be enough to drive organisational research impacts forward. Instead, a wider perspective that encompasses intrinsic elements like job contentment, encouragement for taking risks, and mental stimulation should be considered. In addition, as suggested by (Bhaduri & Kumar, 2011, p. 52), meeting extrinsic motivations may “crowd out intrinsic motivation to innovate”, meaning that if systems of innovation focus primarily in the development of intellectual property that has an immediate commercial benefit, other more cutting edge research initiatives may be left by the wayside through lesser provision of funding. Similarly, as discussed in Section 7.2.2, placing an increased emphasis on particular research performativity metrics may cause a decline in traditional academic egoism which was focused on the pursuit of breakthrough research (Macfarlane, 2023). As noted by (Suominen et al., 2021, p. 3) “motivating research with operational motives rather than the intrinsic purposes of science is challenging”.

Clearly every researcher is different, each has his/her own wants, needs, desires and expectations in terms of their research orientation, and this varies by research field. For example, Goel and Göktepe-Hultén (2018, p. 252) discussing levels of knowledge valorisation and impact relative to research field, highlight that “it is no surprise that research from all academic disciplines is not equally patentable. So policymakers should keep in mind the limitations of patents in fostering overall evolution of knowledge.”, while Hmieleski and Powell (2018, p. 70) contend that

the traditional view that universities have taken toward focusing on the innovations developed by faculty in engineering and the physical and life sciences has led to an underexploited opportunity to capitalize on the creative productions of those working in other areas, such as the arts, humanities, and social sciences” (see also (Slaughter, 2019) as discussed in Section 2.3).

This work has shown that institutional supports and policies play a major role as influences on research orientation, and that a ‘one size fits all’ approach does not work in this context. Host institutions need to be cognisant that researchers have multiple intrinsic and extrinsic motivations, in degrees that vary according to the individual researcher profile, and that in order to best support these researchers the institutions, and research managers therein, need to gain a deeper understanding of what motivates and drives its research cohort. This can be achieved in part through deeper engagement and conversations with researchers, perhaps through revised performance management and career development initiatives. Designing incentive schemes to align with research motivations is highly dependent on developing this understanding of individual researchers. As noted by Jindal‐Snape and Snape (2006, p. 1325) schemes that involve financial rewards don’t always have the desired effect, and many researchers could be motivated through the addressing of other motivations such as the provision of “time and resources to pursue own research interests; funds to attend international conferences and investment in physical resources (e.g. laboratory refurbishment, new equipment, etc.)”. As posited by Gerbin and Drnovsek (2016, p. 1006)

academic institutions should bear in mind that financial incentives are not the only available [incentive] mechanism, since life science researchers sometimes more highly value the opportunity to receive industry funds to expand the research activities of their laboratory than only receiving the financial compensation from royalties.

As noted by Lam (2011, p. 1366), and reflected in this findings from this research, as researchers “are motivated by a complex mix of extrinsic and intrinsic rewards, then policy initiatives focusing narrowly on providing financial rewards might be inadequate or even misplaced”. Accordingly, institutional management should “evaluate the effectiveness of present incentivisation schemes and use them in a differential manner with different bands of [researchers]” (Jindal‐Snape & Snape, 2006, p. 1340). These could include mechanisms such as regular addresses and acknowledgement from research directors/management or displaying key publications in public spaces. Findings from this research related to motivations and incentives for knowledge valorisation have been brought forward by the researcher to the European Commission “community of practice on industry-academia collaboration for knowledge valorisation” (European-Commission, 2023).

Care must also be taken in the context of provision of training supports for researchers as prior research (see Section 7.3.1) has shown that in certain circumstances researchers can be turned away from a particular research orientation if the training they receive over-signals difficulties associated with different types of research, for example the timeframes and complexity associated with achieving breakthrough research or the difficulty in achieving commercial success (Wegner et al., 2019). Similarly, discussing the impact of training and social capital on younger researchers, Perkmann et al. (2021, p. 11) highlights that

the available evidence on social contexts suggests university and departmental measures should be designed to expose individuals to the benefits of [industrial] engagement but minimise the pressure to commit research time and resources (e.g. through master classes or involvement in projects with engagement undertaken by more senior team members).

Finally, it is critical that institutions set out their stall clearly for all researchers, in terms of prioritising basic science or commercial engagement for example, so that expectations are clear from the outset (Bentley et al., 2015). Relating this to researchers’ desire for tenure or promotion opportunities, if for example an academic institution has a primary focus on pushing an entrepreneurial agenda, appropriate associated metrics for tenure and promotion, which are currently typically associated with scientific productivity, should include commercial measures such as production of IPR or patents (Hossinger et al., 2020).

* + 1. Personal reflection on findings

The findings arising from this research have a number of practical implications related to my own working environment and responsibilities. As a note on context, I am the founder and Executive Director of an ICT Research Institute based in South East Technological University (SETU[[6]](#footnote-6)), Ireland. My research institute, called the Walton Institute for Information and Communication Systems Science[[7]](#footnote-7), is the only research entity categorised as a research institute within SETU, and is reflective of its size and breadth of research activities. SETU itself was formed in 2022, through the merger of two Institutes of Technology.

Within Walton Institute we are 100% self-funded, and undertake basic, applied and commercial research activities, supported through funding from multiple agencies nationally and internationally, as well as through direct industry funding. A critical challenge in this environment is to secure funding and maintain a balance of research activities focused on fundamental science through to commercial application. As such it is imperative that researchers are supported and encouraged to undertake excellent research, secure funding, and ensure impact. Accordingly, understanding the multiple motivations that researchers have is critical in order to find and fund a balanced research portfolio. Additionally it is important to leverage their motivations to ensure that they stay within the organisations in situations where they could earn substantially higher salaries should they move to industry. In this regard, academic freedom is a key motivator for researchers, while ensuring industry engagement related to our research outputs is critical. To that end I have established mechanisms, through our HR department, to enable research managers to better understand their staff members and to focus on the key motivations that each finds important. This is rolled out through our in-house performance management and review system.

Within the broader SETU organisation I am a member of the Academic Council and multiple strategy groups that focus on increasing research performance across the organisation. A particular challenge in this context is to encourage academic staff to undertake research activities, as they currently experience high teaching workloads. Understanding the motivations underlying research orientation for these staff members is critical if SETU is to reach its Government-specified research targets, which are placed on the organisation as part of its remit as a newly founded Technological University. To help with this process I regularly feed my research findings into working group and management discussions, and I have provided training materials for less research-active staff to help them identify different types (basic, applied, commercial) of research and to identify their own research orientation accordingly. Finally, I engage with the HRS4R and Athena Swan teams in the organisation to support their various accreditation applications, and to provide a motivations and policy impact perspective on their work.

Externally, I am President of Waterford City’s Chamber of Commerce, and a member of the Southern Regional Assembly, where my remit is to drive the innovation agenda for local business in the City of Waterford and in the wider region. While not directly related to my research focus, my gained knowledge about motivating researchers to engage with local industry has enabled me to provide more nuanced support and strategy for all sides of the triple helix.

Additionally, I am a member of the European Commission Community of Practice (CoP) on industry-academia collaboration for knowledge valorisation (European-Commission, 2023). As my research progressed it enabled me to feed insights into this CoP, with a particular focus on ensuring that individual researchers were taken into account within policy recommendations (European\_Commission, 2024), whereas previously the focus was primarily on industry and academic institutions as a whole.

* 1. Future Research Recommendations

“The outcome of any serious research can only be to make two questions grow where only one grew before.” – Thorstein Veblen

While this research focuses on researchers who are embedded in academia, Hayter and Parker (2019) note that extant research excludes the situation where PhDs and Postdocs move to non-academic careers – this is something to be explored in future work. A lot could be gained through studying researchers who have moved from academia to industry, or vice versa, as motivational factors will have changed accordingly. Indeed, further work could also examine the motivations that cause a researcher to move to an industrial position, coupled with an analysis of their pre-move expectations versus the reality of employment in an industrial context.

Wang et al. (2018) note that the funding model under which a researcher is funded can directly impact on their level of scientific output, with “lesser” researchers having access to more constrained funding types. They contend that more established researchers have access to block funding which enables more academic freedom and drives more basic science. This work could be enhanced by integrating additional constructs that examine the influence of financial incentives on researchers. (Walter et al., 2018) provides an analysis of the potential incentives and they “propose a triad of incentives, where the freedom to pursue academic endeavours relatively undisturbed by commercialisation efforts (‘grace’) and financial participation in the outcome (‘gold) is combined with opportunities to make technology transfer achievements count in the larger context of overall performance assessment and subsequent career advancement (‘glory’)” (Walter et al., 2018, p. 1754).

Future researcher profile related work also needs to consider the crossroads between the institutional, (Lerchenmueller & Sorenson, 2018) and familial (Whittington & Smith-Doerr, 2005) context of the researcher (particularly when it comes to gender (Derrick et al., 2022)). For example, Defazio et al. (2020) discovered that researchers with young children tended to withhold research results and data due to the potentially resultant increase in workload that can arise from this activity. There is a potential opportunity here for universities to provide additional, typically unfunded by the underlying research project, supports in terms of regulatory analysis, navigating legal data release approval processes, data management, documentation and archiving. Staying on the gender track, additional work could examine the differences in social capital development across genders, and the relative influences of each on career decisions. Also, on the topic of social capital, as discussed in Section 3.4.1.3, the harmful potential of social capital warrants further study.

Future work needs to also look at publication rates / productivity (Murray & Graham, 2007) relative to researcher motivations and research orientation. Whittington and Smith-Doerr (2005) suggests that as “lines between university and commercial science become blurrier in the new economy, science careers also take on a composite character. In addition to seeing industrial scientists publish, increasingly we see academic scientists patenting, particularly in the life sciences” (p. 356).

Another interesting avenue for research is to look at the impact of recently established initiatives such as DORA and CoARA, perhaps in the context of a longitudinal study of researcher careers or on changes in research outputs at institutional level. Only time will tell whether these types of international initiatives will have their desired effects realised.

Finally, although results pertaining to social / civic research and tenure were statistically insignificant in this research, future studies could revisit these elements of the work, focusing on early career researchers for example. In particular the apparent lack of impact of the desire to undertake socially impactful research (in the face of other, typically external, pressures) is worthy of investigation.

* 1. Conclusion

This thesis highlights the significant role of research in academic institutions in driving innovation and scientific advancement. It underscores the importance of researchers' orientation in shaping the direction and impact of research efforts, particularly regarding basic, applied, or commercial research. The findings of this study emphasize the critical need to understand the factors that influence researchers' career choices to enhance their effectiveness in driving research outcomes that promote economic growth, societal advancement, and human well-being. Ultimately, by better understanding the influences on individuals’ research orientation, stakeholders can develop strategies that enhance their capacity to make informed decisions that align with the broader goals of research, promote optimal outcomes and maximize the benefits of research to society.

1. Appendix A – Prior Research on Motivations of Researchers

Table 38 *Prior research on researcher motivations*

| **Intrinsic** | **Extrinsic** | **Research Method** | **Key Findings Related to Motivations** | **Reference** |
| --- | --- | --- | --- | --- |
| Independence  Desire for intellectual / meaningful work  Dedication to field of study  Self actualisation  Sense of achievement  Intellectual challenge | Status / reputation  Increased power | Structural equation modelling (based on survey data). | Results showed that internal self motivation was the strongest force, whilst extrinsic motivations had the weakest effect. | (Ryan, 2014; Ryan & Berbegal-Mirabent, 2016) |
| Learning from industrial problems | Financial reward  Access to industrial resources  Status / reputation  Contacts | Literature review to identify various motivations and external drivers/barriers, followed by statistical analysis to verify results. | Results indicated that external drivers and barriers influenced the impact of motivations on actions with the exception of barriers related to relationship building, and results usability. | (Davey et al., 2016) |
| Personal Satisfaction  Self Esteem  Identifying new avenues for research  Knowledge sharing  Desire for intellectual challenge  Independence | Financial reward (wage increase, royalties, equity)  Reputation  Promotion  Grants  New Infrastructure | Literature review to identify motivations, followed by statistical analysis for verify results. | Results showed that intrinsic, but not extrinsic, motivations had an influence on industrial knowledge transfer activities. | (Olaya Escobar et al., 2017) |
| Problem solving satisfaction | Prestige and recognition  Salary  Research funds  Publications  Patents | Mixed: Interviews and statistics. | Research funding was identified as the highest motivating factor, with personal income at the bottom. Additionally, Lam’s researcher types displayed different levels of response to the motivations tested. | (Lam, 2011) |
| Enjoyment  Sense of duty  Confidence / competence | Financial gain  Peer group pressure\*  Statutory bindings\*  Work deadlines\* | Literature review, focusing on the ‘innovation process’ accompanied by descriptive statistics. | The analysis undertaken categorised motivations as Intrinsic and Extrinsic, with no finer grained details. Accordingly results were mixed depending on the stage of innovation of the respondents. | (Bhaduri & Kumar, 2011) |
| Curiosity  Good science  Self-actualisation  Learning  Making a difference | Collaboration / team working  Management  Salary and promotion  Need to keep job  External recognition  Publications  Winning grants  Job enrichment | Semi structured interviews with 18 researchers (in the UK) | Sense of achievement and challenge were the highest influencing motivations (i.e. Intrinsic). Financial gain was not a motivator. Promotion was seen as an extrinsic motivator. | (Jindal‐Snape & Snape, 2006) |
| Self-efficacy\*\*  Courage  Interest  Freedom  Curiosity | Not considered | Statistical model using 402 respondents | Demonstrated the impact of intrinsic motivations on researchers imagination. Identified that self-efficacy was a mediating factor in this relationship. | (Liang & Chang, 2014) & (Hsu et al., 2014) |
| Not considered | Tenure\*\* | Statistical model to evaluate the impact of tenure and leisure on researchers’ work efforts (with a focus on licencing). | Tenure was seen to be a significant influencing factor (with less effort being expended after tenure was secured). | (Thursby et al., 2007) |
| Not considered | Patents  Financial Gain | Statistical analysis using 912 respondents | Both financial gain and patenting were identified as influential factors. | (Glenna et al., 2011) |
| Not considered | Public access research output | Statistical analysis | Researcher orientation identified as an influential factor. | (Goel & Göktepe-Hultén, 2018) |
| Freedom | Recognition through papers/presentations  Securing research grants  Securing tenure / promotion  Financial gain / royalties  Human capital  Patents | Statistical analysis | Tenure seen as a driver of more industrial engagement / commercialisation. | (Link et al., 2017) |
| Problem solving  Personal interest | Career enhancement  Financial reward (royalties)  Financial reward (freedom to undertake consulting) | Statistical analysis examining drivers of researcher collaboration. | Problem solving was seen as a driver for collaborative research, as was the need to secure more pooled resources. | (Iglič et al., 2017) |
| Not considered | Patents  High impact Publications  Reputation | Literature review to develop a conceptual framework. | Production of high impact publications noted as being an indicator of less inclination to commercialise work. | (Gerbin & Drnovsek, 2016) |
| Not considered | Career prospects  Reputation  Financial reward | Literature review related to research ambidexterity. | Results demonstrated the effects of numerous control variables (next section) on the effect of researcher ambidexterity | (Chang et al., 2016) |
| Self confidence  Job stability (reluctance to change) | Not considered | Literature review to determine how best to engage researcher types with entrepreneur types. Followed by descriptive statistics analysis. | Nothing specific to individual motivations. | (Würmseher, 2017) |
| Maintaining stability in job (as a negative influence on entrepreneurship)  Risk minimisation | Promotion | Literature review (looking at promotion and prevention focused researchers, and the influence of this on entrepreneurship). Followed by statistical analysis. | Identified that a researcher’s focus on promotion or prevention (risk aversion) directly influenced their commercial engagement. | (Johnson et al., 2016) |

\*Represents cases where an author identifies motivations, which are more generally considered to be influencing factors (by a larger group of authors).

\*\*Represents cases where an author identifies influences, which are more generally considered to be motivations (by a larger group of authors).

1. Appendix B – Prior research on influential factors for research orientation

Table 39 *Prior research on influencing factors and controls related to researcher motivation*

| **Reference** | **Influencing Factors** | **Controlling factors** | **Research orientation considered?** | **Points of note** | **Research method** |
| --- | --- | --- | --- | --- | --- |
| (Lam, 2011) | History of industrial engagement  Market opportunities | Age  Gender  Career stage | Constructs available and tested, for researcher typology | Female respondents were less likely to engage in commercial work  Younger respondents were less likely to engage in commercial work | Statistics |
| (Bhaduri & Kumar, 2011) | Peer group pressure  Statutory bindings  Work deadlines |  |  | Research too high level to be used in this study. | Statistics |
| (Jindal‐Snape & Snape, 2006) | Working environment  Management Support  Physical resources  Social environment  Financial resources  Work / life balance |  |  | Salary was not seen as an issue – with a general consensus being that people would not be researchers if money was a factor. | Interviews and statistics |
| (Stuart & Ding, 2006) | Employment context / support for commercialisation  Peer / Leader behaviour  Co-location with peers that have achieved high-status as entrepreneurs  Training for commercialisation  Human capital  Ranking of researcher’s own university |  |  | Co-location with high performing peers was seen to be an influence on research orientation (towards entrepreneurship) | Statistics |
| (Glenna et al., 2011) | Available research funds  Researchers beliefs about academic-industrial engagement | Gender  Academic Rank | Constructs for researchers’ views on academic-industry engagement available. | Researchers views on academic-industry engagement were seen to be a significant predictor of commercial activity.  It was noted that more focus on commercial outputs resulted in less focus on basic science / public interest research.  Results indicated (although not statistically significant that females were more focused on basic research rather than commercialisation) | Statistical model |
| (Goel & Göktepe-Hultén, 2018) | TTO capability (size of group and competence)  Professional experience working in industry  Risk aversion  Financial cost of commercialisation  Time cost of commercialisation  Level of industry interaction | Age  Leadership status of respondent  Gender  PhD or not | Researcher orientation (belief that research output should be public access). | Cost of commercialisation influenced researchers’ propensity to patent.  Gender was not seen as a significant controlling factor in terms of the desire to commercialise – however female were seen as more likely to bypass a TTO and commercialise directly with industry. | Statistical analysis. |
| (Hayter & Feeney, 2017) | Training orientation (i.e. whether or not a research was trained in a pro-commercialisation organisation)  Seniority  Rank  Level of industry interaction  Organisational culture  Perceptions of the TTO |  |  |  | Statistical analysis |
| (Link et al., 2017) | Organisation culture  Royalty distribution formula / Organisational incentives  TTO support and capabilities  Social networks / industry engagement  Training / work placement prior to graduation  Dedicated research centre vs traditional university environment  Source of grants (from industry or not) | Gender  Scientific discipline |  | It was noted that females in dedicated research centres are more likely to commercialise than their counterparts in traditional university settings.  Reception of industrial grants was seen to be a driver of commercialisation. | Statistical analysis |
| (Iglič et al., 2017) | Social capital  Human capital  Research experience  Nature of research (interdisciplinary or not)  Trust in colleagues  Resource dependence (the need to increase/pool resources via collaboration) | Prior collaboration experience  Gender  Scientific discipline |  | Trust was not seen as an inhibitor of collaboration (which is at odds with the literature).  Gender (females were seen to collaborate less with external partners and more with partners in the same university). |  |
| (Huyghe et al., 2016) | Awareness of TTO  Royalty distribution % | Gender |  | Contains constructs for level of awareness of TTO function. | Statistics |
| (Olaya Escobar et al., 2017) | University support and services  TTO capabilities  University policies  Research environment (dedicated research centre/park or not)  Entrepreneurial culture | Gender |  | Contains multiple constructs | Statistics |
| (Gerbin & Drnovsek, 2016) | Human and social capital  Available funding  Cultural norms  Industrial collaboration experience  Leadership status  High impact publications  Role models  Training  Institutional policy/strategy  Funding sources  Culture  TTO availability and competence  Royalty schemes  Time commitment required for commercial engagement | Age  Tenure  Gender | Scientific beliefs | High impact publications seen as directly decreasing the level of commercialisation (patents) | Literature review. Conceptual framework development. |
| (Aldridge & Audretsch, 2017) | Human capital  Social capital  TTO Resources  Availability of financial resources | Age  Gender  Research centre or not  University public vs private  University ranking |  | Age is a predictor of academic entrepreneurship  Female researchers less likely to become entrepreneurs  Social capital had the highest impact on entrepreneurship | Statistical analysis |
| (Davey et al., 2016) | University environment.  University mission.  National supports and policies.  Training  Available funding  Resource availability |  |  |  | Statistics and SEM |
| (Al-Tabbaa & Ankrah, 2016) | University flexibility in terms of research orientation  Social capital | Public / private university |  |  | Statistics |
| (Würmseher, 2017) | Social capital | Prior experience (of commercialisation)  Age  Gender  Seniority |  |  |  |
| (Cantner et al., 2017) | Social identity |  |  |  | Using Theory of Planned behaviour, combined with Social Identity to identify entrepreneurial propensity. |
| (Urbano et al., 2016) | Role models  Social image  Fear of failure  University incentives  Training and education |  |  |  | Statistics |
| (Johnson et al., 2016) | Social capital  Leaders  Work environment |  |  |  |  |
| (Fini et al., 2017; Fini et al., 2019) | TTO proactivity  Institute policies |  |  |  | Statistical analysis |

2. Appendix C – Measurement Scales

The table below specifies the measurement scales used for each construct in this research, with any deviations from the original source highlighted in red. Additionally, items shaded in grey were removed during the analysis phase, as described in Section 4.4.1.

Table 40   
*All measurement items*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Main Model Constructs** | | | | | | | | | |
| **Main Construct** | **Survey Question** | | **Variable Item Name** | | **Source** | | **Context of Source Research** | **Original Question + Adjustments** | |
| AcadFree | I am free to choose my own research topics within my project(s). | | AF1 | | Behrens and Gray (2001) | | Sampled early career researchers in a university context. | I have been free to choose my own research topics within the project. | |
| I think research design is slanted to give results favourable to the project sponsor/funding body. | | AF2\_r | | I think the research design is slanted to give results favorable to the project sponsor. | |
| I am free to choose the research tools/methods which I feel are most appropriate for my project(s). | | AF3 | | I have been free to choose the research tools/methods which I feel are appropriate for the project. | |
| The sponsor/funding body insists on immediate results or the project(s) won’t get support. | | AF4 | | The sponsor insists on immediate results or the project won’t get support. | |
| I have been instructed to write up results or otherwise interpret them in ways I do not agree with. | | AF5\_r | | I have been asked to write up results or otherwise interpret them in ways I do not agree with. | |
| There are no constraints on the free exchange of ideas about my project(s) among students and/or staff in my academic organisation, or in other academic organisations. | | AF6 | | There have been no constraints on the free exchange of ideas about this project among students in this department.  There have been no constraints on the free exchange of ideas about project — students in different departments.  There have been no constraints on the free exchange of ideas about project among faculty in this department.  There have been no constraints on the free exchange of ideas about project — faculty in different departments. | |
| Stim | If something is not enjoyable, then it is not worth doing. | | Stim1 | | (Ryan, 2011) | | Developed a generic scale to measure worker motivations. Tested and verified the scale with a set of PhD level researchers employed in a university context. | If something is not enjoyable, then it is not worth doing. | |
| If choosing between two jobs, the most important criterion is “which would be more enjoyable?”. | | Stim2 | | If choosing between two jobs, the most important criterion is “which would be more enjoyable?” | |
| It is important that I work in a job that allows me to use my skills and talents. | | Stim3 | | It is important that I work in a job that allows me to use my skills and talents. | |
| I like to do work that challenges me and gives me a sense of personal achievement. | | Stim4 | | I like to do work that challenges me and gives me a sense of personal achievement. | |
| Satis | I get a feeling of worthwhile accomplishment from my work. | | Satis1 | | Traynor and Wade (1993) | | Developed a scale to measure job satisfaction, tested in a community nursing context.  Scale not verified in an academic context. | The feeling of worthwhile accomplishment I get from my work | |
| My job is varied and interesting. | | Satis2 | | The extent to which my job is varied and interesting | |
| My workload is acceptable. | | Satis3 | | My workload | |
| I have a lot of job security. | | Satis4 | | The amount of job security I have | |
| I receive recognition for a job well done. | | Satis5 | | Macdonald and Maclntyre (1997) | | Developed a generic satisfaction scale and tested across a sample encompassing multiple occupation types.  The scale was used in an academic context by, for example, Hassan et al. (2020), Tesfaye et al. (2022), Ishaq and Khalid (2014), and Pasha and Aftab (2020). | I receive recognition for a job well done | |
| I feel close to the people I work with. | | Satis6 | | I feel close to the people at work | |
| I feel good about working at my current organisation. | | Satis7 | | I feel good about working at this company | |
| In general, I believe work is good for my physical health. | | Satis8 | | On the whole I believe work is good for my physical health | |
| My wages are in line with industry / academic norms. | | Satis9 | | My wages are good | |
| All my talents and skills are used at work. | | Satis10 | | All my talents and skills are used at work | |
| I get along with my supervisors/managers. | | Satis11 | | I get along with my supervisors | |
| Risk | I am generally a person who is fully prepared to take risks. | | Risk1 | | Goel and Göktepe-Hultén (2019) | | Tested on a sample of German researchers employed in multiple research institutes. | How do you see yourself: Are you generally a person who is fully prepared to take risks | |
| I am generally a person who tries to avoid taking risks. | | Risk2\_r | | or do you try to avoid taking risks? | |
| I am more oriented toward preventing losses than I am toward achieving gains. | | Risk3\_r | | Lockwood et al. (2002) | | Tested and verified on a sample of students in Canadian universities. | I am more oriented toward preventing losses than I am toward achieving gains. | |
| My major goal in work right now is to avoid becoming an academic/research failure. | | Risk4 | | My major goal in school right now is to avoid becoming an academic failure. | |
| Overall, I am more oriented toward achieving success than preventing failure. | | Risk5 | | Overall, I am more oriented toward achieving success than preventing failure. | |
| SoCiv | Engaging with and communicating to decision-makers/stakeholders is important to me personally. | | Sociv1 | | Cvitanovic et al. (2015) | | Developed and verified scale with a sample of research researchers employed in Australian Universities and Research Institutes. | Engaging with and communicating to decision-makers is important to me personally | |
| Engaging with and communicating to decision-makers/stakeholders/public is more important to me than having high publication citation indices. | | Sociv2 | | Engaging with and communicating to decision-makers is more important to me than having strong citation indices | |
| I believe that my research is important for decision-makers/ stakeholders/ public. | | Sociv3 | | I believe that my science is important for decision-makers | |
| As a researcher, I have a responsibility to engage with, and communicate to, decision-makers/stakeholders/public. | | Sociv4 | | As a scientist, I have a responsibility to engage with and communicate to decision-makers | |
| I want my organisation to support engagement and communication activities with dedicated time allocations. | | Sociv5 | | I want my organisation to support engagement and communication activities with dedicated time allocations | |
| I would like funding grants to provide dedicated funding for research dissemination. | | Sociv6 | | I would like funding grants to provide dedicated funding for engagement and communication activities | |
| I would like to be valued by my employer for engagement and communication activities. | | Sociv7 | | I would like to be rewarded by my employer for engagement and communication activities | |
| I would like metrics of research impact to include measures of engagement and communication with end-users so that I can prioritise engagement and communication activities on equal footing with publishing. | | Sociv8 | | I would like metrics of science impact to include measures of engagement and communication with end-users so that I can prioritise engagement and communication activities on equal footing with publishing | |
| Reput | I feel that my own research activity will result in an increase in my academic reputation as a researcher. | | Reput1 | | Goethner et al. (2012) | | Developed and verified scale based on research researchers employed in German Universities and “non university” Research Institutes. | Please assess the likelihood of these consequences if you were to participate in the founding of a firm in order to commercialize your own research. | |
| When I have done a good job, it is important to me that my contribution is recognized by others. | | Reput2 | | Ryan (2011) | | Developed a generic scale to measure worker motivations. Tested and verified the scale with a set of PhD level researchers employed in a university context. | When I have done a good job it is important to me that my contribution is recognized by others. | |
| I often make decisions based on what others will think. | | Reput3 | | I often make decisions based on what others will think. | |
| I give my best effort when I know that it will be seen by the most influential people in an organization. | | Reput4 | | I give my best effort when I know that it will be seen by the most influential people in an organization. | |
| I work harder on a project if public recognition is attached to it. | | Reput5 | | I work harder on a project if public recognition is attached to it. | |
| RwrdF | The best aspects of any job are the financial rewards and associated financial benefits. | | RwrdF1 | | Ryan (2011) | | Developed a generic scale to measure worker motivations. Tested and verified the scale with a set of PhD level researchers employed in a university context. | The best aspects of any job are the financial rewards and associated financial benefits. | |
| I only work for the financial reward that it provides me. | | RwrdF2 | | I only work for the financial reward that it provides me. | |
| I would readily leave any job if I were offered an alternative that pays more. | | RwrdF3 | | I would readily leave any job if I were offered an alternative that pays more. | |
| People should always be on the lookout for better-paid jobs. | | RwrdF4 | | People should always be on the lookout for better-paid jobs. | |
| RwrdPT | The possibility of promotion / tenure is a major driver of my research work. | | RwrdPT1 | | Jordan et al. (2018) | | Developed and verified scale with a sample of “education researchers” operating in American medical educational institutions. | Does the possibility of promotion/tenure drive your research work? | |
| My major goal [in work] right now is to achieve my academic ambitions. | | RwrdPT2 | | Johnson et al. (2016) | | Adapted and verified pre-existing scales with a sample of academics working across multiple Scottish universities. | My major goal [in school] right now is to achieve my academic ambitions | |
| I am more likely to be considered for promotions if I engage in knowledge transfer activities. | | RwrdPT3 | | Olaya Escobar et al. (2017) | | Developed and verified scale with a sample comprising academics / faculty in a Spanish University. | I am more likely to be considered for internal promotions if I engage in KTT activities | |
| PolKTT | The inventor royalty share (the share of any royalty payment, resulting from research outputs, given to the researcher) in my institution has a strong influence on my decision to generate patentable inventions. | | PolKTT1 | | Arqué-Castells et al. (2016) | | Developed and verified scale with sample of TTOs and Inventors across multiple Spanish and Portuguese Universities. | What is the influence of the inventor royalty share on your decision to generate patentable inventions? | |
| My department has provided sufficient assistance and incentives for researchers to engage in industry-university cooperative research. | | PolKTT2 | | Chang et al. (2016) | | Developed and verified scales using a sample of faculty members across multiple universities. | My department has provided sufficient assistance and incentive for faculty to engage in industry-university cooperative research | |
| My department has provided sufficient assistance and incentives for researchers to engage in Knowledge and Technology Transfer (KTT) activities. | | PolKTT3 | | My department has provided sufficient assistance and incentive for faculty to engage in technology transfer. | |
| The importance of knowledge and technology transfer is clearly communicated. | | PolKTT4 | | Olaya Escobar et al. (2017) | | Developed and verified scale with a sample comprising academics / faculty in a Spanish University. | The importance of knowledge and technology transfer is clearly communicated | |
| My department has sufficient assistance and incentives for researchers to apply and protect intellectual property rights (e.g. patenting support). | | PolCom1 | | Chang et al. (2016) | | Developed and verified scales using a sample of faculty members across multiple universities. | My department has sufficient assistance and incentive for faculty to apply and protect intellectual property rights. | |
| My department has provided sufficient assistance and incentives for researchers to engage in creating spin-offs. | | PolCom2\_r | | My department has provided sufficient assistance and incentives for faculty to engage in creating spin-offs. | |
| There is adequate time available to pursue creative ideas here. | | PolCom3\_r | | Scott and Bruce (1994) | | Developed and verified scale with a sample of engineering staff across multiple US corporations.  The scale was subsequently verified in an academic context by researchers such as Lashari et al. (2022), Dai et al. (2022), Lee et al. (2019), Hassan et al. (2020), and Hassan and Din (2019). | There is adequate time available to pursue creative ideas here | |
| My organisation actively promotes entrepreneurial activities. | | PolCom4\_r | | Olaya Escobar et al. (2017) | | Developed and verified scale with a sample comprising academics / faculty in a Spanish University. | The university actively promotes entrepreneurial activities | |
| My organisation arranges conferences /workshops on entrepreneurship. | | PolCom5 | | Saeed et al. (2015) | | Developed and verified scale with a sample of university students in Pakistan. | My university arranges conferences /workshops on entrepreneurship | |
| PolRes | My department highly regards demonstrating domestic and world research excellence. | | PolRes1 | | Chang et al. (2016) | | Developed and verified scales using a sample of faculty members across multiple universities. | My department has highly regarded about receiving domestic and world research excellence | |
| My department provides excellent facilities and infrastructure for research. | | PolRes2 | | My department has provided excellent facilities and atmosphere for research works. | |
| My department provides extra incentives for publication. | | PolRes3 | | My department has provided extra incentives for publication. | |
| My university arranges conferences /workshops on research excellence. | | PolRes4 | | My university arranges conferences /workshops on research excellence. | |
| PolTTO | The Technology Transfer Office (TTO) at my organisation provides high quality service to researchers. | | PolTTO1 | | Hayter and Feeney (2017) | | Developed and verified scale with a sample of academic researchers based in multiple US universities. | The TTO at my university provides high quality service to faculty. | |
| The TTO at my organisation is very active in identifying patentable research. | | PolTTO2 | | The TTO at my university is very active in identifying patentable research. | |
| The TTO at my organisation is only interested in certain fields or disciplines especially those that have generated royalties. | | PolTTO3 | | The TTO at my university is only interested in certain fields or disciplines,  especially those that have generated royalties. | |
| The TTO at my organisation has sufficient scientific and technological knowledge. | | PolTTO4 | | The TTO at my university has sufficient scientific and technological  knowledge. | |
| SoCapR | I can trust that others will help me if necessary. | | SocapR1 | | Martín-Alcázar et al. (2019) | | Scales were developed and verified using a sample of researchers employed in multiple Spanish universities. | We can trust that others will help us if necessary | |
| My colleagues and I try to help each other if we have any difficulty. | | SocapR2 | | We try to help each other if we have any difficulty | |
| I enjoy a good interpersonal climate. | | SocapR3 | | We enjoy a good interpersonal climate | |
| I share the same ambitions and visions as my colleagues in the research work. | | SocapR4 | | We share the same ambitions and visions… in the research work | |
| I am excited to achieve the goals and mission of my research colleagues/project team. | | SocapR5 | | We are excited to achieve the goals and mission of the team. | |
| SoCapC | I hold regular meetings to advance my team’s research activity. | | SocapC1 | | Martín-Alcázar et al. (2019) | | Scales were developed and verified using a sample of researchers employed in multiple Spanish universities. | We hold regular meetings to advances the team’s research activity | |
| I share our advances in research. | | SocapC2 | | We share our advances in research | |
| I seek out, and capitalise on, research synergies. | | SocapC3 | | We seek and take advantage of synergies | |
| I exchange ideas with many professionals outside our institution. | | SocapC4 | | We exchange ideas with a large number of professionals from outside our  institution | |
| PhyEnv | How would you describe your academic organisation? | | Phyenv1 | | New Constructs Created | | Scales developed based on work from Link et al. (2017), (Friedman & Silberman, 2003) and (Olaya Escobar et al., 2017) | | |
| The level of industry concentration in the geographic vicinity of my research organisation is: | | Phyenv2 | |
| FinRes | Please estimate the level of baseline /philanthropic research funding you receive (e.g. funding not tied to a particular project, to be used at a researcher’s discretion, gift funding, scholarship…). | | Finres1 | | New Constructs Created | | Constructs created based on the prior work of Davey et al. (2016) and Aldridge and Audretsch (2017) | | |
| Please estimate the level of research grant funding you receive. | | Finres2 | |
| Please estimate the level of consultancy/contract funding you receive. | | Finres3 | |
| There are adequate resources devoted to research and innovation in my organization. | | FinresR1 | | Scott and Bruce (1994) | | Developed and verified scale with a sample of engineering staff across multiple US corporations.  Developed and verified scale with a sample of engineering staff across multiple US corporations.  The scale was subsequently verified in an academic context by researchers such as Lashari et al. (2022), Dai et al. (2022), Lee et al. (2019), Hassan et al. (2020), and Hassan and Din (2019). | There are adequate resources devoted to innovation in this organization. | |
| Lack of funding to investigate creative ideas is a problem in this organization. | | FinresR2\_r | | Lack of funding to investigate creative ideas is a problem in this organization | |
| Personnel shortages inhibit innovation in this organization. | | FinresR3 | | Personnel shortages inhibit innovation in this organization | |
| This organization gives me free time to pursue creative ideas during the workday. | | FinresR4 | | This organization gives me free time to pursue creative ideas during the work day | |
| RO | Public researchers should focus on producing knowledge with market potential. | | RO1 | | Glenna et al. (2011) | | Developed and verified scales with a sample of academic researchers/faculty across multiple US universities. | Public scientists should focus on producing knowledge with market potential. | |
| Industry should play a central role in influencing public research agendas. | | RO2 | | Industry should play a central role in influencing public research scientists’ agendas. | |
| The market is the most accurate judge of the relative social value of new research. | | RO3 | | The market is the most accurate arbiter of the relative social value of a new technology. | |
| Researcher panels are the most appropriate vehicles for setting the research agendas of public researchers. | | RO4 | | Scientist panels are the most appropriate vehicles for setting the research agendas of public research scientists. | |
| Trained researchers are the most accurate judges of the relative social value of new research. | | RO5 | | Trained scientists are the most accurate arbiters of the relative social value of a new technology. | |
| I believe that academia and industry should be distinct, and I pursue success strictly in the academic arena. | | RO6 | | Lam (2011) | | Developed and verified scale with a sample of researchers across multiple UK universities. | I believe that academia and industry should be distinct and I pursue success strictly in the academic arena | |
| I believe that academia and industry should be distinct, but I pursue industrial links mainly to acquire resources to support academic research. | | RO7 | | I believe that academia and industry should be distinct but I pursue industrial links activities mainly to acquire resources to support academic research | |
| I believe in the fundamental importance of academic-industry collaboration and I pursue industrial links activities for scientific/research advancement. | | RO8\_r | | I believe in the fundamental importance of academic-industry collaboration and I pursue industrial links activities for scientific advancement | |
| I believe in the fundamental importance of academic-industry collaboration and I pursue industrial links for application and commercial exploitation. | | RO9\_r | | I believe in the fundamental importance of academic-industry collaboration and I pursue industrial links activities for application and commercial exploitation | |
| I am interested in fundamental research with a ‘practical angle’. | | RO10 | | Karhunen et al. (2017) | | Developed scales and verified with a sample of high-tech entrepreneurs across Finland and Russia All respondents engaged in academic research during their careers. | Interest in fundamental research with ‘practical angle’ | |
| Solving practical challenges is the main aim of research. | | RO11 | | Solving practical challenges the main aim of research | |
| I view research as ‘just a job’ rather than a calling. | | RO12 | | Research viewed as ‘just a job’ rather than calling | |
| I engage in research to pursue commercial opportunities. | | RO13\_r | | Science as source of commercial opportunities | |
| Based on the following definitions, which of the following best describes you as a researcher? - Collaborator (C): at least 10% UBCPs [university-business co-authored publications] in your scientific publication output.- Inventor (I): at least 1 patent (granted or applied) to your name.- Entrepreneur (E): you have been personally involved in commercialisation of research results in the past five years. | | RO14 | | Tijssen (2018) | | Developed and verified scales with a sample comprising researchers from universities across Europe. | Crossover Collaborator (CC type): those with at least 10% UBCPs [university-business co-authored publications) in their scientific publication output.  Inventors (I type): at least 1 patent (granted or applied) to their name;  Entrepreneurs (E type): researchers who answered affirmative to the survey question Have you been personally involved in commercialisation of research results between 2010-2015?Based on the above definitions, which of the following best describes you as a researcher?  Researcher + Collaborator  Researcher + Inventor  Researcher + Entrepreneur  Researcher + Collaborator + Inventor  Researcher + Collaborator + Entrepreneur  Researcher + Inventor + Entrepreneur  Researcher + Collaborator + Inventor + Entrepreneur | |
| **Demographics** | | | | | | | | | |
| **Variable** | **Question** | **Descriptor** | | **Variable** | | **Question** | | | **Descriptor** |
| Age | What is your age group? | Age | | Gender | | Gender: How do you identify? | | | Gender |
| Qual | What is your highest academic qualification? | Qualification | | Employ | | What is your employment status? | | | Employment status |
| Country | In what country do you work? | Country | | CrStage | | What research career stage are you in ? | | | Career Stage |
| Field | What is your field of research ? | Field | | CrStage | | How many years have you been active as a researcher (following your initial degree qualification)? | | | No. years in career. |
| **Legend** | Item rejected during statistical verification of scales (CFA) | |  | | | | | | |
|  | Red Text signifies where a change from an original construct was made. | |
|  | “\_r” item reverse coded | |

1. Appendix D – Final Survey Version

\* Indicates that a survey item is reverse-coded

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | Qualifying question (“No” response to any question below ends the survey) | | | |
|  | | I agree to participate in the research study. I understand the nature and purpose of this study and I am participating voluntarily. I understand that I can withdraw from this study at any time.  Yes / No | | | |
|  | | I grant permission for the data generated from this survey to be used in the researcher’s publications on this topic, subject to it containing no identifying information about me.  Yes / No | | | |
|  | | Are you an active researcher working in an academic institution?  Yes / No | | | |
| Model items (not shown in survey) | | General information | | | |
| Age | | 20 and under, 21-25, 26-30, 31-35, 36-40, 41-45, 46-50, 51-55, 56-60, 61 and over | | | |
| Level of qualification | | Bachelor’s degree or equivalent  Post-graduate qualification (e.g. Masters)  PhD | | | |
| Duration of research | | Number of years experience as a researcher (following initial Degree qualification) | | | |
| Country of work | | Select from drop down list of country codes | | | |
| Field of Research | | 01 Education  02 Arts and Humanities  03 Social Sciences, Journalism and Information  04 Business, Administration and Law  05 Natural Sciences, Mathematics and Statistics  06 Information and Communication Technologies  07 Engineering, Manufacturing and Construction  08 Agriculture, Forestry, Fisheries and Veterinary  09 Health and Welfare  10 Services  [[Ref: UNESCO.org ICSED]](http://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-fields-of-education-and-training-2013-detailed-field-descriptions-2015-en.pdf) | | | |
| Gender | | Gender: How do you identify?  Woman  Man  Non-Binary  Prefer to self-describe \_\_\_\_\_\_\_\_\_  Prefer not to say | | | |
| Employment status | | Permanent / Tenured  Renewable contract  Temporary | | | |
| Stage of research career | | R1 First/Early-Stage Researcher (up to the point of PhD, primarily carries out research under supervision)  R2 Recognised Researcher (PhD holder (or equivalent level of experience and competence) not yet fully independent)  R3 Established Researchers (researchers who have developed a level of independence and/or reputation based on research excellence)  R4 Leading Researchers (researchers leading their research area or field) | | | |
| Model items (not shown in survey) | | The following statements relate to your sense of personal academic freedom. Please indicate your level of agreement with each statement. | | | |
| AcadFree | I have been free to choose my own research topics within my project(s). | | | Scale 1-7 where:  1=Strongly disagree  2=Disagree  3=Disagree somewhat  4=Neither agree nor disagree  5=Agree somewhat  6=Agree  7=Strongly agree |
| I think project research design is slanted to give results favourable to the project sponsor/funding body. | | |
| I have been free to choose the research tools/methods which I feel are most appropriate for my project(s). | | |
| The sponsor/funding body insists on immediate results or the project(s) won’t get support. | | |
| I have been instructed to write up results or otherwise interpret them in ways I do not agree with. | | |
| There have been no constraints on the free exchange of ideas about my project(s) among students and/or staff in my academic organisation, or in other academic organisations. | | |
| Model items (not shown in survey) | | The following statements relate to the stimulation you feel when undertaking your research. Please indicate your level of agreement with each statement. | | | |
| Stim | If research is not enjoyable, then it is not worth doing. | | | Scale 1-7 where:  1=Strongly disagree  2=Disagree  3=Disagree somewhat  4=Neither agree nor disagree  5=Agree somewhat  6=Agree  7=Strongly agree |
| If choosing between two research jobs, the most important criterion is “which would be more enjoyable?” | | |
| It is important that I work in a research job that allows me to use my skills and talents. | | |
| I like to do research work that challenges me and gives me a sense of personal achievement. | | |
| Model items (not shown in survey) | | The following statements relate to the satisfaction you feel when undertaking your **research**. Please indicate your level of agreement with each statement. | | | |
| Satis | I get a feeling of worthwhile accomplishment from my work | | | Scale 1-7 where:  1=Strongly disagree  2=Disagree  3=Disagree somewhat  4=Neither agree nor disagree  5=Agree somewhat  6=Agree  7=Strongly agree |
| My job is varied and interesting | | |
| My workload is acceptable | | |
| I have a lot of job security | | |
| I receive recognition for a job well done | | |
| I feel close to the people I work with | | |
| I feel good about working at this organisation | | |
| In general, I believe work is good for my physical health | | |
| My wages are in line with industry / academic norms | | |
| All my talents and skills are used at work | | |
| I get along with my supervisors | | |
| Model items (not shown in survey) | | The following statements examine how you perceive risk-taking in your **research work**. Please indicate your level of agreement with each statement. | | | |
| Risk | I am generally a person who is fully prepared to take risks | | | Scale 1-7 where:  1=Strongly disagree  2=Disagree  3=Disagree somewhat  4=Neither agree nor disagree  5=Agree somewhat  6=Agree  7=Strongly agree |
| I am generally a person who tries to avoid taking risks | | |
| I am more oriented toward preventing losses than I am toward achieving gains. | | |
| My major goal in work right now is to avoid becoming an academic/research failure. | | |
| Overall, I am more oriented towards achieving success than preventing failure. | | |
| Model items (not shown in survey) | | The following statements examine your views on the civic/socio-economic/public-good aspects of your research. In the statements below “decision-makers/stakeholders” refers to people outside your research organisation (e.g. policy makers, funding agencies… ) Please indicate your level of agreement with each statement. | | | |
| SoCiv | Engaging with and communicating to decision-makers/stakeholders is important to me personally | | | Scale 1-7 where:  1=Strongly disagree  2=Disagree  3=Disagree somewhat  4=Neither agree nor disagree  5=Agree somewhat  6=Agree  7=Strongly agree |
| Engaging with and communicating to decision-makers/stakeholders/public is more important to me than having high publication citation indices | | |
| I believe that my research is important for decision-makers/stakeholders/public | | |
| As a researcher, I have a responsibility to engage with, and communicate to, decision-makers/stakeholders/public | | |
| I want my organisation to support engagement and communication activities with dedicated time allocations | | |
| I would like funding grants to provide dedicated funding for research dissemination | | |
| I would like to be valued by my employer for engagement and communication activities | | |
| I would like metrics of research impact to include measures of engagement and communication with end-users so that I can prioritise engagement and communication activities on equal footing with publishing | | |
| Model items (not shown in survey) | | The following statements relate to the importance of your personal reputation relative to your research work. Please indicate your level of agreement with each statement. | | | |
| Reput | I feel that my own research activity will result in an increase in my academic reputation as a researcher. | | | Scale 1-7 where:  1=Strongly disagree  2=Disagree  3=Disagree somewhat  4=Neither agree nor disagree  5=Agree somewhat  6=Agree  7=Strongly agree |
| When I have done a good job, it is important to me that my contribution is recognized by others. | | |
| I often make decisions based on what others will think. | | |
| I give my best effort when I know that it will be seen by the most influential people in an organization. | | |
| I work harder on a project if public recognition is attached to it. | | |
| Model items (not shown in survey) | | The following statements relate to the rewards you may gain because of your research work. Please indicate your level of agreement with each statement. | | | |
| Rwrd | The best aspects of any job are the financial rewards and associated financial benefits. | | | Scale 1-7 where:  1=Strongly disagree  2=Disagree  3=Disagree somewhat  4=Neither agree nor disagree  5=Agree somewhat  6=Agree  7=Strongly agree |
| I only work for the financial reward that it provides me. | | |
| I would readily leave any job if I were offered an alternative that pays more. | | |
| People should always be on the lookout for better-paid jobs. | | |
| Model items (not shown in survey) | | The following statements relate to the possibility of promotion/tenure resulting from your research work. Please indicate your level of agreement with each statement. | | | |
| RwrdPT | The possibility of promotion / tenure is a major driver of my research work | | | Scale 1-7 where:  1=Strongly disagree  2=Disagree  3=Disagree somewhat  4=Neither agree nor disagree  5=Agree somewhat  6=Agree  7=Strongly agree |
| My major goal [in work] right now is to achieve my academic ambitions | | |
| I am more likely to be considered for promotions if I engage in knowledge transfer activities | | |
| Model items (not shown in survey) | | The following statements relate to the research-related institutional policies and supports in your workplace. Please indicate your level of agreement with the following statements. | | | |
| PolKTT | The inventor royalty share (the share of any royalty payment, resulting from my research outputs, given to the researcher) in my institution has a strong influence on my decision to generate patentable inventions. | | | Scale 1-7 where:  7=Strongly disagree  6=Disagree  5=Disagree somewhat  4=Neither agree nor disagree  3=Agree somewhat  2=Agree  1=Strongly agree |
| My department has provided sufficient assistance and incentives for faculty to engage in industry-university cooperative research | | |
| My department has provided sufficient assistance and incentive for faculty to engage in KTT (Knowledge and Technology Transfer) | | |
| The importance of knowledge and technology transfer is clearly communicated | | |
| PolComm | My department has sufficient assistance and incentives for faculty to apply and protect intellectual property rights (e.g. patenting support). | | |
| My department has provided sufficient assistance and incentives for faculty to engage in creating spin-offs. | | |
| There is adequate time available to pursue creative ideas here | | |
| My organisation actively promotes entrepreneurial activities | | |
| My organisation arranges conferences /workshops on entrepreneurship. | | |
| PolRes | My department highly regards demonstrating domestic and world research excellence | | |
| My department provides excellent facilities and infrastructure for research. | | |
| My department provides extra incentives for publication. | | |
| My university arranges conferences /workshops on research excellence. | | |
| PolTTO | The Technology Transfer Office (TTO) at my organisation provides high quality service to researchers. | | |
| The TTO at my organisation is very active in identifying patentable research. | | |
| \*The TTO at my organisation is only interested in certain fields or disciplines especially those that have generated royalties. | | |
| The TTO at my organisation has sufficient scientific and technological knowledge. | | |
| Model items (not shown in survey) | | The following statements examine social capital in your research workplace. Please indicate your level of agreement with the following statements. | | | |
| SoCapR | I can trust that others will help me if necessary | | | Scale 1-7 where:  1=Strongly disagree  2=Disagree  3=Disagree somewhat  4=Neither agree nor disagree  5=Agree somewhat  6=Agree  7=Strongly agree |
| My colleagues and I try to help each other if we have any difficulty | | |
| I enjoy a good interpersonal climate | | |
| I share the same ambitions and visions as my colleagues in the research work | | |
| I am excited to achieve the goals and mission of my research colleagues/project team | | |
| SoCapC | I hold regular meetings to advance my team’s research activity | | |  |
| I share our advances in research | | |
| I seek out, and capitalise on, research synergies | | |
| I exchange ideas with many professionals outside our institution | | |
| I exchange ideas with many colleagues outside my project team | | |
| Model items (not shown in survey) | | The following question determines the nature of your research organisation and the strength of its links with related industries.. | | | |
| PhyEnv | Please place your research organisation on the following scale | | | Scale 1-3 with anchor points being:  1=Traditional University  2=University with industry linkages  3=Research Campus co-located with industry |
| The level of industry concentration in the geographic vicinity of my research organisation is | | | Scale 1-7 where:  1=Very low  2=Low  3=Somewhat low  4=Neither high nor low  5=Somewhat high  6=High  7=Very high |
| Model items (not shown in survey) | | The following statements relate to the financial resources available to researchers in your workplace. | | | |
| FinRes | Please estimate the level of baseline () or philanthropic research funding you receive (e.g. funding, not tied to a particular project, to be used at a researcher’s discretion, gift funding, scholarship…) | | | Scale 1-7 where:  1=None  2=Low  3=Somewhat low  4=Neither high nor low  5=Somewhat high  6=High  7=Very high |
| Please estimate the level of research grant funding you receive | | |
|  | Please estimate the level of consultancy/contract funding you receive | | |
|  | There are adequate resources devoted to research and innovation in my organization. | | | Scale 1-7 where:  1=Strongly disagree  2=Disagree  3=Disagree somewhat  4=Neither agree nor disagree  5=Agree somewhat  6=Agree  7=Strongly agree |
| \*Lack of funding to investigate creative ideas is a problem in this organization | | |
| \*Personnel shortages inhibit innovation in this organization | | |
| This organization gives me free time to pursue creative ideas during the workday | | |
| Model items (not shown in survey) | | In these final questions, think about the nature of the research work you undertake.  Please indicate your level of agreement with the following statements. | | | |
| RO | Public researchers should focus on producing knowledge with market potential. | | | Scale 1-7 where:  1=Strongly disagree  2=Disagree  3=Disagree somewhat  4=Neither agree nor disagree  5=Agree somewhat  6=Agree  7=Strongly agree |
| Industry should play a central role in influencing public research agendas. | | |
| The market is the most accurate judge of the relative social value of new research | | |
| Researcher panels are the most appropriate vehicles for setting the research agendas of public researchers. | | |
| Trained researchers are the most accurate judges of the relative social value of new research. | | |
| I believe that academia and industry should be distinct, and I pursue success strictly in the academic arena | | |
| I believe that academia and industry should be distinct, but I pursue industrial links activities mainly to acquire resources to support academic research | | |
| I believe in the fundamental importance of academic-industry collaboration and I pursue industrial links activities for scientific/research advancement | | |
| I believe in the fundamental importance of academic-industry collaboration and I pursue industrial links activities for application and commercial exploitation | | |
| I am interested in fundamental research with a ‘practical angle’ | | |
| Solving practical challenges is the main aim of research | | |
| I view research as ‘just a job’ rather than a calling | | |
| I engage in research to pursue commercial opportunities | | |
| Based on the following definitions, which of the following best describes you as a researcher?   * Collaborator (C): at least 10% UBCPs [university-business co-authored publications] in your scientific publication output. * Inventor (I): at least 1 patent (granted or applied) to your name. * Entrepreneur (E): you have been personally involved in commercialisation of research results in the past five years. | | 0=Researcher  1=Researcher + Collaborator  2=Researcher + Inventor  3=Researcher + Entrepreneur  4=Researcher + Collaborator + Inventor  5=Researcher + Collaborator + Entrepreneur  6=Researcher + Inventor + Entrepreneur  7=Researcher + Collaborator + Inventor + Entrepreneur | |

1. Appendix E – Statistical Analysis
   1. Supplementary Information

All detailed statistical analysis outputs related to this research are provided in a separate document “KDoolin EdD 2024 – Supplementary Information” which can be accessed at: <https://tinyurl.com/KD-EDD2024-SuppInfo> .

This includes item communalities, means and reliability analysis for each construct deployed, generated pattern matrix, regression analysis outputs, moderation analysis outputs, construct means and standard deviations, PROCESS software outputs (for generation of interaction charts), and regression analysis to compare individual motivations.

1. Appendix F - Demographics

Figure 28 *Respondents' age profile*

Chart, bar chart

Description automatically generated

Figure 29   
*Respondents' gender profile*

Chart, pie chart

Description automatically generated

Figure 30   
*Respondents' qualification profile*

Chart

Description automatically generated

Figure 31 *Respondents' employment status*

Chart, bar chart

Description automatically generated

Figure 32 *Respondents' career stage*

Chart, bar chart

Description automatically generated

Figure 33   
Respondents' years as active researchers

Chart, bar chart

Description automatically generated

Figure 34 *Respondents' research fields*

Chart, bar chart

Description automatically generated

Figure 35   
*Respondents' host institution type*

Chart, bar chart

Description automatically generated

Figure 36   
Respondents' geographic locations (map)

Map

Description automatically generated

Figure 37   
Respondents' geographic locations (chart)

Chart

Description automatically generated

Figure 38 *Respondents' self-classification*

Chart

Description automatically generated with medium confidence

1. Appendix G - Ethical Approval

The following sections present the ethical information submitted to, and subsequent approval from, the University of Sheffield Ethics Committee. Note, the project title and description refer to the focus (career trajectories) of the original version of this thesis. As there was no necessity to gather new information in the revision of this work, additional ethical approval was not needed.

* 1. Participant Information Sheet

**Participant Information Sheet**

**Research Project Title**

Examining the Motivational Drivers that Influence Research Career trajectories (working title)

**Invitation**

You are being invited to take part in this research project. Before you decide to do so, it is important you understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please contact me (Kevin Doolin, [edp08kd@sheffield.ac.uk](mailto:edp08kd@sheffield.ac.uk) / [Kevin.Doolin@WaltonInstitute.ie](mailto:Kevin.Doolin@WaltonInstitute.ie)) if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

**What is the purpose of this project?**

I am currently undertaking research as part of the Doctor of Education Programme within University of Sheffield. The aim of my research is to examine the influences (drivers and barriers) on researcher career trajectories. These influences can come from many sources, such as working environment, peer/management support, personal goals, academic status, tenure, and social capital. My main objective is to develop a model that will provide an in-depth understanding on the interplay between the influences, and their relative impact on research trajectory (i.e. the inclination of a researcher to focus on basic, applied, commercial research or a combination of same).

**Why have I been chosen?**

You have been chosen because you are an active ICT researcher, and as such you have experience of the academic research environment.

**Do I have to take part?**

No, that decision is fully in your hands. If you do decide to take part you will be able to keep a copy of this information sheet and you should indicate your agreement to the online consent form. You can withdraw at any time. You do not have to give a reason.

**What will happen to me if I take part?**

You will be asked to complete a web-based questionnaire which I estimate will take you 15-20 minutes.

**What do I have to do?**

Please answer the questions in the questionnaire. There are no other commitments or lifestyle restrictions associated with participating.

**What are the possible disadvantages and risks of taking part?** Participating in the research is not anticipated to cause you any disadvantages or discomfort. However, if you are not comfortable answering any of the survey questions, you can exit at any time.

**What are the possible benefits of taking part?**

Whilst there are no immediate benefits for those people participating in the project, it is hoped that this work will contribute to the body of knowledge associated with researcher career development and will inform future researchers, host organisations and policy makers.

**Will my taking part in this project be kept confidential?**

All the information that I collect during the course of the research will be kept strictly anonymous and confidential. You will not be able to be identified or identifiable in any reports or publications. You will not be asked to provide your name, contact details or host institution. Any data collected in the online questionnaire will be anonymously stored offline in a database protected by passwords and other relevant security processes and technologies.

Anonymous data collected may be shared to allow reuse by other researchers.

**What is the legal basis for processing my personal data?**

The survey used for this project does not capture any personal identifying information.

**Who is the data controller?**

The University of Sheffield is the Data Controller for this research. This means that the University is responsible for looking after your information and using it properly.

**Will I be recorded, and how will the recorded media be used?**

You will not be recorded in any way other than your input to the questionnaire.

**What happens if the research study stops earlier than expected?**

Should the research stop earlier than planned it will have no impact on you personally.

**What if something goes wrong?**

In the event that a participant wishes to raise a complaint in the first instance please contact:

Doctoral researcher: Kevin Doolin [edp08kd@sheffield.ac.uk](mailto:edp08kd@sheffield.ac.uk)

Thesis supervisor: Dr Vassiliki Papatsiba at [v.papatsiba@sheffield.ac.uk](mailto:v.papatsiba@sheffield.ac.uk)

In the event that you are not satisfied with how the complaint has been handled, please contact the Head of School, Professor Rebecca Lawthom at r.lawthom@sheffield.ac.uk

Further, if you feel your complaint has not been handled to your satisfaction you can contact the University of Sheffield’s Registrar and Secretary to take your complaint further.

If your complaint relates to how your personal data has been handled, information about how to raise a complaint can be found in the University’s Privacy Notice: https://www.sheffield.ac.uk/govern/data-protection/privacy/general   
The handling of personal data is controlled by the General Data Protection Regulation (GDPR) and associated legislation.

**What type of information will be sought from me and why is the collection of this information relevant for achieving the research project’s objectives?**

The questionnaire will ask you about your opinions related to a range of areas related to researcher careers, motivations and supports, including questions on topics such as:

* Desire for intellectual stimulation / challenge
* Sense of achievement / satisfaction
* Perceived sense of scientific freedom / independence
* Rewards associated with research
  + Financial
  + Reputational
  + Network building
  + Promotion
* Desire to collaborate with others
* Desire to engage with industry
* Desire to do “good science”
* Risk aversion / fear of failure
* Demographic details (age, gender, education level)
* Organisational factors
  + Policies and supports
  + Social Capital
  + Education / training
  + Physical environment
  + Financial supports and resources

Responses to these questions will enable me to execute an analytical model that will demonstrate how these topics relate to each other and to a researcher’s career trajectory.

**What will happen to the results of the research project?**

Results of the research will form the analytical element of my overall research thesis. Ideally, results of this analysis will be published in academic journals. You will not be identified in any report or publication. If you wish to be given a copy of any reports resulting from the research, please contact me directly.

**Who is organising and funding the research?**

This research is being undertaken as part of my Doctor of Education (EdD) within University of Sheffield, apart from fees associated with this doctoral programme, it is not a funded research project.

**Who has ethically reviewed the project?**

This project has been ethically approved via the University of Sheffield’s Research Ethics Review Procedure, as administered by the School of Education.

**Contacts for further information**

Doctoral researcher: Kevin Doolin, Netlabs, Waterford Institute of Technology, Carriganore Co. Waterford, Ireland. Tel: +353 (86) 1527691. Email: [edp08kd@sheffield.ac.uk](mailto:edp08kd@sheffield.ac.uk) / [kevin.doolin@WaltonInstitute.ie](mailto:kevin.doolin@WaltonInstitute.ie) .

Thesis Supervisor: Dr Vassiliki Papatsiba at [v.papatsiba@sheffield.ac.uk](mailto:v.papatsiba@sheffield.ac.uk)

I would like to take this opportunity to thank you for taking part in this research.

* 1. University of Sheffield – Ethics Application Form

The following document replicates the questions specified in Uni Sheffield’s online Ethics application system.

**Applicant Details**

(This is pre-populated with my student number etc)

Does your application need to be reviewed by a department that is not you home department?

* No

Title of Research Project

* Examining the motivational drivers that influence research career trajectories (working title)

Has your research project undergone academic review, in accordance with the appropriate process?

* Yes

Programme Name

* Higher Education (EdD/Higher Education (DL) 4-8yr)

Module Name

* EDUR17

**Basic Information**

Primary Supervisor

* Vassiliki Papatsiba

Project duration

* 01 March 2021 – 1 June 2021

**Suitability** – please indicate if your research:

Is taking place outside the UK – Yes

Is being led by another institution – No

Involves the NHS – No

Involved human tissue – No

Research is a health and/or social care human interventional study – No

Is a clinical trial … - No

Is ESRC funded – No

Research involved social care services provided by a local authority… - No

Is likely to lead to publication in a peer-reviewed journal – Yes

Involves adults who lack the capacity to consent – No

Is social care research requiring review by the Uni Research Ethics Procedure – No

Involves research on groups that are… terrorist groups – No

**Indications of Risk**

Involves potentially vulnerable participants – No

Involves highly sensitive topics – No

Summary of Research

**Aims and Objectives**

The aim of my research is to examine the influences (drivers and barriers) on researcher career trajectories. These influences can come from many sources, such as working environment, peer/management support, personal goals, academic status, tenure, human capital. My main objective is to model the interplay between these influences, and their relative impact on research trajectory (i.e. the inclination of a researcher to focus on basic, applied, commercial research or a combination of same).

**Methodology**

I have developed a survey instrument which captures the constructs to be used within my statistical model- attached with this application. The constructs will come from already verified/tested sources within the literature. The survey will be administered online (and promoted via email and social media) using a standard survey tool such as Surveymonkey.

The survey will cover a range of areas related to researcher careers, motivations and supports, including questions on topics such as:

* Desire for intellectual stimulation / challenge
* Sense of achievement / satisfaction
* Perceived sense of scientific freedom / independence
* Rewards associated with research
  + Financial
  + Reputational
  + Network building
  + Promotion
* Desire to collaborate with others
* Desire to engage with industry
* Desire to do “good science”
* Risk aversion / fear of failure
* Demographic details (age, gender, education level)
* Organisational factors
  + Policies and supports
  + Social Capital
  + Education / training
  + Physical environment
  + Financial supports and resources

Each questionnaire item will require responses on a 7-point Likert Scale, ranging from “Strongly Disagree” to “Strongly Agree”

Survey items have been provided in the appendix uploaded with this application.

When data is gathered I will use IBM SPSS AMOS to carry out my analysis. The analysis method will be Structured Equation Modelling. Model results will be presented in standard statistical format.

**Risk to Researchers**

Does your research raise any issues of personal safety… - No

Have you completed your department risk assessment procedures, if necessary?... Not applicable

**About the participants**

How will you identify potential participants

Participants will be active researchers in the field of Information and Communication Technology. I will identify suitable respondents primarily through my own substantial professional network (2000+ contacts).

**How will participants be contacted, what information will they be given, how will they indicate their initial interest in becoming involved.**

I will initially contact participants through LinkedIn messaging and personal email addresses. If this does not provide the sample size needed for my analysis (circa 350 respondents) I will circulate a call for participants on social media (and I will ask my contacts to do similar).

The online survey will contain a link to the participant information sheet (copy attached with this application). The survey will begin with consent related questions.

Should a direct email invitation be required, the invitation email/message will appear as follows:

Dear X

I am currently undertaking research as part of the Doctor of Education Programme within University of Sheffield. The aim of my research is to examine the influences (drivers and barriers) on researcher career trajectories. These influences can come from many sources, such as working environment, peer/management support, personal goals, academic status, tenure, social capital. My main objective is to develop a model that will provide an in-depth understanding on the interplay between the influences, and their relative impact on research trajectory (i.e. the inclination of a researcher to focus on basic, applied, commercial research or a combination of same). Please see the Participant Information sheet (attached) for more details.

To do this I have developed an online questionnaire which you can access through the following link (LINK to survey will go here). I am contacting you because you are an active researcher in the ICT space. If you could take the time to complete the survey I would very much appreciate it.

Please note that I do not require any personal identifying information as part of this survey, and as such all responses will be fully anonymous. A copy of the final analysis results can be made available to you if you contact me directly.

Your support in this initiative would be very much appreciated.

Regards,

Kevin Doolin

**Consent**

Will informed consent be obtained from the participants? – Yes

How do you plan to obtain informed consent – The survey instrument will contain a repeat of the details outlined in the participant information sheet and will ask consent-related questions prior to the survey-proper, as follows:

1. I agree to participate in the research study. In understand the nature and purpose of this study and I am participating voluntarily. I understand that I can withdraw from this study at any time.

Yes / No

Note: If a participant does not complete the entire survey, their data will be deleted.

1. I grant permission for the data generated from this survey to be used in the researcher’s publications on this topic, subject to it containing no identifying information about me.

Yes / No

If the respondent answers No to either question, the survey will end.

**Payment**

Not applicable (I am not providing financial incentives for participation)

**Potential Harm to Participants**

Participation in this study will not cause physical or psychological harm to participants. However, there is a possibility that answering the questions may bring up difficult or sensitive themes or experiences. If participants are not happy to complete the survey they can exit at any time.

**Data Processing**

Will you be processing personal data as part of this project? No

Please outline how your data will be managed and stored securely, in line with good practice…

Data will initially be captured via SurveyMonkey. None of the survey questions will ask for information which could potentially lead to the identification of an individual. In addition to responses about the main survey instrument, the questionnaire will capture basic demographic information (age, gender, level of education, country). SurveyMonkey will be set to “Anonymous Responses” meaning it will not capture the IP Address of respondents’ computers. When the survey has received enough respondents, data will be exported from SurveyMonkey and will be stored locally in a password protected excel file on a laptop for processing. At this point data stored in SurveyMonkey will be deleted. If any respondent withdraws from the survey (resulting in an incomplete survey) their data will be deleted and not used in the statistical analysis.

* 2. University of Sheffield – Ethics Approval

Graphical user interface, text, application

Description automatically generated

1. Appendix H – Non-respondent Analysis

Table 41 *Survey dropout rates*

|  |  |  |  |
| --- | --- | --- | --- |
| **Survey stage** | **Number of dropouts** | **% of non complete surveys** | **% of survey completed** |
| Screening questions | 101 | 66.9 | 2.8 |
| Demographics | 25 | 16.6 | 10.3 |
| Academic Freedom | 11 | 7.3 | 15.0 |
| Stimulation | 1 | 0.7 | 18.7 |
| Satisfaction / Risk Aversion | 5 | 3.3 | 33.6 |
| Social/Civic Responsibility | 2 | 1.3 | 41.1 |
| Reputation/Reward/Promotion & Tenure | 2 | 1.3 | 52.3 |
| Policies/Supports/TTO | 2 | 1.3 | 69.2 |
| Social Capital | 1 | 0.7 | 78.5 |
| Environment | 1 | 0.7 | 79.4 |
| Finance/Resources &  Research Orientation | 0 | 0.0 | 79.4 |

Figure 39   
*Graph of survey dropout rates*



Figure 40   
*Non-respondent Country Comparison*



Figure 41 *Sample Gender Comparison*



Figure 42 *Sample Field Comparison*



Figure 43   
*Sample Academic Qualification Comparison*



Figure 44 *Sample Career Stage Comparison*



Table 42 *Dropouts After Demographics*

****

Table 43   
*Dropouts After Academic Freedom*

****

Table 44 *Dropouts After Stimulation*

****

Table 45 *Dropouts After Risk Aversion*

****

Table 46   
*Total Dropouts After Social/Civic Responsibility*

****

Table 47   
*Dropouts After Promotion/Tenure*

****

Table 48 *Dropouts After Social Capital*

****

Table 49 *Dropouts After Environment*

****

1. Appendix I – Defining the researcher

The table below presents a brief synopsis of the many ways an individual undertaking research activities, in the context of an academic institution (as defined above), has been identified across the literature. In each case the various terms that have been employed are listed, as well as the focus/context of research, and description of research sample used.

Table 50   
*Varying definitions of the researcher*

| **Reference** | **Term(s) used** | **Research focus** | **Research context** |
| --- | --- | --- | --- |
| Ryan (2011, 2014); Ryan and Berbegal-Mirabent (2016) | Research Scientist / Research Personnel | Motivational drivers. | Research sample specifies “research scientists working in biological, chemical and biomedical research departments in UK universities” (Ryan, 2014).  “… sample of scientists…” (Ryan & Berbegal-Mirabent, 2016) |
| Davey et al. (2016) | Academics | Entrepreneurial intentions. | Survey sent to “rectors and managers (e.g. TTOs) of HEIs in 33 countries in Europe” (Davey et al., 2016). |
| Olaya Escobar et al. (2017) | Researchers / academics | Willingness to engage in technology transfer activities. | Survey was sent to “all faculty working at University Politecnica de Catalunya” (Olaya Escobar et al., 2017). |
| Lam (2011) | Academic scientists / scientists / academic researchers / university scientists | Motivations to engage in commercialisation. | Sample was “735 academic scientists from five leading UK universities” (Lam, 2011). |
| Jindal‐Snape and Snape (2006) | Scientists | General researcher motivations. | Sample was drawn from researchers working in “government research institutes” |
| Thursby et al. (2007) | Faculty / academic researchers / researcher | Effects of licensing on academic research. | Sample was drawn from “faculty” across multiple universities. |
| Glenna et al. (2011) | Faculty / academic scientists / scientists | Researchers’ values and commercial science. | Sampled “academic principal and co-principal investigators”. |
| Goel and Göktepe-Hultén (2018) | Academic patentees / researcher / university researcher / | Factors that drive academic patentees to bypass TTOs. | Survey was sent to researchers at Max Planck Institutes in Germany (public research organisation). |
| Link et al. (2017) | Academics / faculty members / academic scientists | Propensity of academics to engage in informal university technology transfer. | Sample comprised “academic researchers, university scientists and engineers” with a Ph.D. across multiple US universities. |
| Iglič et al. (2017) | Researchers / scientists / academic researchers | Examining why researchers collaborate and with whom. | Survey was sent to researchers from multiple scientific disciplines, in Slovenian universities. |
| Gerbin and Drnovsek (2016) | Academic researchers / researchers / faculty | Knowledge transfer in life sciences. | Literature review-based research. |
| Chang et al. (2016) | Faculty / academic researchers / researchers / early stage researchers / star researchers | Investigation of research ambidexterity in entrepreneurial universities. | Survey distributed to faulty members across multiple disciplines in six universities. |
| Würmseher (2017) | Academic scientist / scientist / academic researchers / researchers | Examining scientists’ needs relative to entrepreneurial models. | Interviews conducted with a sample of university professors. |
| Johnson et al. (2016) | University academics | Examining drivers behind researchers entrepreneurial intentions. | Sample comprised STEM academics across Scottish universities. |
| Wróblewska et al. (2023) | Early career researchers (ECRs) / young scholars | Examining how impact influences ECRs as they plan their future in academia. | ECR participants were sampled through the ENRESSH network, and through personal and professional networks across Europe. |
| Watermeyer et al. (2022) | Academic Researchers / Researchers / Early Career Researchers | Examining the impact of the research excellence framework on academic managers. | Sample comprised departmental research directors and REF2021 Leads from UK universities. |
| Stuart and Ding (2006) | University-employed life scientists / academic scientists / researcher / scholars | Examining antecedents to researchers’ entrepreneurial behaviour. | Sample comprised researchers at varying tenure stages. |
| Hayter and Feeney (2017) | University scientists / faculty / academic scientists / academic researchers | Investigating patenting behaviour among university scientists. | Sample comprised researchers who had/didn’t have patents registered in a particular year. |
| Huyghe et al. (2016) | Researchers / university researchers | Investigated whether researchers are bypassing TTO offices. | Research included interviews with TTOs and researchers from 24 European universities. |
| Aldridge and Audretsch (2017) | Scientists / university scientists | Investigating the impact of the Bayh-Dole Act on researcher entrepreneurship. | Research conducted with a sample of researchers located within US universities. |

1. Appendix J - Moderation Analysis – Interaction Plots
   1. Age moderating the Intrinsic/Extrinsic – RO relationship

Figure 45   
*Moderator: Age; Relationship: Intrinsic-RO*

A graph with lines and arrows

Description automatically generated with medium confidence

Figure 46   
*Moderator: Age; Relationship: Extrinsic-RO*

A graph of a relationship

Description automatically generated with medium confidence

* 1. Gender moderating the Intrinsic/Extrinsic – RO relationship

Figure 47   
*Moderator: Gender; Relationship: Intrinsic-RO*

A graph with blue and green lines

Description automatically generated

Figure 48   
*Moderator: Gender; Relationship: Extrinsic-RO*

A graph with green and blue lines

Description automatically generated

* 1. SocapC moderating the Intrinsic/Extrinsic – RO relationship

Figure 49   
*Moderator: SocapC; Relationship: Intrinsic-RO*

A graph with lines and arrows

Description automatically generated with medium confidence

Figure 50   
*Moderator: SocapC; Relationship: Extrinsic-RO*

A graph with lines and arrows

Description automatically generated with medium confidence

* 1. Field moderating the Intrinsic/Extrinsic – RO relationship

Figure 51   
*Moderator: Field; Relationship: Intrinsic-RO*

A graph with different colored lines and arrows

Description automatically generated

Figure 52   
*Moderator: Field; Relationship: Extrinsic-RO*

A graph with different colored lines and arrows

Description automatically generated

* 1. PKTT/PTTO moderating the Intrinsic/Extrinsic – RO relationship

Figure 53   
*Moderator: PKTT; Relationship: Intrinsic-RO*

A graph of a graph with arrows

Description automatically generated with medium confidence

Figure 54   
*Moderator: PKTT; Relationship: Extrinsic-RO*

A graph with red and blue lines

Description automatically generated

Figure 55   
*Moderator: PTTO; Relationship: Intrinsic-RO*

A graph with blue and red lines

Description automatically generated with medium confidence

Figure 56   
*Moderator: PTTO; Relationship: Extrinsic-RO*

A graph with lines and dots

Description automatically generated with medium confidence

* 1. Finres moderating the Intrinsic/Extrinsic – RO relationship

Figure 57   
*Moderator: Finres; Relationship: Intrinsic-RO*

A graph with lines and arrows

Description automatically generated

Figure 58   
*Moderator: Finres; Relationship: Extrinsic-RO*

A graph with lines and arrows

Description automatically generated

* 1. PhyEnv moderating the Intrinsic/Extrinsic – RO relationship

Figure 59   
*Moderator: PhyEnv; Relationship: Intrinsic-RO*

A graph with different colored lines

Description automatically generated

Figure 60   
*Moderator: PhyEnv; Relationship: Extrinsic-RO*

A graph with different colored lines

Description automatically generated

1. Appendix K – Literature Review Search Query Example

Table 51 *Sample literature search query*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ~academ\* | AND | ~knowl\* | AND | ~drive\* |
| OR |  | OR |  | OR |
| ~universit\* |  | ~basic |  | ~motiv\* |
| OR |  | OR |  | OR |
| ~institu\* |  | ~applied\* |  | ~perform\* |
| OR |  | OR |  | OR |
| ~cent\* |  | ~commerc\* |  | ~eval\* |
|  |  | OR |  | OR |
|  |  | ~valori\* |  | ~system\* |
|  |  | OR |  | OR |
|  |  | ~innovat\* |  | ~barrier\* |
|  |  | OR |  | OR |
|  |  | ~fundam\* |  | ~obstacle\* |
|  |  |  |  | OR |
|  |  |  |  | ~cult\* |
|  |  |  |  |  |
|  |  |  | AND | ~impact\* |
|  |  |  |  | OR |
|  |  |  |  | ~output\* |
|  |  |  |  | OR |
|  |  |  |  | ~techno\* |
|  |  |  |  | OR |
|  |  |  |  | ~TTO |
| **Note(s):** For example: academ\* captures academia, academic, academy, academically; universit\* captures university, universities; institu\* captures institute, institution, institutional; cent\* captures center, centre, central. | | | | |

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